BUILD 60-WATT GUITAR AMPLIFIER

# POPULAR ELECTRONICS

APRIL 1968

50 CENTS

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- Programmed Instruction—New Study Technique
- Twenty Questions on Getting an FCC License

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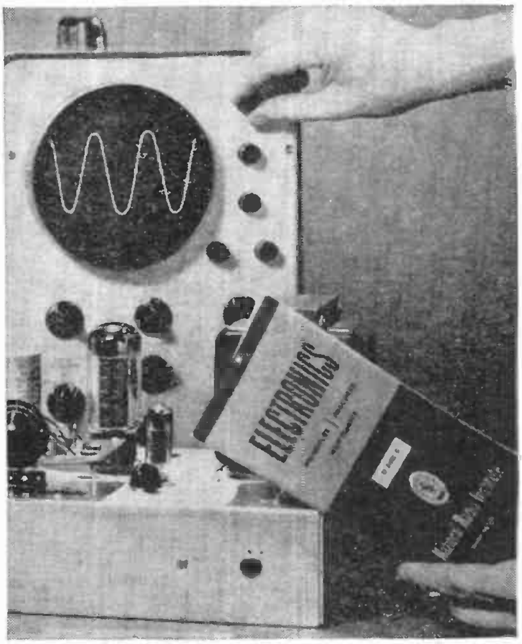

# POPULAR ELECTRONICS

VOLUME 28 NUMBER 4 APRIL, 1968

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE


## CAREERS IN ELECTRONICS



## SPECIAL CONSTRUCTION PROJECT



## FEATURE ARTICLES



## DEPARTMENTS




POPULAR ELECTRONICS is Indexed in the Readers' Guide to Periodical Literature

This month's cover photo by Bruce Pendleton





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# letters
## FROM OUR READERS

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### TO THE RESCUE

May I be of service to you and your readers? I am in a position to supply certain specialized components used in your feature projects. At present, this is a part-time venture for me. I can supply only units manufactured by Fairchild Semiconductor and Motorola. I am able to process orders promptly, accurately, and—most important—at the lowest possible price since I have a very low overhead. I can also supply technical information and specification sheets.

ROBERT A. GLASSMAN
20 Hampton Rd.
Massapequa, N.Y. 11758

*Now there should be no reason why our readers cannot obtain so-called "hard-to-get" Fairchild and Motorola parts. So, if your local distributor disappoints you, don't write to us —write to Bob Glassman.*

### TRANSCEIVER PROBLEM

I don't feel that Charles Schauers was of much help to the person who had a problem with his Hammarlund CB-23 transceiver ("Information Central," February, 1968). [As indicated on a wattmeter, the transmitter was putting out 3 watts, but it could not be heard on a walkie-talkie only 50 feet away nor at a base station five blocks away.] With a short across the output terminals of a normally operating 3-watt transmitter, you would be able to receive the signal on a walkie-talkie 50 feet away. Since the wattmeter registered 3 watts, either one of the crystals in the synthesizer circuit was not operating, or the synthesizer coils in one of the oscillators were improperly adjusted.

In a case like this, I would suggest that a qualified, licensed technician use a VTVM on the input grid of each oscillator stage and tune the tank coils for maximum negative voltage. If one oscillator did not register a bias voltage when tuned, that stage would be inoperative. The technician could then make frequency measurements and corrections as needed.

F. LEE HOOD
Lansing, Mich.

*The question is: was the antenna connected when the power output was measured with*

## LETTERS (Continued from page 8)

*an in-line wattmeter? If this was the case, there could not be a short in the transmitter output circuit. Conversely, if the reading was taken with the antenna and transmission line disconnected from the transmitter, an output indication on the wattmeter could mean that the transmitter was operating correctly and there was a short in the antenna circuit, or that the transmitter was off frequency and there might or might not be a short in the antenna circuit.*

*You are probably correct about a short across the output terminals radiating enough power for a walkie-talkie 50 feet away to pick up a signal. But if we assume that a shorted coaxial cable was used, there would be so little power radiated that a signal might not be heard even 10 feet away.*

### "APRIL FOOL" IN FEBRUARY?

Am I biting on something I should be laughing off? I refer to the "Resistor Standards" article (February, 1968). How in the world did resistor value tolerances suddenly become involved in such things as the twelfth root of ten? It would be much simpler if I could buy a 10% tolerance, 3300-ohm carbon resistor and expect a deviation in value of no more than 330 ohms either way. In fact, this has always been the case in my experience. And the deviation has been even less with wire-wound resistors—which the article claims should give more trouble. Maybe the article was meant for your April issue—as an "April Fool" joke?

JOHN F. BRENNAN
Philadelphia, Pa.

In the article on "Resistor Standards," there seems to be some confusion about the meanings of resistor "tolerance" and "preferred" resistor values. The computation factors referred to in the article are used for determining preferred numbers for nominal resistance values—not the minimum and maximum excursions around a nominal. A series of values (based on the 6th, 12th, and 24th roots of $10^n$) has been adopted for carbon composition resistors to determine the progression of preferred values of 20%, 10%, and 5% tolerance resistors. The value of "n" can be a positive or negative integer. Therefore, each preferred value differs from its predecessor by a multiplier with the result conveniently rounded off to two significant figures.

The tolerance of a resistor is the maximum allowable deviation for nominal resistor values. Thus, ±10% of a specific value means exactly that. So the 3300-ohm carbon composition resistor given as an example in the article would measure between 2970 and 3630 ohms for a stated tolerance of ±10%.

The preferred, or standard, value of 3300 ohms was arrived at by using the 12th root of $10^{42}$ (equal to 3160 ohms); by convention, this figure has been raised to 3300 ohms for the

(Continued on page 95)

# Now There Are 3 Heathkit® Color TV's

## The NEW Deluxe Heathkit "227" Color TV

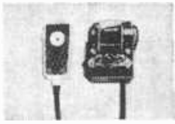
Exclusive Heathkit Self-Servicing Features. Like the famous Heathkit "295" and "180" color TV's, the new Heathkit "227" features a built-in dot generator plus full color photos and simple instructions so *you* can set-up, converge and maintain the best color pictures at all times. Add to this the detailed trouble-shooting charts in the manual, and you put an end to costly TV service calls for periodic picture convergence and minor repairs. No other brand of color TV has this money-saving self-servicing feature.

Advanced Features. Top quality American brand color tube . . . 227 sq. in. rectangular viewing area . . . 24,000 v. regulated picture power . . . improved phosphors for brilliant, livelier colors . . . new improved low voltage power supply with boosted B+ for best operation . . . automatic degaussing . . . exclusive Heath Magna-Shield to protect against stray magnetic fields and maintain color purity . . . ACC and AGC to reduce color fade and insure steady, flutter-free pictures under all conditions . . . preassembled & aligned IF with 3 stages instead of the usual 2 . . . preassembled & aligned 2-speed transistor UHF tuner . . . deluxe VHF turret tuner with "memory" fine tuning . . . 300 & 75 ohm VHF antenna inputs . . . two hi-fi sound outputs . . . 4" x 6" 8 ohm speaker . . . choice of installation — wall, custom or optional Heath factory assembled cabinets. Build in 25 hours.

**Kit GR-227,** (everything except cabinet)
. . . $42 dn., as low as $25 mo. . . . . . . . . . . **$419.95**
**GRA-227-1,** Walnut cabinet . . . no money dn., $6 mo. . . . . . . . **$59.95**
**GRA-227-2,** Mediterranean Oak cabinet (shown above),
. . . no money dn., $10 mo. . . . . . . . . . . **$94.50**

Kit GR-227
**$419.95**
(less cabinet)
$25 mo.

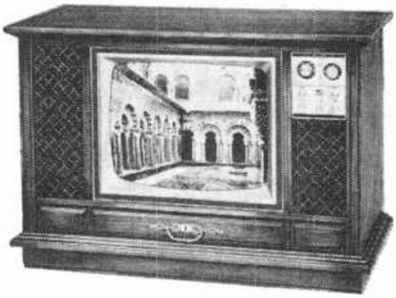
Kit GRA-27
**$19.95**



### New Remote Control For Heathkit Color TV

Now change channels and turn your Heathkit color TV off and on from the comfort of your armchair with this new remote control kit. Use with Heathkit GR-227, GR-295 and GR-180 color TV's. Includes 20' cable.

Kit GR-295
**$479.95**
(less cabinet)
$42 mo.



Kit GR-180
**$349.95**
(less cabinet & cart)
$30 mo.

### Deluxe Heathkit "295" Color TV

Has same high performance features and built-in servicing facilities as new GR-227, except for 295 sq. in. viewing area (industry's largest picture) . . . 24,000 volt picture power . . . universal main control panel for versatile in-wall installation . . . and 6" x 9" speaker.

**Kit GR-295,** (everything except cabinet), 131 lbs. . . .
$48 dn., $42 mo. . . . . . . . . . . **$479.95**
**GRA-295-4,** Mediterranean cabinet (shown above), 90 lbs. . . .
no money dn., $11 mo. . . . . . . . . . . **$112.50**
Other cabinets from $62.95.

### Deluxe Heathkit "180" Color TV

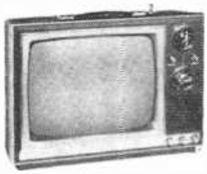
Same high performance features and exclusive self-servicing facilities as new GR-227 (above) except for 180 sq. in. viewing area.

**Kit GR-180,** (everything except cabinet), 102 lbs. . . .
$35 dn., $30 mo. . . . . . . . . . . **$349.95**
**GRA-180-5,** table model cabinet & mobile cart
(shown above), 57 lbs. . . . no money dn., $5 mo. . . . . . . . . **$39.95**
Other cabinets from $24.95

### Deluxe 12" Transistor Portable B&W TV – First Kit With Integrated Circuit

Unusually sensitive performance. Plays anywhere . . . runs on household 117 v. AC, any 12 v. battery, or optional rechargeable battery pack ($39.95); receives all channels; new integrated sound circuit replaces 39 components; preassembled, prealigned tuners; high gain IF strip; Gated AGC for steady, jitter-free pictures; front-panel mounted speaker; assembles in only 10 hours. Rugged high impact plastic cabinet measures a compact 11½" H x 15¼" W x 9⅜" D. 27 lbs.

Kit GR-104
**$119.95**
$11 mo.



**Kit GR-104,** 27 lbs. . . . no money dn.,
$11 mo. . . . . . . . . . . **$119.95**

***No Money Down On $25 to $300 Orders — Write For Credit Form***

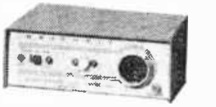
**CIRCLE NO. 19 ON READER SERVICE PAGE**

# 11 New Kits From Heath . . .

## New! Heathkit Wireless Home Protection System for Your Family's Safety

GD-97
Utility Transmitter
for Universal Protection

GD-87
Wireless Smoke/Heat
Detector-Transmitter



GD-77 Wireless Receiver/Alarm
fail-safe, always alert

Applications Unlimited . . . Customize Your Own System. Here's reliable, low cost, 24-hour protection for your family and property. System warns of smoke, fire, intruders, freezing, thawing, cooling, rising or receding water, pressures . . . any change you want to be warned about. Uses unique new signaling method developed by Berkeley Scientific Labs.; exclusively licensed to Heath. Your house is already wired for this system, just plug the units into any AC outlet. "Load transmission" design (not a carrier type as in wireless intercoms) generates unusual signal that is practically unduplicable in other devices or random noise sources. Solid-state circuitry has built-in fail-safe capability to sound alarm if power fails, if power supply components in any unit fail, or if 50,000 hour bulb in smoke detector fails. Receiver Alarm has 2800 Hz transistor alarm and receptacle for extra 117 VAC bell or buzzer to extend range, plus rechargeable battery (always kept charged) to sound alarm if power fails. Smoke-Heat Detector-Transmitter capability may be extended to other areas by adding extra heat sensors to its built-in sensor. Utility Transmitter accepts any type of switch or sensor for any purpose; examples: magnetic reed switches for doors and windows to warn of entry; step-on switches for door or driveway; micro switches with trip wire around yard; heat sensors; water pressure switches warn of pump failure; thermal switches warn of freezing in gardens, or thawing in freezers; two wires act as switch to warn of changing water levels in sump-pump wells, pools, etc. Units are small and unobtrusive in beige and brown non-reflecting velvet finish. Any number of units may be used in the system. All units feature circuit board construction; each unit takes only 3 hours to build. Operating cost similar to electric clocks. Invest in safety for your family now with this unique Heath system.

**Kit GD-77,** receiver/alarm, 4 lbs. . . . . . . . . . . . . . . . . . . . . **$39.95**
**Kit GD-87,** smoke/heat det.-trans., 5 lbs. . . . . . . . . . . . . . **$49.95**
**Kit GD-97,** Utility trans., 4 lbs. . . . . . . . . . . . . . . . . . . . . . . **$34.95**
(numerous accessory switches available from Heath)

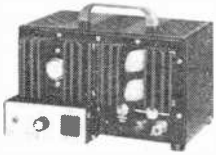
## New! Low Cost Heathkit 5-Band SSB-CW Transceiver

Kit HW-100
**$240.00**

You asked for it . . . a 5-band version of the Heathkit "single-banders" . . . a low cost SSB transceiver for 10 or 15 meters . . . an SSB transceiver equal or superior to many wired rigs but at much lower cost. It's the new HW-100, the most SSB equipment you can get for the money. Features build-it-yourself solid-state (FET) VFO; 80-10 meter coverage; switch-selected upper or lower sideband or CW; crystal filter; full coverage on all bands with 500 kHz per band segment; smooth vernier control; built-in 100 kHz calibrator; separate offset CW carrier crystal; TALC; quiet, enclosed relays; fixed or mobile operation with accessory power supplies; 180 watts PEP, 170 watts CW input; PTT or VOX on SSB; CW transceive by VOX from keyed tone using grid-block keying; less than 100 Hz drift per hour after warmup; less than 100 Hz variation under 10% line voltage variation; receiver sensitivity less than 0.5 uv for 10 dB S+N/N ratio for SSB operation; selectivity 2.1 kHz at 6 dB down, 7 kHz at 60 dB down; image & IF rejection better than 50 dB; easy circuit board construction with one large wiring harness; handsome 2-piece green wrinkle finish cabinet. It's a winner!

**Kit HW-100,** 19 lbs., no money dn., $22 mo. . . . . . . . . . **$240.00**

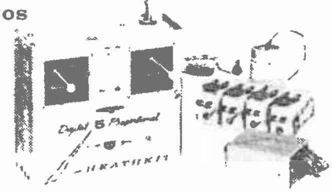
## New! Heathkit High-Power Inverter for Boats, Cars, Campers



Kit
MP-14
**$99.95**

Powers Color & B&W TV's, power tools, radios, phonos, lights, tape recorders, hi-fi systems, shavers, PA systems, ham & CB rigs, any small appliance except compressor-type refrigerators and units having heating elements drawing over 400 watts. Also makes good source of limited emergency power at home. Delivers 500 watts intermittant; 400 watts continuous; freq. and output adjustable for best operation; remote control-output and cables included. 29 lbs.

## New! Heathkit/Kraft 5-Channel Digital Proportional System with Variable Capacitor Servos

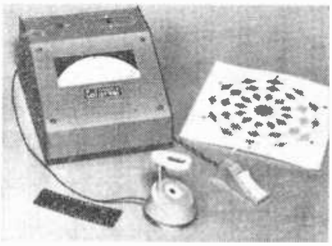


System Kit GD-47
**$219.95**
$21 mo.

This Heathkit version of the internationally famous Kraft system saves you over $200. The system includes solid-state transmitter with built-in charger and rechargeable battery, solid-state receiver, receiver rechargeable battery, four variable capacitor servos, and all cables. Servos feature sealed variable capacitor feedback to eliminate failure due to dirty contacts, vibration, etc.; three outputs: two linear shafts travel 5/8" in simultaneous opposite directions plus rotary wheel. Specify freq.: 26.995, 27.045, 27.145, 27.195 MHz.

**System Kit GD-47,** all of above, 5 lbs. . . . . . . . . . . . . . **$219.95**
**Kit GDA-47-1,** transmitter, battery, cable, 3 lbs. . . . . . . . . **$86.50**
**Kit GDA-47-2,** receiver, 3 lbs. . . . . . . . . . . . . . . . . . . . . . . . **$49.95**
**GDA-47-3,** receiver rechargeable battery, 1 lb. . . . . . . . . . . . **$9.95**
**Kit GDA-47-4,** one servo only, 1 lb. . . . . . . . . . . . . . . . . . . . **$21.50**

## New! Heath/Mitchell COLORVAL Darkroom Computor . . . Kit or Assembled



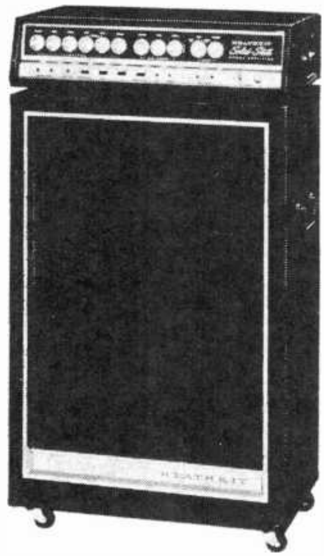
Kit PM-17
**$89.95**
$9 mo.

Colorval takes the work out of color printing, leaves the creativity to you. Colorval is easy to set up . . . you "program" the scan filter pack for the type of film, paper, and equipment you use . . . we show you how. Unique Color Probe allows visual determination of ideal enlarger filter combination. Color Wheel and table shows what filter changes are needed. Exposure Probe scans shadows and highlights; exposure scale on Computer indicates proper contrast for color and b/w printing. Get started in color the right way, quickly, easily.

**Kit PM-17,** 6 lbs., no money dn., $9 mo. . . . . . . . . . . . . . . **$89.95**
**Assembled PMW-17,** 6 lbs. . . no money dn., $13 mo. . . **$125.00**

# See 300 More in FREE Catalog

**What would you expect to pay for a Vox "Jaguar" Combo organ with a 180-watt 3-channel amp? $1000? $1250? $1500? More?**

## You can get both for only $598 during this Special Heathkit Offer!

Now you can get this famous professional combo organ with a versatile high-power piggy-back amp. and matching speaker system for just a little more than you'd expect to pay for the "Jaguar" alone! The Heathkit/Vox "Jaguar" is solid-state; two outputs for mixed or separated bass and treble; reversible bass keys for full 49 key range or separate bass notes; bass volume control; vibrato tab; bass chord tab; four voice tabs (flute, bright, brass, mellow); keyboard range $C_2$ to $C_6$ in four octaves; factory assembled keyboard, organ case with cover, and stand with case. Also available separately; you'll still save $150 (order Kit TO-68, $349.95).

The Heathkit TA-17 Deluxe Super-Power Amplifier & Speaker has 180 watts peak power into one speaker (240 watts peak into a pair); 3-channels with 2 inputs each; "fuzz", brightness switch; bass boost; tremolo, reverb; complete controls for each channel; foot switch; 2 heavy duty 12" speakers plus horn driver. Also available separately kit or factory assembled (Kit Amplifier TA-17, $175; Assembled $275; Kit Speaker TA-17-1 $120; Assembled $150; Kit TAS-17-2, amp. & two speakers $395; Assembled TAW-17-2, amp. & two speakers $545).

Kit TOS-1
Organ, Amplifier & Speaker Kits (240 lbs.)
**$598.00**

Kit TOS-2
Organ Kit, Assembled Amplifier & Speaker (240 lbs.)
**$698.00**

---

## New! Solid-State Portable Volt-Ohm-Meter

So Handy, So Low Cost we call it "every man's" meter. Just right for homeowners, hobbyists, boatowners, CBer's, hams . . . it's even sophisticated enough for radio & TV servicing! Features 12 ranges . . . 4 AC & 4 DC volt ranges, 4 ohm ranges; 11 megohm input on DC, 1 megohm input on AC; 4½" 200 uA meter; battery power; rugged polypropylene case and more. Easy 3 or 4 hour kit assembly. 4 lbs.

Kit IM-17
**$19.95**

## New! Heathkit Guitar Headphone Amplifier

Kit TA-58
**$9.95**

Now you can play and practice your electronic guitar in private! Just plug this miniature amplifier into the jack of your guitar and use a pair of headphones. Solid-state circuit has tailored response; automatic off-on switching; self-contained battery (not supplied); and capability of operating one or two pairs of mono or stereo headphones of 4 to 2 megohms. Ideal for practice or instruction. Easy to build.

**Kit TA-58**, 2 lbs. .................................... **$9.95**


## NEW
### FREE 1968 CATALOG!

Now with more kits, more color. Fully describes these along with over 300 kits for stereo/hi-fi, color TV, electronic organs, electric guitar & amplifier, amateur radio, marine, educational, CB, home & hobby. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022.

HEATHKIT

HEATH COMPANY, Dept. 10-4
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In Canada, Daystrom Ltd.

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Please send model (s)__________
☐ Please send FREE Heathkit Catalog.
☐ Please send Credit Application.

Name__________
Address__________
City__________ State__________ Zip__________

Prices & specifications subject to change without notice. CL-323

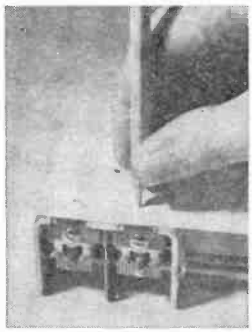
CIRCLE NO. 19 ON READER SERVICE PAGE

PARTS/METHODS/IDEAS/GADGETS/DEVICES

# tips & techniques

## PAPER "TEMPLATE" SPEEDS CHASSIS HOLE DRILLING

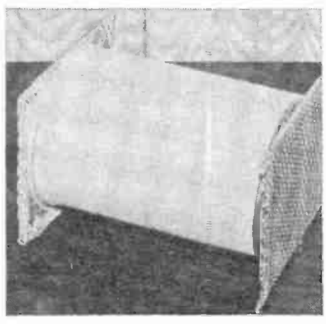
Orienting the mounting holes for irregularly shaped components, such as tuning capacitors, on a chassis can be time-consuming if you use ordinary measuring techniques A much quicker and more direct approach is to line up the edges of a sheet of paper with the sides of the component, locate the holes through the paper by touch, and punch-through the paper with a pencil as shown in the photo. Make sure the paper stays put as you punch the holes. Then flip the paper "template" over and mark the drilling points on the chassis.



—*Robert E. Kelland*

## YOU CAN CONNECT 3.2-OHM SPEAKERS TO YOUR 8-OHM AMPLIFIER

While most modern audio amplifiers are designed for 8-ohm loads, there is a way to connect 3.2-ohm speakers to the new amplifiers without an impedance-matching transformer. You just connect two such speakers in series across the 8-ohm tap on your amplifier (see photo). The 4"-diameter speakers can be mounted at opposite ends of a one-pound coffee can and the speaker cones covered with expanded aluminum grilles or a grille cloth. For other size 3.2-ohm speakers, appropriate size containers can be used. For best results, the speakers should be connected so that their phasing is opposite. (To check phasing, momentarily connect a 1.5-volt battery to the two free wires and observe the movement of the



# POPULAR ELECTRONICS READER SERVICE PAGE

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VOID AFTER MAY 31, 1968

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4 a

TIPS (Continued from page 14)

speaker cones; one cone should pull inward while the other moves outward. If both cones move in the same direction simultaneously, reverse the connections of one of the speakers.)

—*W.S. Gohl*

## BAD POTENTIOMETER CAN CAUSE TROUBLE

Don't be surprised if an electronic device you stored away a few years ago fails to operate properly when you put it back into service. If the set still won't work after you have made all the obvious tests and/or installed new parts, take a look at the potentiometer(s). Connect the probes of an ohmmeter to the center and one of the outer lugs of each potentiometer (if the pot is in parallel with any other component in the set, remove the wires from one of the outer lugs), and rotate the shaft while observing the meter. The meter pointer should deflect smoothly from the minimum to the maximum resistance stamped on the potentiometer. Then check the resistance from each lug to the potentiometer case (see photo); it should be infinite. If incorrect readings are obtained, and a suitable cleaner will not rectify the problem, the potentiometer should be replaced.

—*Lewis A. Harlow*

## "RUBBER-STAMP" YOUR PRINTED CIRCUIT BOARDS

If you want to avoid the tedious job of laying out resist patterns individually for several one-of-a-kind printed circuit boards, you can use a home-made rubber stamp. First, prepare a mold by pouring a $\frac{1}{16}$"-thick layer of melted beeswax into a flat, level container. While the wax is setting, make a tracing of the foil pattern. Then lay the tracing on the wax, and draw a light impression of the pattern on the wax with a ball-point pen. Remove the tracing, and use an X-acto knife to remove the unwanted wax and "true" the lines; cut completely through the wax to the container. Finally, work a pliable adhesive (such as General Electric "Silicone Seal") into the impressions, taking care to prevent air bubbles from forming. Spread a smooth ¼"-thick layer of the adhesive over the entire mold surface, and let it set overnight. When the adhesive has set, remove it from the mold, and cement it to a suitable handle. To stamp the etch patterns on the copper-clad side of the boards, use a regular ink pad.

—*R.B. Halliday*

# "He's a good worker. I'd promote him right now if he had more education in electronics."

# Could they be talking about <u>you</u>?

You'll miss a lot of opportunities if you try to get along in the electronics industry without an advanced education. Many doors will be closed to you, and no amount of hard work will open them.

But you can build a rewarding career if you supplement your experience with specialized knowledge of one of the key areas of electronics. As a specialist, you will enjoy security, excellent pay, and the kind of future you want for yourself and your family.

Going back to school isn't easy for a man with a full-time job and family obligations. But CREI Home Study Programs make it possible for you to get the additional education you need without attending classes. You study at home, at your own pace, on your own schedule. You study with the assurance that what you learn can be applied to the job immediately.

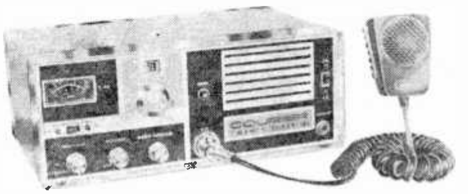
CREI Programs cover all important areas of electronics including communications, radar and sonar, even missile and spacecraft guidance. You're sure to find a program that fits your career objectives.

# NEW PRODUCTS

*Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15 or 115.*

### TUBE-TYPE CB TRANSCEIVER

According to *Courier Communications, Inc.*, its new "Courier 23-Plus" will pull in all 23 channels louder and clearer than any other tube-type rig in its price class. The "Courier 23-Plus" features a cascode front end and nuvistor mixer, and includes every known feature to dampen and filter out the noise you



don't want to hear. Other features: an exclusive modulation sampler that "makes a weak voice strong," dual conversion, single-knob tuning, transistorized power supply, modulation indicator, and a built-in range-expander circuit. Both the S/r.f. meter and channel selector are illuminated for easy reading. The transceiver comes complete with crystals for all channels, mounting brackets, power cords, and a microphone.

Circle No. 75 on Reader Service Page 15 or 115

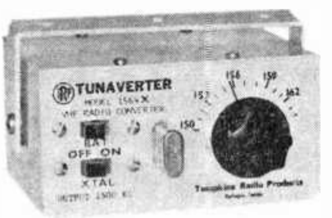
### ALL-IN-ONE TURNTABLE

The "Module SLx" automatic turntable recently introduced by *Garrard* has one feature that most component turntables do not have—it comes complete with simulated wood grain base and magnetic cartridge. Another feature of the SLx turntable is Garrard's exclusive "Synchro-Lab" motor which maintains constant speed under all conditions. The unit has an unusually light and thin tone arm with a built-in stylus pressure gauge, permitting the use of a small-size, lightweight counterbalance and keeping tracking force down to a minimum. The magnetic cartridge that comes with the SLx is pre-matched to the turntable and tone arm, and tracking force is correctly pre-set.

Circle No. 76 on Reader Service Page 15 or 115

### 150-164 MHZ R.F. CONVERTER

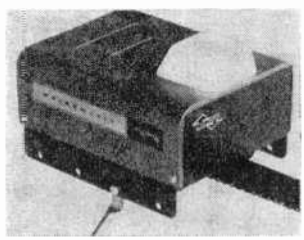
Police, fire, and other public services operating in the 150-164 MHz band can be heard over auto radios when *Tompkins Radio Products'* "Tunaverter" Model 1564X converter is plugged in between the car's antenna and the radio. Announced by Herbert Salch and Co., Marketing Division, the converter employs a FET which makes possible the monitoring of any number of crystal-controlled channels by plugging in the correct crystal. On the other hand, if you want to tune across the band, all you have to do is flip a switch. Each circuit is peaked with a three-gang tuning capacitor to achieve improved selectivity, sensitivity, image rejection, and signal-to-noise ratio. Power for the Model 1564X is provided by a 9-volt transistor battery.




Circle No. 77 on Reader Service Page 15 or 115

### GARAGE DOOR OPENER SYSTEM

With the "Liftmaster" Model G-6100 garage door opener system, you can start the door on its travels from half a block away, so that it's completely up as you pull in. Manufactured by *Perma-Power*, the system consists of a "Signal Sender" solid-state transmitter, a wall-mounted solid-state receiver, and a ceiling-mounted motor mechanism (shown in the photo). A "Velvet Glide" clutch device provides smooth and quiet door operation and is so sensitive that a well-balanced door's travel can be instantly arrested if the door encounters an obstacle, even a fingertip. And a unique signal-and-pause triple code prevents unauthorized signals from actuating the system's receiver. The "Liftmaster" not only opens and closes garage doors by silent R/C command, but it also turns the garage lights on and off.



Circle No. 78 on Reader Service Page 15 or 115

### HIGH-VOLTAGE TEST PROBE

Accurate and safe high voltage checks on all color as well as black-and-white TV re-

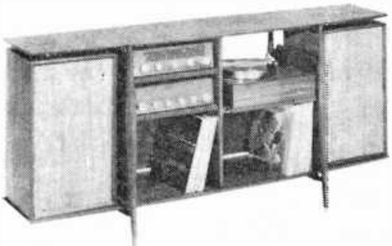
## PRODUCTS *(Continued from page 22)*

ceivers can be performed with the new 40,000-volt d.c. portable test probe designed to operate with *Triplett Electrical Instrument*'s Model 600 volt-ohmmeter. [The Model 600 was discussed in an article in our January issue, page 30.] Three d.c. ranges can be checked with the Model 72-265 probe: 40 kV, 16 kV, and 4 kV. Easy removal of an internal resistor makes the probe flexible so that it can be used with other test instruments.

Circle No. 79 on Reader Service Page 15 or 115

### HI-FI "MUSIC CENTER"

The best place for modern component hi-fi equipment is inside a cabinet like the Model 303 "music center" available from *Audio Originals*. Part of an extensive line of hi-fi equipment cabinets and speaker enclosures, the Model 303 has the graceful flowing lines of



Danish modern furniture. It features two adjustable component shelves, sized to fit most stereo amplifiers and tuners; a changer/turntable shelf that can be pulled out, moving effortlessly on ball-bearing slides; and plenty of space for records. The Model 303 is made of genuine hardwood and finished in oiled walnut.

Circle No. 80 on Reader Service Page 15 or 115

### DUAL-BAND COMMUNICATIONS RECEIVER

Four integrated circuits and a choice of crystal or tunable operation on either of two VHF bands are featured in *Lafayette Radio*'s Model PF-175 solid-state FM communications receiver. This dual-band re-

ceiver provides coverage from 30 to 50 MHz and 152 to 174 MHz. The IC's are in the four i.f. stages, and a single four-position front panel selector switch gives the user his choice of crystal or tunable operation. Other features of the PF-175 include a variable squelch control, illuminated dial, 4" speaker, external earphone jack, tape recorder jack, simulated wood grain finish, and a built-in universal power supply which allows operation from a 117-volt a.c. or a 12-volt d.c. power source.

Circle No. 81 on Reader Service Page 15 or 115

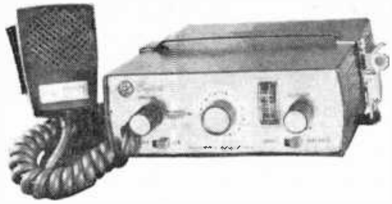
### CB MOBILE ANTENNAS

A unique mounting device called the "Claw" is the featured attraction of *Hy-Gain Electronics*' "Hellcats" (CB mobile antennas). The "Claw" enables an antenna to be mounted in any existing hole between ⅜" and ¾" in diameter; it "grasps" the sides of the hole securely—even if the hole is not perfectly round. Also incorporated in the new "Hellcat" line is an etched copper loading coil which is photographically etched instead of printed to insure consistent micro-accuracy and provide a d.c. ground to help eliminate static. The antenna whip used is a 17-7 PH stainless steel unit. Four models of "Hellcats" are available—roof-mounted; trunk-lip-mounted; magnetic-mounted; and a "shorty" rooftop model.

Circle No. 82 on Reader Service Page 15 or 115

### CB MOBILE TRANSCEIVER

*Browning Laboratories* is introducing a companion to its line of "Eagle" CB base stations: the "Eaglette" mobile unit. A 23-channel, silicon-transistor transceiver, it boasts



an illuminated "S"-meter and channel selector switch, p.a. function with separate jacks for p.a. and remote speakers with 3¼-watts of audio, a squelch control, and a noise limiter. Sensitivity is 0.35 $\mu$V for 10 dB signal-to-noise plus noise at 40% modulation. Crystals for operation on all 23 channels are included.

Circle No. 83 on Reader Service Page 15 or 115

### BLIND RIVETER AND RIVETS

"Pow'Rivets" and a "Pow'Riveter" introduced by *Vaco Products* make it possible to fasten anything up to one-half-inch thick from one side. The four-way head of the blind "Pow'Riveter" has a nozzle that will accommodate any size of blind rivet, and is claimed to outperform all other blind riveters. The "Pow'Rivet," four sizes of which will replace eleven sizes of ordinary blind rivets, expands up to its head diameter for use in wide-tolerance holes, and a superior clamp-up action assures a snug fit. The rivets and riveter can be purchased separately, but they are also available as a kit.

Circle No. 84 on Reader Service Page 15 or 115

# ELECTRONICS library

QUIET

## BEGINNER'S GUIDE TO ELECTRONICS

*by Terence L. Squires*

This is a revised edition of a book that favorably impressed your reviewer in 1964 (see August issue, page 36). We recommended the "Beginner's Guide" because of its clarity and its short-cut method of introducing electronics to the adult or teen-ager. Our recommendation still stands—only more so. The revised edition includes information on developments that occurred in 1965, 1966, and 1967, and one or two minor errors have been corrected. The author is British, but the language of electronics is universal, and you should enjoy his mathematics-less treatment of everything from a single electron to a digital computer.

*Published by Philosophical Library, Inc., 15 East 40th St., New York, N.Y. 10016. Hard cover. 194 pages. $6.00.*

## MOST-OFTEN-NEEDED 1968 TELEVISION SERVICING INFORMATION, Volume TV-27

*Compiled by M.N. Beitman*

Like the earlier volumes in Supreme's TV servicing series, the latest one contains a wealth of information on servicing monochrome TV chassis. Popular TV chassis from every major U.S. manufacturer and Sony's TV-500U and TV-900U solid-state TV chassis are covered in detail. Whether TV servicing is a full-time business for you or a part-time venture, this book belongs on a shelf in your workshop.

*Published by Supreme Publications, 1760 Balsam Rd., Highland Park, Ill. Soft cover. 192 pages. $4.00.*

## ELECTRONIC SENSING DEVICES

*by A. F. Giles*

Not too many years ago almost every manufacturing process was directly controlled by a watchful human operator. That situation is rapidly being reversed and few—if any—steps in some manufacturing plants are left to us poor mortals. The electronics of overseeing industrial operations is the subject of this book. Details on a wide variety of sensors (magnetic, capacitive, solid-state, electrolytic, etc.) are included.

*Distributed in U.S. by the Chemical Rubber Co., 2310 Superior Ave., Cleveland, Ohio 44104. Hard cover. 158 pages. $8.95.* —30—

We know a man doesn't come by $539.80 just like that. And parts with it only after carefully deliberating his alternatives.

So we've put together a new illustrated booklet that explains just what you'll be getting into should you decide to spend $269.90 for our completely hand wired Director 23 mobile radio telephone; just what you'll be getting into should you decide to spend $269.90 for our matching hand wired Guardian 23 (or 23-B) base station radio telephone. And just what you could be getting into should you decide that $539.80 is too much to spend for two two-way radios.

Total cost for the booklet? Nothing. But you've got to mail the coupon to let us know you want one, and that'll set you back six cents.

But just in case you're thinking you'll save six cents because you already know all about our 23's, you might just as well know that we've redesigned them to include some rather exotic new features. (The all solid state Director 23, for instance, now boasts a final transistor that won't blow—even if you key up and forget to connect the antenna. Plus a tone control. Plus a front-mounted speaker.)

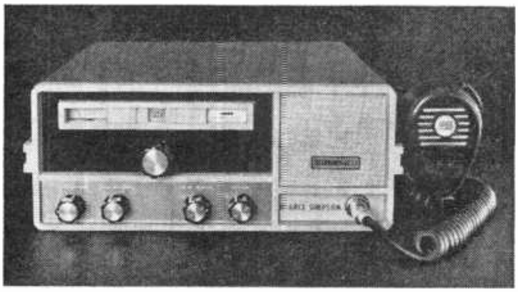
Plus features like HetroSync® Circuitry. (Which has all but completely wiped out spurious signals.) And our remarkable Superhet Receiver. (Which is so good that sloppy signals from adjacent channels have virtually become a thing of the past.)

And electronic switching, dual function S-meter, and your choice of two base stations. (The Guardian 23 comes with a conventional palm microphone. The Guardian 23-B, which comes without a microphone, comes with a built-in solid state pre-amplifier which permits the operator to remain from 1 to 1½ feet from a desk microphone and still broadcast at 100% modulation. Costs are identical.)

In short, we think it's well worth the price of a stamp to know exactly what you're getting into before you decide to get into it. So we'd like to send you one of our brand new illustrated booklets that tells you all about all of our new CB radios, and some things about some CB radios that aren't ours.

If you'll just tell us where to send it.

Director 23 (23-channel mobile unit), $269.90


Guardian 23, 23-B (23-channel base stations), $269.90

# Before you spend $539.80 for one of Pearce-Simpson's new base stations and matching mobile units, spend 6¢ and find out why you should.

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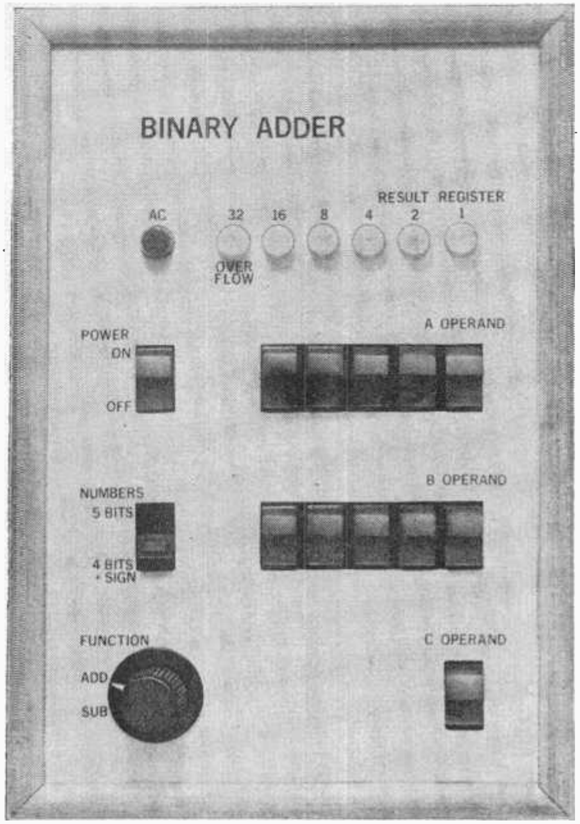




# DEMONSTRATING BINARY COMPUTATION WITH THE *Binary Adder*

**BY BARRY W. BEALS**

SCIENCE FAIR OR CLASSROOM PROJECT ILLUSTRATES FUNDAMENTALS OF DIGITAL COMPUTER OPERATION

THE MODERN digital computer is an awe-inspiring sight and probably represents the most complex piece of equipment that most people have ever seen. However, there are two fascinating facts about a computer that the average individual is completely unaware of: first, all a computer can actually do is add, subtract, and remember (via a magnetic memory); second, the entire number vocabulary of the computer is limited to only two digits.

The choice of two digits becomes obvious when you consider that the entire vocabulary can be generated with a simple s.p.s.t. switch. One position (state) of the switch represents one digit, while the other position (state) represents the second digit. With the introduction of high-speed solid-state switches, operation at many millions of times per second is now possible.

The name of this two-digit arithmetic is "binary notation," with the *bi* representing the base 2. On the other hand, no pun intended, finger counting is called decimal notation (*dec*—to the base 10) because we count on 10 fingers, then repeat. Other values of notation are used in large-scale digital computers, but are too complex to be covered here.

The "Binary Adder" discussed in this article is a very simple, low-cost digital computer that will not only teach you binary arithmetic and give you a good idea of how a modern digital computer works, but will also give you a good insight to the "new math" being taught in our schools.

The article is divided into three sections. The first, starting on page 30, covers binary arithmetic, explains what it is, how it is notated, how it is used, and gives some practice examples as an aid to understanding the subject. The second section, starting on page 31, explains the operation of this simple digital computer; while the third section, starting on page 40, tells you how to build and use the "Binary Adder."

# HOW BINARY SYSTEM WORKS

The peculiarity of the binary number system lies in the fact that a serial arrangement of only two digits, "0" and "1," can be made to represent any number (units, tens, hundreds, thousands, etc.). Before delving into the following analysis of the binary number system, keep in mind that the use of these two digits is especially appropriate to computer technology and electronic calculation. Either "0" or "1" can be represented electrically in many simple ways: a voltage being present or absent; a switch being *on* or *off*; or any other function that can take either of two discrete stable states. Because one electrical switch can only "count" to 1 (e.g., 0, 1), several switches would be required to count to 2, 3. . .10, etc. This is the reason why binary numbers are usually represented in groups of several zero's and one's, with the length of the group depending on the values of the final number you require.

Looking at an array of binary digits, the right-most column represents either a zero or a one and is called the one's (or unit's) column—thus, five-digit binary number 00000 is zero, while 00001 is one. The second digit (or column) from the right is the two's position; thus, 00010 represents two. In combination then, binary 00011 represents three (one 2 plus one 1).

In similar fashion, the value of each binary digit to the left is twice that of the bit to its right. These "place values" in the binary system are therefore 1, 2, 4, 8, 16, etc. Table 1 lists these numbers and their corresponding binary representation. Note that the 1 symbol indicates that a place value is to be counted, while a 0 indicates that it is *not* to be counted.

**TABLE 1: BINARY PLACE VALUES**

| Digit Position | Place Value | Binary Representation |
|---|---|---|
| 1 (right-most) | 1 | 00001 |
| 2 | 2 | 00010 |
| 3 | 4 | 00100 |
| 4 | 8 | 01000 |
| 5 | 16 | 10000 |

**COMMONLY USED TERMS**

**Binary** A numbering system using only two symbols (such as 0 and 1) to express any number by combinations of the symbols. Also referred to as a system whose successive digits are interpreted as coefficients of the successive powers of the base two.

**Bit** An abbreviation of binary digit. Equal to one binary decision, or the designation of one or two possible and equally likely values or states of information being stored. A bit may be conveyed by one binary code element or symbol.

**Carry** A signal or expression produced by an arithmetic operation when the sum of two digits exceeds the base of the numbering system being used.

**Logic Circuit** A set of switches (mechanical or electronic) that performs logical functions: add, subtract, etc.

**Operand** A result, parameter, argument, or an indication of the location of the next computer instruction.

**Overflow** The condition that arises when the result of an arithmetic operation exceeds the capacity of the number representation (e.g., readout).

**Sign Bit.** When used, a bit (the left-most) in a binary number which tells you whether that number is positive or negative.

**Truth Table** A tabular means of identifying all the conditions that can arise in a given logical function. For each combination of inputs to the logic function, the table illustrates all possible outputs.

**Two's Complement** A means of representing negative binary numbers, obtained by inverting all the bits of the binary number (changing 0's to 1's and vice versa) and adding 1 to the result.

Using Table 1, the binary representation of any number up to 31 can be found. For example, the decimal number eleven can be broken up as eight plus two plus one, so that the binary equivalent is 01011 (no units of sixteen, one unit of eight, none of four, one of two, and one of one); decimal number seven is 00111; twenty-six is 11010. and thirty-one is 11111. To convince yourself of the ease with which the binary equivalent of a decimal number can be found, try the following:

(a) five ____________
(b) twelve ____________
(c) thirty ____________

(*Continued on page* 32)

# BASIC ONE-BIT ADDER

The circuit used to perform binary addition of one digit from each of two operands is shown in Fig. 1. Each of the digits is represented by a d.p.d.t. switch and the result is read out on a neon lamp. To understand the operation of this circuit, refer to the extended truth table (Table 3).

Column 4 in Table 3 answers the question "Is the A Operand Bit different from the B Operand Bit?"—with 1 meaning yes, and 0 meaning no. Column 5 answers the question "Are both operand bits a 1?"

Using this table, you will see how the circuit in Fig. 1 performs binary addition—that is, how the Result and Carry Out are formed properly for all combinations of the A Operand Bit, B Operand Bit, and Carry In.

**Result Generation.** As shown in Fig. 1, switches S1(b) and S2(a) connect the B+ supply to the right side of the neon lamp when the switches are in opposite positions. Otherwise, resistor *R2* holds the right side of the lamp at ground potential, for all practical purposes. Thus, the right side of the lamp obeys Column 4 of Table 3, with ground meaning 0 and B+ meaning 1.

In Table 3, notice that the Result is a 1 only when Column 4 differs from the Carry In column. By wiring the left side of the neon indicator to the Carry In terminal, the neon lamp will light whenever the left and right side voltages differ (one at ground and one at B+).

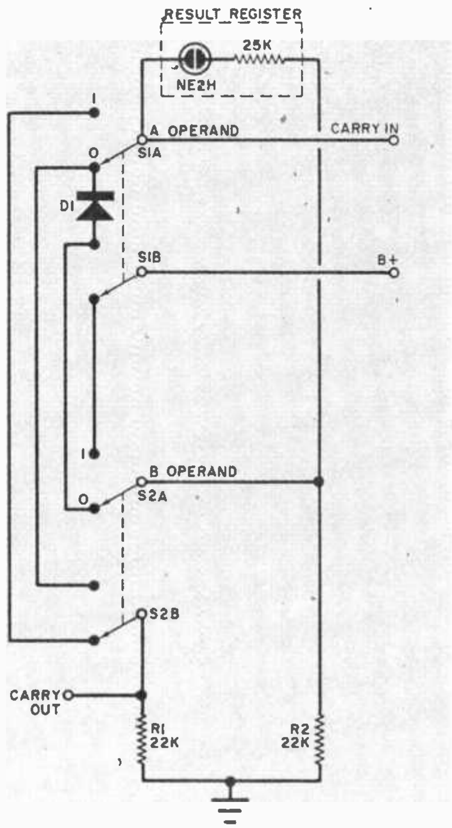


Fig. 1. This basic one-bit adder circuit shows how the Binary Adder operates.

Thus, the neon lamp displays the Result column under all circumstances.

(*Continued on page* 33)

**TABLE 3: EXTENDED TRUTH TABLE**

| 1<br>A Operand Bit | 2<br>B Operand Bit | 3<br>Carry In | 4<br>A=/=B | 5<br>A&B=1 | 6<br>Result | 7<br>Carry Out |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 | 1 | 1 | 1 |

It is just as easy to convert a binary number back into a decimal number. You add up the values of the place values for each binary 1. Thus, 00110 represents four plus two equals six. Likewise, 11011 represents sixteen plus eight plus two plus one equals twenty-seven. Try these conversion examples:*

(d) 01001 ________
(e) 01110 ________
(f) 10011 ________

**Binary Addition.** Adding two binary numbers is also simple. For example, add 01001 (nine) to 10010 (eighteen):

```
 01001 (nine)
+10010 (eighteen)
 11011 (twenty-seven)
```

As in decimal addition, start adding the columns from the right to the left. In this example 1+0 is 1, 0+1 is 1, 0+0 is 0, 1+0 is 1, and 0+1 is 1. However, if the sum of any column exceeds 1 (example, 1+1), then a "carry" into the next column to the left is required. For example, add 01101 (thirteen) to 01101 (thirteen);

```
 11 1  carries
 01101 (thirteen)
+01101 (thirteen)
 11010 (twenty-six)
```

Proceeding from right to left in the above example, 1+1 is two, which is 10 in binary numbers. Therefore, the right-most column sum is 0 with a carry of 1. The carry of 1 plus the two 0's in the next column give a 1 with no carry. The third column again produces a 0 with a carry of 1. The fourth column presents an interesting situation. Here, the carry plus the two 1's gives a column sum of three. Since three is 11 in binary, the result is 1 with a carry of 1. Finally, the left-most column sum is 1. To help you understand binary addition, try:

```
(g)  00100
    +01010
    ------

(h)  00111
    +01110
    ------
```

*Answers to all problems are on page 92.

The preceding examples show that a number of combinations can arise during binary addition. Table 2 lists each of these combinations and their outcomes. This table, called a "*truth table*," shows the situation for a single digit of the binary number. The first two columns in each of the 8 lines show a digit from each of the two operands and the "Carry In" column indicates whether or not a carry *into* the position from the preceding one occurred.

To illustrate the meaning of the truth table entries, let's use it to add seven and fourteen in binary:

```
 00111
+01110
------
```

Starting with the right-most digit, we must add 1+0+no carry-in. Line 3 of the table covers this situation; the "Result is 1 and the "Carry Out" is 0. Thus, the addition so far has yielded:

```
                 00111
                +01110
(partial total)      1
```

Working with the second column, we have 1+1+no carry-in. Line 4 of the truth table shows the "Result" to be 0 with a "Carry Out" of 1. Consequently, we now have:

```
(carries)          1
                 00111
                +01110
(partial total)     01
```

For the third column, use line 8 of the truth table—where the "Result" is 1 with a "Carry Out" of 1. So, the sum is:

```
(carries)         11
                 00111
                +01110
(partial total)    101
```

Line 6 covers the next situation, with the results being:

```
(carries)        111
                 00111
                +01110
(partial total)   0101
```

To complete the addition, use line 5 of

(*Continued on page* 34)

**Carry Out Generation.** An inspection of Table 3 will reveal that the Carry Out signal is the same as the Carry In whenever Column 4 is a 1, 1 when Column 5 is a 1, and 0 otherwise.

Examination of Fig. 1 shows that: the first condition is met by switches *S1(a)* and *S2(b)*, which connect the Carry In terminal to the Carry Out terminal whenever these switches are set differently; the second condition is met by diode *D1*, which conducts the B+ supply voltage to the Carry Out terminal when the switches are both set at 1; and the third condition is met by the grounding of resistor *R1*.

**Subtraction Circuitry.** Binary subtraction is accomplished by adding the two's complement of the second operand to the first. The "invert" step of forming the two's complement is provided by *S3*, as shown in Fig. 2. The four poles of switch *S3* electrically invert *S2* by exchanging its connections to *S1*.

The "add 1" step required to complete the two's complement is accomplished by forcing a Carry In signal into the adder stage for the right-most digit position (which usually has no Carry In), thereby increasing the total by 1. This part of the operation will be discussed more fully in the next section.

**The C Operand Switch.** This switch (*S5*) permits an extra 1 to be added to, or subtracted from, the A Operand and B Operand result. The wiring of this switch is shown in Fig. 3. For clarity, Fig. 3 does not show the wiring of the five individual adder stages (i.e., the wiring in Fig. 2). The Carry Out (CO) of each stage is wired to the Carry In (CI) of the next stage. The Carry In for the first stage (the right-most position, or place value one) is determined by the FUNCTION (ADD/SUB) switch (*S3*) and by the C OPERAND switch.

For the ADD function, the setting of

(*Continued on page* 35)

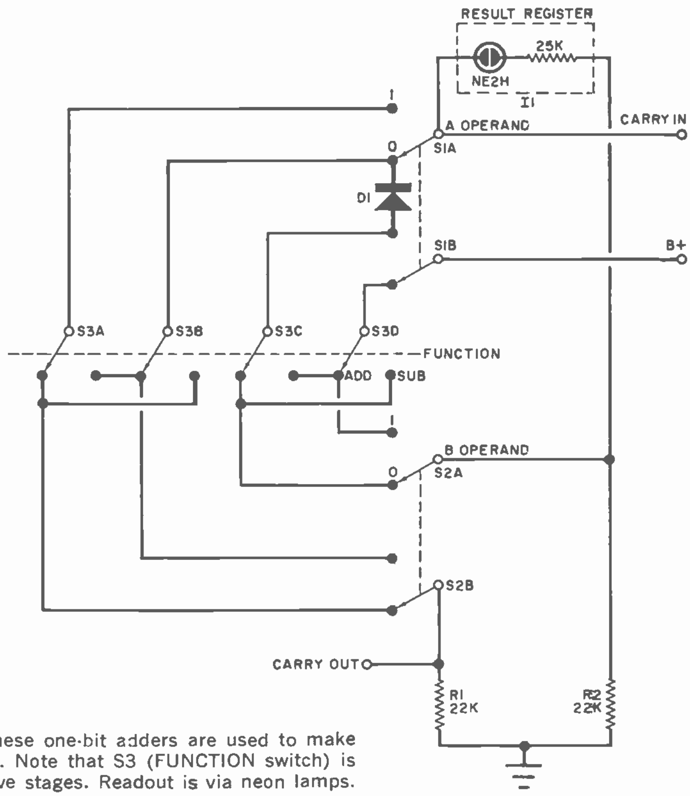


Fig. 2. Five of these one-bit adders are used to make the Binary Adder. Note that S3 (FUNCTION switch) is common to all five stages. Readout is via neon lamps.

the truth table (0+0+"Carry-In" of 1) to give the final result:

```
(carries) 111
          00111
         +01110
          10101
```

**Negative Numbers.** Up to now, we have been dealing solely with positive binary numbers. What about *negative* numbers? In decimal operations, we normally precede a number by a minus sign (−) to show that it is less than zero. However, in computers it is necessary to use an extra binary digit (or *bit*) to convey the sign of the number: 0 meaning "plus" and 1 meaning "minus."

It has been shown that a plus five would be written as 00101. Rather than use the left-most bit as the sixteen position, we will now use it as the sign bit (and having made that decision, we must cease to think of it as the "sixteen" digit, to avoid confusion). Thus, a minus five might be written as 10101. In this example, the magnitude of the number (i.e., the five) is represented the same way in both its positive and negative form—10101. This means of representing negative numbers is called the *true* form.

Obviously, this form is convenient to use—we simply append a sign bit (0 or 1) to the left end of a binary number. However, true-form negative numbers are not used in today's computers, since the circuitry required to manipulate them is unnecessarily complicated (and therefore slower and more costly). Rather, a complement form of manipulation is used.

**Two's Complement Form.** The *two's complement* form for negative numbers makes it possible to build computers in which *no* special provision has to be made for negative numbers. This form is obtained by inverting every digit of the number (that is, changing all 1's to 0's and all 0's to 1's) and then adding 1. For example, to find the two's complement representation of minus five:

| | | |
|---|---|---|
| (a) | plus five in binary | 00101 |
| (b) | invert every bit | 11010 |
| (c) | add 1 | 11011 |

The representation 11011 is minus five in two's complement form. As with true form, the left-most digit is used as the sign; here the left-most 1 indicates a negative number. Thus, 10010 and 11111 are negative numbers, while 01110 and 01001 are positive numbers.

Unfortunately, the numerical values of 10010 and 11111 are not apparent by inspection. To find the values of negative numbers, take the two's complement again. For example:

| | | |
|---|---|---|
| (a) | unknown negative number | 10010 |
| (b) | invert every bit | 01101 |
| (c) | add 1 | 01110 |

Since 01110 is plus fourteen, the value of 10010 is minus fourteen. Similarly, the value of 11111 can be found to be minus one. You will want to test yourself on these exercises—in each case, give the *value* of the binary numbers

(*Continued on page* 40)

**TABLE 2: TRUTH TABLE FOR BINARY ADDITION**

| Line | A Operand Bit | B Operand Bit | Carry In | Result | Carry Out |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 1 | 0 | 1 | 0 |
| 3 | 1 | 0 | 0 | 1 | 0 |
| 4 | 1 | 1 | 0 | 0 | 1 |
| 5 | 0 | 0 | 1 | 1 | 0 |
| 6 | 0 | 1 | 1 | 0 | 1 |
| 7 | 1 | 0 | 1 | 0 | 1 |
| 8 | 1 | 1 | 1 | 1 | 1 |

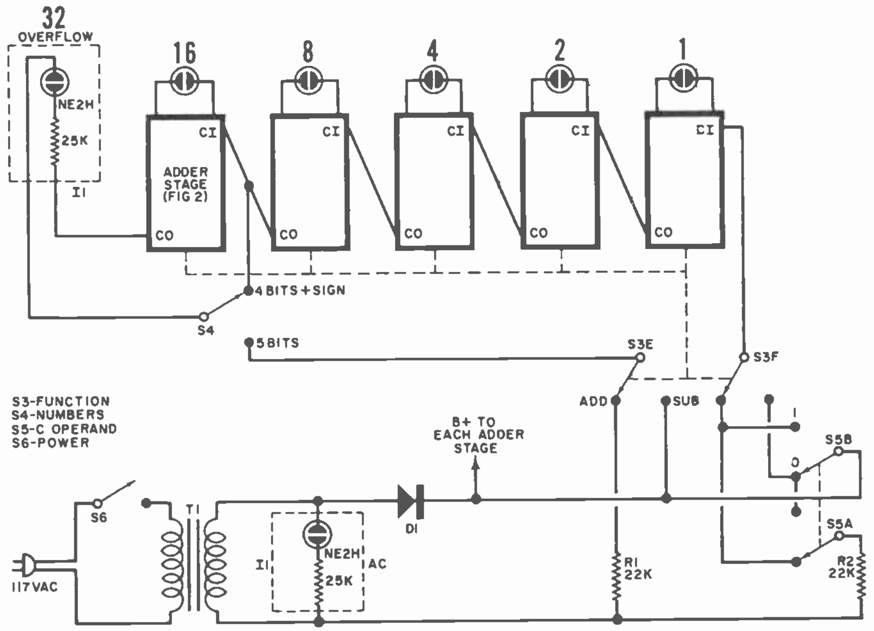


Fig. 3. To reduce illustration complexity, each of the five one-bit adders are shown in block form with only the Carry In (CI) and Carry Out (CO) of each stage identified.

**PARTS LIST**

*D1—Rectifier diode, 200 PIV, 500-mA (six required)*
*I1—Neon lamp assembly, NE2H and 25,000-ohm resistor (Allied Electronics 60 E 8700, six white required, 60 E 8698, one red required)*
*R1, R2—22,000-ohm, ¼-watt resistor (12 required)*
*S1, S2, S4, S5, S6—D.p.d.t. rocker switch, 13 required (Burstein-Applebee 18D512 or similar)*
*S3—24-p.d.t. rotary switch (IRC-CTS T239 or similar)*
*T1—Isolation transformer, 117-volt a.c. to 117-volt a.c.*
*Misc.—Case (preferably wooden), front panel, decals, knobs, rubber feet, power line cable, etc.*

the C OPERAND switch is identical to the Carry In for the first adder stage. If the C OPERAND is set to 0, the Carry In is zero; if it is set to 1, then the Carry In is one, which will increase the sum by 1.

For the SUB(tract) function, the action of the C OPERAND switch is inverted by the wiring of *S3(f)*. That is, when the C OPERAND is in the normal (0) position, the Carry In is a 1 since *S5(b)* selects the B+ supply voltage in the 0 position.

This initial carry-in completes the two's complement operation by adding 1 to the A and inverted-B Operand total. On the other hand, if the C OPERAND switch is in the 1 position, then no Carry In will be present. As a result, the total will be 1 lower than the difference between the operands.

**Numbers Switch.** This switch (*S4*) enables you to use either signed or unsigned binary numbers as the A and B OPERANDS. With *S4* in the "4 BITS+SIGN" position, the binary numbers represented by the A and B OPERAND switches and in the right-most five bits of the RESULT REGISTER are thought of as being signed numbers. For example, 01110 (fourteen) + 11110 (minus two) will be 01100 (twelve).

Notice that, with *S4* in this position, the right-most 5 bits of the RESULT REGISTER cannot contain the sum of all possible numbers that can be entered. For example, 01111 (fifteen) + 00011 (three) will display as 10010. But since the fifth bit is being used as the sign

(*Continued on page* 100)

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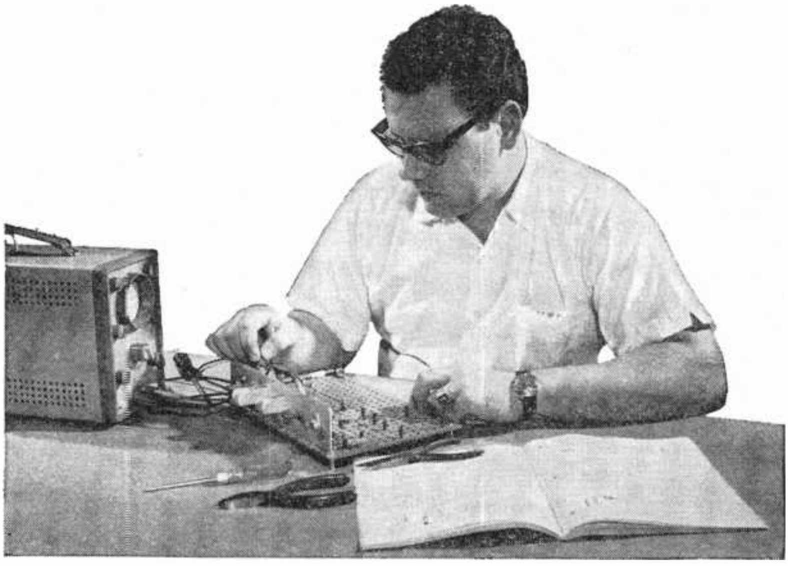

Performing transistor experiments on programmed breadboard — using oscilloscope

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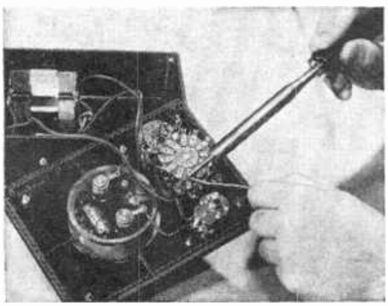
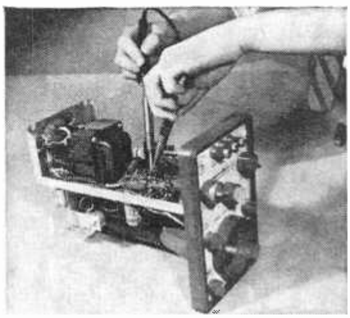
**RCA**

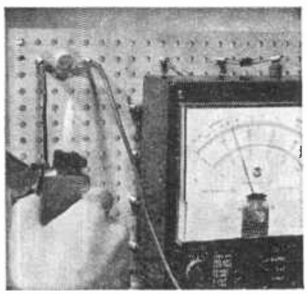
Construction of Multimeter.





Construction of Oscilloscope.

Temperature experiment with transistors.



listed, remembering that the left-most bit is the sign of the number.

(i) 00111 ________

(j) 11001 ________

(k) 10011 ________

**Binary Addition With Negative Numbers.** As was mentioned earlier, the selection of two's complement form for negative numbers means that no special circuitry is required to manipulate them. In other words, the addition of positive and negative numbers is performed exactly as was shown above. For example, the addition of five and minus one would be:

| | |
|---|---|
| carries | 11111 |
| five | 00101 |
| minus one | +11111 |
| four | 00100 |

In this case, the carry out of the left-most bit is simply discarded.

Interestingly enough, if the addition results in a negative total, no extra work is required either. For example, the sum of minus five and one is:

| | |
|---|---|
| carries | 11 |
| minus five | 11011 |
| one | +00001 |
| minus four | 11100 |

That 11100 is minus four can be verified by inverting 00011 and adding 1 (00100).

A final example would be minus five plus minus one:

| | |
|---|---|
| carries | 11111 |
| minus five | 11011 |
| minus one | +11111 |
| minus six | 11010 |

Again, the left-most carry is discarded.

**Binary Subtraction.** We have seen how binary addition works, that "carries" are produced in much the same way as in the decimal system, and we have defined a truth table that shows how to add two binary digits under all circumstances. Likewise, we could (but will not) develop the mechanics of binary subtraction, with rules for "borrowing," etc. In keeping with this straightforward approach, the older digital computers actually had separate circuitry for performing subtraction. But that is unnecessary.

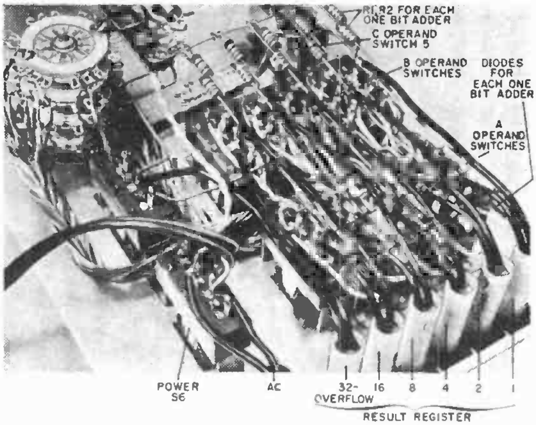
Subtraction can be thought of as the addition of one number with the *negative* of a second number. That is, five minus one is the same as five plus (minus one); or, in general, "x−y" is identical to "x+(−y)." Therefore, today's computers (and the "Binary Adder" as well) perform subtraction by taking the negative of the second operand and then adding the two together. Since we are using two's complement negative numbers, we will perform subtraction by taking the two's complement of the second number, and then adding the two operands together. The

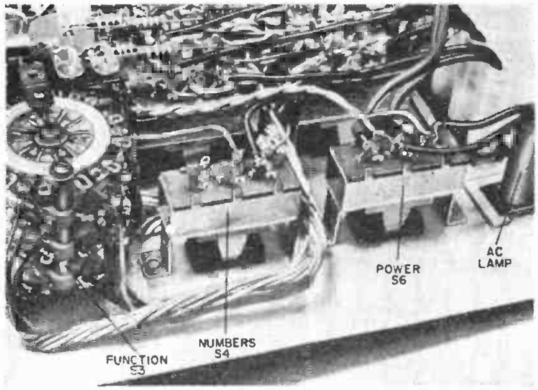
(*Continued on page* 92)

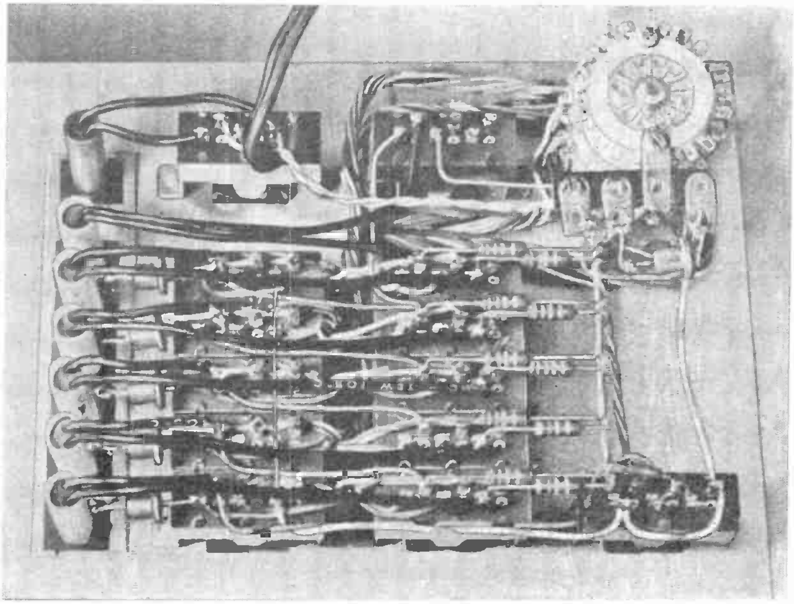
# CONSTRUCTION & APPLICATIONS

No special construction techniques are necessary to build the "Binary Adder." The easiest method is to drill the front panel to accept the various switches and readout lamps before doing anything else. The author used the physical arrangement shown in the photo on page 29, although any other arrangement can be used, depending on the type of switches and lamps you use. A "nibbling" tool was used to make the cutouts for the switches, and dry transfer lettering was used for front-panel marking.

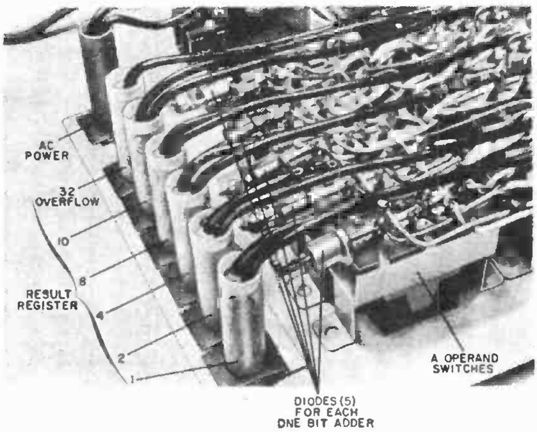
The only requirements for proper layout is that the six readout lamps (RESULT REGISTER) be installed in an equally spaced row across the upper end of the panel, with the "1" indicator at the right and the "32-OVERFLOW" lamp at the left. The five A OPERAND switches should be located sequentially under each readout bulb, starting at the right-hand side; the B OPERAND switches should be located directly under the A OPERAND switches; and the C OPERAND switch should be mounted di-

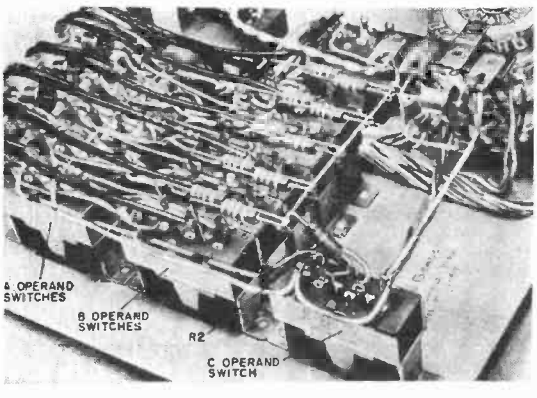


Overall interior view of the Binary Adder is shown at the left. The four photos surrounding this view identify the various components within the circuit. Note the alignment of each A and B Operand switch with its associated Result Register readout indicator.



rectly under the right-hand column (see the photos on pages 29 and 41).

Each OPERAND rocker switch is mounted so that the switch is "off" when the side toward the user is "down." The positions of the other switches and the a.c. indicator lamp are not important. The power transformer and its associated rectifier can be mounted wherever convenient.

Once all components are properly mounted, wire the circuit point-to-point in accordance with Fig. 3. (This figure does *not* detail the repetitive internal circuitry of the five adder stages in Fig. 2 to avoid schematic complexity.) Make sure that all diodes are mounted with the correct polarity, and properly identify the terminals of the OPERAND switches. Note that a 22-pole, 2-position switch is required for the FUNCTION switch; you will have to identify the required contacts and use color-coded wire to avoid mix-ups.

**Initial Checkout.** Once wiring has been completed and checked as to accuracy, the "Binary Adder" should be tested. Plug the unit into a source of 117-volt a.c. and turn the POWER switch ON—the red a.c. indicator lamp should come on. Place the NUMBERS switch (*S4*) in the 5 BITS position and the FUNCTION switch in ADD. With the A, B, and C OPERAND switches all set to zero (or down), the RESULT REGISTER indicator lamps should all be off.

Working with a single bit at a time, try the following operations:

| | (a) | (b) | (c) | (d) |
|---|---|---|---|---|
| A OPERAND | 0 | 0 | 1 | 1 |
| B OPERAND | 0 | 1 | 0 | 1 |
| C OPERAND | 0 | 0 | 0 | 0 |
| RESULT REGISTER | 0 | 1 | 1 | 0 plus carry out |

"Carry out" is indicated by the next light (to the left) coming on. For example, if the "2" digit position is being tested, carry out is signaled by the "4" lamp coming on. As a test of the carry circuitry, perform the following addition:

| | | | | | | |
|---|---|---|---|---|---|---|
| A OPERAND (21) | | 1 | 0 | 1 | 0 | 1 |
| B OPERAND (10) | | 0 | 1 | 0 | 1 | 0 |
| C OPERAND (1) | | | | | | 1 |
| RESULT REGISTER (32) | 1 | 0 | 0 | 0 | 0 | 0 |

If the above tests are good, the subtract operation can be checked. Place the FUNCTION switch in the SUB(tract) position and perform the following operations:

| | (a) | (b) | (c) |
|---|---|---|---|
| A OPERAND | 11111 | 00000 | 00000 |
| B OPERAND | 11111 | 00000 | 00001 |
| C OPERAND | 0 | 1 | 0 |
| RESULT REGISTER | 000000 | 111111 | 111111 |

As a final check, place the NUMBERS switch in the 4 BITS + SIGN position and perform the following operations:

(a)

| | |
|---|---|
| A OPERAND (+5) | 00101 |
| B OPERAND (sub. −6) | 11010 |
| C OPERAND | 0 |
| RESULT REGISTER (+11) | 01011 |

(b)

| | |
|---|---|
| A OPERAND (−16) | 10000 |
| B OPERAND (sub. +2) | 00010 |
| C OPERAND (sub. +1) | 1 |
| RESULT REGISTER | 01101 + OVERFLOW |

In the (b) example above, the expected result of −19 exceeds the limitations of the "Binary Adder" (which is restricted to the range of +15 and −16 inclusive) so that the OVERFLOW indi-

(*Continued on page* 92)

## CONTROLS AND INDICATORS

**NUMBERS Switch** This s.p.d.t. switch changes the arrangement of the RESULT REGISTER indicator lamps. When it is in the "4 BITS + SIGN" position, the left-most bit is considered as the sign bit, so that the A and B OPERANDS may be positive or negative. When it is in the "5 BITS" position, no sign bit is used, so the left-most bit has the place value of sixteen; and only positive operands may be entered.

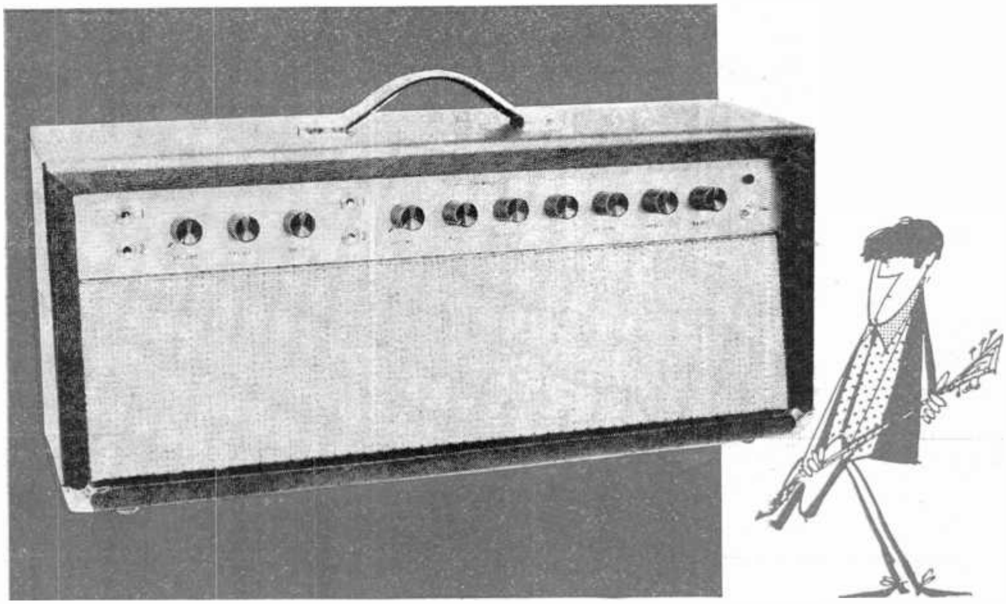
**FUNCTION Switch** This switch selects either an "ADD" or "SUB" (subtract) function.

**A OPERAND Switches** A set of five d.p.d.t. switches used to insert one five-bit binary number.

**B OPERAND Switches** A set of five d.p.d.t. switches used to insert a second five-bit binary number.

**C OPERAND Switch** A single d.p.d.t. switch with which a binary 1 may be added or subtracted from the total.

**RESULT REGISTER Indicator Lamps** A set of six neon indicator lamps which display the sum or difference of the "A, B, or C OPERANDS." A turned-off lamp indicates a binary 0, while a glowing lamp indicates a binary 1.



BUILD THE

# M/M/M Instrument Amplifier

## 60-WATT SOLID-STATE GUITAR AMPLIFIER WITH TREMOLO, REVERB, AND FUZZ

**PART 1**

**BY DANIEL MEYER**

HOW WOULD YOU like to build a custom sound system for your electric guitar with the exact controls and features that you want? Or, if you are satisfied with your present arrangement, how would you like some "add ons"—such as controllable fuzz, tremolo, and reverb, that can very easily be hooked up to your system? If you already have a relatively low power amplifier, how about a clean 60-watt booster so that you can be heard?

If desired, the entire system can be built "from scratch" for about $85, and will have features not found in most professional units which cost many times as much. It even includes a high-quality straight preamplifier for vocals or voice announcements.

The M/M/M (Mix, Match, Musical) Instrument Amplifier is built on four printed boards each of which can be made or purchased as a complete kit, so circuit duplication will present no problem. To put the icing on the cake, the entire system has been tested over a period of eight months by a professional combo and has aroused much comment. Circuit reliability has proven excellent.

**Power Amplifier.** The power amplifier circuit, shown in Fig. 1, uses five silicon transistors to insure maximum temperature stability. The two power output transistors, *Q4* and *Q5*, are complementary types, as are drivers *Q2* and *Q3*. These four transistors form a class-B, push-pull, emitter-follower power ampli-

## POWER AMPLIFIER PARTS LIST

*C1, C3—10-µF, 15-volt electrolytic capacitor*
*C2—200-µF, 6-volt electrolytic capacitor*
*C4—50-µF, 25-volt electrolytic capacitor*
*C5—4000-µF, 50-volt electrolytic capacitor*
*D1, D2—1N3754 diode*
*D3—Silicon bias diode (1N645 or similar)*
*Q1, Q3—MM4005 transistor (Motorola)*
*Q2—MM3005 transistor (Motorola)*
*Q4—SJ3507 transistor (Motorola)*
*Q5—MJ2802 transistor (Motorola)*
*R1—10,000-ohm, ½-watt resistor*
*R2, R3, R4, R9—4700-ohm, ½-watt resistor*
*R5—68,000-ohm, ½-watt resistor*
*R6—220-ohm, ½-watt resistor*
*R7—50,000-ohm trimmer potentiometer*
*R8—47-ohm, ½-watt resistor*
*R10—2200-ohm, ½-watt resistor*
*R11, R12—470-ohm, ½-watt resistor*
*R13, R14—0.27-ohm, 5-watt resistor*
*SPKR—4-ohm, 60-watt capability speaker*
*Misc.—Heat sink, diode clamps (2), mica insulating washers (2), mica transistor insulator, silicone grease, mounting hardware, etc.*

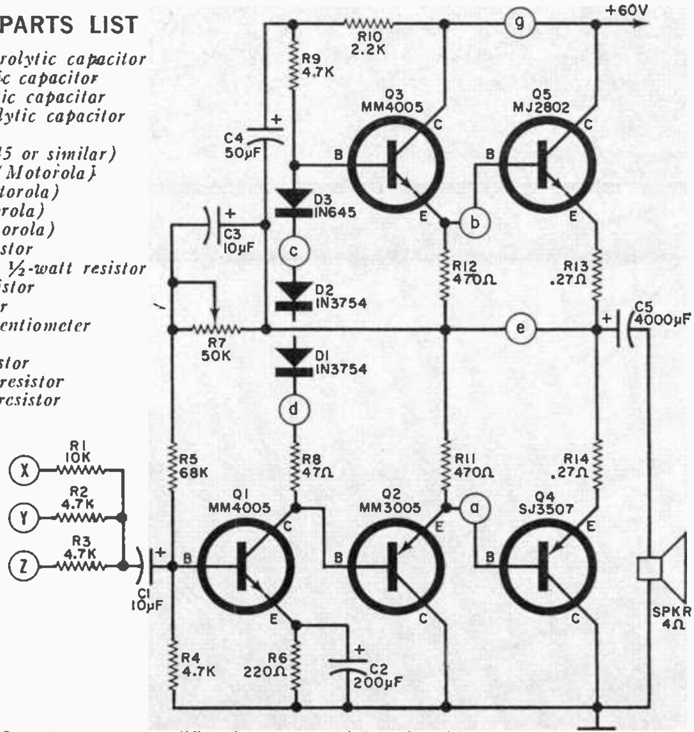



Fig. 1. This 60-watt power amplifier is a true hi-fi unit with response from 20 Hz to over 50 kHz. It can be built separately and used as a power booster for any instrument (or audio) system.

fier that provides exceptionally clean output at high power and low cost. The first stage, *Q1*, is a conventional voltage amplifier.

Diodes *D1*, *D2*, and *D3* are connected between the bases of the driver stages and provide forward bias to turn the output transistors slightly on to prevent crossover distortion. Two of these diodes (*D1* and *D2*) are clamped to the output transistors' heat sink so as to stabilize the forward bias for any variations in operating temperature of the output power transistors.

Power output is a continuous 60 watts, corresponding to a peak music power rating of about 140 watts. Frequency response is from 20 Hz to at least 50 kHz, and the amplifier is designed to supply any 4-ohm speaker that can carry the power. Two 8-ohm speakers, each having at least a 35-watt rating can be used connected in parallel.

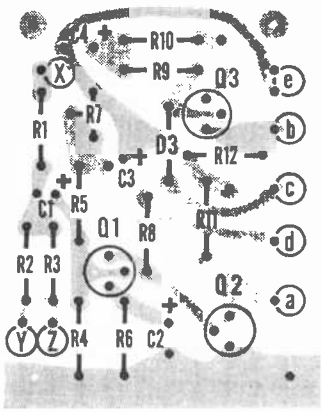
The power amplifier, with the exception of the two output transistors (*Q4* and *Q5*), their associated diodes (*D1* and *D2*), emitter resistors *R13* and *R14*, and output capacitor *C5*, is assembled on a printed board such as that shown actual size in Fig. 2. Components are affixed to the board as shown in Fig. 3. The letter-coded connections in Fig. 3 correspond to those in Fig. 1 for wiring to the external components.

The two power transistors are mounted on the heat sink, with a mica insulating sheet and insulating washers used on *Q5* only. Use a thin coating of silicone grease on both sides of the mica insulator sheet, and on the bottom of both transistors so as to make a good thermal bond between the transistors and the heat sink. One mounting screw of each power transistor should also secure a diode clamp. Insert one 1N3754 diode in each clamp, then tighten the screws. (The author's assembly is shown in Fig. 4.)

Make sure that diodes *D1* and *D2* are correctly wired into the circuit by ob-

Fig. 2. Actual-size printed board for amplifier. The two power transistors and associated components are mounted externally due to their heat dissipation.

Fig. 3. Install the board components as shown. The letter designations correspond to those in Fig. 1.




serving that a red dot on each diode case identifies the cathode of the diode. Failure to wire these diodes correctly may damage the power transistors.

Once the heat sink assembly has been completed, it can be wired to the printed board (see Fig. 1). The two emitter resistors (*R13* and *R14*) and output capacitor *C5* are mounted elsewhere on the chassis.

In testing the power amplifier, use a 60-volt power supply, preferably the one designed for this circuit and covered in Part 2 of this article. Connect a voltmeter to the junction of *R13* and *R14* (or point "e" on the circuit board), and adjust trimmer *R7* for half the power supply voltage (about 30 volts). If you have a sine-wave audio generator and oscilloscope, drive the amplifier to full output with a 4-ohm load connected and adjust trimmer *R7* for symmetrical clipping of both sides of the sine wave.

**Instrument Preamplifier.** The major difference between a preamplifier designed for a hi-fi system and one designed for an instrument amplifier is that in the latter case there is no need for equalization, and a greater dynamic range must be handled. A recording seldom has more than a 40-dB dynamic range (due to the limitations of the tape or record being used). However, this limitation is not placed on a musical instrument, and the preamplifier must be capable of handling

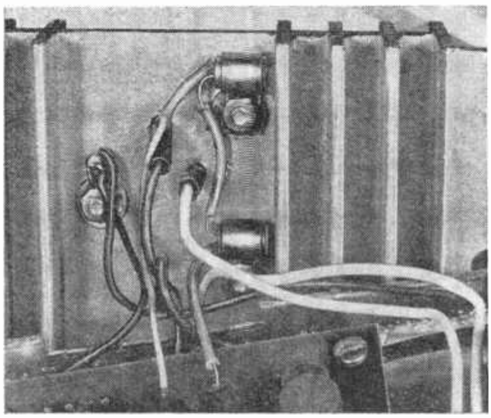


Fig. 4. Diodes D1 and D2 are thermally coupled to Q4 and Q5 by means of a heat sink and diode clamps.

in excess of 60 dB dynamic range during operation. It must also be capable of handling signals from a millivolt up to a volt or so without overloading or clipping.

The main circuit, shown in Fig. 5, makes a very useful instrument preamplifier and incorporates a number of circuits not usually found in most preamps. Besides the usual bass and treble tone controls, this preamp features a built-in fuzz and tremolo circuit.

The first stage (*Q1*) is a common-emitter amplifier directly coupled to an emitter follower output stage (*Q2*). The

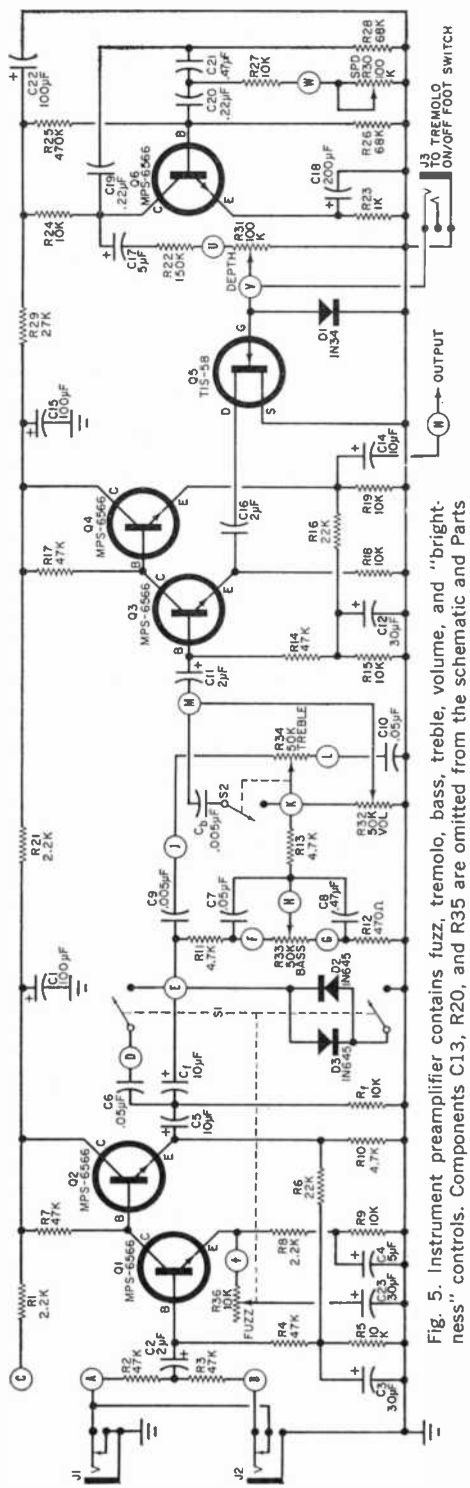



Fig. 5. Instrument preamplifier contains fuzz, tremolo, bass, treble, volume, and "brightness" controls. Components C13, R20, and R35 are omitted from the schematic and Parts List since they are not used here but in the straight preamp which is built on a similar board.

two inputs are fed to *Q1* through isolation resistors *R2* and *R3* wired so that they will be in parallel only when *J1* is being used. The emitter circuits of *Q1* and *Q2* contain the fuzz arrangement.

When "Fuzz" level control *R36* is rotated from its off position, switch *S1* operates. One pole of this switch introduces a pair of clipping diodes (*D2* and *D3*) into the audio circuit. The other pole introduces a parallel coupling capacitor (*C6*) into the interstage coupling. This switching does two things to the signal: first, the diodes clip all signals that exceed one-volt amplitude; second, all low-frequency signals are attenuated and given a sawtooth shape. As *R36* is rotated, the amount of unbypassed emitter resistance in the *Q1* circuit is reduced and the stage gain is increased, which, in turn, increases the amount of clipping and distortion caused by the diodes. This type of variable fuzz is far more versatile than the more conventional fixed fuzz.

## INSTRUMENT PREAMPLIFIER PARTS LIST

*C1, C15, C22—100-µF, 50-volt electrolytic capacitor*
*C2, C11, C16—2-µF, 15-volt electrolytic capacitor*
*C3, C12, C23—30-µF, 6-volt electrolytic capacitor*
*C4, C17—5-µF, 15-volt electrolytic capacitor*
*C5, C14—10-µF, 25-volt electrolytic capacitor*
*C6, C7, C10—0.05-µF capacitor*
*C8, C21—0.47-µF capacitor*
*C9, Cb—0.005-µF capacitor*
*C18—200-µF, 6-volt electrolytic capacitor*
*C19, C20—0.22-µF capacitor*
*Cf—10-µF, 15-volt electrolytic capacitor*
*D1—1N34 or similar germanium diode*
*D2, D3—1N645 or similar silicon diode*
*J1, J2—Closed-circuit phone jack*
*J3—3-conductor phone jack*
*Q1, Q2, Q3, Q4, Q6—MPS6566 transistor (Motorola)*
*Q5—TIS58 field-effect transistor (Texas Instruments)*
*R1, R8, R21—2200 ohms*
*R2, R3, R4, R7, R14, R17—47,000 ohms*
*R5, R9, R15, R18, R19, R24, R27, Rf—10,000 ohms*
*R6, R16—22,000 ohms*
*R10, R11, R13—4700 ohms*
*R12—470 ohms*
(R1 through R12 above: *all ½-watt resistors*)
*R22—150,000 ohms*
*R23—1000 ohms*
*R25—470,000 ohms*
*R26, R28—68,000 ohms*
*R29—27,000 ohms*
*R30, R31—100,000-ohm linear potentiometer*
*R32, R33, R34—50,000-ohm potentiometer*
*R36—10,000-ohm CCW log taper potentiometer*
*S1—D.p.s.t. switch (on R36)*
*S2—S.p.s.t. switch (on R34)*

Fig. 6. Actual-size printed board for assembly of instrument preamplifier. The preamp can also be used independently with any instrument audio system.

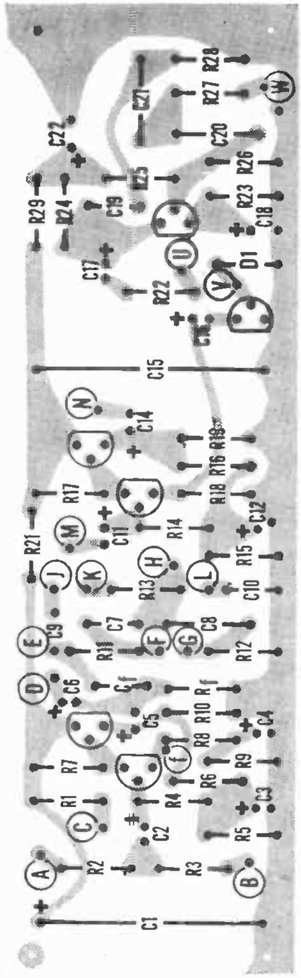


Fig. 7. Component layout for instrument preamplifier. Components Rf and Cf determine the degree of fuzz, and may be varied in value from those shown.

The signal from *Q2* is then passed through a bass and treble tone control circuit (15 dB cut or boost) before it is further amplified by *Q3*. There is one unique feature about the treble control used here. When switch *S2* is activated, capacitor $C_b$ is introduced to bypass the high-frequency sound around volume control *R32*. Introducing this capacitor in the circuit produces a "bright" signal that is a type of fixed treble boost. Although switch *S2* is shown coupled to *R34*, it can be an independent switch.

The output signal at the collector of *Q3* is directly coupled to emitter-follower *Q4*, from which it is fed to the power amplifier. However, the built-in tremolo is introduced at the emitter of *Q3*.

The tremolo circuit consists of *Q3*'s emitter bypass capacitor (*C16*) in se-

(*Continued on page* 99)

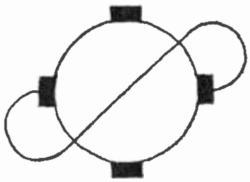
# *Electronic "A" Quiz*

BY ROBERT P. BALIN

Electronic technicians and hobbyists must learn the meaning of many technical terms related to their work. Illustrated below are 10 such terms having nothing in common except that they all begin with the letter "A." Test your knowledge of electronic terminology by filling in the missing letters.

(*Answers appear on page* 98)

1



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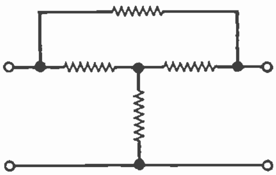

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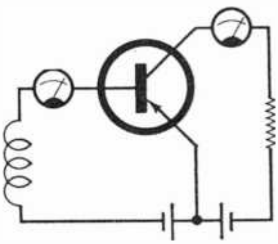

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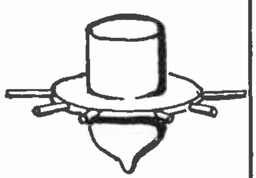

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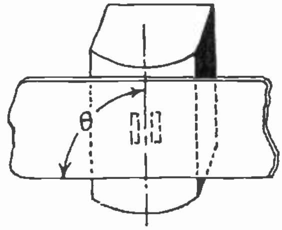


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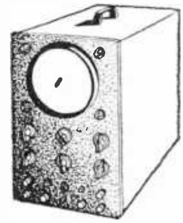

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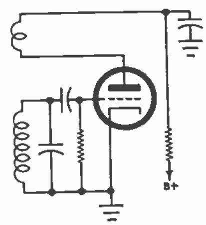


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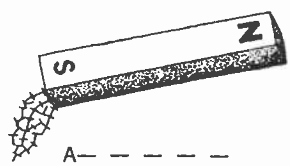


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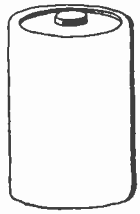

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# PROGRAMMED INSTRUCTION

## DOES IT WORK FOR EVERYONE?

*by*

EDWARD A. LACY

*Introducing*

**A DRAMATIC NEW STUDY TECHNIQUE**

*Book by*

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ALL THE BUDDING YOUNG ELECTRONICS ENGINEERING TECHNICIANS

### Careers in Electronics

THE NEWEST TOOL of the education innovators—programmed instruction—is coming to the aid of the electronics correspondence or home study institute. If you study at home, programmed instruction (PI) promises to make it easier and faster for you to learn almost any subject (including electronics), and to retain more of what you learn for a longer time than with other study techniques.

Programmed instruction is theoretically *the* most effective home study technique. Students using PI materials need neither the help of a teacher nor additional textbooks. In fact, the philosophy of the people who prepare PI materials is: "If you don't understand a topic or point after reading it in a PI book, you're not to blame—it's the fault of the person who wrote it."

Many names have been given to PI materials. Regardless of what name is applied to them, however, you can recognize PI materials by their carefully-worded, bite-size bits of information. These bits are usually arranged in such a manner that they force you to focus your attention on them. As a result, the once tedious process of learning becomes almost effortless.

If you find it rough going trying to study from conventional textbooks, it

Careers in Electronics

will be well worth your while to investigate PI books. You will see for yourself at first hand that you have nothing to lose and everything to gain from these new materials.

**What Programmed Instruction Is.** The unique techniques used in programmed instruction evolved from the work of Professor B. F. Skinner, a psychologist at Harvard University. In 1954, Professor Skinner described the first PI course wherein each student reads the same material from start to finish without skipping ahead. His technique is known today as "linear programming," and came about as the result of extensive studies of animal and human behavior and learning habits.

The characteristics of linear programming are small, bite-size bits of information, each of which is followed immediately by a question—and its answer (given on the same page as the question or on the page directly following it). A sample of the linear programming technique is shown on page 51. Each successive bit of information is based on the bits preceding it so that the student is forced to remember what he has learned in earlier frames. (A frame consists of a statement, a question, and an answer.)

SAMPLER OF PI BOOKS ON BASIC ELECTRONICS

**Basic Electronics.** Edited by Jack W. Friedman, Harry G. Rice, and Gerald McGinty, RCA Institutes, Inc. Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Linear program. (Subject material is concerned with basic electricity.) 533 pages. $9.95.

**Basic Electricity/Electronics,** A Programmed Learning Course. By Training and Retraining, Inc. Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206. Five-volume set. Each volume is divided into two-page segments, each covering a single idea. Set includes a total of 1300 pages, and sells for $19.95. Volumes are: Basic Principles And Applications, $4.50; How A.C. And D.C. Circuits Work, $4.50; Understanding Tube And Transistor Circuits, $4.50; Understanding And Using Test Equipment, $4.50; Motors And Generators—How They Work, $4.50.

**D.C. Circuit Principles.** By Training Systems, Inc., and Stanley L. Levine. Published by Hayden Book Co., Inc., 116 West 14 St., New York, N.Y. 10022. Linear program, 246 pages. $3.95.

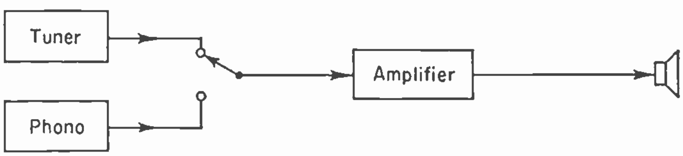
**Introduction To Electronics.** By R.J. Hughes and P. Pipe. Published by Doubleday Book Co., Garden City, L.I., N.Y. 11530. Branching program under trade name "TutorText." 421 pages. $4.95.

**A Programmed Course In Basic Electronics.** By New York Institute of Technology. Published by McGraw-Hill Book Co., 330 West 42 St., New York, N. Y. 10036. Linear program; takes approximately 50 hours to complete. 416 pages. $4.95.

**Electron Tubes At Work,** A TutorText. By James B. Owens and Paul Sanborn. Published by Doubleday Book Co., Garden City, L.I., N.Y. 11530. 557 pages. $6.95.

**A Programmed Course In Basic Electricity.** By New York Institute of Technology. Published by McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036. Linear program; takes approximately 50 hours to complete. 333 pages. $4.95.

In the following diagram, switching a hi-fi amplifier input from "Tuner" to "Phono" is what type of precision check?




Page 94. Moderately precise
Page 106. Very precise; it covers few possibly defective parts
Page 124. Not very precise; it covers many possibly defective parts

This sample page of a scrambled PI textbook appears in "Logical Electronic Troubleshooting" by Donald H. Schuster (page 86). Copyright 1963 McGraw-Hill. Used by permission of the McGraw-Hill Book Company.

How small is a bit of information? To keep the reader's attention focused on the text of PI books in linear programming, each statement is kept as short as possible. The wording is of extreme importance, and every word or phrase that does not directly contribute toward getting the topic or idea across to the reader is painstakingly weeded out. Consequently, a statement can be as short as a single sentence for a simple idea, or it can cover several pages if the subject or topic is of extreme complexity.

Don't mislead yourself into believing that a PI book is one long examination because of the frequent questions asked; this can hardly be true since answers are promptly given. There is a psychologically sound reason for presenting statement, question, answer in rapid-fire order. This technique, many psychologists have found, helps to firmly impress the idea behind each statement in the reader's memory.

It can be shown that making a statement—no matter how long or short—does not in itself cause the reader to remember it. Asking a question about the statement at once, however, causes the reader to think about what he has read. And, to finally impress the essence of the statement indelibly in the reader's mind, the answer is immediately given. If the reader's response to a given question is correct, knowing he is correct will force it home. If he gave an incorrect response, the reader is more likely to go back over the material to see where he went wrong.

Now compare PI's linear programming technique with textbook techniques. With

---

## SET 41 Common-Emitter Amplifier: Voltage Gain

•

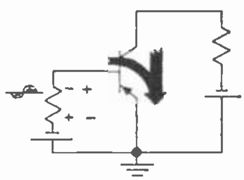
stronger, larger
greater

**41-1** An important application of the common-emitter circuit is in devices requiring a voltage gain. By voltage gain, we mean that the output signal voltage is ______________ than the input signal voltage.

•

less

**41-2** Let us now determine how voltage gain occurs. An a-c signal alternately drives the base more negative and ______________ negative.



•

(1) and (2) increases, decreases *or* aids, opposes

**41-3** The varying base-to-emitter voltage alternately (1) ______________ and (2) ______________ the forward base bias.

•

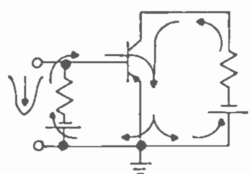
varies, changes

**41-4** The varying base bias ______________ the resistance of the base-emitter junction.

•

change, vary

**41-5** When the resistance of the base-emitter junction changes, the base current and the collector current must ______________.



Sample from a linear programmed PI book. RCA Service Company, "Fundamentals Of Transistors: A Programmed Text" © 1966 (page 121). Reprinted by permission of Prentice-Hall, Inc., Englewood Cliffs, N. J.

Careers In Electronics

conventional study books, the reader is forced to wade through an entire chapter before he is asked a question about what he has learned. If a chapter is sufficiently long, he will have forgotten most of what he has read; so to answer all the review questions, he may have to reread the chapter several times. Then, he may have to look in another section of the book for the answer key—if the book contains the answers.

All of this is time-consuming, boring, and frustrating. Behavioral psychologists feel that a delay of even a few seconds between statement, question, and answer tends to spoil the learning effect.

Anyone who studies by means of conventional techniques doesn't know what kind of progress he is making. He generally has to wait until he attempts to answer the review questions at the end of each chapter before he realizes that he missed an important point. This is not the case with PI books; the student knows exactly what his progress is at all times. If he misses a point anywhere in a PI book, he has to stop and immediately retrace his steps; there is no point in going on since that will only compound the problem.

In addition to linear programming, there are at least two other techniques used in PI books available at present. Although linear programming is by far the most popular, "intrinsic" or "branching" programming is preferred by many students. A third type—adjunctive programming—is also being tried.

The big difference between linear and branching programming is the makeup and arrangement of each frame. While linear frames are short and concise, the branching technique uses more wordy statements, generally has multiple-choice questions following the statement, and each choice directs the reader to a different page in the book to tell him whether he is correct or incorrect. If an incorrect response is given, the reader is also told what page to refer back to so that he can determine where he went astray.

The pages in the branching programmed book are intermixed, or scrambled, making it impossible for the reader to make any sense out of the text if he were to read each page in numerical order. In any case, if he should attempt to read the text in this manner, a statement such as: "If you're reading this page, you're not following instructions" would set him straight.

Some people still feel that the small steps used in PI books tend to bore the reader. On the other hand, proponents of PI strongly feel that any subject, no matter how complex, can be broken down into a sufficient number of bite-size pieces to make a program that any reader can easily absorb.

Even so, some experts in the field hesitate to define exactly what programmed instruction is. Allen Calvin, President of Behavioral Research Laboratories cautions, "Just calling materials 'programmed' does not create a true program sequence." But there can be little doubt that PI has caught on and is definitely growing.

**Who Uses PI.** When PI first appeared on the scene in the mid-1950's, it was loaded with fancy teaching machines and a lot of sales double-talk. A few salesmen went so far as to promise school administrators that their teaching ma-

SAMPLE PI BOOKS ON SOLID-STATE ELECTRONICS

**Simplified Transistor Theory, A Programmed Text.** By Training Systems, Inc., and Stanley L. Levine. Published by Hayden Book Co., Inc., 116 West 14 St., New York, N.Y. 10011. Linear program. 228 pages. $3.95.

**Transistors.** By Federal Electric Corp. Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Linear program; takes approximately 47 hours to complete. 430 pages. $13.25.

**Fundamentals Of Transistors, A Programmed Text.** By RCA Service Co. Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Linear program; takes approximately 15 hours to complete. 223 pages. $12.00.

**A Programmed Course In Basic Transistors.** By New York Institute of Technology. Published by McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036. Linear program; takes approximately 50 hours to complete. 473 pages. $5.95.

**Special Purpose Transistors.** A Self-Instructional Programmed Manual. By Federal Electric Corp., Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Linear program; takes 8 to 11 hours to complete. 129 pages. $6.75.

chines would eliminate the teacher in the classroom. The teachers who would be affected obviously had strong feelings against PI. But after a few years had elapsed and the wild claims died down, teachers began to accept—and even welcome—the help PI can give in the classroom. There will always be a need for teachers, but PI can make their jobs easier.

Today, teaching machines have all but disappeared; the ones remaining are used on an experimental basis until their worth can be better ascertained. But although the machines are gone, PI textbooks abound. An estimated five million students, from elementary school through college, will use PI materials during 1968. And, although this is a big jump over last year's figure, it is small when compared with estimated future jumps.

A few top men in the education field still feel that PI is a passing fad. But other education officials—as well as large corporations and well-known foundations—continue to study and heavily invest in PI. The Ford Foundation and Carnegie Corporation are among those supplying grants for the investigation and possible utilization of PI materials. The American Management Association and the National Society for Professional Engineers offer PI courses to their membership.

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PI BOOKS ON MATHEMATICS FOR ELECTRONICS

**Math For Electronics.** By Federal Electric Corp. Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Linear program; takes 40 to 60 hours to complete. 640 pages. $11.95.

**Mathematics For Electronics Engineers And Technicians.** Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206. 256 pages. $6.95.

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PI BOOKS ON TROUBLESHOOTING

**Transistor Circuit Troubleshooting Course,** ETR 4423. By General Electric Co., Dept. B, 3800 N. Milwaukee Ave., Chicago, Ill. 60641. 3 volumes, 240 pages. $14.25.

**Logical Electronic Troubleshooting, A Programmed Book.** By Donald H. Schuster. Published by McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036. Scrambled program. 303 pages. $4.50.

**Electronic Troubleshooting, A Self-Instructional Programmed Manual.** By Philco Technical Institute. Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Scrambled program. 274 pages. $10.50.

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Professors at 23 universities have prepared programs that are considered to be "remarkably effective." Through a Programmed Learning Committee, the American Society for Engineering Education has been instructing engineering professors in the preparation and use of PI materials.

At last count, the Air Training Command, the Air Force's training arm, is using a total of 339 PI packages. As a result of the effectiveness attributed to PI techniques, ATC has directed all of its technical training centers to add them to airman training programs.

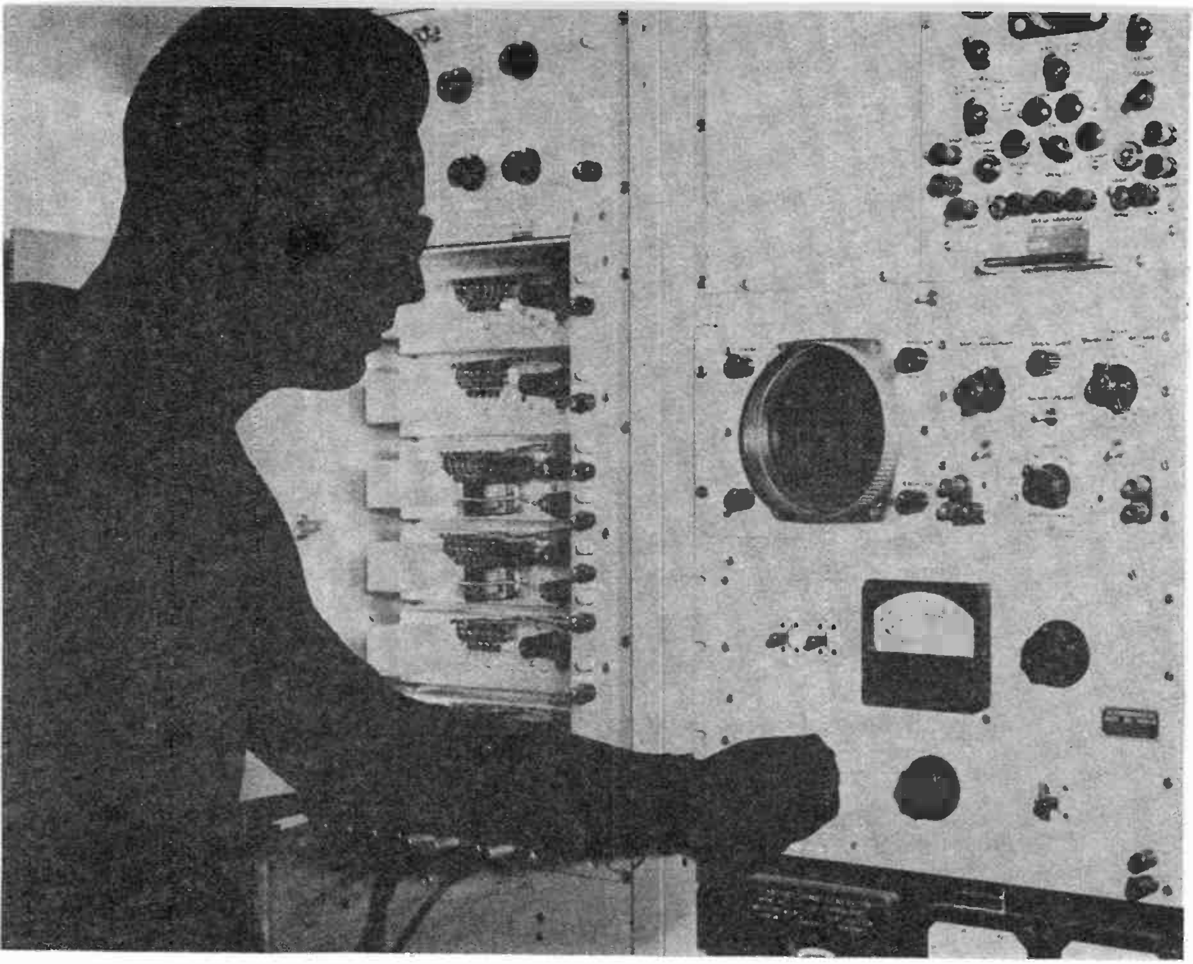
Correspondence schools employ variations of all three PI techniques (linear, branching, and adjunctive). The RCA Institute PI course, "Introduction to Electronics," has been available since 1963. This course is written in a linear programming style called "Auto-Text" by RCA.

Jack W. Friedman, Director of RCA Institutes Home Study School says: "Students learn more quickly with programmed material, and they greatly prefer programmed lessons to the conventional type. However," he adds, "we have no evidence that scholastic results are very much better than those achieved by conventional material. We do not use programmed texts for any other course in the Home Study School primarily because of high costs and long production time."

At International Correspondence Schools, elements of PI are used in several textbooks on different subjects—chiefly to provide a review and drill after the student has gone through a conventional textbook. Since 1964, ICS has offered an electronics fundamentals course in both the PI and conventional formats. In the PI course, the student reads a regular ICS book, then completes a PI study guide for each book. The individual ICS study guides contain up to 500 linear programmed self-instruction frames.

National Technical Schools is developing and marketing a "Programmed Tutor" which introduces the reader to a form of programmed review examinations. According to NTS officials, the "Programmed Tutor" is a modification of the "multiple-branch" linear programming technique.

(*Continued on page* 96)



# The Electronics Technician— His Job and His Future

Careers in Electronics

GUIDANCE FOR THOSE PLANNING TO WORK IN ELECTRONICS AFTER COMPLETING HOME STUDY OR RESIDENT COURSES

BY ELWIN L. LISKE

DURING the past few years, electronics has grown far beyond its traditional limits of radio, television, and commercial broadcasting. At present, almost every industry in the United States uses some form of electronics for day-to-day business. The home, too, is a proving ground for electronic devices and gadgets. And in every consumer and business area, the use of electronics is expected to become even more widespread.

This expansion has caused a growing need for technically trained personnel to produce, maintain, and repair electronic gear. Where will the technically prepared men who are in current demand—and those who will be in even more demand in the future—come from? Are there enough industry-satisfying programs being offered in today's educational institutions? And, finally, where do currently available electronics technicians and trainees fit into the picture?

To obtain the most authoritative answers, these and other questions were put to 15 different companies employing technicians. These 15 companies represented an approximate total of 48,000 employees of which about 6.3% were electronics technicians. The products manufactured by these companies include integrated circuits, communications equipment, electronic kits, vacuum capacitors, aerospace equipment, magnetic recording devices, transmitting tubes, satellite tracking and communications systems, digital and microwave equipment, etc. All of the information garnered from these companies plus technical bulletins provide background material to help you decide whether or not you want to aim for a technical career in electronics.

**Employment Outlook.** According to Department of Labor forecasts for a period extending through 1975, the need for technicians in all categories will continue to increase significantly. In Bulletin #1512 (titled "Technician Manpower: Requirements, Resources, and Training"), the Department states: "Requirements for engineering technicians, the largest technician specialty, are expected to grow from about 309,000 in 1963 to 533,000 in 1975, or about 73%, a rate of increase similar to the rate for all technicians. Because of the relative size of the field, however, more people will be needed to fill openings arising from growing requirements in the engineering technician specialty than in any other specialty."

This forecast was made in 1966, and has already been proved accurate. Each of the companies contacted during the preparation of this article agree that good technicians are hard to find—sometimes even more difficult than engineers.

A number of major companies have representatives who travel throughout the U.S. interviewing interested individuals for possible employment. Quite a few plants indicated that they currently had a large number of vacancies for technicians, and some of the larger companies have in-plant training programs to supplement their technician force. Candidates for in-plant training are chosen from among the unskilled labor force.

Service technicians who repair and maintain consumer goods are also in short supply. The RCA Service Company, for example, recently decided to establish permanent training centers in six key cities. This giant undertaking, the first of its kind in the television industry, will enable RCA to train 2500 TV service technicians in 1968—about double the number trained in 1966. Estimates have been made which indicate that some 25,000 additional color TV service technicians will be needed in each of the next five years to keep pace with expected color TV sales increases during this period. At the present time, every major color TV manufacturer is in dire need of factory service technicians.

**Salaries And Benefits.** Electronics is a highly competitive field, but a good technician is generally assured of premium

### WHAT IS AN ELECTRONICS TECHNICIAN?

The term "technician" has no generally accepted definition. It is used by schools and industry to apply to a wide range of occupations. There is very little correlation between one application and another as to the work performed or educational preparation required.

In general, technicians do work similar to that of scientists and engineers but with greater emphasis on the practical. The technician must be able to solve problems and present written and/or oral reports relative to his work. In addition to his particular specialty, the technician is expected to be quite adept at one or more of the skilled trades. He is not, however, expected to perform with the precision of a craftsman in these areas, but must be familiar with industry machinery, tools, equipment, and processes.

Technicians are normally classified according to the area of specialization—for example, instrumentation, aeronautics, electronics, etc. These classifications are then subdivided to pinpoint the particular work to be performed by the technician.

According to the survey made by the author, there is considerable variation between companies as to electronics technician subcategories. In the majority of the plants contacted, however, there were two basic categories: engineering technician; and production technician. The engineering technician generally works in research and development, assisting the engineers; he is often called on to perform minor design and/or redesign and modification of existing equipment. The production technician usually is concerned with product testing, calibration, checkout, or maintenance of equipment.

Careers in Electronics

salary and excellent fringe benefits. Neither salaries nor benefits are standardized throughout the various electronics industries, but a fairly accurate idea of what you can expect in the way of wages can be obtained from the "Average Pay Scales" table shown below. The table reflects the high and low wages paid by

AVERAGE PAY SCALES

| COMPANY | PER HOUR RATE | |
|---|---|---|
| | LOW | HIGH |
| A | $2.28 | $4.85 |
| B | 2.50 | 5.00 |
| C | 2.75 | 5.00 |
| D | 2.88 | 4.60 |
| E | 3.00 | 4.25 |
| F | 3.10 | 4.85 |
| G | 3.18 | 4.50 |
| H | 3.30 | 5.05 |
| I | 3.57 | 4.12 |

nine of the major aerospace companies on the West Coast, but the figures given can apply as well to salaries in most areas of the country. If engineering technician pay rates were not at the top of all pay scales for non-electronics technicians and skilled tradesmen, they were very near it.

The 40-hour work week appears to be standardized, and suitable pay adjustment is generally made for work done in excess of 40 hours. In some areas of the country—especially in the Northeast—a great many companies have a 35-hour work week, but overtime pay is still based on the 40-hour week.

In addition to base pay, fringe benefits are generally substantial. One company executive estimates that the cash value of the benefits amounts to an additional $1 to $1.25 per hour. Among the more common benefits you are likely to find are profit-sharing plans, the privilege of purchasing company stock, substantial retirement pensions, insurance policies, sick leave, paid holidays and vacations, and educational assistance plans.

The profit-sharing plans are often most attractive, representing a mean of 7% additional pay over gross income. Employees, generally only in the larger companies, have an opportunity to buy company shares at from 25 to 50% off the regular market value of the stocks. The retirement pension plans are usually entirely paid for by the company, and actual benefits received by the employee at retirement depend on length of service with the company. Personal health, accident, life, and disability insurance are almost always paid for—at least in part—by the employer.

Most companies encourage their employees to continue their education by attending adult education classes or taking correspondence courses. To provide an incentive for employees to pursue higher education, many companies will reimburse a good part of the tuition paid by their employees. If a course is job-related, the entire tuition is generally repaid.

At the present time, electronics technicians are held in high regard by the

### JOB DESCRIPTION SHEETS

Most companies use what is termed a "Job Description Sheet" which describes in detail the requirements for a particular job. Such sheets also include information on job qualifications, the work to be performed, equipment to be used, etc. Shown below is the content of a typical job description sheet for a beginning electronics technician.

JOB TITLE: Test Technician

DEPARTMENT: Production

FUNCTIONS AND GENERAL SCOPE OF JOB:

Under moderate supervision, the performance of necessary testing to ascertain that the instruments meet the electrical specifications prescribed by a detailed procedure. Writing reports from test data. Applicant must have the ability to read and understand electronics specification sheets, test procedures, schematics, blueprints, and sketches.

WORKED PERFORMED:

(1) Testing of electronic instruments using standard test equipment such as vacuum-tube voltmeter, power supplies, oscilloscope, and related equipment.
(2) Calibration of instruments by following written test procedures.
(3) Replacement of faulty components when tests indicate malfunctions.
(4) Writing necessary test reports on findings.

QUALIFICATIONS

High school plus one or two years of electronics theory. Basic knowledge of electronics. Work record consistent with high standards of quality, quantity, and attitude. Radio amateur background helpful.

EQUIPMENT USED:

All standard electronic measuring devices such as oscilloscope, frequency meter, vacuum-tube voltmeter, volt-ohm-milliammeter, pulse analyzer, signal generators, etc.

| ELECTRONIC TECHNOLOGY PROGRAM* | | | | |
|---|---|---|---|---|
| COURSES | CLASS HOURS | LABORATORY HOURS | OUTSIDE STUDY HOURS | TOTAL HOURS |
| FIRST SEMESTER | | | | |
| Physics for Electronics I (Electricity) | 3 | 6 | 6 | 15 |
| Technical Mathematics I (Algebra & Trigonometry) | 5 | | 10 | 15 |
| Electronic Devices | 3 | 6 | 6 | 15 |
| Communication Devices | 3 | | 6 | 9 |
| TOTAL | 14 | 12 | 28 | 54 |
| SECOND SEMESTER | | | | |
| Physics for Electronics II (Mechanics, Heat) | 3 | 3 | 6 | 12 |
| Technical Mathematics II (Applied Calculus) | 4 | | 8 | 12 |
| Circuit Analysis, A.C. & D.C. | 3 | 6 | 6 | 15 |
| Electronic Amplifiers | 3 | 6 | 6 | 15 |
| TOTAL | 13 | 15 | 26 | 54 |
| THIRD SEMESTER | | | | |
| Instruments and Measurements | 3 | 6 | 6 | 15 |
| Communication Circuits | 3 | 6 | 6 | 15 |
| Introduction to Computers | 4 | 3 | 8 | 15 |
| Technical Reporting | 2 | | 4 | 6 |
| Drawing, Sketching, and Diagramming | | 3 | | 3 |
| TOTAL | 12 | 18 | 24 | 54 |
| FOURTH SEMESTER | | | | |
| Control Circuits and Systems | 3 | 3 | 6 | 12 |
| Communication Systems | 3 | 3 | 6 | 12 |
| Electronic Design and Fabrication | 1 | 5 | | 6 |
| Introduction to New Electronic Devices | 2 | | 4 | 6 |
| General and Industrial Economics | 3 | | 6 | 9 |
| Industrial Organizations and Institutes | 3 | | 6 | 9 |
| TOTAL | 15 | 11 | 28 | 54 |

**U.S. Department of Health, Education and Welfare, "Electronic Technology: A Suggested 2-Year Post High School Curriculum"*

industries which employ them. Most companies regard their technicians as professional men, rather than tradesmen, giving the technician a greater degree of freedom and opportunity for initiative and advancement.

**Education.** The byword of the electronics industries is education . . . and more education. Although a tremendous need for technicians exists, the various industries still carefully screen applicants for technical positions. The decision as to whether a company hires or does not hire you depends on your technical and practical education.

A technical education generally has its roots in high school mathematics and sciences. On this score, the Electronics Industries Association points out that graduation from high school is important, and the student should take as many courses in math and science as his school has to offer. The industrial arts—such as radio, electronics, drafting and blueprint reading, sheet metal work, and machine shop work—should receive equal attention in your high school education.

Careers in Electronics

## MIDDLE-LEVEL MODEL CURRICULUM*

| COURSE | SEMESTER HOURS | SELECTED TOPICS |
|---|---|---|
| FIRST SEMESTER | | |
| Electronics I | 3 | P-N junction diodes, tunnel and zener diodes, silicon controlled rectifiers, E-I characteristics (diode and transistor) |
| Electrical Principles I | 5 | |
| Mathematics I | 3 | Introduction and review of general mathematics, simple linear equations, algebraic processes, slide rule |
| | 11 | |
| SECOND SEMESTER | | |
| Electronics II | 3 | Transistors (p.n.p. and n.p.n.), current in solid-state devices, E-I characteristics (diode and transistor), dynamic parameters of electronic devices |
| Electrical Principles II | 5 | |
| Mathematics II | 3 | Algebraic processes, elementary topics in geometry and trigonometry, slide rule |
| | 11 | |
| THIRD SEMESTER | | |
| Electronics III | 6 | Transistor multivibrators, transistor amplifiers, feedback effects, filters, regulated power supplies |
| Mathematics III | 3 | Application of number systems, logic systems |
| | 9 | |
| FOURTH SEMESTER | | |
| Electronics IV | 5 | Logic circuits (basic): techniques for triggering, gating, synchronization; techniques for storing and comparing |
| Electronics Specialty | 3 | |
| | 8 | |

**COURSE TOTAL: 39 HOURS**

*Angelo C. Gillie, "Planning Future Content of Electronics Curriculums,"* Technical Education News, McGraw-Hill Book Company, *December, 1966.*

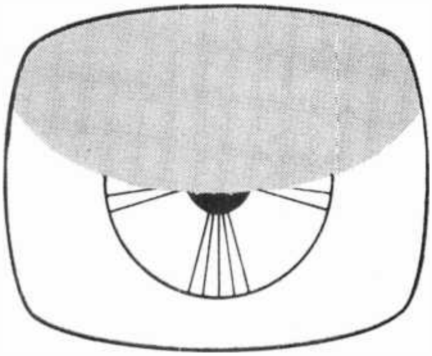
If you are still in high school, make an effort to participate in school science programs and/or radio club activities. In high school or out, keep up with electronics developments by subscribing to and reading magazines, and read new books and technical bulletins. For practical experience, you can join an amateur radio club.

Bear in mind that industry is generally reluctant to hire you unless you have some practical experience in your specialty. Post high school education in a technical school, junior college, college, or military school is preferred. Even then, most companies will put you in a training program to familiarize you with specific pieces of equipment. Remember that as electronics grows so must your technical knowledge.

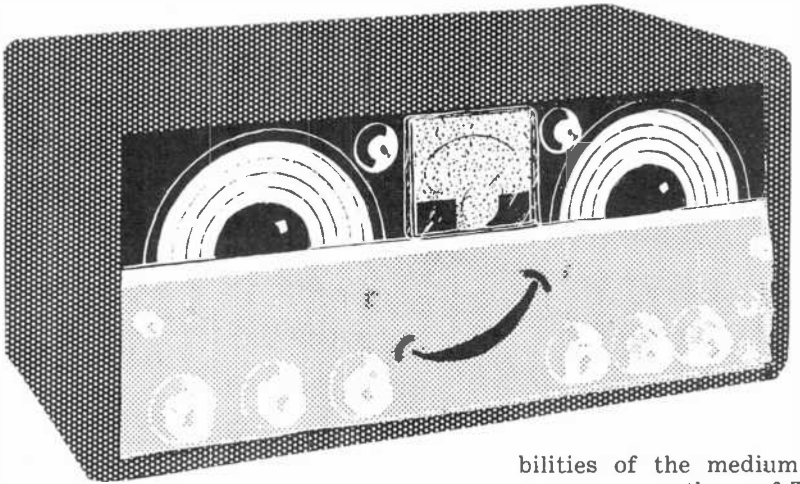
Industry has some very definite views on the type of training a technician should have. Today's technician must have a working knowledge of overlapping fields; he must know and understand basic electronics theory, understand applied physics and basic mechanics, and be able to handle power tools used in fabrication.

In this regard, A. C. Bodeau, manager of the Vehicle Testing Laboratory of the Ford Motor Company has the following to say in the "Technician Edu-

(*Continued on page* 102)



# TIRED OF TV?



# TRY RADIO DRAMA

GIVE YOUR EYES A BREAK AND LISTEN IN ON THE SHORT WAVES

**BY LARRY LISLE, K9KZT**

IN THE last few years there has been a reawakening of interest in "radio drama" in America. It is reflected in the increasing numbers of dramatic programs heard on AM and FM stations, sales of records and tapes of old radio shows, and the publication of several books on the subject.

This current enthusiasm for radio drama can't be classed entirely as nostalgia, for many of the most devoted listeners are too young to remember the golden age of radio. Instead, it evidently stems from an appreciation for the capabilities of the medium, which in some ways surpass those of TV or motion pictures. Which, for example, seemed more realistic: the time machine built for a recent TV series—or the space ships of the invaders from Mars on the Orson Welles radio program of thirty years ago?

Radio stimulates the listener's imagination. Heroes are as heroic and villains as villainous as the listener wants to make them. Settings can be ancient Rome or modern New York with equal ease. On radio, the listener "identifies" and almost becomes a member of the cast.

Twenty years ago, we suffered with "One Man's Family," leaped tall buildings with Superman, and became invisible with the Shadow as we fought the evil lurking in the hearts of men. Today these programs and others like them are becoming available in America more and more.

In many foreign countries, radio drama has never lost its popularity, and is often featured as part of short-wave schedules. With a few exceptions, the programs in the table below are broadcast by the more powerful short-wave stations. So, if all the TV shows are starting to look alike to you, dust off that old console radio in the living room and listen to something different! -30-

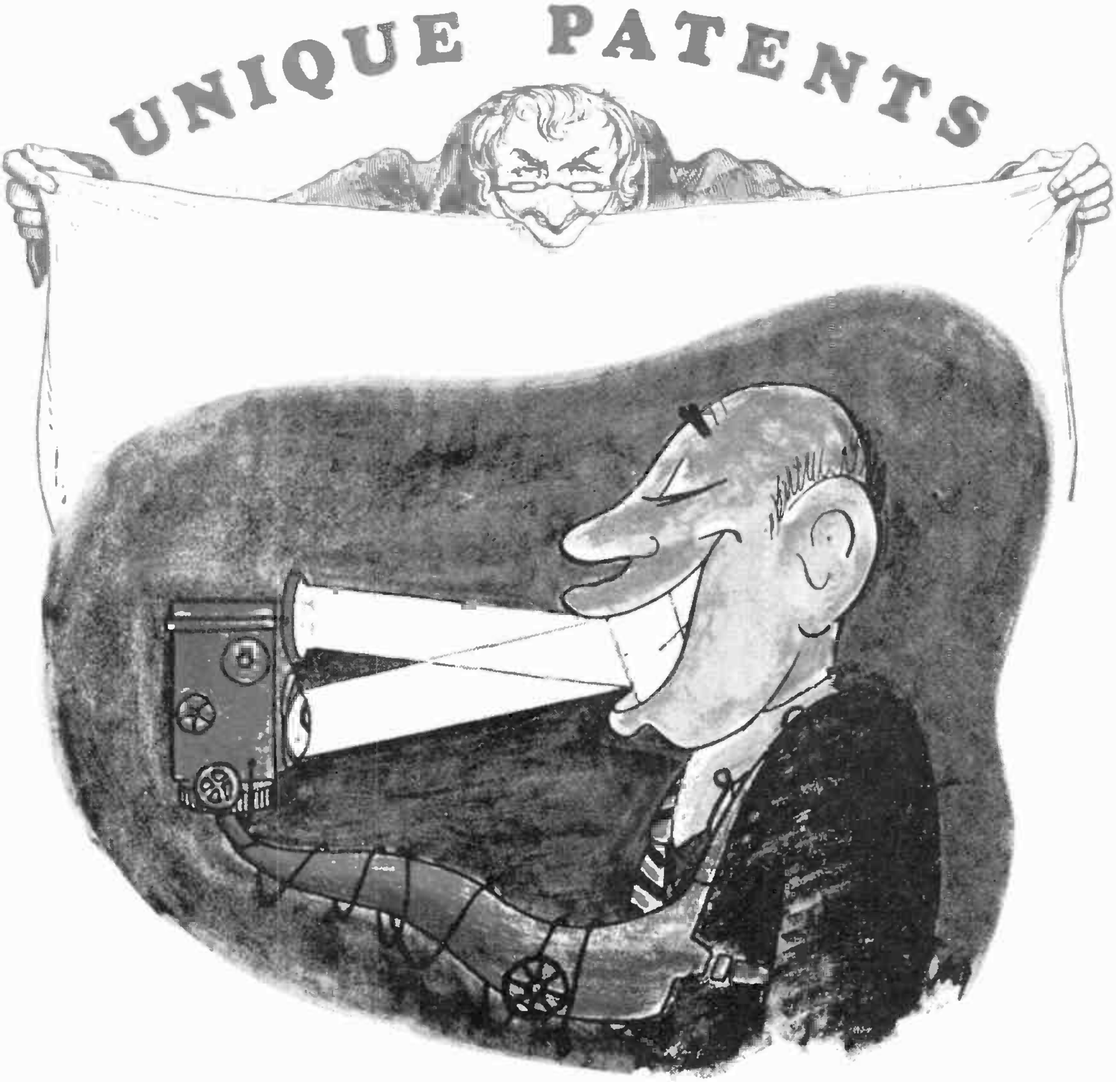
**STATIONS THAT BROADCAST RADIO DRAMA**

| STATION | FREQUENCY (megahertz) | DAY | BROADCAST TIME (EST) | PROGRAM |
|---|---|---|---|---|
| Australian Overseas Service | 15.320, 17.840 | Mondays | 8:05 p.m. | Storyteller |
| Perth Regional Network (Australia) | 9.610 | Sundays | 7 a.m. | Sunday Playbill |
| | 15.425 | Sundays | 7:45 p.m. | Serial |
| | 15.425 | Sundays | 9 p.m. | Serial |
| | 15.425 | Mondays | 7:45 p.m. | Serial |
| | 15.425 | Mondays | 9 p.m. | Serial |
| | 9.610 | Tuesdays | 6:45 a.m. | National Radio Theatre |
| | 15.425 | Tuesdays | 7:45 p.m. | Serial |
| | 15.425 | Tuesdays | 9 p.m. | Serial |
| | 15.425 | Wednesdays | 12:30 a.m. | Story Time |
| | 15.425 | Wednesdays | 7:45 p.m. | Serial |
| | 15.425 | Wednesdays | 9 p.m. | Serial |
| | 15.425 | Thursdays | 12:40 a.m. | Stories for the Junior Listener |
| | 9.610 | Thursdays | 8:15 a.m. | Thursday Night Feature |
| | 15.425 | Thursdays | 7:45 p.m. | Serial |
| | 9.610 | Fridays | 6:45 a.m. | Encore |
| Station CBL (and other Canadian Broadcasting Corp. medium-wave affiliates) | 0.740 | Sundays | 2:03 p.m. | CBC Stage |
| | | Tuesdays | 10:30 p.m. | Anthology |
| | | Tuesdays | 11:03 p.m. | Introducing |
| | | Wednesdays | 9:03 p.m. | Midweek Theatre |
| | | Fridays | 7:03 p.m. | Adventure Theatre |
| | | Fridays | 9:30 p.m. | Mystery Theatre |
| | | Saturdays | 8:30 p.m. | A Touch of Greasepaint |
| British Broadcasting Corp. World Service | 6.110, 9.580, 11.865, 15.140 | Sundays | 8 p.m. | Drama Series |
| | | Mondays | 9:15 p.m. | Serial |
| | | Wednesdays | 6:15 p.m. | World Theatre |
| | | Wednesdays | 8 p.m. | Short Story |
| | | Saturdays | 7:30 p.m. | Theatre of the Air |
| Radio RSA (Rep. of South Africa) | 9.705, 11.875, 15.220 | Sundays | 7 p.m.* | 300 Years in Africa |
| | | Mondays | 7 p.m.* | Bantu Fireside Tales |
| | | Saturdays | 7 p.m.* | Stories of the Veld |
| Voice of America (beamed to Latin America) | 11.885, 11.955, 15.250, 9.650,** 9.565** | Sundays | 8:15 p.m. | American Short Story |
| | | Wednesdays | 6:15 p.m. | Short Stories |
| | | Saturdays | 10:00 p.m. | American Musical Theatre |
| Voice of America (beamed to Europe) | 5.960, 15.205 | Sundays | 11:15 a.m. | American Short Story |
| | | Sundays | 1:15 p.m. | American Short Story |
| | | Sundays | 4:15 p.m. | American Short Story |
| | | Wednesdays | 9:15 a.m. | Short Stories |
| | | Wednesdays | 12:15 p.m. | Short Stories |
| | | Saturdays | 9:30 a.m. | American Musical Theatre |

**Repeated at 7 p.m., local time, for all zones; higher frequencies to East Coast, lower frequencies to West Coast*

***These frequencies are in use after 8:30 p.m.*

ELECTRICAL/ELECTRONIC INVENTIONS OF PARTICULAR NOTE




# Electronic Lip Reader

Invented by E. G. Nassimbene Patented June 29, 1965—No. 3,192,321

Are you interested in becoming the feature attraction of a tooth whitener and brightener TV commercial? Do your friends say that you open your mouth too much? Is your "00" syllable enunciation as good as it should be? If you want to double-check, this is the invention that may hold all the answers. Consisting of one or more miniature light sources, and two, three, or four miniature photocells, it reads out the reflectivity around your mouth, lips, teeth, and tongue. Wonder if the same idea could be applied to reading someone else's lips—what a handy spy device!

# "CIE training helped pay for my new house,"

says Eugene Frost
of Columbus, Ohio

**Gene Frost was "stuck" in low-pay TV repair work. Then two co-workers suggested he take a CIE home study course in electronics. Today he's living in a new house, owns two good cars and a color TV set, and holds an important technical job at North American Aviation. If you'd like to get ahead the way he did, read his inspiring story here.**

IF YOU LIKE ELECTRONICS—and are trapped in a dull, low-paying job—the story of Eugene Frost's success can open your eyes to a good way to get ahead.

Back in 1957, Gene Frost was stalled in a low-pay TV repair job. Before that, he'd driven a cab, repaired washers, rebuilt electric motors, and been a furnace salesman. He'd turned to TV service work in hopes of a better future—but soon found he was stymied there too.

"I'd had lots of TV training," Frost recalls today, "including numerous factory schools and a semester of advanced TV at a college in Dayton. But even so, I was stuck at $1.50 an hour."

Gene Frost's wife recalls those days all too well. "We were living in a rented double," she says, "at $25 a month. And there were no modern conveniences."

"We were driving a six-year-old car," adds Mr. Frost, "but we had no choice. No matter what I did, there seemed to be no way to get ahead."

### Learns of CIE

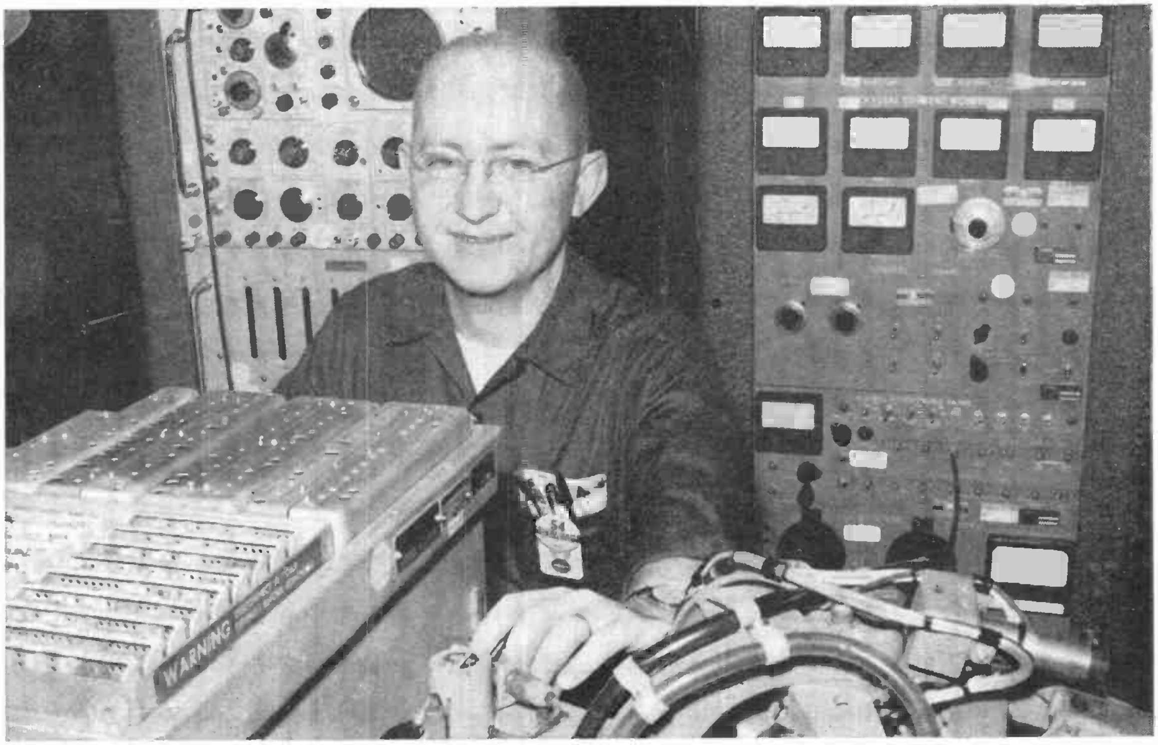
Then one day at the shop, Frost got to talking with two fellow workers who were taking CIE courses... preparing for better jobs by studying electronics at home in their spare time. "They were so well satisfied," Mr. Frost relates, "that I decided to try the course myself."

He was not disappointed. "The lessons," he declares, "were wonderful—well presented and easy to understand. And I liked the relationship with my instructor. He made notes on the work I sent in, giving me a clear explanation of the areas where I had problems. It was even better than taking a course in person because I had plenty of time to read over his comments."

### Studies at Night

"While taking the course from CIE," Mr. Frost continues, "I kept right on with my regular job and studied at night. After graduating, I went on with my TV repair work while looking for an opening where I could put my new training to use."

His opportunity wasn't long in coming. With his CIE training, he qualified for his 2nd Class FCC License, and soon afterward passed the entrance examination at North American Aviation. "You can imagine how I felt," says Mr. Frost. "My new job paid $228 a month more!"




Currently, Mr. Frost reports, he's an inspector of major electronic systems, checking the work of as many as 18 men. "I don't lift anything heavier than a pencil," he says. "It's pleasant work and work that I feel is important."

**Changes Standard of Living**

Gene Frost's wife shares his enthusiasm. "CIE training has changed our standard of living completely," she says.

"Our new house is just one example," chimes in Mr. Frost. "We also have a color TV and two good cars instead of one old one. Now we can get out and enjoy life. Last summer we took a 5,000 mile trip through the West in our new air-conditioned Pontiac."

"No doubt about it," Gene Frost concludes. "My CIE electronics course has really paid off. Every minute and every dollar I spent on it was worth it."

**Why Training is Important**

Gene Frost has discovered what many others never learn until it is too late: that to get ahead in electronics today, you need to know more than soldering connections, testing circuits, and replacing components. You need to really know the fundamentals.

Without such knowledge, you're limited to "thinking with your hands" ...learning by taking things apart and putting them back together. You can never hope to be anything more than a serviceman. And in this kind of work, your pay will stay low because you're competing with every home handyman and part-time basement tinkerer.

But for men with training in the fundamentals of electronics, there are no such limitations. They think with their heads, not their hands. They're qualified for assignments that are far beyond the capacity of the "screwdriver and pliers" repairman.

The future for trained technicians is bright indeed. Thousands of men are desperately needed in virtually every field of electronics, from 2-way mobile radio to computer testing and troubleshooting. And with demands like this, salaries have skyrocketed. Many technicians earn $8,000, $10,000, $12,000 or more a year.

How can you get the training you need to cash in on this booming demand? Gene Frost found the answer in CIE. And so can you.

**Send for Free Book**

Thousands who are advancing their electronics careers started by reading our famous book, "How To Succeed In Electronics." It tells of the many electronics careers open to men with the proper training. And it tells which courses of study best prepare you for the work you want.

If you'd like to get ahead the way Gene Frost did, let us send you this 40-page book free. With it we'll include our other helpful book, "How To Get A Commercial FCC License." Just fill out and mail the attached card. Or, if the card is missing, write to CIE at the address below.

**ENROLL UNDER G.I. BILL**

All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now, check box on reply card for G.I. Bill information.

**CIE**

**Cleveland Institute of Electronics**
1776 E. 17th St., Dept. PE-65
Cleveland, Ohio 44114

Accredited Member National Home Study Council

CIRCLE NO. 14 ON READER SERVICE PAGE

# Megahertz UJT Oscillator

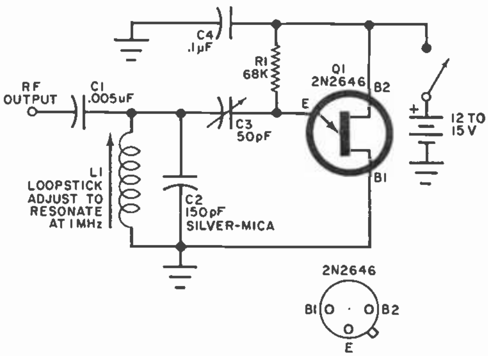
THEY SAID IT COULDN'T BE DONE

BY FRANK H. TOOKER

USED in simple relaxation oscillators, unijunction transistors (UJT's)—particularly those of the inexpensive variety—will not operate very far into the low radio-frequency range. However, the circuit shown at right enables sine-wave output from 2N2646 UJT's at 1 MHz. With selected UJT's of this type, the circuit will continue to operate up to about 1.5 MHz, above which frequency performance is poor.

In the circuit, *L1* and *C2* make up a tuned circuit which is resonated at 1 MHz by adjusting the core of *L1*. Components *C3* and *R1*, in series with *L1-C2*, comprise a relaxation oscillator circuit. Capacitor *C3* charges through *R1*, and when the peak-point emitter voltage of UJT *Q1* appears across *C3*, the UJT fires, discharging *C3* across the *L1-C2* tuned circuit. This sets the tuned circuit into oscillation and, thereafter, the positive-going excursions of the voltage across *L1-C2* add to the voltage across *C3* to fire the UJT.

Conventional UJT's will not operate at 1 MHz—and even selected ones operate poorly at 500 kHz—but at lower submultiples of 1 MHz (333 kHz, 250 kHz, and 200 kHz), the UJT fires dependably. The setting of variable capacitor *C3* determines *Q1*'s firing rate. Thus, by adjusting *C3*, the firing of the UJT can be synchronized (accurately locked-in) with every third, fourth, or fifth cycle of oscillation of the *L1-C2* tuned circuit.




The UJT operates at submultiple of output frequency and shock-excites tank circuit to generate r.f. output. This oscillator circuit can reach 1.5 MHz.

Since a comparatively large voltage is developed across *L1-C2*, the lock-in setting of *C3* isn't especially critical. In practice, all that is necessary is to adjust *C3* to the minimum value of capacitance that will produce a maximum signal at the oscillator's r.f. output terminal. To avoid hand-capacitance effects while you're adjusting *C3*, it is essential that its stator (not the rotor) be connected to the emitter of the UJT.

If you have several UJT's, try each one, for some 2N2646's work better in this circuit than others. The output of the oscillator is at a very high impedance; thus, if it is to be loaded at all, it must be worked into a high impedance to maintain oscillation.

—30—


Careers in Electronics

# Twenty Questions ON GETTING Your FCC License

BY E. F. RICE and ANDREW J. MUELLER

ANY TIME is a good time to prepare for a commercial radio operator's FCC license. But now, while the technician shortage is in full swing, is a particularly advantageous time. The electronics industries need technicians and the communications field in particular needs *licensed* technicians. There are far too many positions open for the available licensed technicians to fill. Those technicians who obtain FCC licenses now, before the manpower shortage eases off, will be in seniority positions and have established well-paying careers when and if a surplus arises.

Employers are willing—and sometimes eager—to pay "top dollar" for the services of the capable licensed technician or operator. In fact, the wages paid to experienced First Class License holders average $10,000 per year. And inexperienced Second and Third Class License holders are receiving very high starting salaries in comparison with the rest of the electronics industries.

In some respects, a First Class Radio Telephone License can be worth a great deal more to you than a college diploma. It can be the key to an interesting and well-paying future—even if you decide not to go into the communications field. The exacting requirements for a license are known to practically all employers.

It will require study time and perse-

### LICENSEE ACTIVITIES

RADIO TELEPHONE LICENSES

**Third Class Operator Permit:** Bearer can operate any type of phone transmitter, under supervision of First Class licensee; is permitted to operate certain classes of broadcast transmitters with Broadcast Endorsement.

**Second Class License:** Licensee may tune and adjust transmitters in Public Safety, Business, and Citizens Bands, and operate certain classes of broadcast transmitters.

**First Class License:** Licensee has all of the above privileges, may also operate all broadcast FM and TV stations.

RADIO TELEGRAPH LICENSES

**Third Class Operator Permit:** Bearer may operate coastal CW stations up to 250 watts and certain low power aircraft transmitters.

**Second Class License:** Licensee may operate all CW stations, operate and maintain ship CW transmitters (after passing Coast Guard Exam for Ship Radio Officer and serving six-month apprenticeship); must take First Aid course before going to sea.

**First Class License:** Licensee must have one year experience as a Second Class Radio Operator; is qualified for chief operator on ship.

**Restricted Radio Telephone Permit.** Bearer may operate ship-to-shore radio under 4 MHz; may not adjust or tune transmitter in any way. (No exam is required. Applicant must be a minimum age of 14 years. Request FCC Form 753; fill in and mail to the Federal Communications Commission, Gettysburg, Pa. 17325.) Apply at any FCC District Office.

verance, but if you have an interest in electronics, an FCC license can take you a great deal further than you might have gone if you remained an unlicensed technician. Career opportunities in communications electronics are wide open. It is even possible for you to work your way up from an operator or maintenance man to occupy an executive position.

If you have been planning to obtain your license, but have been holding back because of a lack of adequate information, the following questions and answers should help clear the air. The twenty questions are those most often asked by prospective licensees.

### Who needs a license?

Anyone who operates or maintains commercial communications transmitters and associated equipment is required by law to possess an FCC license.

### How many types of licenses are there?

The FCC has divided all licensing into two very broad categories—radiotelephony and radiotelegraphy. Special types of communications equipment operation and/or maintenance fall under restricted headings called "endorsements." The telegraphy and telephony licenses are each divided into three classes, with more privileges accorded as you go from third- to second- to first class.

An endorsement is an extra privilege accorded you in addition to the privileges you receive with a given class and type of license. For example, a Second Class Radio Telephone License does not allow operation of a CW transmitter in an aircraft unless you have an Aircraft Telegraphy endorsement.

There are four separate endorsements available: Radar, Aircraft Telegraphy, Broadcast, and Telegraphy.

The privileges accorded for each class and type of license are outlined in the FCC Regulations, Volume I, Part 13, and a brief description is given in most license preparation texts.

### LICENSING REQUIREMENTS

Applicants for commercial radio operator licenses must be citizens of the United States and pass an FCC exam composed of the appropriate elements outlined below.

RADIO TELEPHONE

**Third Class Permit:** Elements 1 and 2
**Second Class License:** Elements 1, 2, and 3
**First Class License:** Elements 1, 2, 3, and 4

RADIO TELEGRAPH

**Third Class Permit:** Elements 1, 2, and 5. Applicant must be able to send and receive 20 words/minute plain language, 16 words/minute Morse code groups

**Second Class License:** Elements 1, 2, 5, and 6. Applicant must be able to send and receive plain language and Morse code groups as for Third Class Permit

**First Class License:** Elements 1, 2, 5, and 6. Applicant must be able to send and receive 25 words/minute plain language or 20 words/minute Morse code groups, be 21 years of age, and have at least one year of experience in public ship or Coast Guard Station using CW.

ENDORSEMENTS

**Radar:** Element 8
**Aircraft Telegraphy:** Element 7
**Broadcast:** Element 9
**Telegraphy:** No exam. Applicant must show proof of at least six months service on ship.

## ELEMENT BREAKDOWN

| ELEMENT | MATERIAL COVERED |
|---|---|
| 1 | Basic radio laws, treaties, and regulations |
| 2 | Basic operating procedures in communication between AM stations |
| 3 | Legal and technical matters for operation of radiotelephony stations other than commercial broadcast stations |
| 4 | Advanced legal and technical matters concerned with operation of broadcast stations |
| 5 | Radiotelegraphy procedures covering communications with radiotelegraph stations but not including maritime mobile |
| 6 | Advanced radiotelegraphy procedure covering technical and legal matters applicable to operation of all radiotelegraphy station classes |
| 7 | Basic theory and practices for operation of radio communications and navigational equipment in general use in aircraft |
| 8 | Specialized theory and practices for servicing and operating ship radar |
| 9 | Basic regulations for operation of commercial and non-commercial broadcast stations |

The material covered in most study guides and all formal courses is divided into nine categories, called "elements" to conform with the FCC's testing procedure. Different combinations of these elements are needed for each class and type of license and endorsement. The elements are of two types: one type is devoted to the FCC Rules and Regulations; the other covers purely technical material.

### How do I prepare for the FCC exam?

There is no "best" method that can be recommended for everyone interested in obtaining a commercial radio operator's license. You can take a resident full-time course in a technical institute that features licensing instruction, you can take a correspondence course, or you can elect to "go it alone" with the help of authoritative textbooks. Whichever method of preparation you choose will depend on your budget, the amount of time you can spend in study, the pace you want to set, and your technical background.

Most people who cannot devote themselves to full-time study benefit from an accredited correspondence course. Only if you have a considerable background in electronics should you attempt to go it alone.

### Is much math required?

If you can transpose equations, use logarithms and powers of ten, and have no difficulty in solving for unknowns in the questions in your study texts, you should have no trouble with the math on the FCC exam. A knowledge of elementary algebra and trigonometry will be sufficient.

### Are there many questions about transistors on the FCC exam?

At the present time, there are very few questions on solid-state devices. You might, for example, be asked to interpret a set of transistor specifications. But to be fully prepared—in case of a change in the exam—study transistor biasing networks, power dissipation, heat sinks, and other related transistor topics.

### How long will it take me to prepare for the first class license exam?

This depends on several factors: the extent of your interest and/or experi-

## SOME USEFUL STUDY TEXTS

| | |
|---|---|
| Study Guide and Reference for Commercial Radio Operator Examinations (Revised). U.S. Government Printing Office, Washington, D.C. | 75¢ |
| Second Class Radiotelephone Handbook, Second Edition. By Edward Noll. Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206 | $4.75 |
| First Class Radiotelephone Handbook, Third Edition. By Edward Noll. Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206 | $4.95 |
| Radar Endorsement Handbook. By Edward Noll. Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206 | $2.95 |
| Radio Operator's License Q and A Manual. Seventh Edition. By Milton Kaufman. John F. Rider Publisher, Inc., 116 West 14 St., New York, N.Y. 10011 | $7.10 |
| Electronic Communications, Second Edition. By Robert L. Shrader. McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036 | $9.50 |

ence in electronics, the method you choose to prepare for the exam, etc. If you are an active ham or have worked in electronics for a considerable time, you can prepare for the exam in six months. For most people who have little or no familiarity with electronics, it may take 15-18 months.

## What type of questions are asked?

The entire exam contains only multiple-choice questions. Although you can reasonably expect to do a lot of mathematical computation for the technical elements of the exam, you will not be expected to show your work.

## Should I try to memorize the material in my study texts?

Memorizing the material—particularly in the technical sections—can be more harmful than helpful. The only things you should know by rote are the exact operating frequencies and power limits specified by the FCC. So far as the Rules and Regulations are concerned, a basic understanding of what they mean will see you through—that's the most important thing.

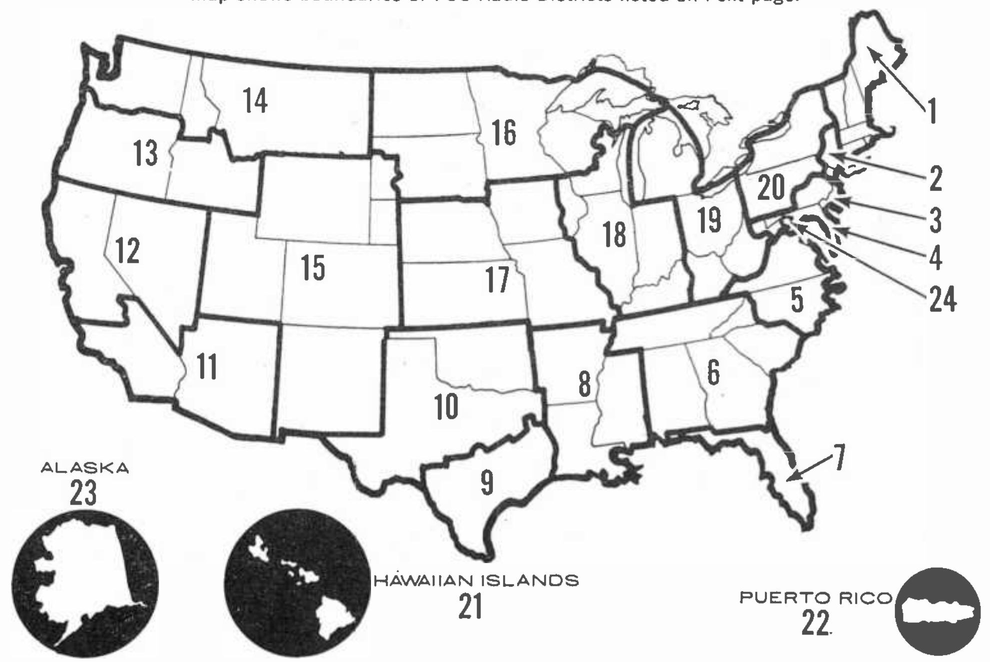
## How do I apply for my FCC exam?

When you are ready to take your exam, contact, or write to, your FCC District Office and request FCC Forms 756 and 756B and a copy of the exam schedule so that you will know exactly when the exam you want is given. Fill in both sides of the two forms, make out a check or money order (payable to the Federal Communications Commission), and mail them to the District Office where you want to take the exam. Or apply in person at the District Office.

## When and where does the FCC conduct exams?

The exams are given at regular intervals at all District Offices (see page 71). You do not need a prior appointment if you report on the proper day for a given exam. It is best to check first, since schedules change, and be prepared to pay the fee by check or money order—not cash. If you wish, however, to take the exam at a location other than the office of the Engineer in Charge, you must mail in your application and fee prior to the exam date. You will be notified when to appear.

Map shows boundaries of FCC Radio Districts listed on next page.



## ADDRESSES OF FCC RADIO DISTRICT OFFICES

1 Customhouse
Boston, Mass. 02109

2 Federal Building
641 Washington St.
New York, N.Y. 10014

3 New U.S. Customhouse
Philadelphia, Pa. 19106

4 U.S. Customhouse
Gay & Water Sts.
Baltimore, Md. 21202

5 Federal Building
Norfolk, Va. 23510

6 2010 Atlanta Merchandise Mart
240 Peachtree St., NE
Atlanta, Ga. 30303
*Post Office Building
P.O. Box 77
Savannah, Ga. 31402

7 Federal Building
P.O. Box 150
Miami, Fla. 33101

8 Federal Building
600 South St.
New Orleans, La. 70130
*U.S. Courthouse
& Customhouse
Mobile, Ala. 36602

9 New Federal Office
Building, Room 5636
515 Rusk Ave.
Houston, Texas 77002
*Post Office Building
P.O. Box 1527
300 Willow St.
Beaumont, Texas 77704

10 States General Life
Insurance Building
708 Jackson St.
Dallas, Texas 75202

11 849 South Broadway
Los Angeles, Calif. 90014

12 Customhouse
555 Battery St.
San Francisco, Calif. 94126

13 New U.S. Courthouse
620 SW Main St.
Portland, Ore. 97205

14 Federal Office Building
First Ave. & Marion St.
Seattle, Wash. 98104

15 New Customhouse
19 St. (Between Calif.
& Stout Sts.)
Denver, Colo. 80202

16 Federal Courts Building
Sixth & Market Sts.
St. Paul, Minn. 55102

17 Federal Office Building
911 Walnut St.
Kansas City, Mo. 64106

18 U.S. Courthouse
219 South Clark St.
Chicago, Ill. 60604

19 New Federal Building
Detroit, Mich. 48226

20 Post Office Building
Buffalo, N.Y. 14203

21 Federal Building
P.O. Box 1021
Honolulu, Hawaii 96808

22 Federal Building
P.O. Box 2987
San Juan, Puerto Rico
00903

23 U.S. Post Office &
Courthouse Building
P.O. Box 644
Anchorage, Alaska 99501

24 1919 M St., N.W.
Washington, D.C. 20055

*Denotes District Sub-Office

## QUARTERLY EXAM LOCATIONS

Alabama, Birmingham
Arizona, Phoenix
Arkansas, Little Rock
California, Fresno
Indiana, Fort Wayne
Indiana, Indianapolis
Iowa, Davenport
Iowa, Des Moines
Kentucky, Louisville
Michigan, Grand Rapids
Missouri, St. Louis
Nebraska, Omaha
New York, Schenectady
New York, Syracuse
North Carolina, Winston-Salem
Ohio, Cincinnati
Ohio, Cleveland
Ohio, Columbus
Oklahoma, Oklahoma City
Oklahoma, Tulsa
Pennsylvania, Pittsburgh
Pennsylvania, Williamsport
South Dakota, Sioux Falls
Tennessee, Knoxville
Tennessee, Memphis
Tennessee, Nashville
Texas, Corpus Christi
Texas, San Antonio
Utah, Salt Lake City
West Virginia, Charleston
Wisconsin, Milwaukee

### What fees are charged by the FCC?

The fees charged are determined by the class of license you apply for and the services you want. First, second, and third class license fees are $5, $4, and $3, respectively, and separate endorsements are each $2. (There is no charge for the endorsement when both a license and an endorsement are applied for simultaneously.) Renewals, duplicates, and replacements—no matter what class of license—are each $2.

### What materials am I allowed to take with me into the exam room?

You can take a slide rule—if it doesn't have any electronics formulas or tables on it—and math tables that are not part of a textbook. Come prepared with several pencils, an eraser, a pen, and a rule or straightedge.

### Is there an exam time limit?

There is no specific time limit. However, you must complete the exam for each element required for the class of license you apply for by the District Office closing time. You will not be allowed to leave the room while you are answering any element of the exam.

### What is the passing grade?

You must earn at least 75% on each element required for the class of license you apply for. If you fail some elements and pass others, you will be awarded the highest class license for which you qualified. However, if you fail either element 1 or element 2, you will not receive a license—even if you receive 100% on every other element.

(*Continued on page* 100)

# the product gallery

## REVIEWS AND COMMENTARY ON ELECTRONIC GEAR AND COMPONENTS

### PROFESSIONAL SWL RECEIVER (Heathkit Model SB-310)

"At least someone knows we're alive" is the way one short-wave listener (SWL) greeted the announcement of the SB-310. Yes, apparently last in line (after the hams and CB'ers), the SWL's now have a truly professional short-wave receiver with direct frequency dialing and readout, plus all the little extras that go into making a good product great.

The SB-310 is an offshoot of the renowned Heathkit SB line-up of amateur radio equipment. This means that the SB-310 is a tried-and-true receiver incorporating the preassembled and tested Heathkit LMO (Linear Master Oscillator)—the heart of the direct frequency dialing technique. Dialing accuracy has been checked at POPULAR ELECTRONICS as being better than 200 Hz on all nine tuning ranges of the SB-310.

Unlike the ordinary broad-coverage short-wave receiver, the SB-310 tunes special segments of preselected short-wave bands. Each segment is a little over 500 kHz wide starting at 3.5, 5.7, 7.0, 9.5, 11.5, 14.0, 15.0, 17.5, and 26.9 MHz. Thus, included in the segments are the 49-, 41-, 31-, 25-, 19-, and 16-meter international broadcast bands; the 75-, 40-, and 20-meter ham bands; and the 11-meter CB channels.

From a circuit viewpoint, the SB-310 is a double-conversion superhet with two i.f. stages, a high gain r.f. stage, noise limiter, AM detector, product detector for SSB reception, S-meter, built-in 100-kHz calibrator, and three special crystal filters for optimizing selectivity. In addition to the usual loudspeaker and earphone outputs, the SB-310 has a hi-fi output connection and a 500-ohm audio line feed that the SWL will find handy for use with his tape recorder.

Assembling the SB-310 takes 18-20 hours. A few kit builders might shave this to 16 hours and a "first time out" builder might need 22-23 hours. All in all, 19 hours is a good average. There are no significantly difficult steps in building an SB-310. Wiring around the coil band and band change switch must be executed with care—but even this step takes only 1½-2 hours.

Alignment of the completed receiver is easy because the built-in 100-kHz calibration oscillator can be used as a r.f. signal generator and the strength of the upper-sideband signal can be accurately measured via the S-meter. However, in order to set up the all-important heterodyne oscillator, a VTVM or TVM (set for negative 5 volts full scale) is required. Your reviewer aligned the SB-310 first with the 100-kHz oscillator and again using a RCA WR-50B r.f. signal generator. Sensitivity difference between the two methods was less than two S-units in favor of the outboard r.f. generator.

When attached to a 125′ flat-top antenna, the SB-310 assembled by your reviewer was the equal of any SWL receiver he has used in the past 10 years—including one model costing over $1000. All three ham bands were alive and crowded with signals while the international broadcast bands offered up premium DX. In a few hours of casual tuning, stations from 33 countries were heard and identified while many more could only be "guessed at" according to frequency and language.

In your reviewer's opinion, the nine tuning ranges of the SB-310 are a good—but not a perfect—choice. Tuning the 49-, 41-, 31-, 25-, 19-, and 16-meter international broadcast bands is mandatory, but inclusion of the CB tuning range in place of the 13-meter broadcast band is an unfortunate selection.* On the ham bands, some SWL's might prefer the substitution of 15 meters for the 75-meter ham band.

When buying the SB-310 kit, the ham-band SWL DX'er should consider buying the SB-310-2 Deluxe SSB Filter ($39.93) as an accessory. This filter makes for superior SSB reception on all ham bands and sharpens up selectivity to enable the SWL to dig out the weak DX signals on 40 or 20.

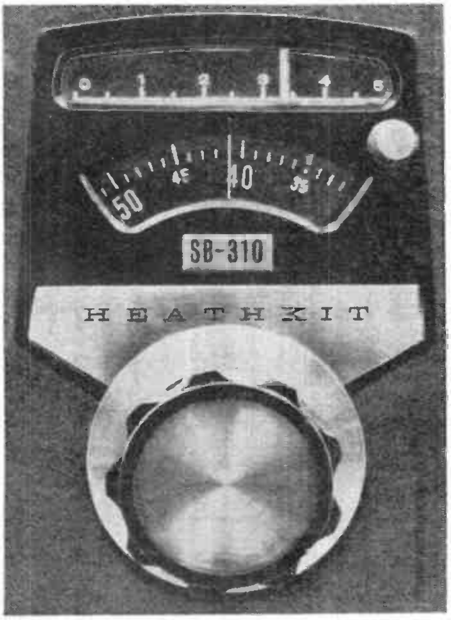
The SB-310 is a welcome addition to the ranks of top-quality SWL receivers. The "mix" of broadcast band and ham bands provides for interesting DX possibilities at any time of day or night. The inclusion of a crystal calibrator, noise limiter and BFO for CW and SSB reception are "extras" not seen in competitive products.

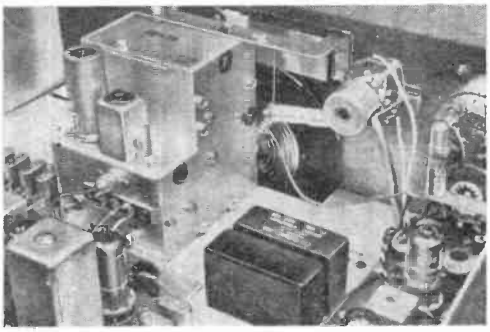
**Circle No. 85 on Reader Service Page 15 or 115**

**The Heath Company is considering the release of a modification kit which will permit SWL's to tune the 13-meter band—eliminating CB coverage. Details from Mr. Al Robertson, Heath Co., Benton Harbor, Mich.*

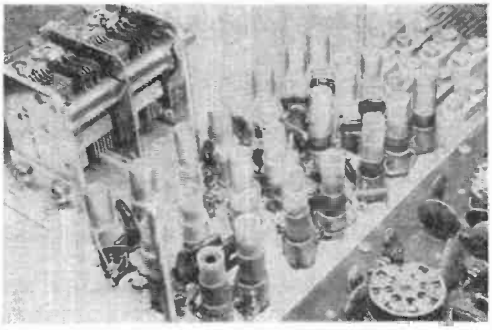
# HEATHKIT SB-310 PROFESSIONAL SHORT-WAVE RECEIVER

New Heathkit receiver, patterned after tried-and-proven SB line-up of ham radio gear, is shown above with optional extra SB-600 matching speaker. Heart of the SB-310 is the linear oscillator which permits direct dialing to exact frequencies. In view below, dials are set to readout 341 kHz. This frequency is added to primary crystal frequency.



Inside the SB-310, the two black rectangular boxes are the special filters that permit optimum selectivity on both international broadcast and ham bands. Tunable linear oscillator is at upper left.



This is the coil bank before the shielding is installed. Tuning these coils requires a VTVM or TVM.

# tpg

## CONTINUED

### IC'S FOR THE EXPERIMENTER (RCA KD-2112 Kit)

For the past couple of years, several companies have been putting low-cost solid-state kits on the market. Such kits usually include an etched and drilled PC board, all the required components, and a small booklet explaining how to assemble the kit, how the circuit works, and suggested uses for the kit. It was only a matter of time before a manufacturer started producing a line of low-cost integrated-circuit kits to introduce the electronics experimenter to the new world of IC's.

Radio Corporation of America has now taken this first step with the introduction of the KD-2112 Experimenter's Kit (suggested retail price of $9.95, available at most RCA distributors). The kit is based on the RCA CA3020 monolithic silicon multipurpose wideband audio amplifier. This particular chip contains seven transistors, 11 resistors, and three diodes, all in a 12-lead TO-5 package (about the size of a conventional small-signal transistor).

The blister-packaged kit comes with an etched and drilled PC board, and all the components required to make either a low-power (500-mW) audio amplifier, or an audio oscillator for use either as a code-practice oscillator or as a source of fixed frequency audio tone. Components not supplied are battery, speaker, and the telegraph key for the oscillator. The well-written construction manual contains all details of circuit assembly, and includes a brief description of integrated circuits, how they are made, and how they work.

An interesting item—the RCA kit also includes an "open" IC (a complete silicon chip bonded to its base, but without the metal top hat) so that the experimenter can see the "innards" of an IC by using a magnifying lens. Incidentally, your reviewer found that this open IC makes a cute decoration when soldered to a tie clasp.

The IC amplifier goes together nice and easy, and shouldn't take anyone more than an hour or so to assemble. The 500-mW output is more than enough to drive a small speaker. A crystal receiver was used to drive the amplifier and the combination sounded pretty good. So far as the oscillator is concerned, the tone was pleasant and had more than enough volume to fill a room.

Circle No. 86 on Reader Service Page 15 or 115

### PROFESSIONAL VTVM (EICO Model 235)

If you don't already own one, now is a good time to think about buying a vacuum-tube voltmeter. A VTVM is a must if you work on modern solid-state or vacuum-tube equipment where voltage readings must be accurate and meter loading can become a serious problem. While there isn't much difference among available VTVM's when it comes to the loading effect they have on circuits under test, there is a great deal of diversity in features and versatility among the individual units offered.

For the hobbyist or technician looking for modest cost vs. versatility, EICO's Model 235 Professional VTVM (available from EICO Electronic Instrument Co., Inc., 283 Malta St., Brooklyn, N.Y. 11207) probably ranks among the few meters anyone would want to start and stay with. It is the equal of any VTVM—and superior to some—on the market in its price range ($49.95 as a kit; $64.95, factory-wired and calibrated).

With the Model 235 VTVM, the user can accurately measure d.c. voltages from a low of 0.1 volt to 1500 volts (up to 3 kV with optional high-voltage probe) in eight ranges. Input resistance on all d.c. voltage ranges is 11 megohms, and accuracy is within 3% full scale.

Seven a.c. r.m.s. ranges are provided—0 to 1.5, 5, 15, 50, 150, 500 and 1500 volts—also accurate within 3% full scale (for less than 1% harmonic distortion sine-wave input). The first five ranges have an input impedance of 830,000 ohms, while the 500-volt range impedance is 1.3 megohms, and the 1500-volt range is 1.5 megohms. Frequency response is ±1 dB from 30 Hz to 3 MHz, but it can be extended to 250 MHz with optional r.f. probe.

There are also seven ohmmeter ranges for measuring resistances as low as 0.2 ohm and as high as 1000 megohms. Other features include zero-center for accurate FM detector alignment, a single zero point adjustment for all functions and ranges, floating ground, and a heavy-gauge steel cabinet continuing EICO's "professional" look. One other feature deserves special mention—direct readout of peak-to-peak conversions for measured a.c. r.m.s. voltages.

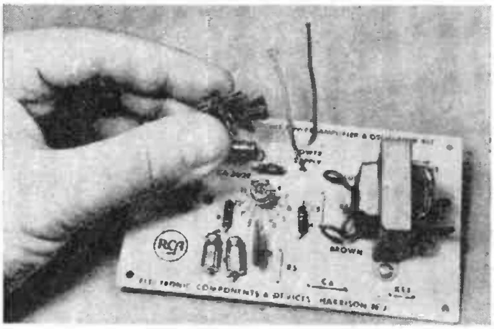
Assembly time for the kit will average between four and five hours, with the greater part of the time being spent on wiring the range and function switches. But once the unit is assembled, less than a half hour is required to calibrate the individual ranges for each function.

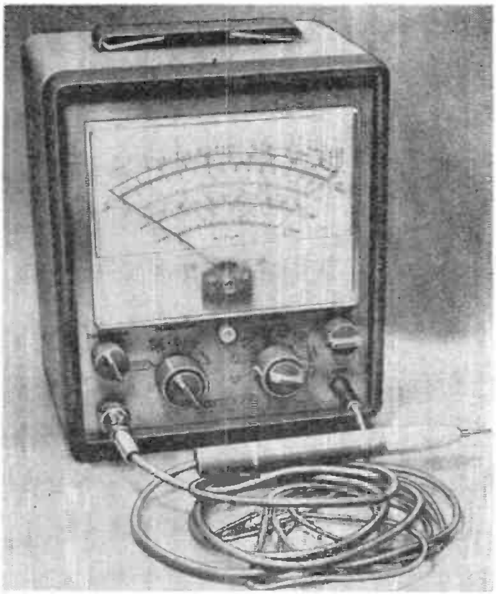
Many of the features available with the EICO Model 235 VTVM can be found on

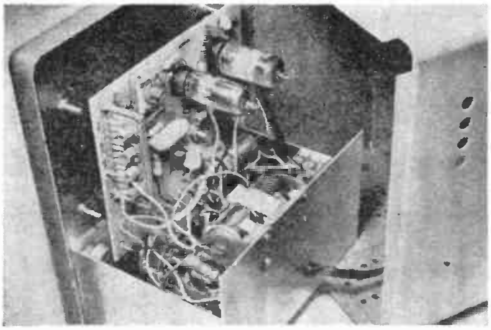
(*Continued on page* 94)


## RCA IC EXPERIMENTER'S KIT

The first in a series of kits introducing this experimenter to RCA integrated circuits (IC's), this blister-packaged kit contains all components needed to make a 500-mW audio amplifier or a code-practice oscillator. The instruction book is complete, and everything is furnished (PC board mounting) except battery, speaker, and a telegraph key.



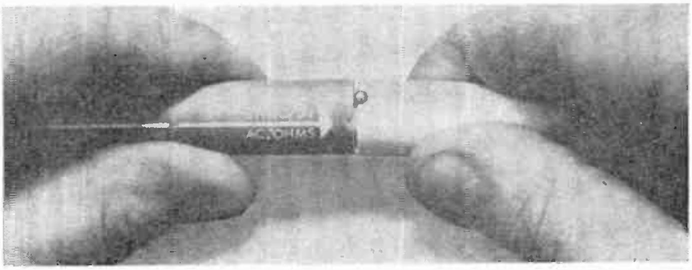




## EICO PROFESSIONAL VTVM

This VTVM has the neat, functional appearance of a professional instrument. Almost all components inside the roomy heavy-gauge steel cabinet mount on an oversized printed circuit board for simplified assembly. The meter movement features a one-position zero-set for all range and function scales. Several holes in the cabinet provide easy access to the various calibration potentiometers.

"Uni-Probe" provided with the Model 235 eliminates the need for separate test leads for each function. The nose portion of the probe revolves and has two lock-in positions; one position is for a.c. volts and resistance measurements, the other position (with built-in 1-megohm resistor) for d.c. voltage measurements.



# INFORMATION CENTRAL

By CHARLES J. SCHAUERS, W6QLV

A NUMBER of letters have been received by your *Information Central* editor relative to a.c. adapter problems. (An a.c. adapter converts the 117-volt a.c. power line to some low value of d.c. for transistor radios, tape recorders, etc.) Most problems occur when you use a low-cost adapter not specifically designed for the device being powered.

The most common problem is hum. In most cases, a 500-$\mu$F (or larger) electrolytic capacitor, of the correct voltage rating and proper polarity, can be connected across the adapter output to reduce the hum level.

The second problem is voltage output. Sometimes it is too low to power the radio properly, etc., and sometimes it is far too high. In the former case, very little can be done outside of a complete redesign of the adapter. In the latter case, you should use a resistor in series with one d.c. output lead, terminated in a large value electrolytic, to reduce the voltage to that required. The value of the resistor depends on how much voltage you want to drop; the capacitor should be about 500 $\mu$F or larger.

**Adding A.F.C.** *I have an FM tuner that drifts badly. How can I add a.f.c. to the set?*

Adding a.f.c. to any tuner is a major operation. Basically, the drifting problem lies in the local oscillator drifting with heat, so try to keep your tuner away from radiators or other heat-generating objects. Also, make sure that the set is well ventilated. And you could try having a serviceman check the fixed capacitors in the oscillator circuit—some may have to be changed.

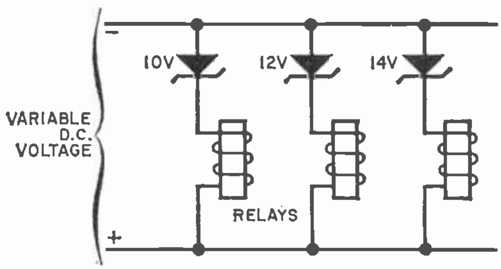
Stabilizing the voltage to the local oscillator may help. You can stabilize it with a zener diode if the oscillator is a transistor circuit or a voltage-regulator tube if it is a vacuum-tube circuit. Here again, it might be worthwhile to consult your serviceman.

**RC Time Constant.** *What is the time constant of a resistor-capacitor (RC) circuit, and how is it figured?*

The time constant (*tc*) of an *RC* circuit is the time required to charge the capacitor to 63.2% of its final voltage or to discharge it to 36.8% of its original charge. To calculate the *tc*, the following formulas can be used: $t$ (sec) $= R$ (ohms) $\times C$ (farads); $t$ (sec) $= R$ (megohms) $\times C$ ($\mu$F); $t$ (microseconds) $= R$ (ohms) $\times C$ ($\mu$F); and $t$ (microseconds) $= R$ (megohms) $\times C$ (pF).

**Remote Control.** *I want to remotely control three sequential functions using only a variable d.c. source. Can you recommend a circuit?*

As shown in the schematic below, all you need is three zener diodes of appropriate voltages in series with three relays across the line. As the variable voltage is raised to 10 volts, the first relay will close. As the




voltage goes up, each zener will conduct at its voltage and close its associated relay. You can select the zeners and relays for almost any range of d.c. voltage required.

**"Lighting" Noise Problem.** *Sometimes when we play our electric guitars in TV or recording studios, or entertainment halls, severe noises come out of our speakers. We understand that this may be due to the lighting circuits used in many of these places. What can we do about it?*

It does sound as if you were picking up r.f.-like spikes generated in high-power lighting circuits. Make sure that the guitar leads to the amplifier and the speaker leads from the amplifier are shielded and bonded to the amplifier chassis. Then try to see to it that the chassis is shielded and grounded when you're working in such areas. You may have to feed the a.c. power to the amplifier through 0.5-$\mu$F coaxial capacitors to remove any interference coming in along this route.

**Signal Booster.** *I live in a fringe TV reception area and would like to know if an antenna-mounted amplifier would be worthwhile.*

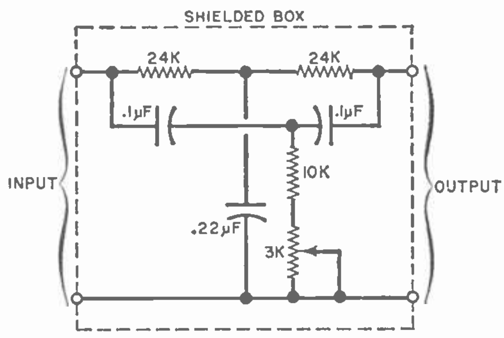
The only way you can find out is by trying. Your local TV dealer will be glad to install one to determine whether or not it will help your reception.

**Stalled Record Player.** *When I load my record player (it's a good model) and trip the "Reject" button to drop the first record on the turntable, the player immediately stalls. Then I have to push the turntable around until the record drops and the motor takes over. What could be wrong?*

Since the record doesn't drop, there is something binding the action of the record release mechanism. Just what that something is may be difficult to find out unless you have details of the mechanism itself in your instruction manual. Have you oiled the record player according to the manufacturer's instructions? Since each player is different (and we don't know which one you have), we suggest sending it to the manufacturer's warrantee or repair service shop.

**60-Hz Attenuator.** *I must remove as much 60-Hz stray signal as possible from an experimental amplifier I am constructing. I can't connect a large value filter capacitor across the input for obvious reasons. What can I do?*

Try the selective 60-Hz reject network shown below. Install the reject network in




series with the signal lead and adjust the potentiometer for maximum 60-Hz rejection.

**Color-TV Antenna.** *I have been told that an ordinary TV antenna is not good for color-TV reception. Is this true?*

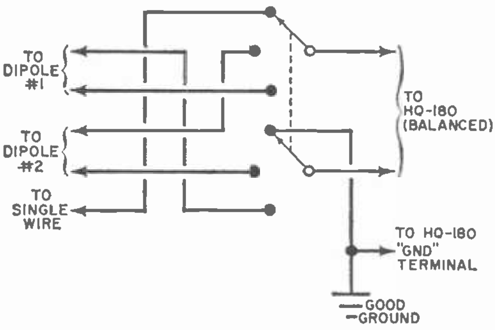
Generally, yes. However, if you are in a strong signal area, an ordinary TV antenna *will* work—but not as well as one designed for color reception. A color-TV antenna is designed for maximum bandwidth.

**Transistor Battery Charger.** *I have a 9-volt transistor battery charger and it seems to work fine; but when I tried using it to directly power the radio set, it wouldn't. Do you know why?*

Your battery charger evidently was not made to power equipment, but just to charge batteries with *low* current. Such units simply do not put out enough power to operate a transistor radio.

**SWL Antenna Switching.** *My new SWL setup has a Hammarlund HQ-180 and three antennas. Two of the antennas are dipoles and the third is a single-wire-fed long-wire. How can I arrange a switch to select any antenna I want?*

Very simply, if you can locate a 2-pole, 3-position rotary switch. Since that is un-




likely, we would suggest a 2-gang switch (it's easier to work with) such as the Mallory Type 1325L. You will then have extra positions available in case you decide to add another receiver or another antenna to your setup. Wire the switch according to the diagram above (we are assuming that you have 300-ohm twin-lead dipoles).

**Replace Tubes With Transistors.** *I like my tube-type VTVM, but having to wait while it warms up is a nuisance. Also, the tubes age, and I always have to reset the "zero." Can I replace the tubes with some of these new field-effect transistors?*

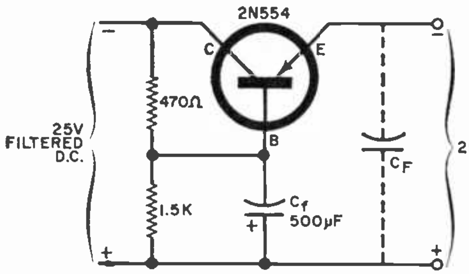
Sorry, but just because FET's have the characteristics of vacuum tubes doesn't mean that the two are interchangeable. And if the tubes *could* be replaced by FET's, the voltages in the VTVM would need to be reduced, and so would all of the component values in the surrounding circuitry.

**Cannibalized Receivers.** *I have developed the knack of cannibalizing Japanese transistorized radio receivers but don't understand what the color-coded components are that look like miniature dumbbells.*

They are miniature resistors with ¼-watt ratings. Both of the connecting leads are at one end of the resistor. The color coding is only three numerals (no tolerance color coding). You read the coding down, starting from the end away from the leads. For example, a descending color code (assuming that the resistor is soldered to a PC board) of red, violet, and yellow would mean that the resistor was valued at 270,000 ohms.

**High-Value Filter.** *I need a large-valued filter capacitor (in excess of 10,000-μF) rated at about 15 volts. I can't seem to find one. Can you help me?*

If you think of a capacitor as a passive device that has certain electrical characteristics and not as two pieces of conducting material separated by a dielectric, you can come up with the electronic filter shown below. The effective filter capacitance $C_F$ appearing across the load is approximately




equal to $C_f$ $H_{FE}$ where $H_{FE}$ is the current gain of the transistor being used. In the example shown, the effective $C_F$ is about 25,000 μF.

**Sealed Vs. Open Switches.** *Do you recommend a sealed or unsealed rotary switch, and why?*

The sealed type of rotary switch, where the contacts are not exposed, lasts much longer. Dust, which can often carbonize and foul the contacts, is prevented from reaching the contacts.

**Mono or Stereo Cartridge.** *I have an old mono phono system that I would like to convert to stereo. How is this done?*

Usually, it doesn't pay to convert old systems, as you need a stereo cartridge, a new needle, another amplifier with similar characteristics to the one you now have, another speaker, and probably a beefed-up power supply to handle the greater load. The cost, in money and effort, is just not worth it.

**Vacuum Cleaner Noise.** *My biggest problem when trying to listen to the short-wave bands is the enormous amount of noise generated by vacuum cleaners operating in my apartment house. What can I do to reduce this noise?*

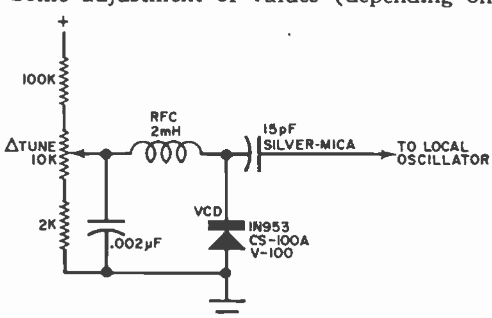
Outside of putting a noise filter on each vacuum cleaner, your best bet is to get the most out of your antenna and feeder system. Put the dipole as far up and as far away from the noise source as possible, and use a good-quality coaxial cable between the antenna and the short-wave set, making sure that the braid of the coax is well grounded at the receiver. Then make sure that the short-wave receiver is well shielded and grounded. In fact, both the receiver metal chassis and the coax braid should be connected to a cold water pipe for best grounding. You can also use plug-in line noise filters (properly grounded) on the set's input line cord. Another possibility is to bridge both sides of the power line to ground (chassis) inside the set, using 0.01-μF capacitors.

**Output Impedance Matching.** *The transistor stereo amplifier that I have specifies an 8-ohm output impedance. Why can't I use 4-ohm speakers with it?*

In most cases, the power that the amplifier delivers to the load (speakers, in this case) is a function of the load impedance. If you reduce that value too far, the amplifier will literally burn itself up trying to power the wrong load. This can lead to destroyed transistors.

**Off-Set Tuning.** *Can you supply a diagram for incorporating off-set tuning in my transceiver? I would like to tune about 2 kHz or so either side of my crystal-controlled frequency.*

The circuit below should do the trick. Some adjustment of values (depending on




the variable capacitor diode used) may be necessary. Delta tuning is accomplished by varying the value of the 10,000-ohm potentiometer.

**Rejuvenating Tubes.** *I understand that it is possible to rejuvenate certain types of vacuum tubes. How is this done?*

There have been many schemes for "rejuvenation." One is to use a slightly higher filament voltage, as in commercial CRT brighteners. Another is to apply about 400 volts d.c. or so for about 10 seconds between the cathode and grid; the positive lead goes to the grid and the negative lead goes to the cathode. However, neither of these methods gives any really extended life to the tube. —30—

# AMATEUR RADIO

By HERB S. BRIER, W9EGQ
Amateur Radio Editor

## WAS THAT EMERGENCY NECESSARY?

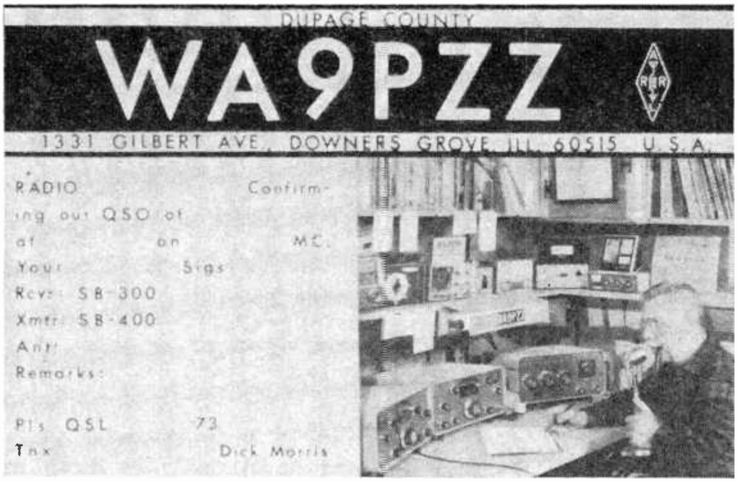
"WHAT were they trying to prove? What bit of scientific information heretofore unknown and indispensable to man did they bring back?" These questions from a veteran amateur and commercial ship operator were triggered by the account in this column (October, 1967) of how amateur, commercial, and military services cooperated to rescue three adventurers from their sinking balsa raft in the Pacific. The men were attempting to float from Ecuador to Australia in emulation of prehistoric sailors, but our bitter friend points out that the trip has already been made several times (Kon-Tiki, etc.); therefore, they were risking their lives for no good purpose.

This veteran amateur's ship was in the Gulf of Mexico at the time that the balsa raft was sinking, and every half hour from 11 p.m. until daylight, NBA in the Canal Zone repeated the information that the raft was in difficulty, and that its crew had requested immediate rescue. Each transmission triggered the ship's automatic distress-call warning system. The operator questions the necessity of NBA keeping hundreds of ships "awake" all night by transmitting the same information again and again. He concluded his comments with: "If such 'expeditions' were forced to post healthy cash bonds to guarantee the rescue they expect when they get their feet wet, there would be fewer of them."

The above plaint reminds your Amateur Radio Editor of the time when he and dozens of other members of an emergency net monitored the transmissions of a mobile amateur who insisted on attempting to travel with his wife and two small children (one of whom was ill) from Chicago, Ill., to Dayton, Ohio, during one of the midwest's severest snow storms. Ignoring the advice of everyone, including the weather bureau and the highway patrols of Illinois, Indiana, and Ohio, he started out early in the morning and spent the entire day creeping down one road until it became completely impassible, then back-tracking to a crossroad and try-

### AMATEUR STATION OF THE MONTH


When Ivar J. Lindstrom, W7UZU, of White City, Oregon, closes the doors of the home-built cabinet in which his amateur station is located, it looks like a fine piece of light-oak living room furniture. The cabinet houses a Johnson "Viking-II" transmitter, VFO, antenna "Match Box," and Collins 75A-4 receiver. Licensed since he was 14 years old, Ivar is now Net Control Station for two MARS nets and holder of a MARS "Operator of the Month" award. W7UZU will receive a one-year subscription for submitting the winner for April in our Amateur Station of the Month contest. To enter the contest, send a clear picture of your station with you at the controls and some details on the equipment you use and your ham career to Amateur Radio Photo Contest, c/o Herb S. Brier, Box 678, Gary, Ind. 46401.




Dick Morris, WA9PZZ, of Downers Grove, Ill., uses his skill as a professional photographer to design and print his own QSL cards, a facsimile of which is shown here. See "News and Views" on page 117 for information on Dick's hamming equipment.

ing again. The family finally ended up at dark in a motel less than 75 miles from the point where the "expedition" had started ten hours earlier—much to the relief of the members of the snow emergency net who realized that if the car had become snowbound a rescue party would have to go out and bring the family in to safety.

Fortunately, as long as there is human life involved, there always seems to be someone brave enough and compassionate enough (or stupid enough?) to go out and rescue people from the results of their own heedless actions.

**Illinois Sesquicentennial.** In the photo below, L. A. Wollan, Jr., Assistant Director of the Illinois Sesquicentennial Commission, and R. W. "Bud" Drobish, W9QVA, of Hallicrafters Company, are shown presenting Illinois Governor Otto A. Kerner with the first of 100,000 Illinois Sesquicentennial QSL cards to be supplied to Illinois amateurs by Hallicrafters. Watching, at the right, are Edmond A. Metzger, W9PRN, Vice Director, American Radio Relay League Inc., and Charles Wilson, W9FFP, QSL Chairman of the Sangamon Valley Amateur Radio Club. Illinois amateurs may receive a supply of the QSL cards from W9FFP, Illinois Sesquicentennial Commission, 1016 Myers Building, Springfield, Ill. 62701.

Non-Illinois amateurs may earn an attractive certificate by working 10 Illinois stations on the VHF bands or 25 stations on the high-frequency bands. Illinois amateurs must work 60 other Illinois stations on the VHF's or 150 on the HF's to qualify for a certificate. Applications go to W9FFP at the address given; must be postmarked no later than midnight, June 30; and should list call letters, dates, times, and frequency bands of claimed contacts. (Since the claimed contacts will be cross-checked by a committee, no QSL cards should accompany the applications.)

**AM Phone Downgraded Again.** Further handwriting on the wall for those amateurs who still insist that conventional AM phone is superior to SSB is contained in the Fall, 1967, Collins *Signal*. The *Signal* reports that the commercial maritime services of several

(*Continued on page* 116)

The first of 100,000 free Illinois Sesquicentennial QSL cards is being presented here. See text above for the details.

# ON THE CITIZENS BAND

By MATT P. SPINELLO, KHC2060, CB Editor

## CB JAMBOREE SEASON

A HEFTY BUNDLE of money is being spent by CB clubs across the U.S. and Canada in preparation for the 1968 CB Jamboree season. Many groups are promising spectacular events with fireworks, carnival rides, concession stands, Bingo, TV celebrities, thousands of dollars in prizes, etc. Other, less wealthy organizations will be content to invite the entire country to their localized "picnic," and you gotta bring your own everything!

At least one group plans to attract the curious from all over the U.S. by promising the theme of *CB's Tenth Anniversary Celebration!* The Citizens Radio Service, as exercised on 11 meters, will officially reach its 10th birthday in September.

Rumors indicate that another CB organization will sponsor a "CB Happening." We would suppose that transceivers to be used and shown at the event will be psychedelically trimmed, equipped with mini-mikes, and the action wild and woolly, or, *moderate!*(?)

One harbinger of doom is taking bets that CB Jamborees in some areas this year will bring about the downfall of a number of clubs. He maintains that thousands of CB'ers who will make a success of CB jamborees displaying 50 or more booths (with only 5 or 6 of those booths relating to electronics or CB communications) will make a flop of next year's events by failing to attend. In the last five years, CB'ers have begun to weed out the dead ones. They're getting tired of traveling hundreds of miles to a highly promoted jam only to find that the local club got financially out from under by selling display space to anyone who could be pitched.

Also, they're a little fed up with organizing large caravans that are presented with the "first prize" trophy for their efforts—especially when the award is a 49-cent, 1½-inch "Great-Golfer" trophy, with the inscription changed to read "Courageous Caravan!" And most of all, CB'ers are getting a little discouraged at traveling 1, 10, or 1000 miles to find themselves staring at several hundred other communications buffs all day, with very little interest, due to poor planning on the part of the jamboree programming committee.

Successful jamborees will be presented by

(*Continued on page* 96)

### 1968 OTCB JAMBOREE CALENDAR

Citizens Band clubs that are planning jamborees, get-togethers, banquets, or something that will be "happening" (for the good of CB) are requested to send the details to the 1968 OTCB Jamboree Calendar, POPULAR ELECTRONICS, One Park Avenue, New York, N.Y. 10016. If possible, include a report on last year's event, plus a glossy photograph (or photographs) taken at the 1967 shindig. For more detailed information on the jamborees listed below, contact the club or club representatives at the addresses given.

**Rockford, Illinois** — **May 19**
Event: Fourth Annual RRVCBC Jamboree. Location: Rockford Armory, 605 N. Main Street. Sponsor: Rock River Valley Citizens Band Radio Club. Contact: Pierre LaBounty, KPK3273, 2015 Glenwood, Dept. AP, Rockford, Ill.

**Wooster, Ohio** — **May 31-June 2**
Event: Annual Wayne County REACT Campout and Jamboree. Sponsor: Wayne County REACT. Contact: Jamboree, P. O. Box 281, Wooster, Ohio.

**London, Ontario, Canada** — **June 29-30**
Event: Campout '68, held in conjunction with London's annual Fortnight Festival. Sponsor: South Western General Radio Association. Contact: Peter Harding, Campout '68 Chairman, 26 Grosvenor St., London, Ontario, Canada.

**Lexington, Massachusetts** — **June 16**
Event: CB Jamboree. Location: Suburbs of Boston, Mass. Sponsor: Paul Revere Emergency Radio Service. Contact: Robert Sweet, Secretary, P.O. Box 495, Lexington, Mass.

**Lexington, North Carolina** — **August 17-18**
Event: First CB Jamboree. Location: Davidson County Fairgrounds. Sponsor: Pioneer CB Club. Contact: Virginia Athay, KOK3171, 11 Hawthorne Lane, Lexington, N.C. 27292.

**Warminster, Pennsylvania** — **Date Pending**
Sponsor: Eastern Pennsylvania REACT, Inc. Contact: Edward Wolfgang, president EP/REACT, P.O. Box 309, Warminster, Pa. 18974

# ENGLISH-LANGUAGE BROADCASTS TO NORTH AMERICA FOR THE MONTH OF APRIL

**Prepared by ROGER LEGGE**

### TO EASTERN AND CENTRAL NORTH AMERICA

| TIME EST | TIME GMT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|---|
| **7:15 a.m.** | 1215 | Melbourne, Australia | 11.71 |
| | | Montreal, Canada | 9.625, 11.72 |
| **7:45 a.m.** | 1245 | Copenhagen, Denmark | 15.165 |
| **6 p.m.** | 2300 | Helsinki, Finland | 15.155 |
| | | London, England | 6.11, 9.58, 11.78 |
| | | Montreal, Canada | 9.625, 11.945, 15.19 |
| **6:45 p.m.** | 2345 | Tokyo, Japan | 15.135, 17.825 |
| **7 p.m.** | 0000 | Moscow, U.S.S.R. | 9.665, 11.735, 11.90 |
| | | Sofia, Bulgaria | 9.70 |
| **7:30 p.m.** | 0030 | Budapest, Hungary | 9.833, 11.91, 15.16 |
| | | Johannesburg, South Africa | 9.705, 11.875 |
| | | Kiev, U.S.S.R. (Mon., Thurs., Fri.) | 9.665, 11.735 |
| | | Stockholm, Sweden | 11.805 |
| **7:50 p.m.** | 0050 | Vatican City | 9.69, 11.76, 15.285 |
| **8 p.m.** | 0100 | Berlin, Germany | 9.50, 9.73 |
| | | Havana, Cuba | 9.525 |
| | | Madrid, Spain | 6.13, 9.76 |
| | | Peking, China | 15.06, 17.68, 17.795 |
| | | Prague, Czechoslovakia | 7.345, 9.63, 11.99 |
| | | Rome, Italy | 9.575, 11.81 |
| **8:30 p.m.** | 0130 | Berne, Switzerland | 6.12, 9.535, 11.715 |
| | | Bucharest, Rumania | 9.51, 11.94, 15.25 |
| | | Cologne, Germany | 9.64, 11.945 |
| | | Hilversum, Holland | 9.59 (Bonaire relay) |
| | | Tirana, Albania | 7.30 |
| **8:45 p.m.** | 0145 | Copenhagen, Denmark | 9.52 |
| **9 p.m.** | 0200 | Cairo, Egypt | 9.475 |
| | | Lisbon, Portugal | 6.025, 9.68, 11.935 |
| | | London, England | 6.11, 9.58, 11.78 |
| | | Melbourne, Australia | 15.22, 17.84 |
| | | Moscow, U.S.S.R. | 9.665, 11.735, 11.96 |
| | | Stockholm, Sweden | 11.805 |
| **9:10 p.m.** | 0210 | Hanoi, North Vietnam | 9.525 (via Havana) |

### TO WESTERN NORTH AMERICA

| TIME PST | TIME GMT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|---|
| **7 a.m.** | 1500 | Tokyo, Japan | 9.505 |
| **6 p.m.** | 0200 | Melbourne, Australia | 15.22, 17.84 |
| | | Taipei, China | 15.125, 15.345, 17.89 |
| | | Tokyo, Japan | 15.135, 15.235, 17.825 |
| **6:30 p.m.** | 0230 | Johannesburg, South Africa | 9.705, 11.875 |
| **7 p.m.** | 0300 | London, England | 6.11, 9.58, 11.78 |
| | | Madrid, Spain | 6.13, 9.76 |
| | | Peking, China | 11.82, 15.095, 17.68 |
| | | Seoul, Korea | 15.43 |
| **7:30 p.m.** | 0330 | Bonaire, Netherlands Antilles | 11.82 |
| | | Prague, Czechoslovakia | 7.345, 9.63, 11.99 |
| | | Stockholm, Sweden | 11.705 |
| **7:45 p.m.** | 0345 | Berlin, Germany | 11.84, 11.97 |
| **8 p.m.** | 0400 | Havana, Cuba | 6.135, 9.525 |
| | | Lisbon, Portugal | 6.025, 9.68, 11.935 |
| | | Moscow, U.S.S.R. (via Khabarovsk) | 9.54, 11.85, 15.18 |
| | | Peking, China | 11.82, 15.095, 17.68 |
| | | Sofia, Bulgaria | 9.70 |
| **8:15 p.m.** | 0415 | Bangkok, Thailand | 11.91 |
| **8:30 p.m.** | 0430 | Bucharest, Rumania | 9.51, 11.94, 15.25 |
| | | Budapest, Hungary | 9.833, 11.91 |
| | | Kiev, U.S.S.R. (Mon., Thurs., Sat.) | 9.665, 11.735 |
| **8:40 p.m.** | 0440 | Hanoi, North Vietnam | 9.525 (via Havana) |
| **8:45 p.m.** | 0445 | Berlin, Germany | 11.84, 11.97 |
| | | Cologne, Germany | 9.545, 11.945 |
| **9 p.m.** | 0500 | Havana, Cuba | 6.135, 9.525 |
| | | Tokyo, Japan | 15.105 |
| **9:15 p.m.** | 0515 | Berne, Switzerland | 6.12, 9.695 |
| **10 p.m.** | 0600 | Moscow, U.S.S.R. (via Khabarovsk) | 9.54, 11.755, 11.85 |
| **10:30 p.m.** | 0630 | Havana, Cuba | 9.655 |

# SHORT-WAVE LISTENING

By **HANK BENNETT**, W2PNA/WPE2FT
Short-Wave Editor

## GREAT BRITAIN GOES TO GMT PLUS ONE

GREENWICH Mean Time, known and respected the world over as the absolute basis of timekeeping on our planet, has been abondoned by the British as their primary time zone. DX'ers will recall that for many years Great Britain has had a form of Daylight Saving Time whereby it was on GMT during the winter months and on "British Summer Time" (or GMT plus one hour) for the remainder of the year. Now, in a move little noted by the Western Hemisphere press, Great Britain has changed its local time to GMT plus one on a permanent basis, thereby placing the country in the same time zone as most of Western Europe.

Greenwich Mean Time is still universal time to all extents and purposes, however. It will continue to be used as local time in Portugal, Canary Islands, Ghana, Morocco, Togo, Mali, and other points along the Greenwich meridian. And it will continue to be recognized and used by scientists, airline pilots, ship navigators, and radio operators.

Furthermore, Great Britain's change of time zone will in no way affect the operation of this column. All material published here continue to be listed as Greenwich Mean Time (EST plus five hours).

(*Continued on page* 110)

### DX Award Honor Roll

*Here is an up-to-date listing of the DX Award Honor Roll, for which the following DX'ers have qualified. When will we be able to add your name to the list? The figures at the right indicate the number of countries, states, and Canadian provinces/territories verified, in that order.*

| | | | |
|---|---|---|---|
| James Young (WPE6ENA) Wrightwood, Calif. | 230 | 50 | 12 |
| Chuck Edwards (WPE4BNK) Fort Lauderdale, Fla. | 180 | 50 | 10 |
| Ed Fellows (WPE7BLN) Seattle, Wash. | 200 | ... | 12 |
| Paul Kilroy (WPE3FOB) Washington, D.C. | 150 | 50 | 12 |
| Don Jensen (WPE9EZ) Racine, Wis. | 190 | 20 | .... |
| L. E. Kuney (WPE8AD) Detroit, Mich. | 150 | 50 | 10 |
| Charles Matterer (WPE6DGA) San Leandro, Calif. | 150 | 50 | 8 |
| Richard Markell (WPE6DXC) Los Angeles, Calif. | 150 | 50 | .... |
| Frank Scolaro, Jr. (WPE2LUZ) Yonkers, N. Y. | 150 | 50 | .... |
| Nathan Rosen (WPE2CY) New York, N. Y. | 150 | 50 | .... |
| Frank Peters (WPE9EZI) Chicago, Ill. | 200 | .... | .... |


Robert Bergner, WPE4JNU, DX'es from Fort Myers, Fla., with a Zenith M660-A receiver. His antenna is a 75-foot inverted-L. A member of the BBC World Radio Club, Bobby has a record of 31 states and 41 countries verified to date.

# SOLID STATE

By LOU GARNER, Semiconductor Editor

ENGINEERS and scientists at the Bell Telephone Laboratories (where the transistor was invented) have been among the leaders in developing new applications for semiconductor devices. Understandably, many of their developments have been in the communications field. The latest BTL development may, one day, permit deaf people to communicate via telephone by

Bell Telephone Laboratories developed this experimental device to enable deaf people to use phone.

reading letters and numbers flashed on the screen of a small device attached to their home telephones.

The new experimental device uses solid-state circuitry and digital logic techniques to convert coded tone signals generated by a conventional Touch-Tone® telephone into sequential letter and number displays. The letters A through N, except I and J, appear in the left window (see photo), O through Z in the center window, and letters I and J as well as digits 0 through 9 in the right window. Flashes of light in two lower windows indicate the end of a word or sentence, or that letter coding is in progress.

A simple code has been developed which utilizes the arrangement of the letters as they actually appear on the dial buttons. Letters A, B, and C are sent using the "2" button, D, E, and F with the "3" button, and so on through the alphabet. Depressing the "2" button once indicates A, twice indicates B, and three times, C. A special readout circuit (triggered by the 0 button) stores the signals until a letter is fully coded. Letters of the alphabet not used in dialing (Q and Z) are coded with the 1 button, which is also used as a word separator (as 111) and to end a sentence (as 111,111). The 1 button can also be used to erase stored signals.

Tests of the new device, which are still continuing, indicate that the average user can attain a coding rate of eight words per minute with just a little training. This rate can be doubled with practice and increased even more by adaptation of the short-hand signals normally used by the deaf in manual communications. The maximum speed of the present device is about 150 letters per minute, which compares well with acceptable rates in Morse code.

The unit is still experimental and no production is planned for the immediate future. Further development will depend not only upon the results of the continuing experiments but also upon the refinement and perfection of less costly and less demanding visual display devices.

**Readers' Circuits.** Inexpensive component testers are popular projects with many hobbyists and experimenters because, properly used, they can be real time and money savers. A spare parts box full of questionable capacitors, for example, might become an assortment of valuable parts if checked and classified.

Two readers—Kenneth Scharf (2569 W. 2nd St., Brooklyn, N.Y. 11223) and Eugene Richardson (310 E. Mason Ave., Alexandria, Va. 22301)—have each submitted a simple capacitor checker circuit. Both circuits use semiconductor devices—one a transistor and the other a diode. Both are easy to build and use, require relatively few components, and either can be assembled in a single evening. Their principles of operation are entirely different, however.

Ken's circuit (Fig. 1) uses a *pnp* power transistor as a simple audio oscillator, with its feedback provided by the capacitor (*Cx*) under test. It is suitable for checking mid-range (0.002 to 0.1μF) mica, ceramic, plastic film, or paper capacitors, and will indicate whether the component is defective (open or shorted) and its approximate value.

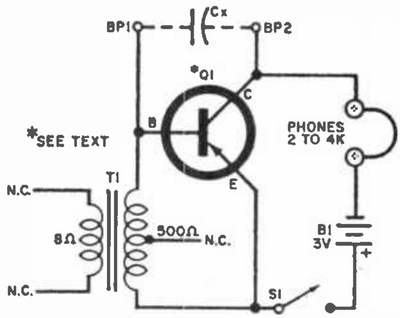



Fig. 1. Suggested by Kenneth Scharf, this capacitor tester has an audio output tone whose frequency is determined by the capacitor undergoing test.

Transistor *Q1* is a general-purpose power transistor (a 2N176, 2N301, 2N554, or similar) while *T1* is a 500-ohm CT to 8-ohm miniature output transformer. Transformer *T1*'s 500-ohm primary is used as an inductance in this application, and the CT and 8-ohm leads are not connected. Battery *B1* is made up from two penlight cells in series, and *S1* is a s.p.s.t. toggle or slide switch. Test terminals *BP1* and *BP2* can be binding posts, banana jacks, alligator clips, or similar connectors. Moderate impedance (2000- to 4000-ohm) electromagnetic headphones are used. The instrument can be "jury-rigged" breadboard fashion or, if preferred, assembled in a small metal or plastic case as a permanent addition to the home laboratory.

In operation, feedback capacitor *Cx* determines the circuit's frequency, and hence the output tone serves as an indication of the test component's value. To use the instrument, connect the unknown capacitor to test terminals *BP1* and *BP2*, and, while listening through the headphones, close switch *S1*. If the capacitor is shorted or open, no tone will be heard. If an audio tone is developed, a higher-frequency tone (pitch) indicates a smaller value. You can "calibrate" the instrument, if you wish, by checking capacitors of known value and noting the pitch of the resulting tones, comparing these to the signals produced by the test capacitors.

In contrast to Ken's design, which features an audible output signal, Eugene's circuit (Fig. 2) uses an inexpensive neon bulb as a visual indication device. It can be used for checking most types of capacitors, including electrolytics, with rated working voltages of 150 volts or more.

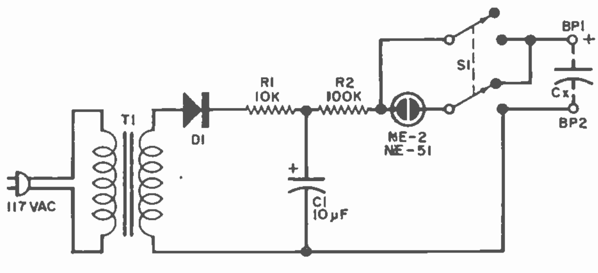
In operation, transformer *T1* and half-wave rectifier *D1* form a basic d.c. power supply, with *R1* and *C1* serving together as a simple ripple filter. Resistor *R2* acts as a current-limiting device to protect the neon bulb which, in turn, is used both as a test indicator and as a relaxation oscillator. Two test modes are provided, selected by d.p.d.t. switch *S1*.

Transformer *T1* is a standard 1:1, 117-volt isolation transformer, while *D1* is a general-purpose silicon diode such as an ALCO Type SA-1 or Workman Type S500C. Resistors *R1* and *R2* are half-watt types and *C1* is a 10 to 20 μF, 200-volt electrolytic capacitor. The neon bulb can be an NE-2 or an NE-51. A toggle, slide, or a rotary switch can be used for *S1*. Test terminals *BP1* and *BP2* are panel binding posts or equivalent test jacks.

The instrument can be assembled on a perf board, an etched circuit board, or point-to-point on a conventional metal chassis, as preferred. A metal or plastic case, or even a painted cigar box, can house the completed unit. An additional s.p.s.t. power on-off switch in series with one side of the line cord is optional.

Ceramic, mica, plastic film, and paper capacitors are checked with *S1* in its "up" position (as shown in the diagram). Simply connect the test capacitor (*Cx*) to *BP1* and *BP2* and plug the line cord into a standard outlet. The neon bulb should flash briefly *once* with the brightness and duration of the flash proportional to the capacitor's value.

Fig. 2. Reader Eugene Richardson's capacitor tester has visual readout.



The bulb and capacitor are connected in series during this test, and the bulb lights only as *Cx* charges. If the bulb fails to flash, the capacitor is "open." If the bulb flickers, *Cx* is intermittent. If the bulb lights dimly, but continuously, the capacitor is leaky. Finally, if the neon lights to nearly full brilliancy, *Cx* is shorted.

Electrolytic capacitors are checked with *S1* switched "down." With this arrangement, the capacitor (*Cx*) and neon bulb are in parallel, forming a relaxation oscillator in connection with series resistor *R2*. As before, connect *Cx* to *BP1* and *BP2, observing d.c. polarity*, and plug the line cord into a standard outlet. If the capacitor is in good condition, the bulb should flash at a periodic rate inversely proportional to the capacitor's value—that is, the larger the capacitor, the lower the flashing rate. If the neon lamp lights continuously, the capacitor is either "open" or its value low (the bulb may appear to be on continuously when flashing at a rate faster than the eye can follow). If the bulb fails to light, the capacitor is either leaky or shorted. You can obtain a rough "calibration" by checking capacitors of known value and noting the flashing rate.

**Manufacturer's Circuit.** Featuring a hybrid integrated-circuit operational amplifier, the d.c. millivoltmeter circuit in Fig. 3 has a full-scale sensitivity of only 10 millivolts, yet requires a minimum of components. It is one of the nearly two-score circuit applications described in a folder published by Opamp Labs (172 S. Alta Vista Blvd., Los Angeles, Calif. 90036). Other IC amp applications in the folder include a Wien bridge oscillator, timer, Schmitt trigger, high-voltage d.c. amplifier, tuning fork oscillator, voltage regulator, a.c. millivoltmeter, temperature controller, pulse width modulator, crystal-controlled oscillator, a.g.c. amplifier, and an active notch filter.

Resistors *R1*, *R2*, and *R3* are half-watt'ers, with low tolerance (2% or 5%) types preferred. The IC is an Opamp Labs Model 4009 (these sell for $10 each in unit quantities). The meter is an 0-1 mA unit, while *BP1* and *BP2* can be conventional binding posts or panel test jacks. Either a battery or line-powered type d.c. power supply can be used.

Suitable for a variety of laboratory and experimental applications, the completed d.c. millivoltmeter could be used for such varied tasks as measuring the output of thermocouple elements or other transducers, or even for checking biological potentials. If desired, a step-type voltage-divider could be added to permit the instrument to serve as an ultra-sensitive d.c. voltmeter.

**Device News.** Accurate time delays of up to 30 days may be possible with a new device developed by the Battery Division of the Sonotone Corporation (Elmsford, N.Y. 10523). The solid-state timer uses a special nickel-cadmium control cell as its timing element in place of the more familiar capacitor, taking advantage of the cell's characteristically short rise in voltage as it reaches full charge. Early experimental models have achieved delays for periods of from an hour to a week, but the firms's engineers feel that refinements in design will extend the range of future models to from 10 minutes to 30 days.

Another new device has been announced by Bell Telephone Laboratories—a monolithic FM discriminator which is about as "solid" as a solid-state device can be. As shown in the drawing, Fig. 4, the discriminator consists of a quartz plate about

(*Continued on page* 104)

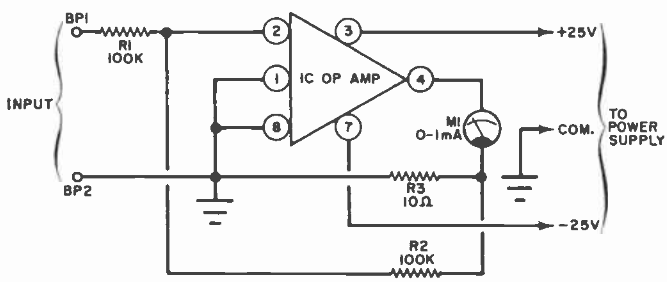



Fig. 3. Opamp Labs millivoltmeter circuit, which features an IC, is capable of measuring down to 0.01 volt full scale.

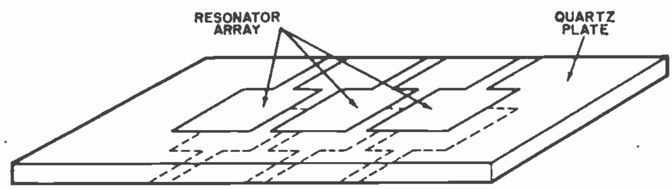



Fig. 4. The new look in FM discriminators? Another Bell Labs contribution, this device can operate between 10 and 30 MHz.

# OPERATION ASSIST

*Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information, write him directly—he'll appreciate it. If you need help, send a postcard to Operation Assist,* POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name and model number of the unit. If you don't know both the maker's name and the model number, give year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

**Atwater Kent** Model S65-976, circa 1935. Schematic and servicing data needed. **National** Model NC 125 receiver. Operating manual needed. (William J. Ziaja, 38 Oxford Ave., Dudley, Mass.)

**National** SW-3 receiver. Schematic needed. (Perrin C. Cothran, HQS Camp Howard, APO San Francisco, Calif. 96271)

**Dumont** Model RA113-B3 TV receiver. Schematic and servicing data needed. (Flavio Dotta, Jr., Av. San Joao 253, 4 Andar Conjunto 41, Sao Paulo, Brazil)

**Hallicrafters** Model TW-1000 radio receiver. Volume control needed. (Walter Wilusz, 316 Bruck Ave., Perth Amboy, N.J.)

**Superior instruments** Model TV-12 transconductance tube tester. Schematic and operating manual needed. (Paul I. Brunk, 2733 Quail Ln., Dayton, Ohio 45439)

**Radiotechnic Lab** Model 130 tube and battery tester. Latest tube chart needed. (Louis Malaric, 5093 French Rd., Detroit, Mich. 48213)

**Radio City Products** Model 657 VTVM. Schematic or wiring diagram and/or details of power supply needed. (P.G. Summerfield, 3 Lancelot St., Five Dock, Sydney, Australia)

**Hallicrafters** Model DD-1 "Skyrider Diversity" receiver, 1938. Receiver with accessories and manual wanted. (Bruce Sugarberg, 1415 DeWitt Dr., Akron, Ohio 44313)

**Lear Jet** Model ASFM 830 8-track stereo car player, with FM receiver, universal mount. Schematic and servicing instructions needed. (G.E. Durtler, 2248 E. 46 Ave., Vancouver 16, B.C. Canada)

**Solar** Model C-E capacitor checker. Operating instructions needed. (Ralph Musco, 2119 74 St., Brooklyn, N.Y. 11204)

**Philco** Model 48-200 BCB receiver; code 121; has 5 tubes; 115-volt a.c. or d.c. Schematic needed. (Tim Ohrman, 1210 Old Concord Rd., Monroeville, Pa. 15146)

**Webster** Model 80-1 "RMA 375" wire recorder. Operating manual, schematic, and extra wire spools needed. (Albert M. Foster, 1515 Avenue B, Eau Claire, Wis.)

**Superior** Model TV-12 tube tester. Tube chart needed. (Agostino DiCamillo, 27 Lawrence St., Milford, Mass.)

**Grundig** "Majestic Model 8095" radio receiver. Tuning capacitor (part =1005-022) needed. (James C. Masters, Jr., Star Route 3, Box 48, Alsea, Ore. 97324)

**Multi-Elmac** Model AF-67. Instruction manual and schematic needed. (George R. Young, 49 Freetown Rd., Belize City, British Honduras)

**Harman-Kardon** "Citation V" amplifier and "Citation I" stereo control center. Operating manuals needed. (Garry Weingarten, 45 Burch Dr., Morris Plains, N.J. 07859)

**Superior Instruments** Model TV-50A "Genometer" signal generator. Schematic or instruction manual needed. (R.J. McGinty, 831 Ratone, Manhattan, Kan. 66502)

**Philco** receiver, code 121, circa 1939; has 5 tubes; tunes broadcast band and SW up to 18 MHz. Schematic needed. (Steve Zimmerman, 542 E. Huntington, Rossville, Ga. 30741)

**Grundig** "Reporte 500" tape recorder; has 4 tubes and magic eye. Schematic needed. (SSgt. D. B. Summers, Jr., 95th C.A.M.S., Box 458, APO, New York, N.Y. 09677)

**Encore** transistor radio, AM-FM, 10 transistors; made in Japan. Schematic needed. (Marvin D. Hanson, 130 E. Northwest Highway, Des Plaines, Ill. 60016)

**RCA** Model 5T6 receiver; tunes 540-6600 kHz. Schematic and source for parts needed. (David Christenson, 162 Forest Rd., Aromas, Calif.)

**Nelson** radio receiver; European-made. Schematic and information as to what tube to substitute for EK2 needed. (Paul D. Crotts, 1003 Nancy Ln., Winston-Salem, N.C. 27107)

**Landers, Frary & Clark** recorder/reproducer; subassembly sound RD-149/TNH-2B. Schematic or information on power supply and amplifier needed. (Leo J. Stengel, 1126 Charles St., Louisville, Ky. 40204)

**UV199 tube** and socket needed for home-brew radio receiver. (Lawrence Meikle, R.R. =1, Richmond Hill, Ontario, Canada)

**DeVry** Model IG09 5" oscilloscope; supplied with training course in kit form. Schematic and assembly instructions needed. (John Petrucelli, 135 Mt. Pleasant St., Meriden, Conn. 06450)

**Emerson** ED354 receiver, "Silver Jubilee" model, circa 1945 or earlier; tunes 55 to 150 kHz. Tube chart, instruction manual, and schematic needed. (Thom Ramsey, 143 Devon Rd., Albertson, N.Y. 11507)

**Multi-Elmac** mobile receiver; tunes 0.55 to 28.7 MHz. Tube layout for receiver and power supply needed. (D.E. Richards, 1327 N. St., Fresno, Calif. 93721)

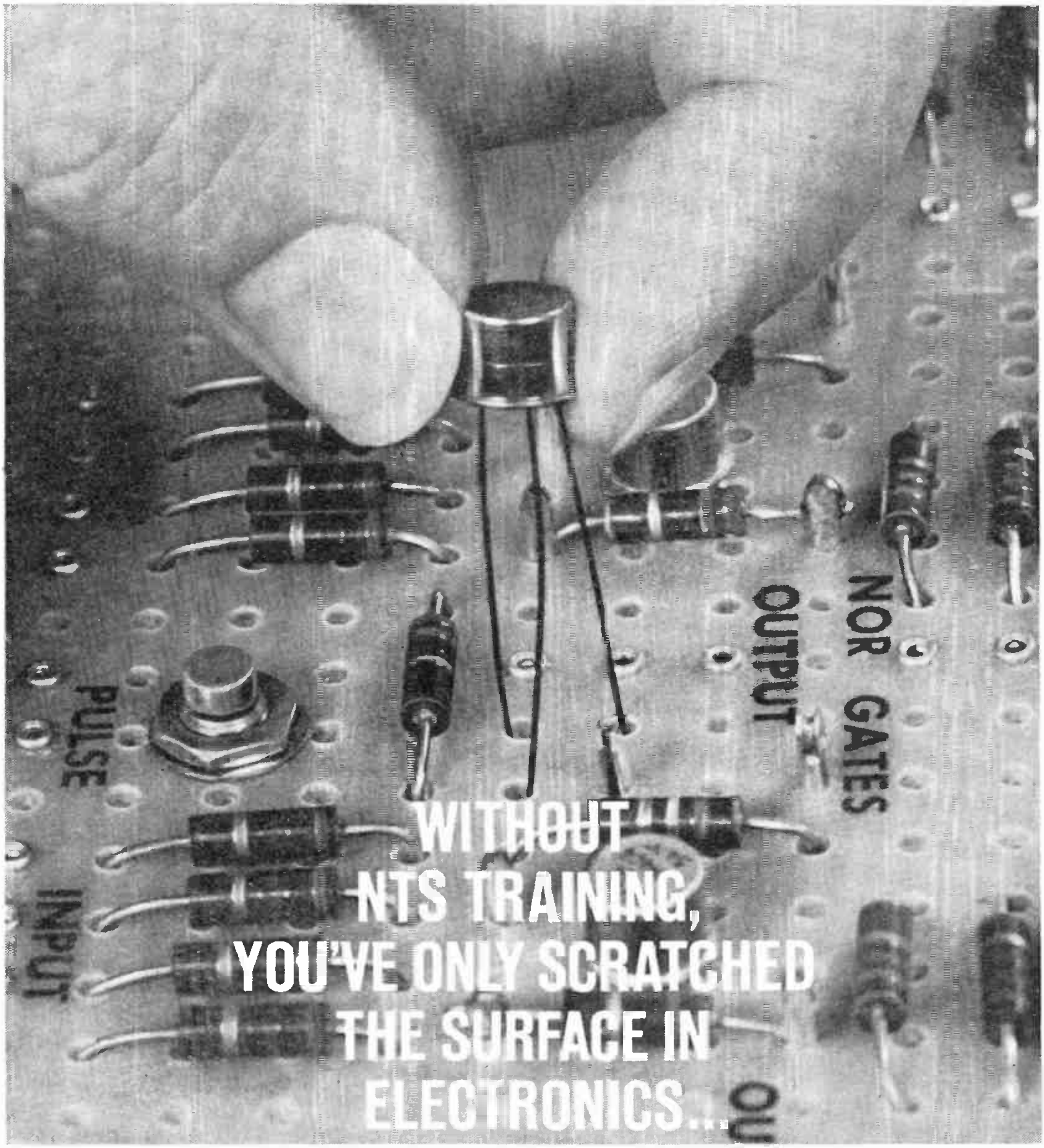
**Phonograph needles** made before 1940 needed; steel, tungsten, or other substances; .003-inch tips. (Ron Graham, 63A Werner Ave., Daly City, Calif. 94014)

**Philco** Model 37-160 receiver. Schematic, operating manual, and source for parts needed. (Herman G. Herbig, P.O. Box 425, Gardnerville, Nev. 89410)

**Alfred Barber** Model 32 high-frequency electronic voltmeter. Schematic and calibration data needed. **Motorola** Model H11-1AM walkie-talkie with trans. type 1A-113; operates on 33.14 MHz. Schematic, alignment procedure, and conversion data needed. **Hickok** Model 547A mutual conductance tube tester. Tube chart, schematic, and source for adapters needed. (Donald E. Smith, 1142 W. Grand, Pomona, Calif. 91766)

### SOURCES OF INFORMATION

"Operation Assist" is published as a service to the readers of POPULAR ELECTRONICS who cannot find schematics, parts, etc., for old or no-longer-manufactured equipment. Military—or Government surplus—equipment is not itemized in this column, since schematics and copies of Tech Manuals for military equipment can be obtained from a variety of independent sources: Slep Electronics, Drawer 178, Ellenton, Florida 33532; Quaker Electronics, P.O. Box 215, Hunlock Creek, Pa. 198621: etc. Unusual or difficult-to-find schematics and servicing information can frequently be obtained from Supreme Publications, 1760 Balsam Rd., Highland Park, Ill., for a slight charge.




*Only NTS* penetrates below the surface. Digs deeper. Example? Take the above close-up of the first transistorized digital computer trainer ever offered by a home study school.

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# COMPUTATION WITH THE BINARY ADDER

*(Continued)*

## HOW SYSTEM WORKS

*(Continued from page 40)*

subtraction of seven from ten proceeds as follows:

```
Step (a)   01010  (ten)
          -00111  (seven)

           11     (carries)
Step (b)   01010  (ten)
          +11011  (minus seven)
           00011  (three)
```

Likewise, ten from seven is:

```
Step (a)   00111  (seven)
          -01010  (ten)

            11    (carries)
Step (b)   00111  (seven)
          +10110  (minus ten)
           11101  (minus three)
```

Try the following example as an exercise.

```
    (m)    01100  (twelve)
          -00111  (seven)
```

After you have read the above text, you might want to gain a greater familiarity with binary arithmetic by creating a number of exercises and solving them using the methods demonstrated.

**ANSWERS TO BINARY PROBLEMS**

(a) 00101; (b) 01100; (c) 11110; (d) nine; (e) fourteen; (f) nineteen; (g) fourteen; (h) twenty-one; (i) plus seven; (j) minus seven; (k) minus thirteen; (m) change 00111 to 11001 and add to give 00101 (five).

## CONSTRUCTION & APPLICATION

*(Continued from page 42)*

cator lamp comes on, and the contents of the RESULT REGISTER are incorrect.

**Using the "Adder."** The following exercises can be done on paper first, then checked on the "Binary Adder." Place the NUMBERS switch in the 4 BITS + SIGN position. All numbers must be thought of as *signed* binary numbers.

To better appreciate the binary number system, and the "place value" concept, add a few simple positive numbers (2+2, 3+5, etc.), by first converting the decimal numbers to binary, then confirming the result on the "Binary Adder." Then add both positive and negative numbers (2+ minus 1, 7 + minus 8, etc.). Remember that the negative number must be represented by the two's complement.

For more experience in using the two's complement form, perform some subtraction: 8—(—2), 12—(—5), 4—(—6), —3—(—1), etc. Remember that negative numbers themselves must be in two's complement form, and that when you are performing the subtract operation, you must first find the two's complement of the second number, then add the two numbers together.

When working with the "Binary Adder," the complement function required to perform the subtraction is done automatically by the circuitry with the FUNCTION switch placed in the SUB(tract) position. —30—

# THE PRODUCT GALLERY

*(Continued from page 74)*

similar meters—sometimes at an additional cost. But on a cost-versus-versatility basis, this meter is an excellent buy.

Circle No. 87 on Reader Service Page 15 or 115

## VHF MONITOR RECEIVER

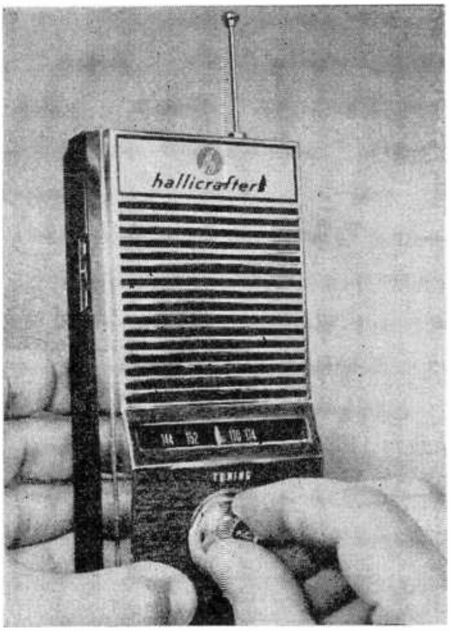
### (Hallicrafters Model CRX-102)

Hand-held VHF receivers are becoming as common as any other type of transistorized pocket or portable radio receiver. One of the three new VHF receivers marketed by Hallicrafters (600 Hicks Rd., Rolling Meadows, Ill. 60008) was recently tested by POPULAR ELECTRONICS. This particular receiver tuned from 144 through 174 MHz (Model CRX-102 —$39.95, list price) and is similar in styling and appearance to the manufacturer's other models tuning 27-50 MHz and 108-135 MHz.

The CRX-102 is a 9-transistor superhet with 3 i.f. stages powered by a regular NEDA 1604 9-volt battery. Good sensitivity is insured by a separate r.f. stage that also serves to decouple the collapsible antenna from the mixer. Automatic gain control and noise limiting are included in the superhet circuit. Jacks mounted around the case are provided to power the receiver from an external 9-volt source, for connection to an outdoor antenna, and for an earphone.

Portables such as the CRX-102 are not intended to replace the easily tuned a.c.-operated base station receivers, but to permit the owner to monitor a special channel or frequency (police, fire, CAP, ham, weather, etc.). If this distinction between types of receivers is accepted, the user will find that the portable has many advantages. For example, frequency drift is eliminated, battery life is usually very long, and the handiness of taking the receiver with you (if only from room to room) cannot be denied.

(Circle No. 88 on Reader Service Page 15 or 115)




Volunteer firemen or auxiliary police should welcome the advantages of a desk or bedside VHF receiver. Sensitivity with built-in antenna is usually sufficient for local 3-7 mile VHF reception. Use of outdoor antenna tuned to VHF will triple receiving range. Similar models tune CB or aero bands.

### *WWV and WWVH Use New Codes*

The standard frequency broadcasting stations of the National Bureau of Standards have instituted a new coding system for "Geoalerts." The new system will permit three types of information to be announced at each broadcast —each in the form of letters repeated three times in slow International Morse Code. Geoalerts advise listeners of past, present, or future short-wave receiving conditions. Forecasts are made at 0400 GMT and the first broadcast for a given day is heard over WWV at 0418 GMT and WWVH at 0448 GMT. The broadcasts are repeated hourly until a new alert is issued.

A sample broadcast in slow Morse would be: GEO SSS EEE DDD. The GEO letter group is the standard introduction and the SSS is a prediction of a proton solar flare. If no event is predicted, the EEE group would have been transmitted in place of SSS. Similarly, a III group indicates that solar flares are predicted and TTT indicates that a magnetic storm disrupting radio communication is expected. The UUU group says that both flares and a magnetic storm are expected, and the VVV group says that a proton flare and magnetic storm are predicted. Additional groups, HHH, DDD, BBB, and MMM, pertain to similar events, but include a stratospheric warning. The last, and next to last group of letters transmitted pertain to the occurrence of and the approximate time of observed solar or geophysical events in the preceding 24 hours.

Details can be obtained from the National Bureau of Standards, Boulder, Colorado 80302. Ask for Bulletin Number 53.

## LETTERS (*Continued from page 10*)

preferred value. The next highest preferred value with a 10% tolerance would be 3830 (using the 12th root of $10^{43}$); this is rounded off for a preferred value of 3900 ohms.

FRED STERN
Chief Engineer,
Philadelphia Division
IRC, Inc.
Philadelphia, Pa.

*After what Fred has written, what more can we say but that he is perfectly correct? The mixup obviously occurred as the result of a misinterpretation of the meanings of tolerances and preferred values for resistors. But when the article went to press, it was not meant as an "April Fool" joke, John.*

### READY-MADE PROJECT SUPPLIERS

I noticed the question from one of your readers in the "Information Central" column (February, 1968) asking if there was anyone who builds and sells POPULAR ELECTRONICS projects. While Precision Devices is primarily a maker of quartz crystals, it has a well-equipped facility to assume all tasks from procurement of parts to machine work and assembly in connection with any construction project printed in your magazine. Since this facility was recently idled due to completion of a government contract, it is possible that many of your readers would find such a service valuable.

DAVID SULLIVAN, President
Precision Devices Div.
619 Vermont Ave.
Lawrence, Kans. 66044

*We are receiving an unusually large response from readers willing to supply ready-made* POPULAR ELECTRONICS *projects on a one-shot basis. Look for a complete listing in the May issue.*

### INCORRECT COLOR CODE

Anyone who buys the Alco FR-101 isolation relay described in "Meet Mr. Versatile" (December, 1967) will realize that you made a mistake in the color-coding of the relay's wires. The correct coding should be: relay contact wire, blue; other contact common with the 117-volt line, white; and the remaining 117-volt line, black.

DAVID LANSDOWN
Chico, Calif.

*You are probably correct about the particular relay you have, but the color-coding that appeared in the article was and is correct for the latest model of the FR-101 isolation relay. Alco tells us that the color-coding of the relay's wire leads was changed recently to conform with accepted industry standards. If anyone who has purchased this relay is in doubt about which wires go where, refer to instructions that came with the relay.* —30—

## PROGRAMMED INSTRUCTION

*(Continued from page 53)*

Cleveland Institute of Electronics uses the adjunctive technique for all of its technology level courses; lessons written before 1963 are currently being revised. Using this technique, sections in the CIE "Auto-Programmed" books—called "What Have You Learned?"—are placed at the end of each topic to insure active participation by the student. Answers are given immediately below the questions.

Dr. Robert A. Nottenburg, Vice-President for Education and Training at CIE states: "We accept for the most part the definition and criteria of programmed instruction generally adopted by the field; that is, small bits of information carefully sequenced; each concept built on what was previously learned; the student responds actively; the correctness of each response is immediately confirmed; and each student proceeds at his own pace."

"With the exception of immediate reinforcement," Dr. Nottenburg continues, "these criteria are not far from the home study technique that has been used in this country for over 75 years."

Says H. B. Bennett, Director of the Student Services Division of National Radio Institute: "While NRI does not use programmed instruction, we are fully aware of the importance it has attained in education. Programmed Instruction has proved itself in many situations, but we believe it leaves much to be desired as a home study method of teaching. With PI, the student becomes increasingly aware that he is performing a mechanical process. In our courses using NRI's discovery teaching method [described in the Summer, 1966, issue of the "Home Study Review" available from NRI on request], we try to foster an atmosphere in which each student knows he is an individual."

But Mr. Bennett concludes: "NRI does not arbitrarily rule out PI or any other learning device. Actually, most correspondence schools, including NRI, use some principles of PI."

Most book publishing houses are engaged in producing the PI-type textbook for general use. The PI books you will find on electronics generally came into being as a result of courses given by large electronics companies to their employees. With PI writers on their staffs, these companies have an excellent means of validating and testing their material at first hand.

For example, RCA has been developing custom-tailored PI materials for the government, business, and industry since 1959. Their programs range from gas station attendance to property management for the Department of Agriculture. Varian Associates gives a course on klystrons to its sales engineers and junior engineers. The General Electric Industrial Sales Division uses PI courses on semiconductors and capacitors. And DuPont has prepared its own PI courses for more than 150 job-related subjects since 1959. Today there are PI courses available for virtually every area of private business, industry, and government.

**Will PI Help You?** Programmed instruction materials, you'll find, are generally more expensive than conventional textbooks. But they are extensively tested and retested over a long period of time for flaws, and this must be taken into account.

The PI books spotted throughout this article are devoted entirely to the subject of electronics. They encompass general and specialized areas, both on basic and advanced levels. If you are planning to study electronics at home, one or more of these books should suit your needs.

The only way you'll ever really know if PI can help you is to give it a try. Your evaluation of PI can be honest only after you have used it. -30-

## ON THE CITIZENS BAND

*(Continued from page 81)*

groups that have plans to entertain the whole family, from junior to grandpa, but not necessarily with psychedelic or carnivalistic designs. Fun should be part of a jamboree, but not used as a primary draw. Programs of interest should include latest electronic equipment displays, addresses by D.O.T. or FCC personnel, technical and authoritative chats by equipment manufacturers' personnel, etc. *Then* bring on the fun!

Thousands of dollars will be raised by many groups this year, with the proceeds going (as in the past) to needy families, children's homes, hospitals, and homes for the mentally retarded. Others will use profits to modernize the clubhouse, renovate the old school bus into a communications van, and add needed equipment to local police or sheriff's headquarters for emergency CB monitoring.

A listing of upcoming jamborees that have reached your CB Editor's attention appears on page 81. As we go to press, late news has been received of a CB jamboree that will take place in Lawrenceville, Georgia, on May 4-5. Location: City Park, Highway 29. Sponsor: The Gwinnett Communications Club of Georgia. Contact: William L. Bell, R.F.D. 4, Lawrenceville, Ga. 30245. The proceeds will go to the Hi-Hope School building fund for retarded children.

**Club Chatter.** Middle Georgia CB Radio Club, Inc., Macon, Ga., has supplied its members with a new decal which signifies their participation in Red Cross and Civil Defense activities. The club membership of


20 in 1961 has grown to 160. Club emergency van has served in search and rescue, is equipped with emergency communications and rescue gear. Official club publication is *The Little Beam,* edited by Wayne Barr.

The *CB Chatterbox,* club publication of the Cereal City Citizens Radio Club, Inc., Battle Creek, Mich., recently celebrated its fifth birthday. Sixty-one successive issues have been printed and distributed monthly without fail by CCCRC Chatterbox editors. The first issue appeared through the efforts of Skip Schepel (then KHG5557); Don Cortright, KPM0665, picked up the honors after the third issue and followed through until May, 1966; at which time George Gemrose, KRM9159, took charge.

The Citizens Radiophone Association, Detroit, Mich., recently reported in the *Gridleak* the receipt of very impressive brochures and application forms from an "organization" called the Associated Special Investigators and Police, International, with an invitation for the club members to join the Highway Radio Patrol, International. For $2.85, members were promised an I.D. card and badge, presenting each as a worldwide combatant of crime and aide to emergency operations. When checked by the Canadian Government and the province of New Brunswick, the "organization" was found wanting as to legal existence and recognition.

San Gabriel Valley REACT would like to exchange news and ideas with other CB groups. Interested parties should contact Ron Hamlet, editor of the S.G.V. REACT NEWS, P.O. Box 3271, Industry, Calif., 91744.

I'll CB'ing you,

*—Matt, KHC2060*

## ANSWERS TO "A" QUIZ

(*Quiz appears on page* 48)

1 An AMPLIDYNE is a rotary magnetic amplifier used as a power amplifier stage in servo systems.

2 An ATTENUATOR is a circuit used to reduce a signal by a known ratio while also matching input source and output load impedances.

3 The ALPHA, or current amplification factor, of a transistor is the ratio of collector to base currents.

4 An ACORN tube is a UHF amplifier designed for high-frequency operation by eliminating the base and bringing the pins directly out through the sides of the glass envelope.

5 The ARMATURE of a motor is the rotating winding assembly energized through the commutator and brushes.

6 The AZIMUTH angle of a tape recorder is the angle between the tape and the gap in the recording head.

7 ASTIGMATISM refers to a CRT problem whereby an out-of-round or out-of-focus spot appears on the screen.

8 An ARMSTRONG oscillator circuit uses a two-winding, four-terminal oscillator coil to provide plate-to-grid feedback.

9 ALNICO is a commonly used magnetic material made of aluminum, nickel, and cobalt alloyed with iron.

10 An ALKALINE cell of the common manganese-zinc type can deliver 30-40 watts per pound with high overall efficiency.

## INSTRUMENT AMPLIFIER

(*Continued from page* 47)

ries with a FET (*Q5*) acting as a voltage-variable resistor. As the voltage to the FET gate is varied, more or less bypass is introduced into the *Q3* circuit. This, in turn, will vary the gain of the output signal, producing tremolo (signal level variation).

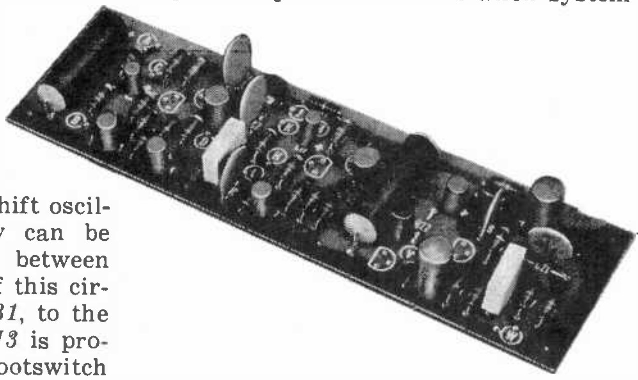


Fig. 8. Completed instrument preamplifier on printed board before installation of the transistors.

Transistor *Q6* is in a phase-shift oscillator circuit whose frequency can be varied (by speed control *R30*) between 4 and 15 Hz. The a.c. output of this circuit is fed, via level control *R31*, to the gate of *Q5*. Open-circuit jack *J3* is provided so that an external footswitch can be used to turn on the tremolo if desired.

### PC BOARDS AND PARTS KITS

The following are available from Southwest Technical Products: etched and drilled PC board for instrument preamplifier (#141), $3.00; straight preamplifier (#141P), $2.50; reverb unit (#141R), $2.10; and power amplifier (#141A), $2.10. A complete amplifier kit including all parts and punched chassis, less cabinet and panel markings (#MMC141) is $85.00. Send self-addressed envelope for price list on separate parts kits for each portion of the system to Southwest Technical Products Corp., 219 W. Rhapsody, Box 16297, San Antonio, Texas 78216.

The actual-size printed board for the instrument preamplifier is shown in Fig. 6 with the components mounted as in Fig. 7. A completed board, before the semiconductors are installed, is shown in Fig. 8. This board was made from the kit.

Part 2 of this article (to appear next month) will contain the construction details for a straight preamplifier that can be used for announcements, vocals, or instruments not requiring signal conditioning; an adjustable reverberation system that has no signal loss, including some methods of installing it in any audio system; a power supply capable of operating either the entire M/M/M Instrument Amplifier, or any portion of it; and the interconnection details for assembling the entire instrument amplifier system in one package.

Incidentally, the straight preamplifier will also make an excellent hi-fi preamplifier for any audio system. It incorporates adjustable bass and treble controls —15 dB boost or cut—and an independent volume control. –30–

## BASIC ONE-BIT ADDER

(*Continued from page* 35)

bit, 10010 should be read as minus fourteen, which of course is incorrect. In such a case (i.e., when the capacity of the RESULT REGISTER has been exceeded), the sixth (left-most) 32-OVERFLOW indicator of the register will light. This overflow indicator mirrors the situation that arises in large computers—when an operation produces a result that exceeds the register capabilities, an indicator is turned on so the computer programmer can test for overflow and take corrective action.

With *S4* in the "5 BITS" position, the binary numbers are thought of as having no sign bit, and the left-most bit of the operands simply represents a place value of sixteen. Thus, numbers in the range from zero (00000) through thirty-one (11111) may be entered, and they are always considered positive.

With the NUMBERS Switch in the "5 BITS" position, the left-most indicator in the RESULT REGISTER (32-OVERFLOW) has a dual meaning, depending upon the setting of the FUNCTION switch. For an ADD operation, that indicator is just another bit of the result and has a place value of thirty-two. For example, if 01111 (fifteen) and 10110 (twenty-two) are added, the result will show as 100101 (thirty-two plus four plus one equals thirty-seven).

With *S4* in the "5 BITS" position, and for a subtract operation, the left-most indicator is the sign of the result. For example, 01001 (nine) less 01011 (eleven) will display as 111110, which is minus two in two's complement form. Likewise, eleven minus nine will be 000010, or plus two.

As shown in Fig. 3, the wiring of the NUMBERS switch and the "32-OVERFLOW" indicator is simple. With *S4* in the "4 BITS+ SIGN" position, the indicator is connected across the last adder stage's Carry In (CI) and Carry Out (CO) terminals. Thus, it will light whenever the carry in and the carry out of the "16" place value stage differ. Such a test is all that is needed to determine if the register capacity has been exceeded. —30—

## TWENTY QUESTIONS

(*Continued from page* 71)

### What are the most common reasons for exam failures?

Most failures are due to not knowing the Rules and Regulations outlined in Elements 3 and 4. Jumping to conclusions about answers is another cause for failure. Many people tend to choose the first answer that seems reasonably correct without reading all the choices given.

Don't attempt to take too many elements at one sitting. By doing so, you may tire, become discouraged, and not be able to do your best. It is better to take fewer elements and obtain a good score than to take many elements and get only mediocre or even some failing scores.

### If I fail, how long must I wait before I can apply again?

Under current FCC regulations, the minimum waiting period is two months. However, if requested for a good reason, the examiner may give you a waiver to allow you to be re-examined sooner. Waivers are normally given at the discretion of the field engineer on the basis of the score obtained and the amount of further preparation it is felt you need. If you fail by only a few points, for example, chances are good that you will receive a waiver, since it is obvious that you need very little extra preparation time. When you apply a second time, you must fill in FCC Forms 756 and 756B once more, and pay the license fee again.

### How long after taking the exam will I be notified of the results?

If you pass, you will receive your license in from one to three weeks after you take the exam. Applicants failing to pass are normally notified within ten days. If you are impatient to know the results, you might wait around for a half hour or so after submitting your answer sheet and ask the examiner whether or not you passed; most answer sheets are immediately checked.

### Are licenses issued for any specific length of time?

Each class and type of license is good for a period of five years from the date of issue and must be renewed thereafter. Endorsement renewals are automatic with the renewal of a license. To renew a license, simply complete FCC Forms 756 and 756B again, and send them and your $2 renewal fee to your District Office. You do not have to show proof that you need a license in order to perform your work. The FCC has temporarily waived the "proof of service" clause in the regulations.

Application for a license renewal should be made during the last ninety days of the five-year period. If you fail to renew on time, you are allowed an additional one-year grace period in which to do so without having to take the exam again. During the grace period, your license will be invalidated, and you will not be allowed to perform the duties of a commercial licensee.

### For what reasons can a license be suspended or revoked?

Any intentional violation of the rules and regulations—such as allowing someone else to use your license—are grounds for suspension of a license. Evidence of cheating on the exam or false statements on your application will result in a revocation.

### After I'm licensed, where can I get a job?

Broadcasters, airports, trucking and shipping firms, taxi cab companies, construction and salvage outfits all require FCC licensed personnel to supervise the operation of transmitters. And any small organization using two-way radio equipment has it serviced by licensed technicians.

Civil Service job openings range all the way from radar installations on the DEW Line to state, county, and city police operators and technicians. These positions require qualifications through Civil Service exams in addition to an FCC license.

Also, the Merchant Marine Service recently issued a call for licensed operators to sail on American cargo vessels. The minimum requirement here is the Second Class Radio Telegraph Operator License and a passing grade on the Coast Guard exam for radio officers aboard ships. —30—

## ELECTRONICS TECHNICIAN

(*Continued from page* 58)

cation Yearbook" (1965-1966): "Our more competent technicians are generally outstanding in technical knowledge and manual skills. The characteristic most essential to the competent technician is technical knowledge about the components tested and the equipment to be used. Manual skills are a highly essential quality for an engineering technician, and it is technical knowledge that directs the effective application of these skills."

The majority of the company executives interviewed for this article indicated that the junior college is one of the best sources of training for technicians. However, the general feeling is that existing junior colleges should modify their programs so that they provide improved technical training. The areas most often suggested for improvement are instrumentation, circuit analysis, test and troubleshooting procedures, and solid-state theory. The general consensus is that communications skills (speaking and writing), general physics courses, courses in the use of the slide rule and in logic should be strengthened.

It is thought that some schools, in attempting to cover a broad area in a short time, are defeating the purpose of education. Many company officials feel that schools should pare away the frills, eliminate or greatly reduce vacuum tube theory, and give only cursory attention to calculus. Algebra and trigonometry are considered sufficient for electronics technicians. There were a few officials who felt that a three-year technology program (instead of the usual two-year programs now being offered) would be a good idea for junior colleges.

Military schools in electronics are generally quite well-thought-of. The feeling, however, is that military schools are too specialized. But military education in electronics can provide a sound building block leading to a more liberal and general education in electronics engineering technology. Military training has one redeeming compensation: it lets you learn while you earn and fulfill your military obligation as well.

A number of agencies have been studying electronics programs and have developed suggested curriculums for electronics technology students. A direct comparison can be made between the curriculums suggested by the U.S. Office of Education and the industries that hire technicians (see pages 57 and 58). The program suggested by the industry was developed by Dr. Angelo Gillie, Associate Professor at Rutgers University. This program represents the conclusions of a study conducted by program experts in electronics, supervisors of electronics departments in industry, and directors of technical personnel in industry.

**The Technician Gap.** Electronics is an exciting, interesting, and challenging field. It has a better than 6% annual growth rate, making it the fastest-growing and most diversified industry. The number of people employed in electronics has quadrupled since 1950, and there does not seem to be an end to the growth in the foreseeable future.

This phenomenal expansion has created what is commonly known as the "Technician Gap." There are simply not enough technically prepared men to meet the current demand, and the situation will worsen before it gets better. The electronics equipment manufacturing industry alone will require an additional 45,000 technicians during the next four years.

The future of electronics and electronics technicians is bright. But to take full advantage of the many opportunities for growth, pioneering new horizons in aerospace, avionics and astrionics, cryogenics, and plasma electronics—not to mention the many fields now well established in electronics—you have to start early.

Where do you fit into this picture? You'll never know until you make a commitment, and if you invest your time and money in an electronics career, only you can decide how far and how fast you'll go. Think about it. —30—

## SOLID STATE

(*Continued from page* 86)

½-inch long by ¼-inch wide with three gold electrodes deposited on each of its two major surfaces. The amount of gold deposited makes the middle region resonant at the desired center frequency, while the other two regions are adjusted to the proper frequencies above and below the center value by the same method. In operation, electromechanical conversion is achieved through the piezoelectric effect. Suitable for use in a variety of FM receivers, discriminators can be produced to operate at center frequencies in the range of 10 to 30 MHz, with passbands ranging from 0.01% to 0.02% of the midband frequency.

Major semiconductor manufacturers have been trying for some time to combine junction type FET's and bipolar transistor elements in a single monolithic structure. Ironically, the news that this long sought-after goal has been achieved comes—not from a semiconductor manufacturer—but from an instrument firm, Tektronix, a producer of top-quality oscilloscopes. Developing the technique for their own use, the firm has produced a three-stage, wideband amplifier containing five *p*-channel FET's and 30 *npn* bipolar transistors on a 50-mil square chip.

If you're looking for a "second source" of solid-state lamps similar to those described in "Let There Be Light" in the December, 1967, column, you might check with Monsanto Electronics (800 N. Lindbergh Blvd., St. Louis, Mo. 63166). This firm offers a series of solid-state lamps, including lasers, visible and infrared light sources, and multiple arrays. Single unit prices range as low as $9.85 for an infrared type.

A new series of 25-ampere silicon triacs has been introduced by Texas Instruments, Inc. (P.O. Box 5012, Dallas, Texas 75222). Designed specifically for power control applications, they are available with voltage ratings of 200, 400, and 600 volts, and are designated, respectively, as Types 2N5273, 2N5274, and 2N5275. Although relatively small, these devices can handle up to 10 kW of a.c. power in motor speed control, light dimming, temperature regulation, and similar applications.

**Transitips.** "Which transistor tester should I buy?" Your columnist has been asked this question hundreds—perhaps thousands—of times. Ethical considerations prevent suggesting specific brands, and the pat answer, "the best you can afford," is simply a dodge, for it is not the right answer.

Choosing a transistor tester is an individual and, to some extent, a very personal thing, for your needs and expectations as well as the state of your finances must be the determining factors in your final choice of an instrument. The "best" tester for an experimenter who uses bargain transistors and specializes in audio circuitry may not be the "best" for the advanced hobbyist or student working with microwaves, nor for the service technician repairing transistorized receivers and CB equipment.

Before choosing a tester, your first step should be to write down a list of the operational features *you actually need* in your work or hobby. Add to this a supplementary list of the features you'd like to have. Then check the specifications of available testers to see which offer the features on both lists, comparing the relative costs of any "extras" you'd like, but which are not essential to your work.

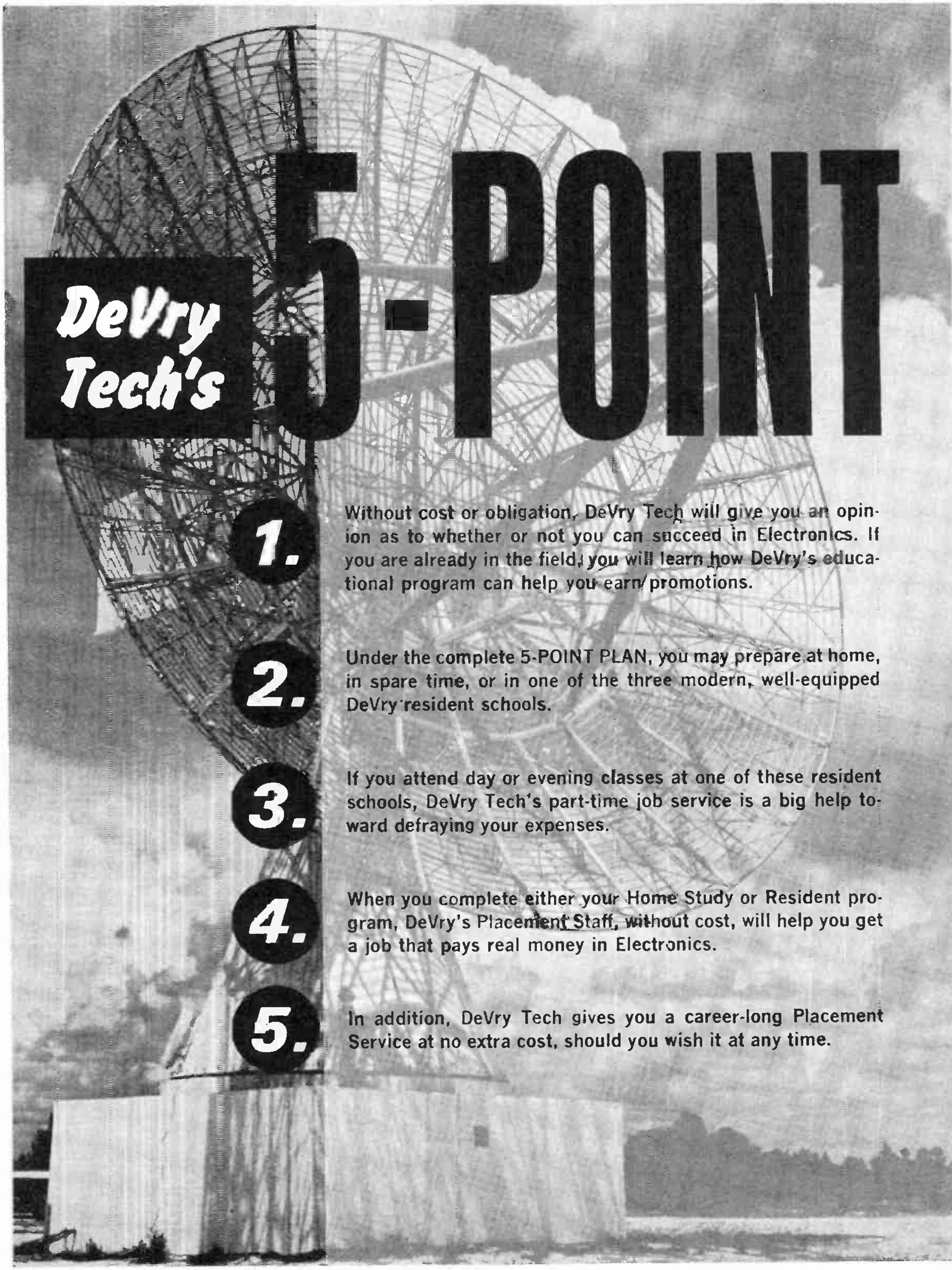
Technical specifications and operational features are important, but relative values must be considered. If you use, say, only a dozen transistors a year and always buy top-quality units, you might not consider it wise to invest several hundred dollars in a tester, for it would be far, far cheaper to buy a few extra transistors. But you might consider an inexpensive tester for quick tests. On the other hand, if you use hundreds of transistors a year and like to purchase "bargain packs" and low-cost "assortments," you might find that the additional features of a moderately priced tester are justified in helping you to sort and classify your purchases.

Your "basic" tester should have some provision for leakage and gain (*beta*) measurements. A simple "good-bad" indication is adequate for many applications, but if you work with critical circuits or do part-time servicing, you might prefer a tester which will give quantitative readings—actual gain and leakage figures.

If servicing is a major part of your activity, you'll find that an "in circuit" test feature is highly desirable as a time-saver, but not at the cost of such a basic test as leakage. The ability to identify a transistor as to basic type (*pnp* or *npn*) is a highly desirable feature when you're working with unfamiliar electronic equipment or with hard-to-identify transistors (as are often found in bargain assortments). In the final analysis, however, only *you* can determine what type of tester *you* need, and how much that tester is worth to you in terms of hard cash.

Until next month . . .

*—Lou*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Without cost or obligation, DeVry Tech will give you an opinion as to whether or not you can succeed in Electronics. If you are already in the field, you will learn how DeVry's educational program can help you earn promotions.
2.
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3.
If you attend day or evening classes at one of these resident schools, DeVry Tech's part-time job service is a big help toward defraying your expenses.
4.
When you complete either your Home Study or Resident program, DeVry's Placement Staff, without cost, will help you get a job that pays real money in Electronics.
5.
In addition, DeVry Tech gives you a career-long Placement Service at no extra cost, should you wish it at any time.

## SHORT-WAVE LISTENING

*(Continued from page 83)*

**Club Notes.** The Canadian DX Club (CDXC) is now celebrating its eighth anniversary with the proud boast that it is the largest DX Club in Canada and the second largest in North America. The club bulletin, *CADEX,* features columns on short-wave, broadcast, utility, FM, and TV station DX'ing, and card swapping. Present officers include: Ralph Irace, Jr., president (4 Fox Ridge Lane, Avon, Conn. 06001), to whom all membership requests should be sent; Michael Scott, secretary; and Dave Bennett, publisher.

Congratulations are in order for Don Billingsley, WPE6GXM, Sacramento, Calif., who has been appointed Editor of "Short Wave Review," a feature column of the American Short Wave Listeners Club (ASWLC). Information on this club can be obtained by writing to the ASWLC, 16182 Ballad Lane, Huntington Beach, Calif. 92647.

Your Short-Wave Editor recently sent out a number of Leaflet H (Clubs and Publications) which, through an error, had been printed on only one side of the paper. If you have received such a copy, please return it to us and we will send you the complete leaflet.

**New Short-Wave Booklet.** A 16-page booklet entitled "Your Window On The World" is now being offered by the Hammarlund Mfg. Co., 73-88 Hammarlund Drive, Mars Hill, N.C. 28754. Tightly written, this booklet describes the short-wave bands, radio signal propagation, and receiver operation. Also covered are antennas, time signals, and where to get more information. Price, 25 cents.

### CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports are as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to SHORT-WAVE LISTENING, P.O. Box 333, Cherry Hill, N.J., 08034, in time to reach your Short-Wave Editor by the fifth of each month; be sure to include your WPE identification, and the make and model number of your receiver.

**Albania**—*R. Tirana* is again active on 9515 kHz, as noted at 0255 closing a Spanish xmsn and at 0300 opening in Russian.

Your Short-Wave Editor has received a report that *R. Shkodra* is being heard on 8215 kHz with an editorial program at 0000-0100, but this does not agree with the listed schedule of 0500-0630, 1300-1400, and 1630-2000. Can anyone definitely confirm the above time period?

**Biafra**—*V. of Biafra,* Enugu, has been found on 6145 kHz with music from 0540, an IS and tuning signal at 0600, then Eng. news, Eng. commentary at 0611, and pop music until 0648 fade.

**Bolivia**—*R. Cruz del Sur,* La Paz, is moving from 4985 kHz to 5025 kHz, according to a note from the

## DX PROVINCES AWARDS PRESENTED

*To be eligible for one of the DX Provinces Awards designed for WPE Monitor Certificate holders, you must have verified stations (any frequency or service) in 6, 8, 10, or 12 Canadian provinces. (For these awards, the Yukon Territory and the Northwest Territories are considered as provinces.) The following DX'ers have qualified for and received awards in the categories indicated.*

**TWELVE PROVINCES VERIFIED**

Gary Ligon (WPE4JAX), Cliffside, N. C.
Roger Thering (WPE6FUB), Barstow, Calif.
Charles Milhans (WPE7COE), Tacoma, Wash.
Clarence Hagerman (WPE2NRU), Delaware, N. J.

**TEN PROVINCES VERIFIED**

Ronald Hartwig (WPE5ELA), Midland, Texas
Robert Brickner (WPE3FYF), Pittsburgh, Pa.
Jack Forbing (WPE9AMH), Fort Wayne, Ind.
Fred Noakes (VE2PE2E), Montreal, Quebec, Canada
Kerry Plantenga (WPE9ITC), Lafayette, Ind.
Viktor Decyk (WPE1FCD), Pawtucket, R. I.

**EIGHT PROVINCES VERIFIED**

Jim Homan (WPEØEUS), Florissant, Mo.
Christopher Lucas (WPE1FNH), Fairfield, Conn.
Fred Bourjaily (WPE8JIE), Seven Hills, Ohio

**SIX PROVINCES VERIFIED**

Douglas Robinson (WPE2OVM), Johnstown, N. Y.
Kevin Wiese (WPEØEZY), Madison, S. D.
Sheldon Chorney (WPE2AWZ), Brooklyn, N. Y.
Robert Buckner (WPE2NMO), Rush, N. Y.
David Greene (WPE4IUM), Pensacola, Fla.
Sam Chmell (WPE9ITW), Elmwood Park, Ill.
Richard Houlis (WPE3GOK), Monessen, Pa.
Gary Cooper (WPE7CQV), Nampa, Idaho
Glenn Haffly (WPE4JBO), Randelman, N. C.
Bill Lee (WPEØEJK), Lawrence, Kan.
Jack Bacon (WPEØFDJ), Bloomington, Minn.
Mike Finigan (WPE4ISQ), Monroe, N. C.

Program Director. At press time, the station was still operating on 4985 kHz, but some tests were apparently being made on the higher channel.

**Brazil**—*R. Globo*, Rio de Janeiro, 11,805 kHz, was tuned at 0100 with Brazilian music to past 0135; ID's, commercials, and anmts in Portuguese make up the balance of the format. *Radio Rio de Janeiro* is definitely being tuned on 5045 kHz at 2300 with typical native programming. Other loggings include: ZYV74, *R. Guarani*, Belo Horizonte, 6175 kHz, at 0000-0100 with Brazilian ballads and commercials, and news at 0100; and ZYR78, *R. Bandeirantes*, Sao Paulo, found with a similar format at 0130-0200 on 11,925 kHz; all-Portuguese.

**Czechoslovakia**—*R. Prague* operates on 9575 kHz in Eng. with news from 0700 beamed to the Pacific, Far East, and Europe.

**Dahomey**—*R. Cotonou* is audible on the West Coast on 4870 kHz from 0600 with BBC Eng. lessons conducted in French.

**Ecuador**—*R. Cultura Religioso*, Banos, is a newly reported station on 2470 kHz that is being heard at times from 1030 with anthem, to 1105 with Catholic Mass, and to fade-out with organ music. Station HCBX2, *R. El Mundo*, Guayaquil, 4750 kHz, is fair around 0330 with U.S. and Latin American pop music.

**Egypt**—Cairo, 12,005 kHz, was logged with clock chimes and anthem at 1900, then Italian, and from 2145 s/on in Eng. to Europe. An outlet on 21,580 kHz was noted in an African dialect from 1810 to 1835, with the familiar clock chimes at 1830.

**Ethiopia**—*V. of Ethiopia*, Addis Ababa, 6185 kHz, carries Somali service from 0330 to 0430, then goes into Arabic. This channel may parallel 7293 kHz.

**Fiji Islands**—Fiji B/C Commission, Suva, has this current schedule: Eng. at 1800-0345 on 6005 kHz, and at 0345-1030 on 3230 kHz; vernacular at 1800-0330 on 5955 kHz, and at 0330-1030 on 3286 kHz. The use of 60 meters has been cut down to a religious broadcast relay at 1800 on Saturdays on 4756 kHz (500 watts).

**France**—*Ici Paree ORTF*, Paris, listed for 5955 kHz, is presently operating on 5960 kHz, as noted at 0410, with light variety programming. The 9620-kHz channel has French at 0800 beamed to French

**SHORT-WAVE ABREVIATIONS**

| | |
|---|---|
| anmt—Announcement | kW—Kilowatts |
| BBC—British Broadcasting Corporation | N.A.—North America |
| B/C—Broadcasting | QRM—Station interference |
| Eng.—English | R.—Radio |
| ID—Identification | s/off—Sign-off |
| IS—Interval signal | s/on—Sign-on |
| kHz—Kilohertz | V.—Voice |
| | xmsn—Transmission |

Polynesia, New Caledonia, and New Hebrides. English is noted on 15,130 kHz at 1915-1930 (news, commentary, and music) and on 21,580 kHz at 1300-1330; French follows at 1330. The service to Latin America includes Spanish at 2300 and 2345, and Portuguese at 2315 on 11,845 and 17,730 kHz. French at 0000 on 9755, 11,845, 15,245, and 17,730 kHz, and Spanish from 0030 to 0200 on the same channels (but only to 0130 on 17,730 kHz).

**Germany (East)**—*R. Berlin International*, 21,540 kHz, has Eng. to S. E. Asia heard around 1330.

**Ghana**—*R. Ghana*, Accra, has this Eng. schedule: to N. A. and Caribbean at 2000-2100 on 9760 and 11,850 kHz; to South and Central America and Australia at 1500-1545 on 17,910 and 21,545 kHz; to Europe at 2045-2215 on 9545 kHz; to W. Africa at 1400-2215 on 6130 kHz; and to S. Asia, Far East, and E. Africa at 1400-1430 on 17,910 kHz, at 1500-1545 on 21,720 kHz, and at 1645-1730 and 1815-1900 on 15,285 kHz.

**Guatemala**—Station TGCH, *R. Chortis*, Jocotan, 3380 kHz, has light music from 0230 to 0305 s/off (with the theme from "Bonanza"). Station TGWB, Guatemala City, 6180 kHz, is the easiest Guatemalan to log on the West Coast; it can be heard any time after 0000 with marimba music. Station TGNA, Box 601, Guatemala City, has Eng. on 5955 kHz at 0300-0430 weekdays.

**Honduras**—Station HRVC, *Evangelical Voice of Honduras*, Tegucigalpa, 4820 kHz, was heard at 0116-0130 with light music, to 0200 with a religious program, and at 0300-0330 in Eng. (Mondays only).

**India**—*All India Radio*, New Delhi, was found with Eng. on 9915 kHz from 2040 to past 2135 beamed to Africa; and on 11,810 kHz (dual to 15,-175 kHz) to S. E. Asia at 1328-1415, with news given at 1330.

**Indonesia**—*R. Republik Indonesia*, Djakarta, 9770 kHz, has a National Program in Indonesian from 1430 to past 1505; news at 1500.

In a Dutch TV program, information was given on *R. Panbjasila*, operated by students in Djakarta on 3950 kHz. Simply equipped, the station broadcasts march music, requested music, and news. No schedule was mentioned.

**Iraq**—*R. Baghdad* has retimed its s/on to 0425, in Arabic; both the 7180-kHz and 11,785-kHz channels are affected. English can be heard well on 6095 kHz at 1940-2020.

**Ivory Coast**—A new frequency for *R. Abidjan* is 11,920 kHz, noted with s/off just prior to 0000; pop music and a news session in French are featured before closing.

**Jordan**—Amman, 11,810 kHz, was logged from 1500 to 1615 with news at 1500 and 1600; the remainder of the program consisted of talks and Arab instrumental and vocal music. This is the Arabic

John Zapisek, WPE2OKD, Wading River, N.Y., has two receivers: a Knight-Kit "Star Roamer" and a Conar 500. It's no coincidence that the latter unit has ham-band coverage: John is also a radio amateur and just received his General license (WB2DRW). His SWL'ing record is 19 states and 40 countries.

Eric Lebowitz, WPE2JJY, of Jackson Heights, Long Island, N.Y., and his Hallicrafters SX-42 receiver have racked up 4 provinces, 25 states, and 54 countries verified (out of a 117-verie total.) Eric's most prized QSL's came from his monitoring a contact between VIS25, Overseas Radio Terminal, Sydney, Australia, and the British liner "Orsova" (GNDL), located on a bearing 91° from Sydney.

Home Service. Listen very carefully for the ID; it is literally whispered at times.

**Kenya**—*V. of Kenya*, Nairobi, 4915 kHz, opens at 0330 after a flute and drums IS; then time pips and s/on in (possibly) Swahili; news at 0400; time pips at 0415. The outlet on 4934 kHz has a variety musical program in vernacular with a newscast at 0400 and time pips on the hour and each quarter-hour. However, the two channels have not been found to be operating in dual.

**Korea (South)**—*V. of Free Korea*, Seoul, 9640 kHz, was tuned at 1031 with Eng. news to S. E. Asia; at 1035 there was a commentary and a cultural talk; at 1059, s/off.

**Liechtenstein**—The government of this country has declared that there will be no private radio stations. There had been a rumor that a private station might be operating from Liechtenstein in the near future.

**Mozambique**—Lourenco Marques has been providing good reception in the West on 11,780 kHz with the Eng.-Afrikaans "B" program from 0400; this program features pop and orchestral music, commercials, and dual-language anmts. The channel is dual to 6050 and 4855 kHz, neither of which is audible. A new frequency for the Portuguese service is 15,296 kHz; this service is heard well at 1725.

**Niue Island**—West Coast DX'ers might try for 2ZN operating on 550 kHz with 2000 watts. They are scheduled on Tuesdays, Thursdays, and Saturdays at 0530-0730 in Eng. and Nuiean. Good DX—if you can log it!

**Panama**—The only known Panamanian station operating on the short waves that we know of is *La Voz del Baru*, David, 6045 kHz. Often strong, it can be heard until 0400 in Spanish with frequent gongs and ID's.

**Poland**—*R. Warsaw's* Eng. service to N. A. has been heard at good level at 0315-0345 on Saturdays on both 7205 and 9655 kHz. By the time you read this item, this service should be on 11,870 kHz.

**South Africa**—*R. RSA*, Johannesburg, calls Libya, Egypt, and Jordan at 1700 in Eng. on 25,790 kHz, opening with news; this channel is dual to 21,535 kHz and runs along with the Central and West African service to 1854 s/off. Another new frequency in use is 15,360 kHz, Portuguese was heard from 2000 s/on to past 2045.

**Swan Island**—*R. Americas, The Continental Voice of Truth*, 1157 and 6000 kHz, is requesting that reports be sent to P. O. Box 11186, Pereo de Chacow, Caracas, Venezuela. S/on is at 0958. The 1157-kHz outlet is being reported widely all over the eastern half of N. A.

**Switzerland**—The low-powered HER22, 3985 kHz, reported here last month, continues to be heard in many areas, with German at 0600, French at 0615, Spanish at 0630, and Eng. at 0700.

**U.S.A.**—While *Voice of America,* Honolulu, is inactive so far as regular broadcasting is concerned, maintenance tests are being conducted on Mondays, Tuesdays, Thursdays and Fridays at 1900-0000 with 100-kW power. All reception reports should be sent to Washington, D. C.

**U.S.S.R.**—*R. Yerevan,* Armenian S. S. R., is heard well on the West Coast on both 15,140 and 15,180 kHz with music, an Eng. ID at 0325, Russian at 0328.

**Vatican City**—*Vatican Radio* has been noted on a new frequency of 21,530 kHz at 1554 closing an Eng. xmsn to India and S. E. Asia.

**Vietnam (South)**—*R. Vietnam,* Saigon, was noted on 9640 kHz at 1500 with IS, time pips and ID, at 1501 with what appeared to be Vietnamese opera; from 1527 with ID and Vietnamese music to 1545. At 1600, a new broadcast day begins with the ID *Day la Tieng Noi Nuoc Viet-Nam phat thanh tu Thudo Saigon;* news from 1603.

**Windward Islands**—W. I. B/C Service, St. Georges, 11,970 kHz, was heard at 0130 with hymns, at 0145 with a religious program, at 0200 with BBC news and regional and home news, at 0215 with s/off after frequencies are given, plus schedule, hymn, prayer, and anthem, beamed to Jamaica. The 15,115-kHz channel was heard at 2230 with home news and from 2245 with the BBC World Service.

**Zambia**—Salisbury, 4911 kHz, was noted on one occasion on an extended schedule from 2045 to 2121 with rock-and-roll alternated with native music and a time check in Eng. between the playing of each recording.

—30—

## SHORT-WAVE CONTRIBUTORS

Chris Lobdell *(WPE1GCI)*, Reading, Mass.
Conrad Baranowski *(WPE1GXX)*, Boston, Mass.
Harley Rutstein *(WPE2HKR)*, Englewood, N. J.
William Graham *(WPE2LMU)*, Binghamton, N. Y.
Eugene Shiwotsuka *(WPE2NBL)*, New York, N. Y.
Peter Macinta *(WPE2ORB)*, Kearny, N. J.
John Banta *(WPE2PHU)*, Bay Shore, N. Y.
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Marc Riddell *(WPE3HGG)*, Williamsport, Pa.
Rudolph Menna *(WPE3HIV)*, Philadelphia, Pa.
Robert Wilkner *(WPE4ACP)*, Pompano Beach, Fla.
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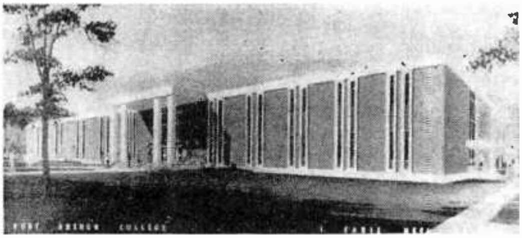





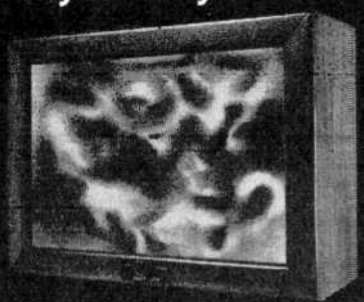



## AMATEUR RADIO

(*Continued from page* 86)

nations already use SSB exclusively for voice communications. In the United States, no AM transmitters will be licensed or relicensed for use in the high-frequency (4 to 22.5 MHz) maritime bands after 1970; and after 1974, no conventional AM at all will be permitted in this service. These rules do not necessarily mean that the FCC will eventually outlaw conventional AM in the crowded, low-frequency amateur bands. In this writer's opinion, however, SSB has had no difficulty in establishing its superiority over AM under difficult conditions without the benefit of any special laws.

In the January issue of the *Xtra News Letter,* Clif, K6BX, takes the American Radio Relay League, Inc., severely to task for not petitioning the FCC to outlaw AM in the amateur phone bands. He claims, in fact, that the ARRL is anti-SSB—a claim which will surprise most AM operators who usually complain that the ARRL is anti-AM and pro-SSB!

**Hoosier "500" Award.** The Indiana Radio Club Council, Inc., offers an especially attractive certificate free of charge to any amateur who earns 500 points by working members of amateur radio clubs affiliated with the Indiana Radio Club Council, Inc. A minimum of two points are earned for each club member worked, but additional points (up to a total of 28 or more) can be earned if the operator worked happens to hold the Indiana "Outstanding Amateur Award," the "Hoosier Courtesy Award," or has other qualifications outlined in the official award rules.

Because between 100 and 250 stations must be worked to earn the Hoosier "500," amateurs located more than a few hundred miles from Indiana may find the award difficult to obtain. However, everyone is cordially invited to try for it, no matter where he or she is located. Full rules and logging sheets are available upon a request accompanied by a large return envelope with 18 cents postage affixed addressed to: Hewitt Mills, WA9LTI, 289 W. Sumner Ave., Martinsville, Ind. 46151.

**Urgent Message Handled.** Stewart Reed, CE3UF, Santiago, Chile, recently broke in on Bill Cole, K4EN, Miami, with an urgent message. The father of a man vacationing in Miami had been killed in an accident and the mother was in very critical condition. CE3UF had no address at which the man could be reached. Could Bill do anything?

It was Sunday; the Chilean Consulate was closed, and the Consul had an unlisted phone number. But Bill managed to contact Eduarde Gallarde, U.S. Sales Manager of the Chilean Air Lines at his home.

Gallarde promised to do all he could to trace the wanted man, and Bill made a schedule with CE3UF for 6 p.m. After exhausting other leads, Senor Gallarde started to call all hotels in the Miami area systematically. Many calls later, he got his man, who arranged to fly back to Chile on the first available plane at midnight.

At the 6 p.m. schedule time, K4EN and CE3UF could not hear each other. However, John Shea, VE5JS, Regina, Saskatchewan was copying both stations and relayed the necessary information between Santiago, Chile, and Miami, Florida.

Our thanks to *Spurious Radiations* of the Rockaway Park, N.Y., Amateur Radio Club, and the *Oscillator* of the Etna, Pa., Amateur Radio Club for relaying this item, which originally appeared in the Miami, Florida, *Herald*.

## NEWS AND VIEWS

**Dick Morris, WA9PZZ,** 1331 Gilbert Ave., Downers Grove, Ill., became interested in amateur radio via the SWL route. In a year, he has collected enough cards for both Worked-All-States and Worked-All-Continent certificates although he is more of a rag-chewer than a DX chaser. A Heathkit SB-300 receiver, an SB-400 transmitter, and an SB-200 linear amplifier work with an 80-, 40-meter "trap" dipole and a 10-, 15-, 20-meter. 2-element quad antenna . . . **David L. Daniel, WAØSVO,** 1626 Cadet Ave., Lawrence Kans., really isn't "code happy," even though he works all day as a Morse code telegrapher for the Union Pacific Railroad and hams in his spare time. It took Dave two months to go from Novice to General license. His National NCX-3 transceiver and Hy-Gain 14-AVS vertical antenna have put 20 states and Canada in the WAØSVO log—some on SSB, and some on CW . . . **Tommy L. Halliburton, WN6ZNL,** 13073 Carl St., Pacoima, Calif., doesn't make the power company rich with his 15-watt AMECO AC-1 transmitter. Nevertheless, he racked up Canada and six states in his first two weeks on the air. Two receivers—a Hallicrafters S-85 and S-120—help with the indoor work, and an inverted "V" does the outside work. If things turned out as Tommy planned, he is now signing a WB6 call.

**Michael Pozzani, K3WBD,** P.O. Box 131, North Apollo, Pa., has worked all bands from 80 through 6 meters. At present, he works 6 meters with a 60-watt transmitter, 5-element beam, and a 6-meter converter in conjunction with a Gonset G-66B receiver. All but the G-66B are home-constructed. Actually, however, Mike's big interest has been in improving his technical knowledge. As a result, he now possesses Amateur Extra, Commercial First Class phone, and Second Class Telegraph licenses. Mike says he was no whiz in high school and has had no formal radio training, but he obviously did plenty of studying on his own . . . **Bob Wilson, WN1IZS,** 179 Knollwood St., Springfield, Mass., didn't waste much time after getting his license. He earned a Rag Chewer's Club (RCC) certificate the first day and had worked eight states by the end of the third day! Bob uses a Lafayette "Starflite" transmitter, Lafayette HA-700 receiver, plus three antennas, and he operates

Steve Blakley, WA7GUC, Phoenix, Ariz., played a trick on his uncle, K7ZWR. See text below.

on the 80-, 40-, and 15-meter Novice bands. The antennas include a vertical, a horizontal dipole, and a 2-element, 15-meter beam . . . **Joe Malecki, Jr., WN3HSI,** 490 Long Vue Rd., New Kensington, Pa., worked 43 states and 28 countries running 50 watts to a Heathkit DX-60 transmitter and one more state with a DX-100 at 75 watts. He receives on a Hammarlund HQ-110, and a simple dipole does the radiating. With his General exam already passed, Joe has his bug all oiled up for 30 wpm in the General bands . . . **Cliff "Beany" Stoll, WB2PSX,** 276 Rodney Ave., Buffalo, N.Y., president of Techams, the Technical High School Amateur Radio Club (WA2WVF), expected to add at least three Novice licensees to the club membership very shortly to bring the number of licensed members to six. Running 70 watts from an EICO 720-730 combination to two dipoles 80 feet high has permitted the club to amass a total of some 40 states and 35 countries. "Beany" himself has passed the Advanced exam, finding it "moderately hard."

**Stephen L. Blakley, WN7GUC/WA7GUC,** 3336 W. Rosewood Ave., Phoenix, Ariz., is a little tricky. Seeing his uncle's station (K7ZWR) inspired Steve to get his Novice license. Then, without telling his uncle, he studied for and obtained his Technician license. One day K7ZWR called "CQ" on 6 meters and was answered by Steve signing WA7GUC. His uncle dashed over to Steve's house (they live next door to each other) and demanded, "What are you doing? You want to get us both in trouble?" Steve then proudly displayed his new Technician license. Steve uses a Johnson "Ranger" to excite a Hy-Gain vertical antenna on the lower frequencies and a Heathkit "Sixer" to excite a 4-element beam on 6 meters. A Navy TCS or Hallicrafters SX-28 receiver helped Steve to work 25 states and Canada . . . According to Florida *Skip*, **Barry Goldwater, K7UGA,** a member of Air Force MARS, ran over 1300 phone patches from American Servicemen in Vietnam and Southeast Asia last year . . . **Mark Halliday, WN3HMU,** 24 Scott Rd., Doylestown, Pa., has 37 states and six countries worked—ZD8CW, Ascension Island, rates as his best DX. Mark uses a Heathkit DX-60A transmitter, Hallicrafters SX-110 receiver, and a multiband dipole on the three low-frequency Novice bands.

There is no better time than now to mail us your "News and Views" and a picture of you at your station. Remember, if it is a good, sharp photo, your station has an excellent chance of becoming the "Amateur Station of the Month." Keep club papers and club news coming, too. Send all material to: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P.O. Box 678, Gary, Ind. 46401.

73, *Herb, W9EGQ*

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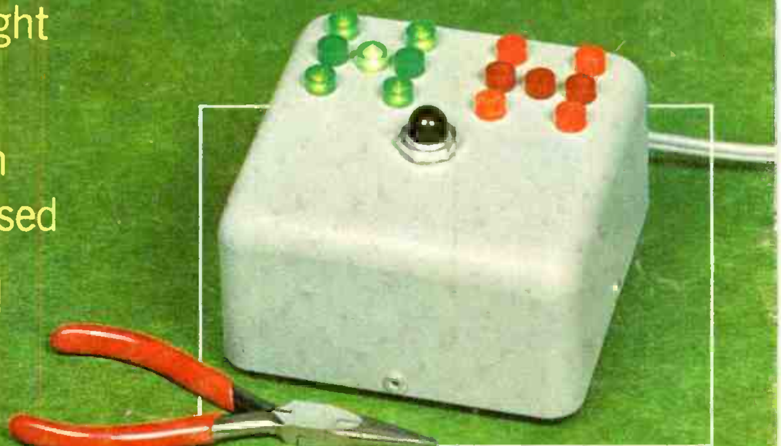

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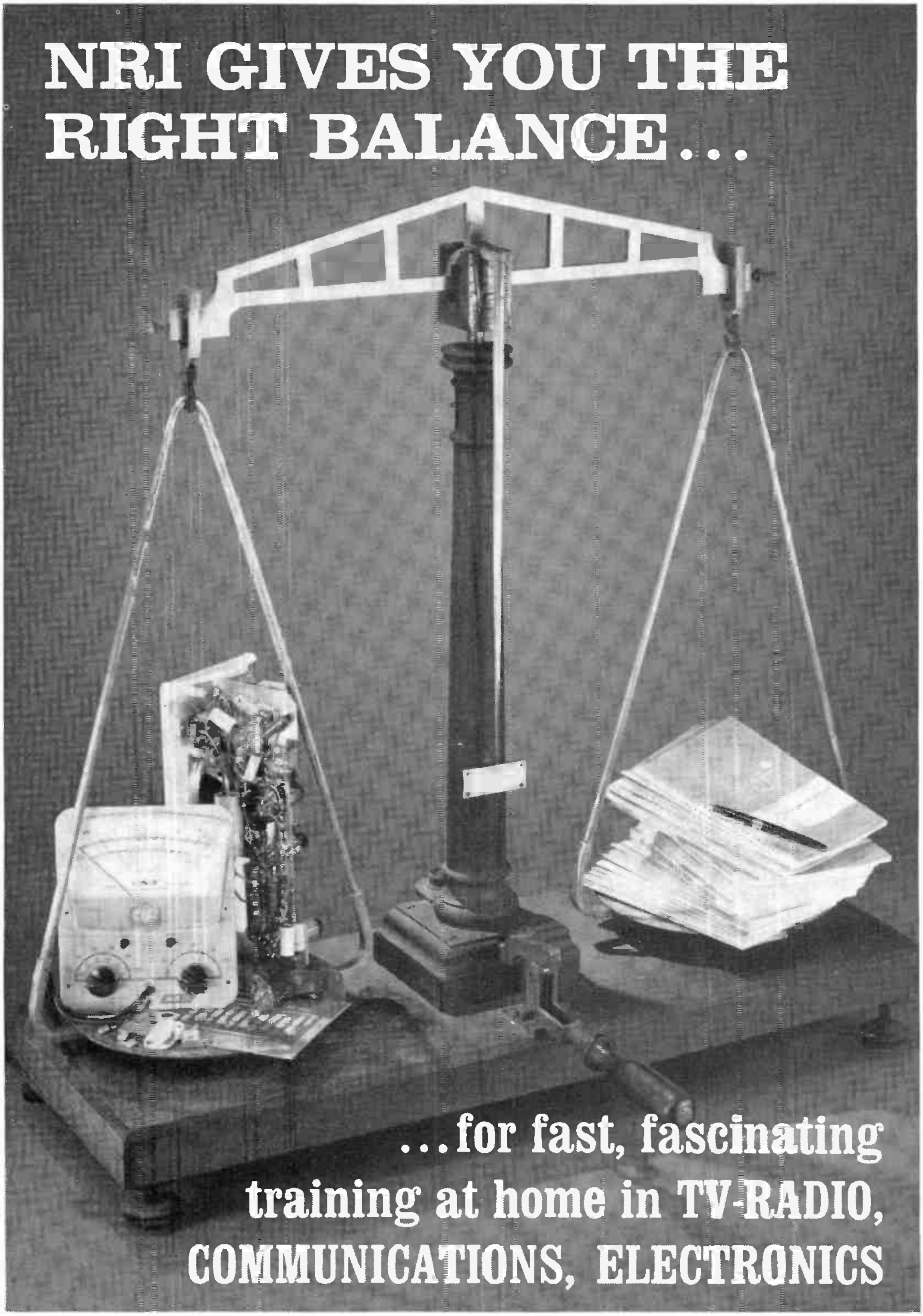
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VOLUME 27 **SEPTEMBER, 1967** NUMBER 3

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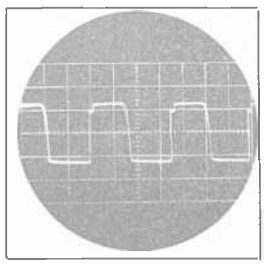

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# LETTERS FROM OUR READERS

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## YOU CAN RECHARGE DRY CELLS

Although Fred Shunaman did not try to charge alkaline cells for his article ("Can Dry Cells Be Recharged," July, 1967), I would like to confirm the fact that they can indeed be recharged. I have used a battery charger identical to that described in the article, and I can add that if carbon-zinc cells prove to be outstanding performers, alkaline cells are even superior. I've used four "AA" cells every day for well over a year for more than an hour a day. These batteries charge back up to almost the initial voltage each time and no end appears in sight. I charge them about once every two weeks, and I only started recharging them six months after I started using them.

JULIAN M. GOKHALE
Washington, D.C.

## IMPROVED AUTO THEFT ALARM

I would like to suggest an addition to the "Auto Sentinel" theft alarm ("Stamp Out Auto Theft," March, 1967). In my area, tow-in by overzealous local agencies is a greater threat than actual auto theft. They have ways of removing completely locked cars. If a mercury switch is added to the "Auto Sentinel,"


the alarm will go off if the car is moved bodily, or even bumped hard. The switch can be mounted in a universal joint and connected to the "trigger switch" and ground terminals of *TS1*. The universal joint is necessary to allow adjustments to be made when traveling over hilly ground.

FRANK S. REID, K4VHJ
Lexington, Ky.

## PULSE COMMAND RESPONDER

I read with interest the article on the "Pulse Command Responder" (July, 1967), since a friend and I had built a similar device

## LETTERS (*Continued from page 8*)

for a science fair project. I would like to point out, however, that the Guardian IR-MC stepping relay called out in the project's Parts List is not equipped with electrical reset. The Guardian stepping relays that do have electrical reset are the MER-115AC, PER-115AC and RER-115AC.

JOHN KOZAKIEWICZ
Hudson Heights, P.Q.

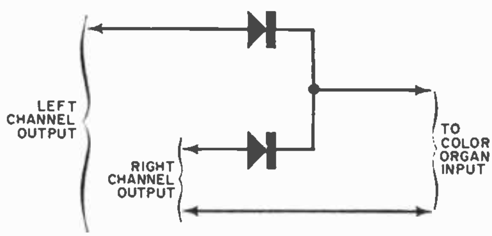
*You're absolutely right, John. The relay specified in the Parts List was actually supposed to be the Guardian IR-MER or similar relay. The relays you have specified fall into the "or similar" category.*

### COLOR ORGAN

Last summer I built the "Musette" Color Organ (July, 1966). Construction was simple and went very quickly. I did run into a problem when I tried to connect both channels of my stereo receiver to the audio input, however. I could not do so without mixing the outputs to my speakers. Rather than build another color organ, I decided to use the Musette with only one channel.

Then I encountered a second problem. When I turned up the volume on my receiver to a certain point, the color organ set up a feedback path to my receiver and shorted out the receiver's ouput transistors. I decided to put a diode into the input circuit to prevent the feedback.

It later occurred to me that if I put two diodes into the circuit (see drawing), I could




mix both channels from my receiver into the color organ and, at the same time, preserve the stereo effect at the speakers. The outputs to the speakers are tapped ahead of the diodes, before any mixing takes place.

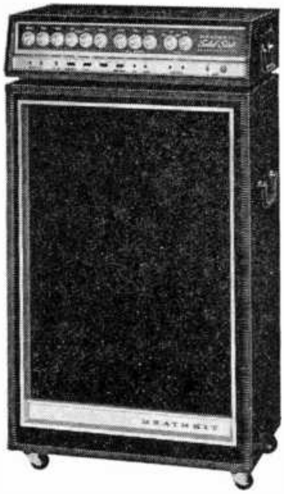
WILLIAM J. CALL
Belmont, Mass.

### LET'S HAVE PARTS CLEARLY IDENTIFIED

Recently I bought ten resistors and some other parts from two large electronic parts distributors, and every one of them was incorrectly packed. Eight of the resistors bore no resemblance to the ones I had ordered! If distributors cannot afford to employ people who have at least a basic knowledge of the products they deal in, then it should be the responsibility of the distributors to see to it

(*Continued on page 14*)

# Look What's NEW In The



## NEW! Deluxe Solid-State Combo Amplifier & Speaker System!

Kit TA-17 Amplifier
**$175.00**
40 lbs.

Kit TA-17-1 Speaker System
**$120.00**
100 lbs.

**Special Combo Offer!**
Kit TAS-17-2 Amplifier & 2 Speaker Systems
Save $20.00
**$395.00**
240 lbs.

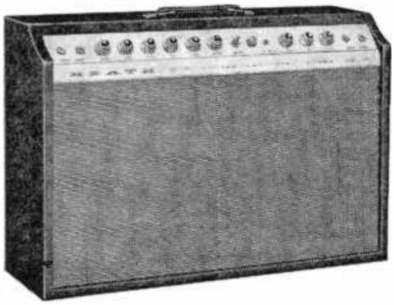
All the "big sound" features every combo wants . . . tremolo, built-in "fuzz", brightness, reverb, plus a shattering 120 watts of EIA music power. Has 3 independent input channels each with 2 input jacks. Handles lead or bass guitars, combo organ, singer's mike, even a record changer. Speaker system features two special 12" woofers, special horndriver and matching black vinyl-covered wood cabinet.

## NEW! Low Cost Single-Channel Solid-State Guitar Amplifier

Kit TA-27
**$89.95**

Boasts 20 watts EIA music power, 40 watts peak power; variable tremolo & reverb; two inputs that handle lead guitars; singer's mike; special heavy-duty 12" speaker; line bypass reversing switch that reduces hum; transformer-operated power supply; and handsome leather-textured, black vinyl covered wood cabinet with extruded aluminum front panel and chrome knobs. 35 lbs.

## NOW Available Fully Assembled . . . Heathkit "Starmaker" Dual-Channel Guitar Amplifier



Assembled TAW-16
**$199.95**
(Kit TA-16 $134.95)

Features all solid-state circuit; 25 watts EIA, 60 watts peak power; two channels, one for accompaniment, accordion or mike, the other for variable tremolo & reverb; two inputs each channel; two 12" heavy-duty speakers; line bypass reversing switch for hum reduction; leather-textured black vinyl covered wood cabinet with extruded aluminum front panel & chrome knobs. For extra savings, build the kit version in just 15 hours. 52 lbs.

## NEW LOW PRICE On Heathkit "180" Deluxe Color TV

**Now Save $30** on this superb set. Features 180 sq. in. rectangular viewing area, plus exclusive built-in servicing facilities so you can converge and maintain the best color pictures at all times. Also has 24,000 volt picture power, automatic degaussing, rare earth phosphors for livelier colors, 3-stage IF, plus many more advanced features. Choice of installation . . . in a wall, your custom cabinet or an old black & white set cabinet, Heath assembled contemporary (Illust. $49.95) or Early American ($75.00) floor cabinets, or new Heath table model ($24.95) cabinet. Build in 25 hours. 102 lbs.

Kit GR-180
Was $379.95
Now Only
**$349.95**
(less cab.)

# '68 HEATHKIT® Catalog!

## NOW Available Fully Assembled . . . World's Most Advanced Stereo Receiver

Assembled ARW-15
**$499.95** (less cab.)
Kit AR-15, $329.95

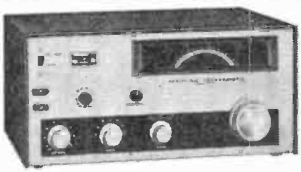
Boasts advanced features like integrated circuits and crystal filters in the IF amplifier; ultra-sensitive FET FM tuner; 150 watts dynamic music power; AM, FM and FM stereo; positive circuit protection; all-silicon transistors; "black magic" panel lighting; stereo only switch; adjustable phase control and many more. 34 lbs. Optional wrap-around walnut cabinet $19.95

## NEW! Professional 10-Band Shortwave Listener's Receiver

Kit SB-310
**$249.00** (less speaker)

Covers 6 shortwave bands (49, 41, 31, 25, 19, & 16 meters) . . . 80, 40 & 20 meter ham bands . . . 11 meter CB. Has 5 kHz crystal filter for AM, SSB and CW; Selectivity that slices stations down to last kHz . . . no more guessing station identities; 11-tube circuit; crystal-controlled front-end; prebuilt & aligned linear oscillator; metal cabinet. Other crystal filters available. 20 lbs.

## NEW! Amateur Novice CW Transceiver

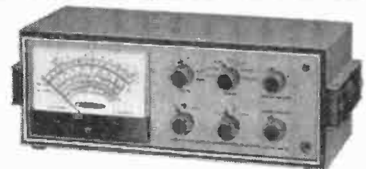


Kit HW-16
**$99.50**

Novices! New Hams! Get on-the-air at lowest cost. Provides CW operation on the first 250 kHz of the 80, 40 & 15 meter bands. 75 watt CW input, up to 90 watts for general class operation. True "break-in" CW operation. Crystal control transmit with VFO receiver tuning. Built-in sidestone. Grid-block keying. Metal cabinet and simple assembly. 25 lbs.

## NEW! Deluxe Solid-State Volt-Ohm Meter

Kit IM-16
**$44.95**



Features 8 DC and 8 AC voltage ranges from 0.5 v to 1500 v full scale; 7 ohmmeter ranges; 11 megohm input resistance on DC ranges; 1 megohm on AC ranges; internal battery or 120/240 v. 50/60 AC power for portable or "in-shop" operation; 6" 100 uA meter; single test probe for all measurements; new Heathkit "unitized" cabinet construction.

## NEW! Heathkit Jr.® Solid-State Portable Phonograph

Kit JK-17
**$19.95**

Perfect for the youngster in your family. Plays all 4 speeds, all record sizes. Crystal cartridge with sapphire stylus for all types of records; 4" speaker; built-in 45 rpm adaptor; preassembled turntable and hardboard cabinet. Build in 1 to 2 hours. 117 VAC, 60 Hz operation. 11 lbs.

## NEW! Heathkit Soldering Iron

Kit GH-17
**$14.95**

Ideal for kit-building or other electronic soldering jobs. Safe 6 volt, 25 watt GE midget iron with non-corroding tip. 3 heat ranges. Excellent heat recovery time. Quick warm-up . . . iron ready in 2 minutes. Protective metal cage. Build in an hour. 5 lbs.


# NEW!

**FREE 1968 CATALOG!**

Now with more kits, more color. Fully describes these along with over 300 kits for stereo/hi-fi, color TV, electronic organs, electric guitar & amplifier, amateur radio, marine, educational, CB, home & hobby. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022.

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☐ Enclosed is $_______________, including shipping.

Please send model (s)_______________________________

☐ Please send FREE Heathkit Catalog.

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Address_____________________________________________

City_________________________State_____________ Zip_______

Prices & specifications subject to change without notice. CL-300

CIRCLE NO. 13 ON READER SERVICE PAGE

## LETTERS

*(Continued from page 10)*

that each part is marked with letters or numerals. I would also like very much to see all components with engraved or etched identifying marks so that the values of parts can be easily read after years of use.

W. SCHNEIDER, WB2ZXB
Franklin Square, L.I., N.Y.

### "LIVING LETTERS"

I am an avid FM enthusiast and would like to make contact with someone in an eastern metropolitan area who would be interested in exchanging tapes of FM radio broadcasts, via the mail. Since I became an FM fan, I have not been out of California, and so have heard no FM stations from any other state. I would very much like to hear some FM stations


from other areas, and get acquainted with another FM fan via "Living Letters." I can supply tapes of all San Francisco stations, Sacramento stations, and many others.

PATRICK G. CONNOLLY
Electronics Technician Third
U. S. Naval Auxiliary Landing Field
Monterey, Calif. 93940

I would very much like a "tapespondent" in the U.S.A. I am an electronics enthusiast, and am working for my amateur radio "ticket" at the present time. Anyone interested in "tapesponding" should please write to me (don't send tapes because the cost of their return would be too high). All letters will be answered. I will tapespond on 3-inch tape spools at any speed desired by my tapespondent.

ANDY DERMONT
175 Moulsham Drive
Chelmsford, Essex,
England

I would like to have tape correspondence with people in different parts of the United States. Anyone interested in having a "tape pal," please write:

PHIL SALLEY
3140 Travis Ct.
Columbia, S. C. 29204

### "APRIL FOOL"

Congratulations on "Announcing Unusually Adaptable Computer" (April, 1967, page 88). In our present world, surrounded by com-

# POPULAR ELECTRONICS READER SERVICE PAGE

## free information service:

Here's an easy and convenient way for you to get additional information about products advertised or mentioned editorially (if it has a "Reader Service Number") in this issue. Just follow the directions below... and the material will be sent to you promptly and free of charge.

**1.** Print or type your name and address on the lines indicated. Circle the number(s) on the coupon below that corresponds to the key number(s) at the bottom of the advertisement or editorial mention(s) that interest you. (Key numbers for advertised products also appear in the Advertisers' Index.)

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VOID AFTER OCTOBER 31, 1967

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NAME *(Print clearly)*____________________

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9

## LETTERS (*Continued from page 10*)

puters, automation, and mechanization, we tend to forget about the most versatile, productive, and important unit of all, Man!

ROBERT P. PORTER
Section Supervisor
Small Computer Systems Test
Control Data Corp.
Arden Hills, Minn.

I think Lou Garner made a mistake in including the news of the "super-powered" transistor on pages 85 and 106 of the April '67


issue. This would have gone over beautifully if it were not for one minor complication: I received the magazine on MARCH 17!

JOHN HOMKO, JR.
Ansonia, Conn.

*Bob, we couldn't agree more. John, hereafter we'll try to arrange to have you receive your subscription copy two weeks late.*

### A "SHOCKING" BOOK

I built a variation of the "Tickle Stick" (February, 1966). I stuck to the given specifications, but instead of using a tubular enclosure, I put the circuitry inside a hollow book. Then I covered the book with aluminum foil and made a ¼" split in the backbone to form the two electrodes. Whenever an innocent victim is handed the book, he soon realizes that he has a "shocking" edition in his hands.

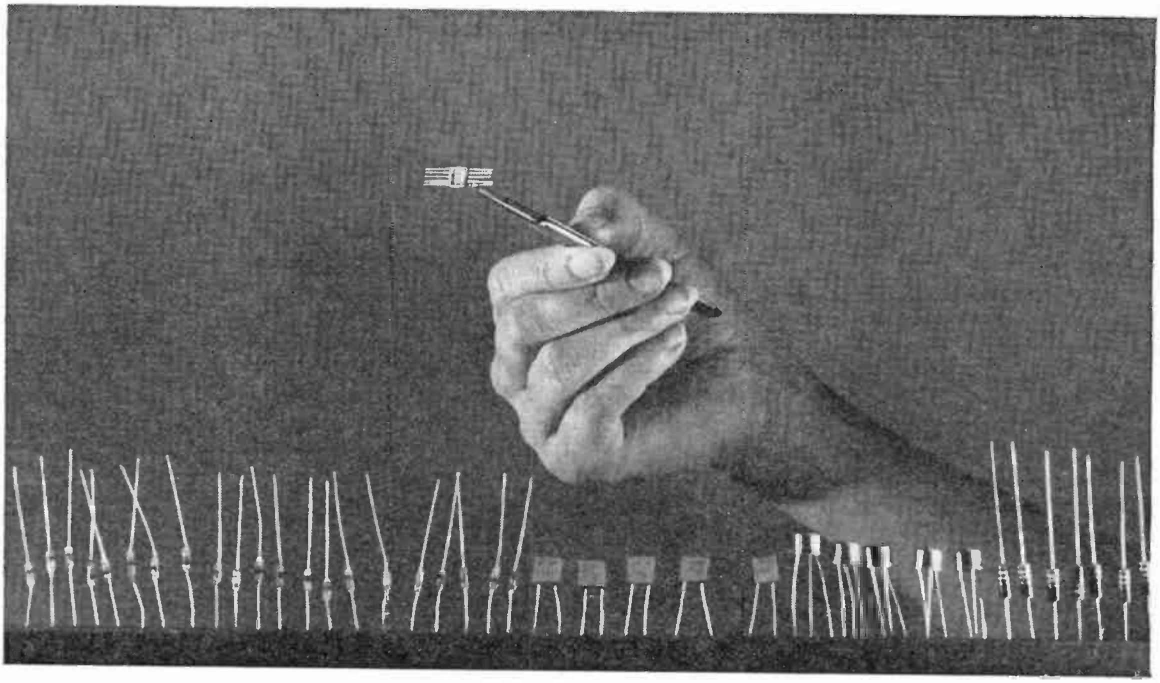
BILL HIGGS
San Marco, Texas

### TROUBLESHOOTING AID

Why not include normal operating voltages at all junctions with your construction projects? These voltages could be neatly placed on the schematic drawing accompanying each project. I believe this addition would be helpful when someone has to analyze or troubleshoot a complicated circuit.

MIKE EATON
San Diego, Calif.

*Mike, because electronic components are available in a wide variety of tolerances and because of possible substitution of parts*
(*Continued on page* 100)



**50 functions in a single chip.** *The functions of 50 separate transistors, diodes, resistors and capacitors can now be formed by the tiny dot in the center of the integrated circuit held by the tweezers.*

# The "Chip"

## ...will it make or break your job future?

**THE DEVELOPMENT OF INTEGRATED CIRCUITRY is the dawn of a new age of electronic miracles. It means that many of today's job skills soon will be no longer needed. At the same time it opens the door to thousands of exciting new job opportunities for technicians solidly grounded in electronics fundamentals. Read here what you need to know to cash in on the gigantic coming boom, and how you can learn it right at home.**

TINY ELECTRONIC "CHIPS," each no bigger than the head of a pin, are bringing about a fantastic new Industrial Revolution. The time is near at hand when "chips" may save your life, balance your checkbook, and land a man on the moon.

Chips may also put you out of a job...or into a better one.

"One thing is certain," said *The New York Times* recently. Chips "will unalterably change our lives and the lives of our children probably far beyond recognition."

A single chip or miniature integrated circuit can perform the function of 20 transistors, 18 resistors, and 2 capacitors. Yet it is so small that a thimbleful can hold enough circuitry for a dozen computers or a thousand radios.

### Miniature Miracles of Today and Tomorrow

Already, as a result, a two-way radio can now be fitted inside a signet ring. A complete hearing aid can be worn entirely inside the ear. There is a new desk-top computer, no bigger than a typewriter yet capable of 166,000 operations per second. And it is almost possible to put the entire circuitry of a color television set inside a man's wrist-watch case.

And this is only the beginning!

Soon kitchen computers may keep the housewife's refrigerator stocked, her menus planned, and her calories counted. Her vacuum cleaner may creep out at night and vacuum the floor all by itself.

Money may become obsolete. Instead you will simply carry an electronic charge account card. Your employer will credit your account after each week's work and merchants will charge each of your purchases against it.

When your telephone rings and nobody's home, your call will automatically be switched to the phone where you can be reached.

Doctors will be able to examine you internally by watching a TV screen while a pill-size camera passes through your digestive tract.

**New Opportunities for Trained Men**

What does all this mean to someone working in electronics who never went beyond high school? It means the opportunity of a lifetime—if you take advantage of it.

It's true that the "chip" may make a lot of manual skills no longer necessary.

But at the same time the booming sales of articles and equipment using integrated circuitry has created a tremendous demand for trained electronics personnel to help design, manufacture, test, operate, and service all these marvels.

There simply aren't enough college-trained engineers to go around. So men with a high school education who have mastered the fundamentals of electronics theory are being begged to accept really interesting, high-pay jobs as engineering aides, junior engineers, and field engineers.

**How To Get The Training You Need**

You can get the up-to-date training in electronics fundamentals that you need through a carefully chosen home study course. In fact, some authorities feel that a home study course is the best way. "By its very nature," stated one electronics publication recently, "home study develops your ability to analyze and extract information as well as to strengthen your sense of responsibility and initiative." These are qualities every employer is always looking for.

If you do decide to advance your career through spare-time study at home, it makes sense to pick an electronics school that specializes in the home study method. Electronics is complicated enough without trying to learn it from texts and lessons that were designed for the classroom instead of correspondence training.

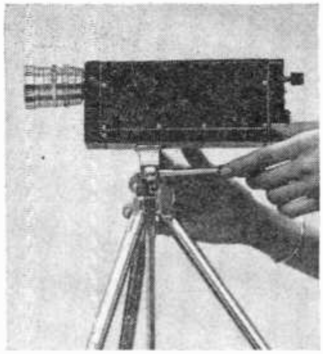
The Cleveland Institute of Electronics has everything you're looking for. We teach only electronics—no other subjects. And our courses are designed especially for home study. We have spent over 30 years perfecting techniques that make learning electronics at home easy, even for those who previously had trouble studying.

Your instructor gives your assignments his undivided personal attention—it's like being the only student in his "class." He not only grades your work, he analyzes it. And he mails back his corrections and comments the same day he gets your lessons, so you read his notations while everything is still fresh in your mind.

**Always Up-To-Date**

Because of rapid developments in electronics, CIE courses are constantly being revised. Students receive the most recent revised material as they progress through their course. This year, for example, CIE students are receiving exclusive up-to-the-minute lessons in Microminiaturization, Logical Troubleshooting, Laser Theory and Application, Single Sideband Techniques, Pulse Theory and Application, and Boolean Algebra. For this reason CIE courses are invaluable not only to newcomers in Electronics but also for "old timers" who need a refresher course in current developments.

**Tiny TV camera** *for space and military use is one of the miracles of integrated circuitry. This one weighs 27 ounces, uses a one-inch vidicon camera tube, and requires only four watts of power.*



**Praised by Students Who've Compared**

Students who have taken other courses often comment on how much more they learn from CIE. Mark E. Newland of Santa Maria, California, recently wrote: "Of 11 different correspondence courses I've taken, CIE's was the best prepared, most interesting, and easiest to understand. I passed my 1st Class FCC exam after completing my course, and have increased my earnings $120 a month."

**Get FCC License or Money Back**

No matter what kind of job you want in electronics, you ought to have your Government FCC License. It's accepted everywhere as proof of your education in electronics. And no wonder—the Government licensing exam is tough. So tough, in fact, that without CIE training, two out of every three men who take the exam fail.

But better than 9 out of every 10 CIE-trained men who take the exam pass...on their very first try!

This has made it possible to back our FCC License courses with this famous Warranty: you *must* pass your FCC exam upon completion of the course or your tuition is refunded in full.

**Mail Card For Two Free Books**

Want to know more? The postpaid reply card bound in here will bring you a free copy of our school catalog describing today's opportunities in electronics, our teaching methods, and our courses, together with our special booklet on how to get a commercial FCC License. If card has been removed, just send us your name and address.

**ENROLL UNDER NEW G.I. BILL**

All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now, check box on reply card for G.I. Bill information.

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CIRCLE NO. 8 ON READER SERVICE PAGE

# NEW PRODUCTS

*Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15.*

### ALL-WAVE RECEIVER

Continuous coverage from 0.54 to 54 MHz is claimed for *Ameco Equipment Corporation*'s Model R-5 "all-wave" receiver. Its five continuous "bands" include: the standard broadcast band; all foreign broadcast bands; all amateur bands from 160 through 6 meters; all 27-MHz CB channels; and all two-way radio frequencies from 30 to 50 MHz. Fully transistorized, the Model R-5 has a BFO and

noise limiter, and a built-in power supply for a.c. operation; with an optional accessory, it can also be used as a portable. It is supplied both in kit form and wired and tested, with cabinet.

Circle No. 75 on Reader Service Page 15

### TACHOMETER AND DWELL METER

Any car, foreign or domestic, 4 or 6 or 8 cylinders, can be tuned up with *Delta Products'* "Transitester" Model T-1000 tune-up tachometer and Model D-1000 dwell meter. Both instruments have 3½" meters and a rugged lightweight case, and will give correct readings on vehicles equipped with transistor ignition, capacitive discharge ignition, or conventional ignition. The tachometer has a range of 0 to 1200 r/min, and simple calibration and setting knobs let you read engine dwell degrees easily with the dwell meter. Each instrument comes with complete instructions for use, and color-coded leads to eliminate guesswork.

Circle No. 76 on Reader Service Page 15

### SENSITIVE LOW-COST VOM

Measuring capabilities never before available in a low-cost VOM are claimed for *Amphenol Corporation's* Model 870 "Millivolt Commander." A field effect transistor (FET) unit, it measures voltages as low as 0.1 volt d.c. full scale, and 0.01 volt a.c. full scale, with accuracies of ± 2% and ± 3%, respectively. Input resistance on all d.c. ranges is 11 megohms, and input impedance on all a.c. ranges is 10 megohms. The 870 is a battery-powered instrument with a.c./d.c. test probe assembly and hinged front cover.

Circle No. 77 on Reader Service Page 15

### AUTOMATIC VOLTAGE REGULATOR

Handling up to 400 watts, the new Model D-210 automatic voltage regulator from *Perma-Power* enables color TV sets to be used more efficiently in areas where line voltage regulation is poor. It eliminates picture distortion such as flutter, shrinking, flop-over and loss of brightness caused by low voltage. The Model D-210 boosts line voltage 10 volts when the line drops below 110 volts. When voltage is normal, it cuts out. It shuts off when the TV set (or any appliance) is not in use. There are no tubes, ballasts, or relays to wear out, and the unit is fully guaranteed for one year.

Circle No. 78 on Reader Service Page 15

### AMPLIFIED HEADPHONE

Now you can start a stereo system with only a tuner or record changer and enjoy the full benefits of stereo listening, according to *Telex*. This company's new "Amplitwin" headphone features a speaker, miniaturized four-stage solid-state amplifier, battery, on-off switch, and volume control, as well as high and low level inputs incorporated in each ear cup. You can connect it directly to turntables, changers, tape transport, deck, or tuner. Acoustic response is 16-15,000 Hz. When the amplifiers are switched off, the "Amplitwin" operates as a conventional headphone with any stereo equipment having a headphone jack. Connecting cords and a heavily padded storage/carrying caddy come with the headphone.

Circle No. 79 on Reader Service Page 15

### MARINE CB ANTENNA

Boat owner CB'ers will be interested in the Model ASM-23 "Sea-Hook," an omnidirectional antenna from *Antenna Specialists* which has an exceptionally low angle of radiation

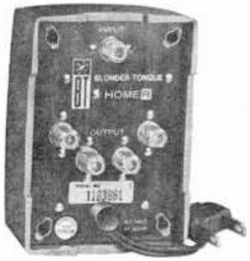
## PRODUCTS *(Continued from page 22)*

for maximum potential overwater range. A full electrical half-wave radiator, the 27-MHz antenna is loaded for an overall length of 97 inches. Special feature: an exclusive pure-white cycolac base with built-in foldover to allow instant "retraction" of the antenna when negotiating bridges and other low obstacles. The impedance is 50 ohms, matching virtually all available CB transceivers, and VSWR is said to be better than 1.5 to 1.0.

Circle No. 80 on Reader Service Page 15

### SOLID-STATE AMPLIFIED SPLITTER

Called the "Homer," the solid-state amplified splitter being manufactured by *Blonder-Tongue* improves TV or FM reception on up to four sets operating from a single antenna.

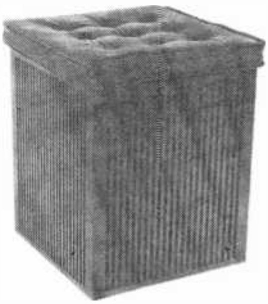


The splitter nearly triples TV or FM signals (9 dB) when operating two sets, doubles the signal (6 dB) gain with four sets. Featuring a new inductive-coupled emitter feedback circuit, it is said to be extremely effective in defeating crossmodulation, harmonic interference, windshield wiper effect, hash, herringbone and beat patterns. Because it draws less power than an electric clock, the "Homer" remains "on" at all times. It can be mounted wherever there is an a.c. outlet, and is supplied with five coax connectors for RG-59 cable.

Circle No. 81 on Reader Service Page 15

### "KITTEN" SPEAKER SYSTEM

It purrs . . . and it roars—from 30 to 18,000 hertz. *Empire Scientific* calls it "Kitten," otherwise known as the Empire Model 2000 speaker system.

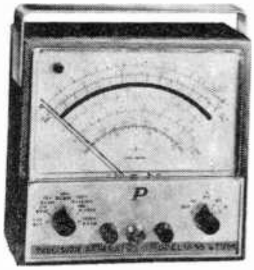


Designed primarily for young people with limited space and limited budgets, "Kitten" comes in three styles: walnut finish, walnut finish with contour cushion (shown in photo), and walnut finish with imported marble top. It contains a 10-inch high-compliance woofer with 2-inch voice coil, and a direct-radiator mid-range and tweeter with wide angle dispersion—the same two drivers used in the "Cavalier" speaker systems. Power-handling capacity: 60 watts of undistorted music power.

Circle No. 82 on Reader Service Page 15

### BATTERY-LESS VTVM

The "professional" Model V-95 VTVM introduced by *Precision Apparatus* (a division of Dynascan Corporation) employs an exclusive solid-state power supply that eliminates the need for batteries to operate the ohmmeter section.



Other features include a 7" meter movement which has a built-in mirror for reducing parallax, specially calibrated 0.5–, 1.0–, 1.5– and 5.0–volt scales for transistor circuit analysis, and simplified peak-to-peak and dB scales. The meter's handle is designed to accommodate the owner's name plate.

Circle No. 83 on Reader Service Page 15

### SIGNAL STRENGTH METER

Portable, lightweight, battery-operated, and housed in a rugged case, the *Jerrold* AIM-718 solid-state signal strength meter was designed specifically for antenna installers.

Reading directly in dBmV and microvolts, the meter shows exact antenna requirements. It's equipped with separate VHF and UHF tuners and provides continuous coverage of 54 to 216 MHz for VHF-TV/FM and 470 to 890 MHz for UHF-TV. Features include an audio output jack, crystal earphone, and two built-in dB attenuators—plus a safety switch that turns off the power when the cover is closed.

Circle No. 84 on Reader Service Page 15

### "HAND-AND-STAND" MICROPHONE

Featured in *Electro-Voice's* Model 631 "hand-and-stand" entertainer's microphone is a "Uniseal" switch. Underneath the snap-on switch actuator is a magnetically operated reed relay switch, sealed away from dirt and corrosion. A magnet in the removable actuator closes or opens the switch contacts when it is moved forward or back on the case; and when the actuator is removed, the contacts remain in a fail-safe "on" position. There are no openings in the microphone case to leak or degrade bass response. And inside the Model 631 is an effective four-stage filter that traps dirt and magnetic particles before they can get to the element, and also provides "blast" and "pop" protection. Frequency re-

## PRODUCTS (*Continued from page 24*)

sponse is 100 to 13,000 Hz, and the microphone's output is —55 dB. A stand clamp is provided.

Circle No. 85 on Reader Service Page 15

### REGULATED D.C. POWER SUPPLY

*Allied Radio's* Model KG-664 Knight-Kit is a three-in-one power supply: B+, filament, and d.c. bias. It delivers 0-400 volts of regulated d.c. power at up to 200 mA continuously; 0-100 volts d.c. at 1 mA regulated for line variation; plus 6.3 volts a.c. at 6 amperes and 12.6 volts a.c. at 3 amperes for filament supply voltage. Two front panel meters continuously monitor

voltage and current. There is less than 1.0% variation in output voltage from no load to full rated load, and less than 1.0% variation in output for ± 10 volts variation in 120-volt a.c. input. Ten isolated 5-way binding posts on the front panel offer maximum versatility in ground polarity connections. The KG-664 is also available factory-assembled.

Circle No. 86 on Reader Service Page 15

### CASSETTE-TYPE RECORDER-REPRODUCER

The *Ampex Corporation* recently introduced a cassette-type tape recorder-reproducer stereo system. Called the Ampex "Micro 85," it consists of a recorder-reproducer, stereo microphones, and a pair of speakers in walnut enclosures. The recorder-reproducer comes in a smartly styled walnut cabinet, has piano-key-type push-button controls and takes up less space than most turntables. It is equipped with all solid-state stereo amplifiers and preamplifiers, and the recording level is continuously monitored through the use of a built-in vu meter. Controls include record level, balance, volume, and tone. The tape passes the heads at a constant speed of 1⅞ in/s, and up to 90 minutes of playing time is possible with a single tape cassette.

Circle No. 87 on Reader Service Page 15

# CB'ers...

# SKIP IS LEGAL

## ON THE HAM BANDS...

in fact, Amateur Radio is based on the intelligent use of natural phenomena to achieve distant communications with relatively low power. Increased sun-spot activity in the next couple of years will bring tremendous propagation opportunities — like worldwide contacts on ten meters . . . tropospheric bending (predictable from an ordinary weather map) brings exciting surprises on two meters . . . Sporadic E skip gets you miles and miles and miles with little power on six meters . . . and more! And that is not all that you have going for you . . . there are no time restrictions . . . less crowding . . . more frequency bands . . . more legal power . . . and greater satisfaction because your knowledge of propagation permits you to plan your contacts. It is all out in the open . . . you can give the man your right name and your call without getting a pink ticket for a chaser.

You *can* get into ham radio easily and quickly (our buck says it will take you only 30 days . . . 45 max.). The technical requirements for a Novice license are *simple*. The test can be administered by a qualified licensee in your own neighborhood. Available licensing booklets lay it all out on a silver platter for you. SURE, we know about the code test, but man, five words — 25 characters — a MINUTE . . . that's less than a minute's worth of notes in a dreamy waltz!

Start it off with a Squires-Sanders 22'er (two-way voice privileges on two meters for Novices) . . . for sixty days we will throw in a free license manual and a code learning record. If you want to go all out, apply for the Technician License . . . a little more complex technical test (you *can* do it) and the same easy five word code exam . . . permits privileges on other bands — like 6 meter two-way voice.

**22'er — 20 watts of high quality two meter AM phone transceiver . . . only $249.95.**
**66'er — 22 watts of same for six meters . . . same free manual and record . . . same price.**

**OK, OK . . . so your only interest is highly intelligible local communications for your personal business . . . your truck . . . your boat . . . your car . . . then go buy the 23'er all transistor 23 channel 5 watt CB transceiver for a modest $235.00 or the 5 channel S5S for $185.00. But, please, just talk to momma . . . or the office . . . or call H.E.L.P.**

## Squires SS Sanders

**See your distributor or write today for details. SQUIRES-SANDERS, INC., Box 319 A, Millington, New Jersey, 07946**

**CIRCLE NO. 26 ON READER SERVICE PAGE**

INTEGRATED CIRCUITS SIMPLIFY CONSTRUCTION OF REAL ELECTRONIC DICE FOR FUN, PLEASURE, OR PROFIT, AND PUT . . .

# SPOTS BEFORE YOUR EYES

By **DON LANCASTER**

COVER STORY

TECHNICALLY SPEAKING, this is a Mod 6 walking ring counter using six J-K flip-flops and lamp drivers. Decoding is reduced to four circuits and the readout is via a selective arrangement of 14 low-voltage bulbs. From a practical aspect, this is an electronic pair of dice that can't be loaded.

While intended primarily for use as a parlor-type family game, this gadget will also make a dandy science fair project for illustrating the basic principles of probability and computer counter circuitry, and will serve as an immediate attention-getting device at any exhibit or display. It measures 6¼" x 3¾" x 2", and should cost from $18 to $30, depending on how fancy you care to make your particular version. Complete kits and/or all special parts are readily available.

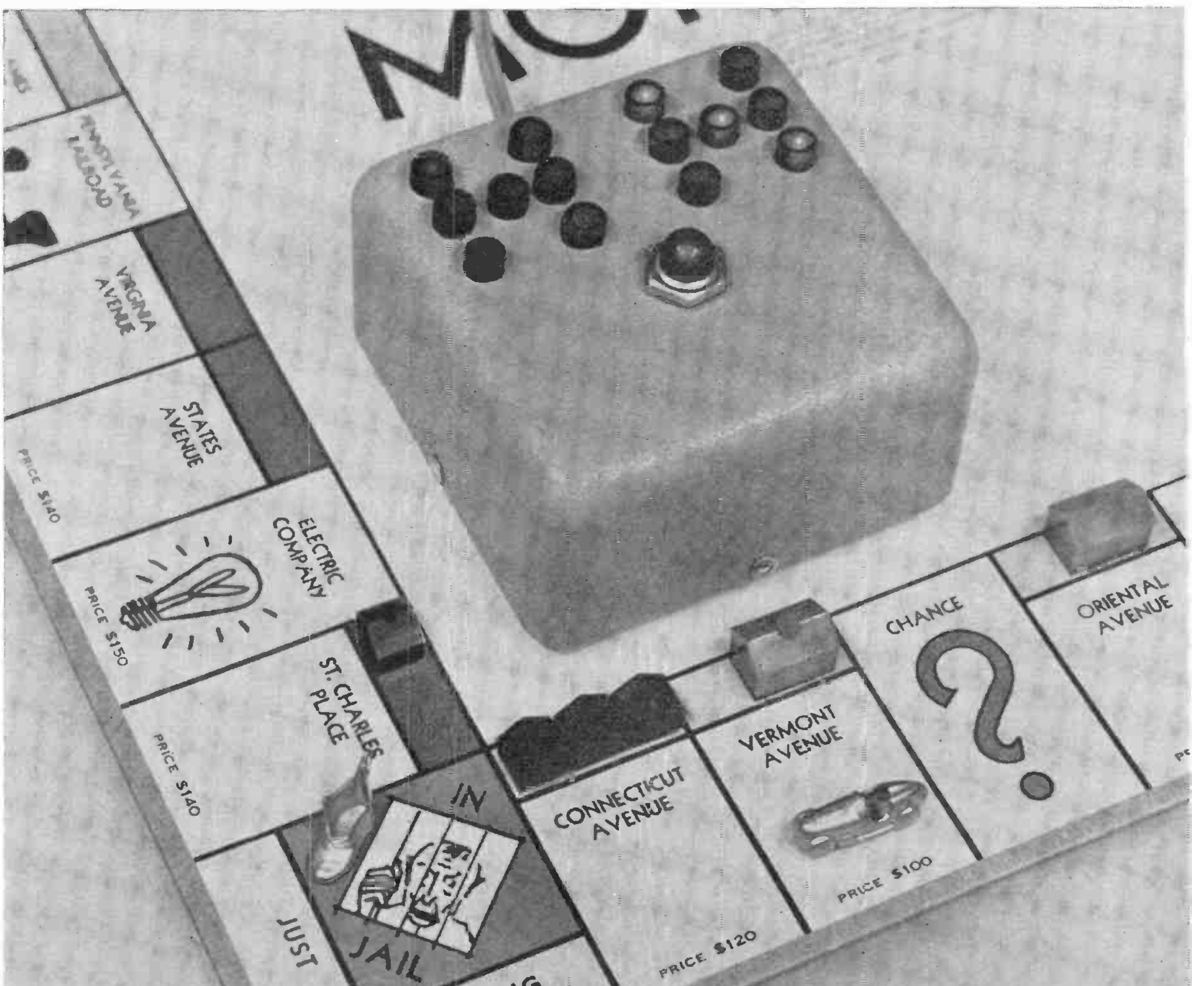


Fig. 1. When push-button switch S1 is depressed, the 3-kHz oscillator starts up. The first counter runs at this speed while simultaneously dividing by six, causing the second counter to run at 500 Hz. When S1 is released, both counters stop and the pertinent indicators light up.

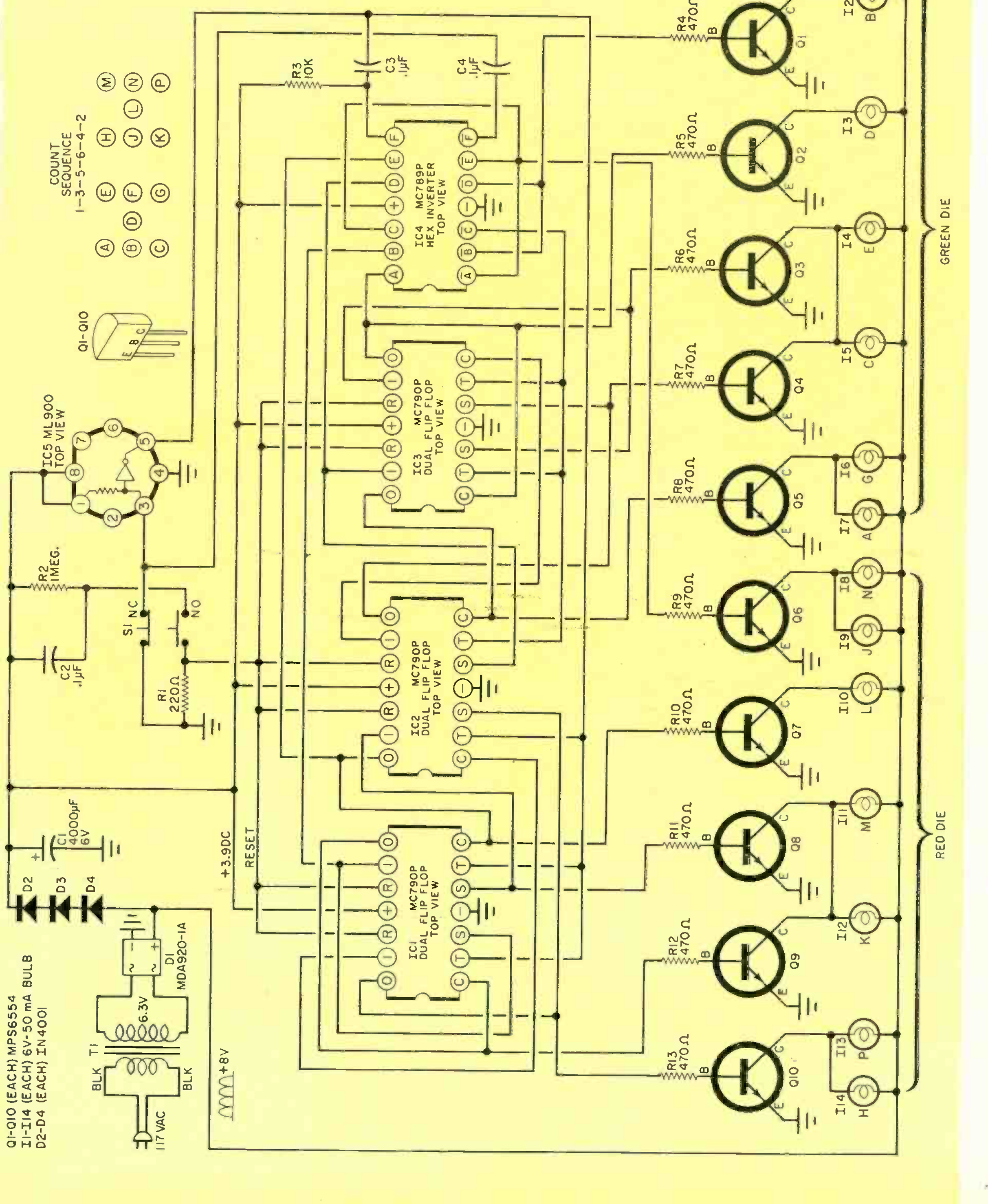
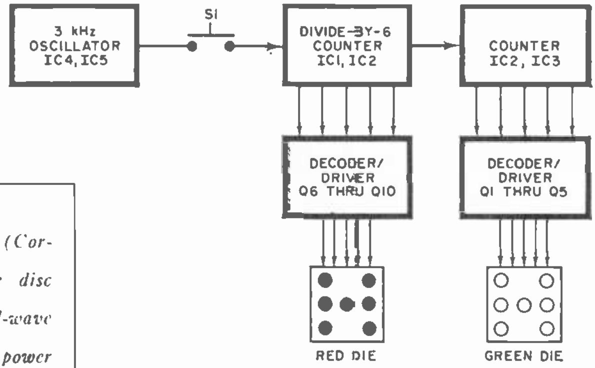


Fig. 2. Since each die is fed from a separate counter, and there is no fixed time during which the counters cycle through their stages, the final lamp indication is random, as with real dice.




## PARTS LIST

*C1—4000-μF, 6-volt electrolytic capacitor (Cornell Dubilier BR 4000-6, or similar)*
*C2, C3, C4—0.1-μF, 10-volt miniature disc ceramic capacitor*
*D1—MDA920-1A 1-ampere, 50-volt, full-wave bridge rectifier assembly (Motorola)*
*D2, D3, D4—1N4001 or similar silicon power diode*
*I1-I14—6.3-volt, 50-mA, pilot lamp assembly, 7 red, 7 green (Southwest Technical Products Corp. L-92, or similar)**
*IC1, IC2, IC3—MC790P dual J-K flip-flop (Motorola)*
*IC4—MC789P hex inverter (Motorola)*
*IC5—μL900 buffer (Fairchild)*
*Q1-Q10—MPS6554 transistor (Motorola)*
*R1—220-ohm, ¼-watt carbon resistor*
*R2—1-megohm, ¼-watt carbon resistor*
*R3—10,000-ohm, ¼-watt carbon resistor*
*R4-R14—470-ohm, ¼-watt carbon resistor*
*S1—Two-circuit "make one, break one" push button, snap-action*
*T1—6.3-volt, 0.6-ampere miniature filament transformer (Knight 54D1416, or similar)*
*1—6¼" x 3¾" x 2" case and cover (Harry Davis #240, or similar)*
*1—3⅝" x 2½" x 1/16" printed circuit board**
*Misc.—Line cord and strain relief, wire nuts (2), PC terminals (17), #6 x ⅜" threaded standoffs (4), #6 x ¼ screws (4), insulated wire jumpers (15), wire, solder, etc.*

*The following are available from Southwest Technical Products Corp. 219 W. Rhapsody, San Antonio, Tex. 78216: etched and drilled circuit board, $3.50; kit of 14 pilot lamp assemblies including 1 spare bulb, $4.00; complete kit of all parts including fully punched and finished plastic case, $30.00; postpaid in USA.

NOTE: Although a metal mounting box is shown both on the cover and in the photo on page 29, the construction details given in this article are for the plastic box called for above.

**How It Works.** Each of the two dies consists of seven pilot lamps that are lit or not lit dependent upon the commands of an electronic counter and decoder circuit. Figure 1 shows the circuit, while the block diagram in Fig. 2 illustrates basic operation.

There are two electronic counters, each of which has six possible states, just like the six sides of a die. Whenever the control push button (*S1*) is depressed, a 3-kHz oscillator is connected in the circuit, and both counters rapidly run through all of their states, the first at a 3-kHz rate; because of the divide-by-six characteristic inherent in the first counter, the second operates at a 500-Hz rate. Since the push button will be held down a good fraction of a second, each counter runs through all of its states many hundreds of times.

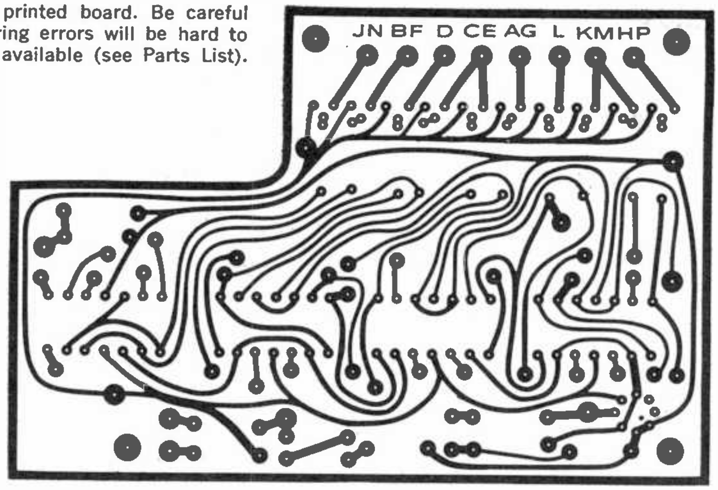
When the push button is released, the counters stop in some random state—truly random, as the operator has no control whatsoever over which number is up on either counter when he releases the button. Since each die cycles at different rates and since the dwell time on any one "side" is identical, true dice odds result.

The six counter states are decoded to produce the familiar die combinations, with the center lamp lit only for a "one," the outside six for a "boxcar," etc. Although seven lamps are used, only those combinations of lit bulbs corresponding to the die patterns are permitted to light.

Each counter requires only four decoding circuits. The first decides "even," or "odd." If the count is "odd," the center bulb lights. The next decoder decides "not one" which lights two diagonally opposite bulbs *except* during a "one." A third decoder decides "four," "five," or "six" and lights the remaining two diagonally opposite bulbs on these counts. The final decoder selects "six" and lights the two remaining bulbs on this count. A bit of reflection will show that these four decodings automatically light the proper number of bulbs in the proper pattern for each die position.

A dual power supply and a special pulse circuit complete the unit. The latter feature resets the counter the instant the push button is depressed, guaranteeing that both counters always start off properly.

Fig. 3. Actual-size layout of printed board. Be careful if you make your own as wiring errors will be hard to find. A commercial board is available (see Parts List).



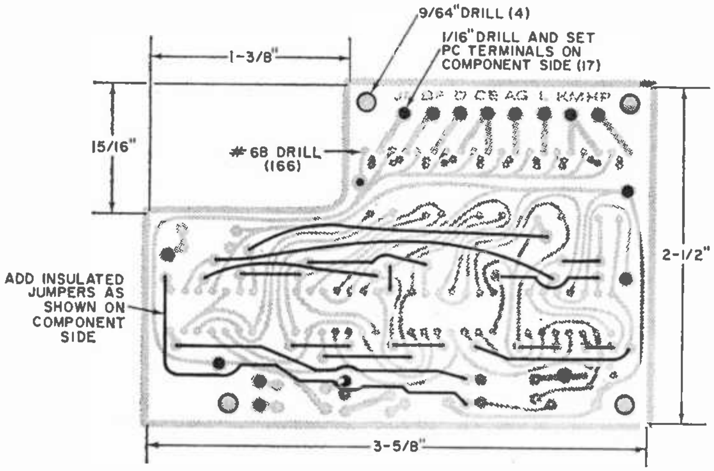
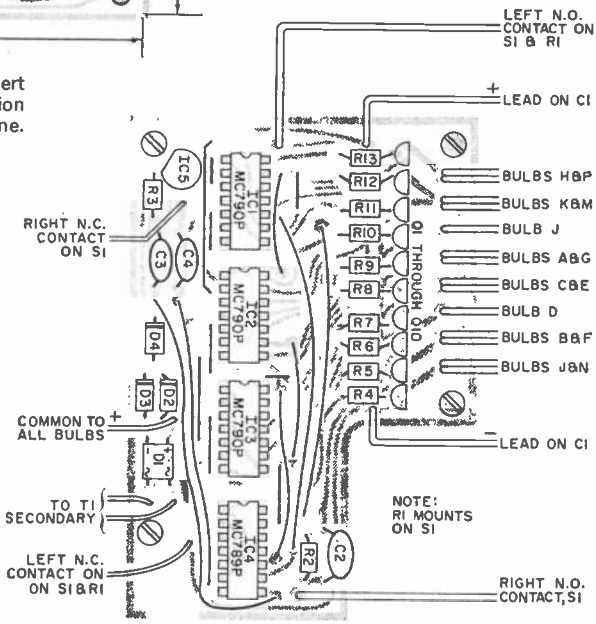




Fig. 4. Before installing components on the board, insert the 16 insulated jumpers as shown here. Observe caution when installing jumpers as errors can be troublesome.

Fig. 5. Component layout and wiring interconnections. Note that IC1-IC4 are identified by notches at one end while IC5 has one flat side. Lettered bulbs are arranged as per Fig. 1.




**Circuit Details.** Integrated circuit *IC5* and part of *IC4* form a 3-kHz multivibrator that runs only when *S1*, a 2-circuit, snap-action push button, is depressed. This 3-kHz signal is routed to the two counters consisting of *IC1*, *IC2*, and *IC3*. Incidentally, the total cost of all the integrated circuits is slightly under $8.00.

High-gain transistors (*Q1* through *Q10*) are used to amplify the low-level logic signals and light one or two bulbs each. Resistors *R4* through *R13* limit the base currents and prevent the bulbs and transistors from excessively loading the counters.

Fig. 6 (right). Finished layout with parts called out in Parts List. Other arrangements can be used if desired.

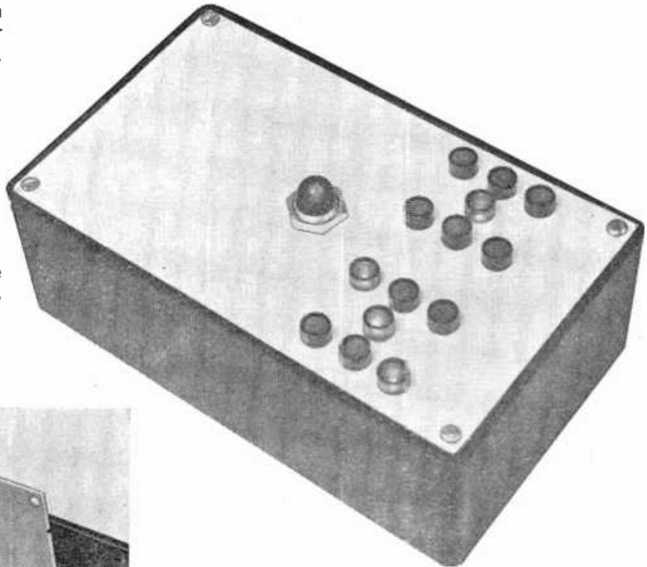
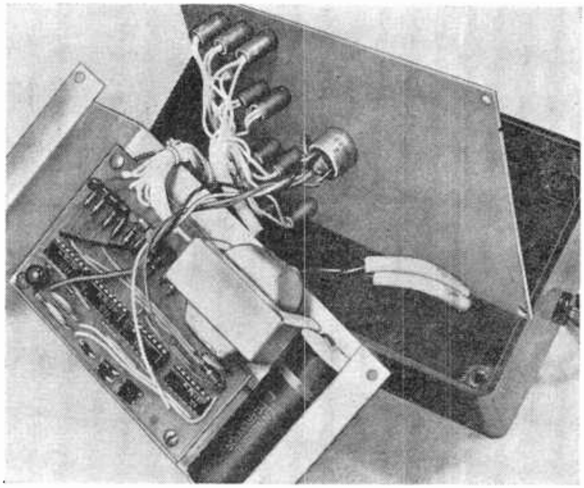


Fig. 7 (below). Internal view of the finished device. Note that R1 is mounted on S1 on the front cover plate along with indicator lamps. Construction details of the U-shaped frame, and the cover, are on page 34.



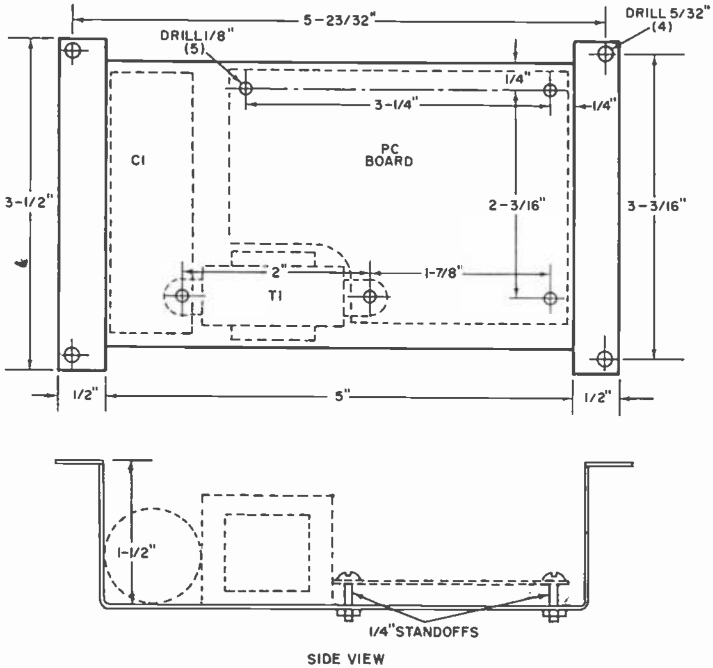
The bulbs consist of 6-volt, 50-mA units, available as complete, matched red or green panel lamp assemblies from the source listed. Use of higher-current bulbs is not recommended due to the requirement of a larger power transformer and the necessity of using power transistors with exceptionally high gain to obtain any reasonable brilliance and uniformity. Even the transistors selected for the 50-mA bulbs must have a *beta* well over 100, specified at a 100-mA current level. Bear this in mind if you make any substitutions. The particular bulbs and power levels selected are more than bright enough for use under normal viewing conditions, and the actual bulb current is purposely held low to gain a long bulb life.

The dual power supply consists of *T1* and diodes *D1* through *D4*. The bulbs and transistors run off the unfiltered, full-wave rectified low-voltage from *D1*. Diodes *D2*, *D3*, and *D4* form a dynamic regulator that drops this voltage and feeds it to filter capacitor *C1* and then to the oscillator and counter circuits. The normal level across *C1* is 3.9 volts; this will vary a tenth of a volt or so with the different die combinations. The value of *C1* selected is the smallest one that will allow the circuit to operate properly—do not substitute for *C1* unless you *increase* its value.

Switch *S1* is a "make one, break one" push button. A d.p.d.t. snap-action type can be substituted simply by not using the extra contacts. Network *R1*, *R2*, and *C2* generates a brief reset pulse each time the push button is initially depressed.

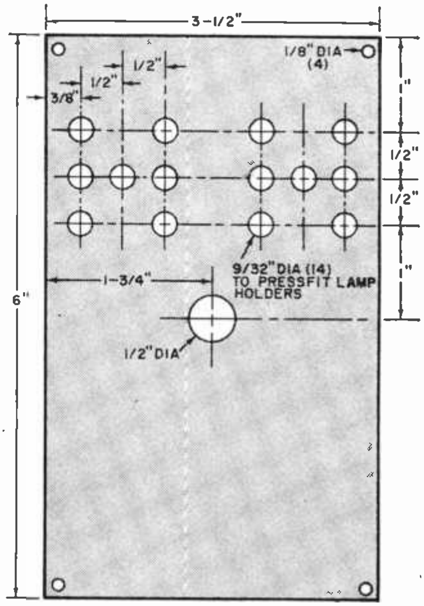
**Construction.** A printed circuit board is an absolute must for this circuit, owing to the large number of connections and the mounting techniques required for the integrated circuits. You can buy the board already etched and drilled commercially (see Parts List). If you prefer, you can lay out, etch, and drill your own, by following the details in Fig. 3. Be exceptionally careful with your layout if you make your own, for a wiring error in the counter portion of the circuit is quite difficult to find.

Sixteen wire jumpers are required for the PC board. These are formed of insulated wire and mounted on the *compo-*




Mechanical details of the U-shaped frame. This frame supports the PC board, capacitor C1, and transformer T1. Note that the PC board uses ¼-inch standoffs. The frame is designed to fit the plastic box specified.

Fig. 8. Drilling details of the front cover. The lamp holes are drilled so that the lamps can be press-fitted.




*nent side* of the circuit board, before any other parts are inserted. Just follow the layout guide in Fig. 4. Be sure to connect the jumpers *exactly* as indicated.

All the circuit parts except *T1*, *C1*, *R1*, *S1*, and the bulb mount on the board. Use a very small iron and fine solder. Double-check all connections with a magnifying glass and remove all excess solder flux.

Component layout and wiring interconnections are shown in Fig. 5. Note that the integrated circuits may only be connected in one manner, and that they are identified by a notch on one end of the flat packs, and a flat beside lead #8 on *IC5*. (All IC's are shown *top view* in the schematic.) Each bulb has its die position identified by the code letters shown in the schematic. Use two contrasting colors of pilot lamp assemblies, one for each die.

The electronic dice may be built in virtually any small enclosure. You can use a deep-drawn aluminum box, a conventional chassis, or a plastic instrument case. Mounting details are shown in the photos (Figs. 6 and 7). The U-shaped frame supports the circuit board, transformer, and filter capacitor. The PC board should be spaced slightly above the bottom of the metal support to avoid any short circuits. The entire assembly can then be mounted in its case.

Details of the lamp assembly drilling on the case cover are shown in Fig. 8. The cover supports the 14 lamp assemblies grouped according to the color and die patterns as well as *S1* and *R1* (mounted on *S1*). —30—

# The Possible Impractical Impossible Circuit

## WOULD YOU BELIEVE A SINGLE-DIODE FULL-WAVE RECTIFIER?

**By TOM DUFFY and JERRY OLEKSY**

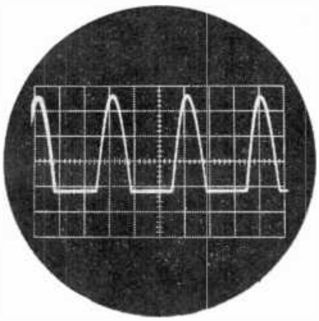
A ONE-DIODE full-wave rectifier? Impossible! Everyone knows you need at least two diodes for full-wave rectification. Or, should we say, everyone *assumes* that you need two diodes.

You can demonstrate one-diode full-wave rectification with the circuit shown below, left. The frequency of the input is relatively unimportant. Connect an oscilloscope across output terminals *D* and *C* and you should get one of the three waveforms shown, depending upon the position of the potentiometer arm.

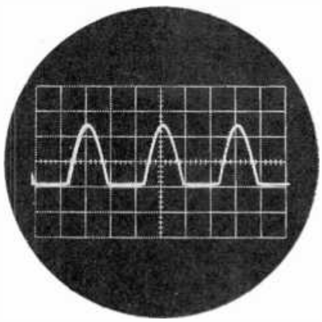
With the potentiometer arm at the top, the waveform should be like the one at the extreme left. Rotating the arm to the other extreme should produce a waveform like the one in the middle photo. If you carefully balance the two waveforms (via the potentiometer), the output should become a typical full-wave rectification pattern (right).

The two theory schematics (center and right) show what's happening. When terminal *B* is negative with respect to *A*, the current flow is indicated by the arrows. Note that current goes through the rectifier and through the load resistor. When the polarity of the input is reversed, current flow through the rectifier is blocked, but a new path is formed through resistor *R1* and current continues to flow through the load. Thus, no matter what the sine-wave excursions are, the direction of flow through the load resistor is the same—hence, you have full-wave rectification.

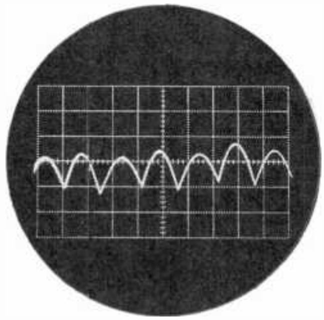
Why isn't this circuit used in practical everyday equipment? Well, in a conventional full-wave rectifier the efficiency can go up to 90%, but in this one-diode arrangement the efficiency is only about 25%. Also, all of the resistors are in series with the load and any voltage drop across them will subtract from the output. —30—



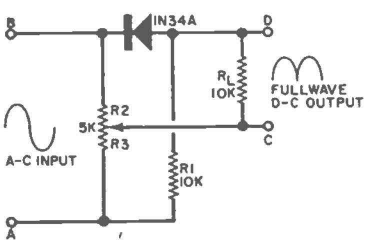
The test circuit diagram is shown below. You can easily duplicate this experiment as a science fair project. All of the scope photos above were taken off a Heathkit Model IO-14.

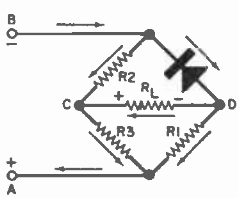


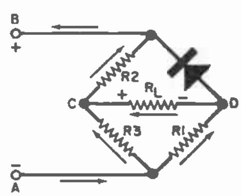
As potentiometer is rotated from one extreme to the other, traces show two different half-wave patterns (above left, and center).



Balance the two half waves and the scope trace should look like the one above. The theory diagrams are shown below.



# BUILD THE BEGINNER'S FET REGEN RECEIVER


## MAKE THIS YOUR FIRST PROJECT USING FIELD-EFFECT TRANSISTORS

**By CHARLES CARINGELLA**

COVER STORY

PUT THE WORLD at your fingertips with a simple all-wave receiver that packs a lot of performance in a small package! Build this FET regenerative receiver and tune in DX as well as local broadcast stations. You'll be able to listen to hams, weather broadcasts, standard time signal broadcasts, maritime telephone operators, and many, many other stations on the short-wave bands.

Simplified printed-circuit construction and nominal cost make this receiver an ideal beginner's project. Three bands can be tuned by simply changing plug-in coils—the broadcast band from 0.55 to 1.5 MHz, as well as two short-wave bands from 1.7 to 5.5 MHz and 5.5 to 18 MHz.

Highlight of the all solid-state regenerative receiver is the FET (field-effect transistor) "front end" stage. This is followed by a 5-transistor complementary-symmetry audio amplifier that delivers a room full of audio power to a built-in loudspeaker. The completed receiver measures only 8¼" x 6¼" x 4".

A vernier drive mechanism, with a tuning ratio of 6:1, is used for easier tuning. An ordinary 9-volt transistor radio battery provides the necessary d.c. power, so the receiver can not only be used at home but is "portable" enough to go camping, on picnics, etc. The unit will also serve as an emergency standby receiver. Since power consumption is low, battery life is quite good.

The receiver will cost about 32 dollars to build if *all* new parts are purchased individually. A savings of about 7 dollars can be realized if the complete "kit" of parts specified in the "Parts List" is purchased.

**How It Works.** The schematic diagram of the FET regenerative receiver is shown in Fig. 1. Transistor *Q1* is of the Texas Instruments 2N3819 n-channel silicon field-effect variety. This is a new low-cost epoxy FET, used as a regenerative detector, which plays a large part in making the sensitivity of this circuit rival that of some superhet communications receivers.

Pre-wound slug-tuned plug-in coils, modified slightly by the addition of a feedback winding and a miniature mounting plug, are used for each of the three bands covered. R.F. signals from the antenna are coupled to the primary winding of *L1* through capacitor *C1*. Variable capacitor *C3* tunes the receiver by resonating with the secondary winding of coil *L1*. A third winding on *L1* provides the necessary feedback for regeneration.

Potentiometer *R1* serves as the regeneration control and determines the amount of a.c. voltage that is fed back through *C2* to the feedback winding on *L1*. For reception of AM signals, *R1* is adjusted to the point just before the stage "pops" into oscillation. This is the point of maximum sensitivity and selectivity. CW signals, as well as SSB signals, are copied by adjusting *R1* so the stage just barely oscillates or regenerates.

The "front end" stage employing *Q1* is inherently stable because of the extremely low power dissipation and the rigid mechanical layout of components on the circuit board. Many of the frequency drift problems common to equivalent vacuum-tube circuits are non-existent in this FET circuit. The author has successfully copied "ham" SSB signals with this receiver, a trick that is often hard to perform with many superhets!

The output signal developed by the regenerative detector is a low-level audio voltage. It is direct-coupled through resistor *R4* to audio preamplifier stage *Q2*, a high-gain, low-cost RCA 40395 germanium *pnp* transistor. Potentiometer *R8* is the volume control. Transistors *Q3* and *Q4* provide further amplification of the audio signal.

Transistors *Q5* and *Q6* operate as a push-pull complementary-symmetry Class B power amplifier. They are sold together as a matched pair and are designated as the RCA 40396. Output distortion is very low and fidelity is excellent. Over 200 milliwatts of audio power can be delivered to the speaker, more than enough to fill an average-size room with sound. D.c. stabilization is provided by the feedback path through resistor *R17*. The output of the audio amplifier is capacitively coupled through *C16* to a 3½"-diameter, 45-ohm speaker, and a miniature closed-circuit phone jack, *J1*, automatically disables the speaker when an earphone is used. Any impedance earphone can be employed.

Battery *B1* is a conventional 9-volt transistor radio battery. Since the d.c. power requirement is very modest, battery life should be quite good, with a single battery lasting for several months under normal operating and listening conditions. The idling current is a low 5 to 8 milliamperes with no signal, jumping to a high of 20 to 25 mA on audio peaks.

**Construction.** The entire receiver circuitry is constructed on a 4" x 2⅞" printed circuit board. The etched copper foil side of the circuit board is shown in Fig. 2. The first step is to mount the coil socket in place with the retainer ring provided with the socket. The flat edge on the socket must face the direction indicated and the solder lugs on the socket should be on the copper foil side of the board.

Next, install variable capacitor *C3*. Use three *6-32* x ⅜" screws and three ¼"-long spacers. The spacers must be inserted between the capacitor bracket and the circuit board to space the capacitor away from the board.

The hole template of the front panel is shown in Fig. 3. The panel thickness should be ⅛", and it can be fabricated from aluminum, plastic, Bakelite, or any equivalent material. Mount the speaker with four *6-32* x ⅜" screws. At the two left-hand holes, use regular *6-32* nuts to fasten down the screws. Use 1"-long spacers that have been threaded for *6-32* screws at the remaining two locations; refer to Fig. 4 for the exact location of the spacers. Mount the vernier drive mechanism with *4-40* x ¼" screws and nuts. The two potentiometers and the phone jack go on last—mount them in the directions indicated in Fig. 5.

Now mount the circuit board on the front panel. (See Fig. 4.) The two circuit board mounting holes should line up with the 1" spacers, and the shaft on the variable capacitor should line up with, and fit into, the vernier drive. Attach the circuit board to the 1" spacers with two *6-32* x ⅜" screws. Make sure the board is exactly parallel to the panel, then tighten the setscrews to lock the tuning capacitor to the vernier drive. The circuit board should now be mounted rigidly in place. Attach a knob to the shaft of the vernier drive, and turn it back and forth from one stop to the other. The vernier drive and the variable capacitor should turn smoothly. If everything checks out properly, you can remove the circuit board assembly and proceed with the wiring.

Bend the solder lugs on the coil socket over and make the connections to them as shown in Fig. 2. Keep these leads as short as possible. Flip the circuit board over and solder the components in place as shown in Fig. 6. Mount all the transistors first. Space each transistor about ¼" away from the circuit board, making

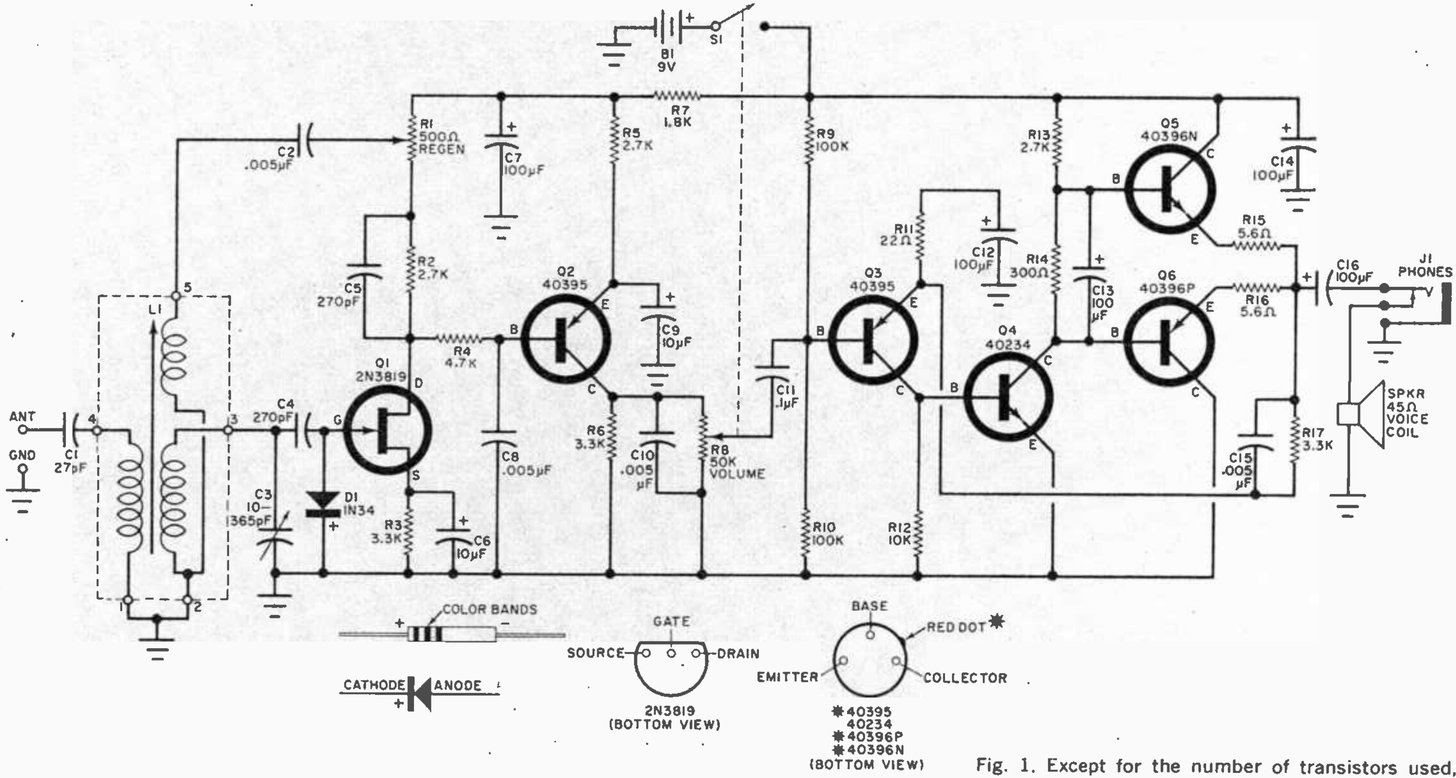
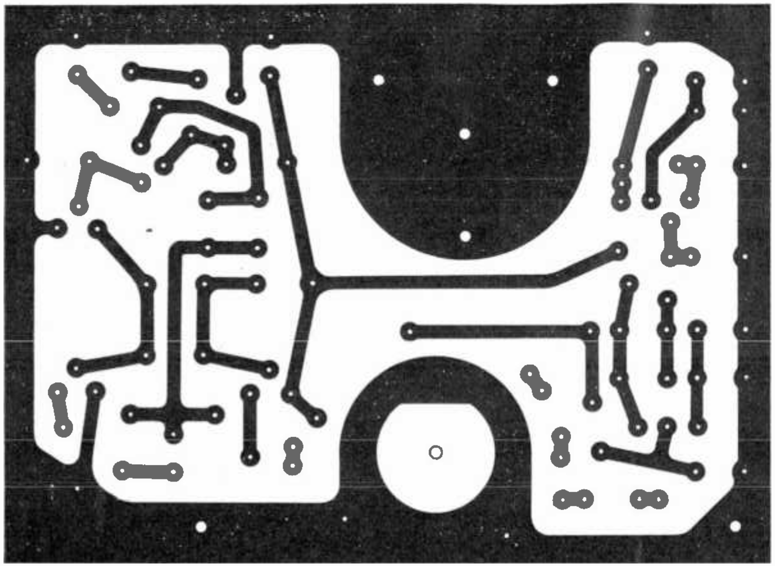



Fig. 1. Except for the number of transistors used, this circuit bears a remarkable resemblance to regenerative receivers of the 1930's. As POPULAR ELECTRONICS has often mentioned in print, the FET is a transistor that thinks and behaves as if it were a vacuum tube. However, many of the tube problems relating to drift and instability are absent.



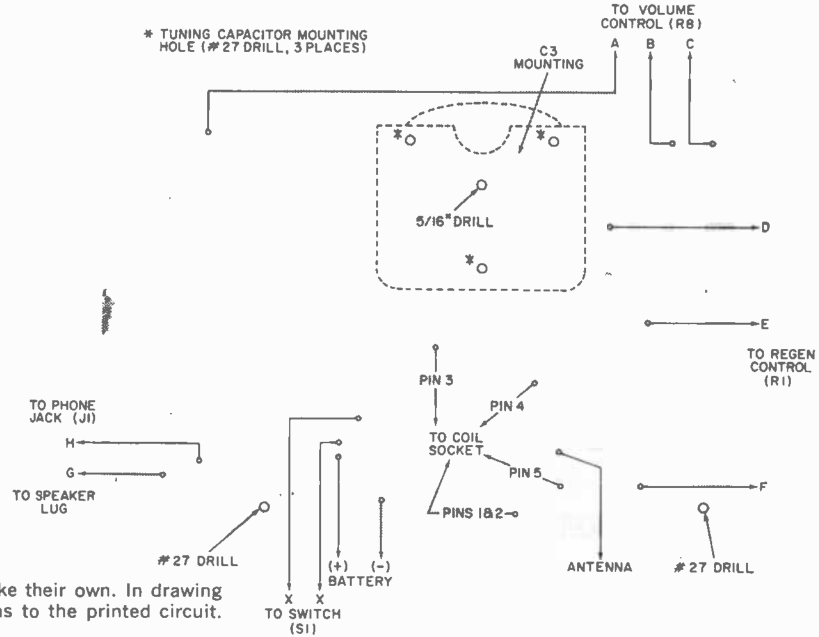



Fig. 2. "Same-size" outline of printed circuit board for readers who like to make their own. In drawing above, right, are notations on drilling of holes and making external connections to the printed circuit.

## PARTS LIST

*B1—9-volt battery*
*C1—27-pF ceramic capacitor*
*C2, C8, C10, C15—0.005 µF ceramic capacitor*
*C3—10-to-365 pF variable capacitor (J. W. Miller 2111)*
*C4, C5—270-pF ceramic capacitor*
*C6, C9—10-µF, 15-volt miniature printed circuit electrolytic capacitor*
*C7, C12, C13, C14, C16—100-µF, 15-volt miniature printed circuit electrolytic capacitor*
*C11—0.1—µF ceramic capacitor*
*D1—1N34 germanium diode*
*J1—Miniature closed-circuit phone jack*
*L1—Coil for Band "A," 0.55-1.5 MHz (J. W. Miller A-5495-A); Band "B," 1.7-5.5 MHz (J. W. Miller B-5495-A); Band "C," 5.5-18 MHz (J. W. Miller C-5495-A)*
*Q1—Texas Instruments 2N3819 transistor*
*Q2, Q3—RCA 40395 germanium pnp transistor*
*Q4—RCA 40234 germanium npn transistor*
*Q5—RCA 40396N germanium npn transistor*
*Q6—RCA 40396P germanium pnp transistor*
*R1—500-ohm linear taper potentiometer*
*R2, R5, R13—2700 ohms*
*R3, R6, R17—3300 ohms*
*R4—4700 ohms*
*R7—1800 ohms*
*(All resistors ½ watt)*
*R8—50,000-ohm, audio taper potentiometer with s.p.s.t. switch S1*
*R9, R10—100,000 ohms*
*R11—22 ohms*
*R12—10,000 ohms*
*R14—300 ohms*
*R15, R16—5.6 ohms*
*S1—S.p.s.t. switch (part of R8)*
*SPKR—3½"-diameter PM speaker with 45-ohm voice coil (Quam 3A07Z45)*
*1—Printed circuit board**
*1—Ball-type vernier drive, 6:1 ratio (Jackson Bros. 4511/DAF)*
*3—Miniature plugs, 5 pin (Amphenol 71-5S)*
*1—Miniature socket, 5-pin (Amphenol 78-S5S)*
*Misc.—Knobs, plastic pointer, speaker grille, cabinet, panel, Fahnestock clips, battery holder, battery clip, No. 28 enameled copper wire, 1" spacers, ¼" spacers, screws, hookup wire, solder, etc.*

*Etched and drilled printed circuit board is available for $3 postpaid from Caringella Electronics, Inc., P. O. Box 327, Upland, Calif. 91786. A complete kit of parts (including above circuit board, pre-punched panel with printed dial, plastic pointer, all components, hardware and wire (but less cabinet and battery) is available for $24.95 postpaid. California residents should add 4% sales tax to all orders.

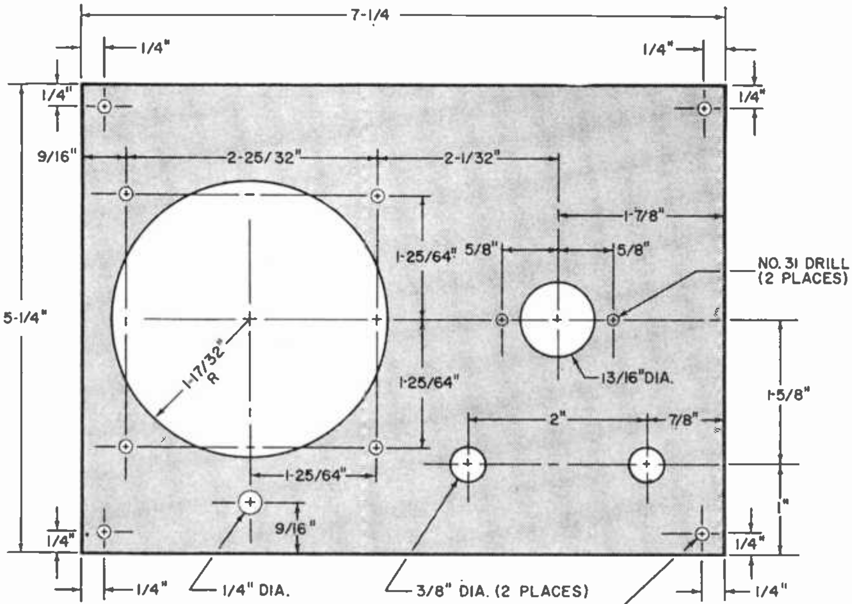
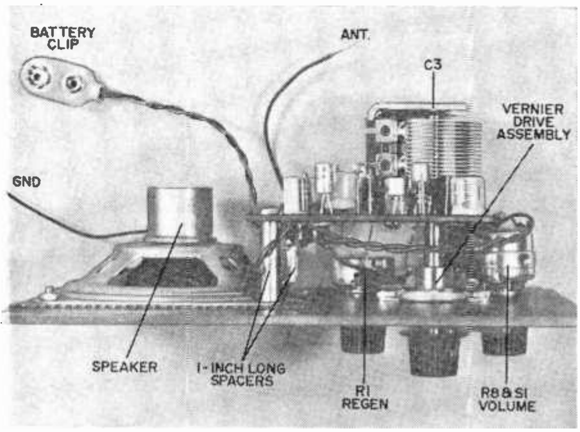
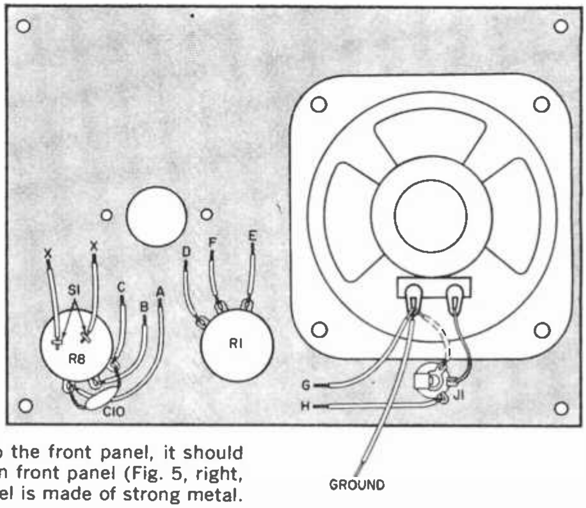



Fig. 3. This drawing shows the front panel arrangement of mounting holes in author's model.




Figs. 4 and 5. When printed circuit board is attached to the front panel, it should look like Fig. 4 above. A few components are mounted on front panel (Fig. 5, right, above) before printed circuit is put in place. Be sure panel is made of strong metal.

sure that each one is oriented properly! A heat sink should be used on each transistor lead while soldering to keep from damaging the transistor.

Next, install the capacitors. They should be flush-mounted against the board. Carefully observe the polarity of the electrolytics when installing them. Capacitor *C10* is the only one not mounted on the circuit board. It is soldered directly across volume control *R8*.

Mount diode *D1* vertically on the board. Space the body of the diode about ¼" away from the board, and carefully observe polarity of the diode when it is mounted. As with the transistors, the leads of the diode should also be held with a heat sink while soldering.

All of the resistors are installed vertically on the board. The connection to tuning capacitor *C3* is made from the "component" side of the board (see Fig. 6). All of the remaining connecting leads are soldered to the copper foil side of the

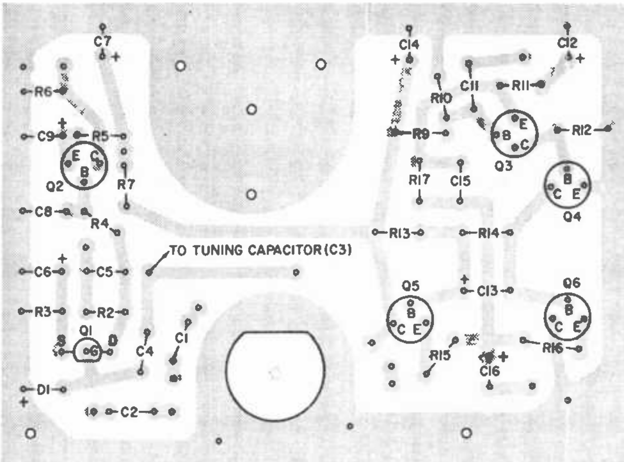



Fig. 6. Flip side of printed circuit board shown in Fig. 2. Note positions of the components, and, in particular, observe lead orientation of the various transistors. The center hole (shaft) for mounting C3 is eventually enlarged so that the shaft passes through freely without binding and C3 is rigidly supported by bolts through the 3 remaining small holes.

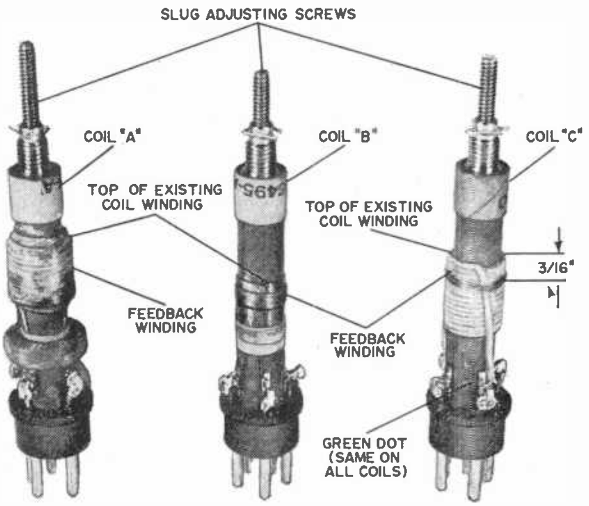



Fig. 7. Each of the plug-in coils is mounted on an Amphenol miniature 5-pin plug. Coil modification details appear in the text on the next page.

board. Flip the board over to the copper foil side (Fig. 2), and make these lead connections last. Leave these leads long; they will be trimmed to the proper length once the board is mounted in place.

Once again, mount the completed circuit board assembly on the front panel. Connect the leads from the board to the two potentiometers, the speaker, and the phone jack as illustrated in Fig. 5. Keep the leads to regeneration control *R1* as short as possible! The lead from *J1* to the speaker lug (represented by the dotted lines) may be omitted if an aluminum panel is used. Recheck all wiring, transistors, electrolytic capacitors, and the diode polarities in accordance with Fig. 6.

**Coil Modifications.** A set of three plug-in coils will cover the frequency range from 0.55 MHz to 18 MHz. Three J. W. Miller pre-wound slug-tuned coils are used for the purpose. As furnished by the manufacturer, each coil consists of a primary winding which is connected to the external antenna and ground, and a secondary winding which is tuned by an external capacitor. A miniature 5-pin plug must be attached to each coil for "plug-in" capability. Also, a simple feedback winding must be added to each coil as shown in Fig. 7.

Heavy, tinned copper wire is used to hold the miniature plugs firmly against the bottom of each coil. The heavy wire connects the plug pins to the coil solder lugs. Solder a 1½" length of No. 18 tinned copper wire into pins 1, 2, 3 and 4 on each of the miniature plugs. Pin 5 will be left empty for the moment. The plug pins are hollow, and each lead should just barely stick out the bottom end of the pin. Make sure each connection has an adequate amount of solder within the pin, but avoid running any excess solder over the outside of the pins.

After all the pins have been soldered, test each plug in the socket on the circuit board to make sure they plug in and

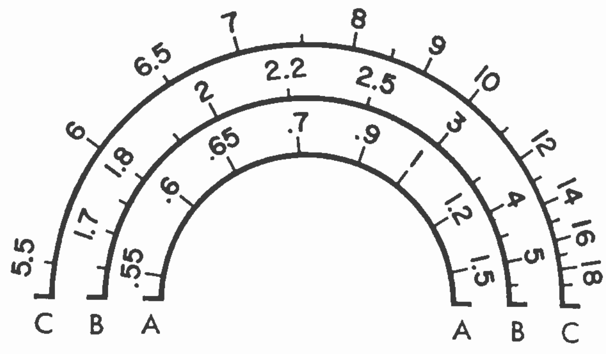



Fig. 9. If you use the coils and variable capacitor specified in the Parts List, the tuning range should be approximately 550-1500 kHz with coil "A"; 1.7-5.5 MHz with coil "B"; and 5.5-18.0 MHz with coil "C". The receiver should regenerate smoothly over this range.

out easily. If necessary, carefully trim away any excess solder. Place the plugs against each coil as shown in Fig. 7. Align the green dot on each coil between pins 2 and 3 on each plug, and attach each lead to the nearest solder lug on each coil. Run each lead through the loop on the solder lugs and cinch the leads tightly to make a rigid assembly out of the coil and plug, then solder each connection. Finally, cut off any excess leads.

Use No. 28 enameled copper wire for the feedback windings on all three coils. On each coil, start the winding by first soldering one end of the enameled copper wire to the coil solder lug which is connected to pin 2 on the miniature plug, then wind the wire as follows:

*Coil "A"—0.55 to 1.5 MHz.* With the plug pins pointed towards you, wind 30 turns close-wound across the existing top coil, in a counterclockwise direction, starting from the bottom and winding towards the top.

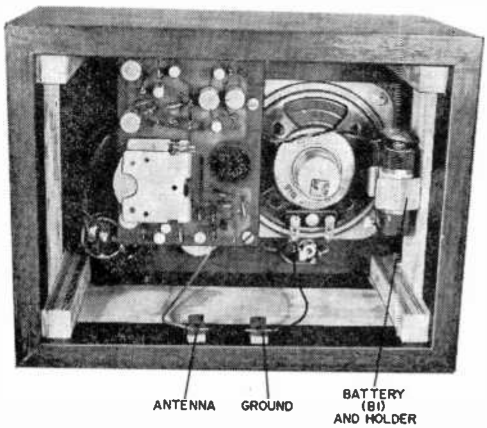



Fig. 8. Back view of the completed receiver in the cabinet designed by the author. You can either make your own cabinet or buy a ready-made metal box.

*Coil "B"—1.7 to 5.5 MHz.* With the plug pins pointed towards you, wind 8 turns close-wound in a clockwise direction, starting about 3/16″ down from the top of the existing winding, and winding towards the top.

*Coil "C"—5.5 to 18 MHz.* With the plug pins pointed towards you, wind 3 turns close-wound in a counterclockwise direction, starting about 3/16″ down from the top of the existing winding, and winding towards the top.

Solder the end of each completed feedback winding to pin 5 of each plug. Then complete each coil assembly by coating the new feedback windings with coil dope.

A preliminary setting can be made on the tuning slug of each coil to get them in the right "ball park." Run the slug completely out of each coil by turning the adjusting screw counterclockwise until it stops. Then, for coil "A" run the slug in about 3 to 4 turns, for coil "B" run the slug in about 8 to 9 turns, and for coil "C" run the slug in about 3 to 6 turns. The coils can be more accurately aligned later.

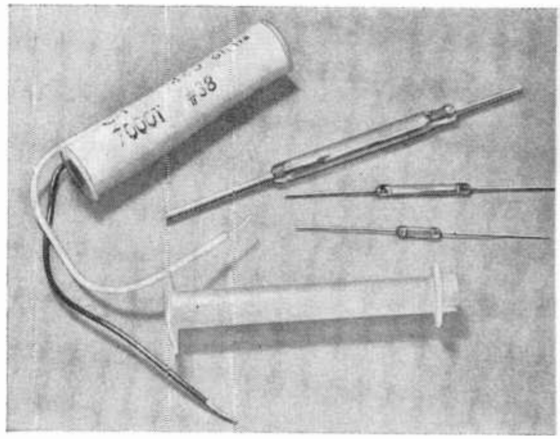
**The Cabinet.** You can construct the cabinet to suit your own taste. The author used ½″-thick plywood.

The cabinet can be "finished" by covering it with self-sticking shelf paper, or painting it the color of your choice. The author used an imitation wood-grain shelf paper; however, there are many types and colors to choose from. Shelf paper is readily found in grocery stores, department stores, etc.

(*Continued on page* 114)

# WORLD'S MOST-SENSITIVE LOW-COST RELAY

By **NEAL P. JENSEN** and **ALEXANDER W. BURAWA**



HAVE YOU EVER DECIDED to build a project only to find that an expensive or hard-to-get sensitive relay was required? If you didn't forget the whole idea right then and there, you probably worked up an "easy-way-out" solution to your relay problem—probably adding an extra amplifying stage to develop enough power to energize a general-purpose relay. But all you would really accomplish with such a solution would be to cut down the cost of the relay and add the cost of the components needed for the extra circuit.

There is a far simpler solution to the problem, but one that many hobbyists and experimenters often overlook. Instead of using a general-purpose relay, you can substitute a magnetic reed switch. With a reed switch, you don't sacrifice sensitivity for price. You can realize up to 90% savings by using a reed switch instead of a conventional relay.

Most experimenters will question the suitability of reed switches in applications that call for a general-purpose relay—regardless of sensitivity. In this article the two devices will be compared, and you can make your own judgment. You will find that the reed switch—though a boon to electronics—will not obsolete the relay in all switching applications, just as the transistor has yet to replace all electron tubes.

**Magnetic reed switches** are second-generation relay-type switching devices. They were invented at the Bell Telephone Laboratories in 1940 to reduce the costs of maintaining and replacing conventional relays and to meet the needs for higher efficiency and greater sensitivity for switching devices used in complex telephone systems.

Partly because they were invented by Bell Telephone and partly because they combined high speed and uniform performance over long periods of time, reed switches played their first major role in telecommunications equipment. But because the reed switch is sensitive, compact, lightweight, and costs only a fraction of the price of a relay exhibiting the same characteristics, its use has extended to business, industry, and now to the experimenter.

Relays are comparatively heavy, bulky affairs. Because relay contacts are often open to the surrounding air—sometimes even corrosive atmospheres—periodic servicing is required to remove dirt and corrosion. By the nature of its construction, the relay is a low-efficiency device, generally insensitive to small energizing currents.

Conversely, the magnetic reed switch is compact and lightweight. Its contacts, sealed in an inert-gas-filled glass tube, never need servicing. And the inert gas in the tube retards arcing between the contacts—another problem with open relays.

Sensitivity not possible with even the best of conventional relays is a characteristic of a reed switch.* For example, it is possible to close a reed switch with less than 3 mA at 6 volts. A costly relay

**The sensitivity of a reed switch depends on the characteristics of its energizing solenoid and whether or not a permanent magnet is used to bias the switch—in much the same manner as biasing is used in an amplifier circuit.*

would have to be custom-made to provide this sensitivity and current handling (at the contacts) capacity.

Relays are low-speed switching devices, almost totally inadequate at switching speeds exceeding approximately 150 open and-close actions per second. Reed switches, on the other hand, are high-speed devices, usable at switching frequencies up to 500 open-and-close operations per second. The average contact make-or-break response time of a reed switch is on the order of 1 millisecond.

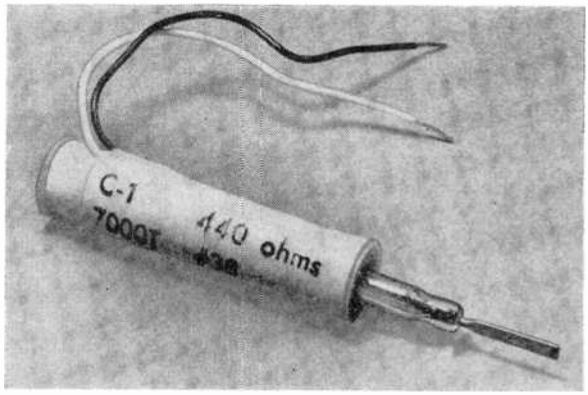
The useful life of a typical reed switch will generally exceed 10-million operations. In circuits where current flows only after the contacts are closed, this figure can be as high as 500-million operations. No relay yet designed can compare with these figures.

Reed switches, of course, have certain disadvantages that make them unsuitable for some applications. Presently available reed switches can handle low to moderate power loads, up to about 50 voltamperes. Reed switches are also limited to a simple on/off action. Complex switching arrangements, however, can be obtained by "ganging" several reed switches and operating them with a common energizing power source.

Unlike some relays that can be energized from either an a.c. or a d.c. source, reed switches are restricted to d.c. sources only. If an a.c. source were used, the reed switch would open and close in step with the frequency of the applied power.

**The most readily apparent** difference between reed switches and conventional relays is in their respective construction (see photo at right). There is a significant difference in the proximity and orientation of the energizing solenoids. The relay's movable contacts are spring-returned to their passive position when no power is applied to the energizing solenoid. The only spring action in the reed switch is the slight amount built into the reeds.

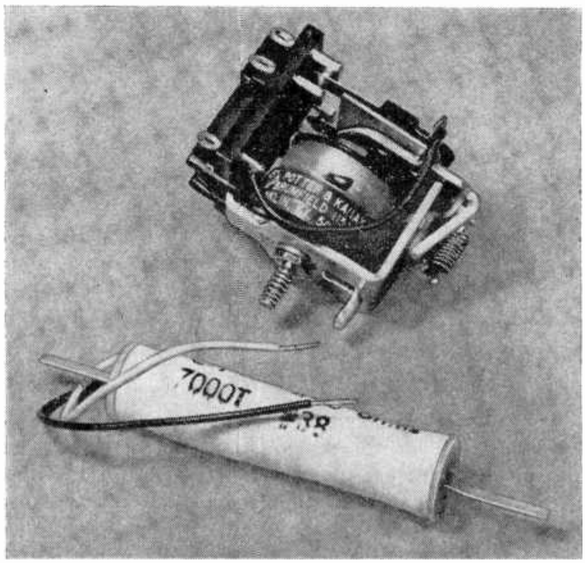
What does this difference in construction mean in terms of sensitivity? In a nutshell, it means all the difference in the world. The relay action depends on the electromagnetic field (from one end of the solenoid) being strong enough to overcome the tension of the spring. This




When a reed switch is used in place of a conventional relay, a solenoid is needed to close the reeds by means of electrical energy. The reed switch must be inserted in hollow core of solenoid.

is a waste of electromagnetic energy. The contacts of the reed switch form the core of the energizing solenoid and are at the center of the electromagnetic field.

Since the energizing solenoid extends from one end of the reed switch to the other end, an interesting phenomenon takes place when the solenoid is connected to a power source. The contacts become separate magnets with opposing magnetic poles. These low mass contacts, overlapping and closely spaced, are in-




Different methods of construction used in conventional relay (top) and reed relay (bottom) account for wide variations in sensitivity between devices.

stantly attracted to each other. The density and strength of the magnetic field running through the center of the solenoid is considerably greater than that around the outside of the solenoid, so less power is required to close the reed-switch contacts than is required to close the relay's contacts—considerably less. Almost all the energizing current flowing through the solenoid is used to close the contacts of the reed switch, while less than 50% is used in the relay.

Where only a few milliamps of current are available for closing the contacts of a reed switch, a permanent magnet is often used to increase sensitivity. The permanent magnet biases the reed switch in such a way that its field and the field of the solenoid aid each other. As a result, the amount of current needed to close the contacts can be reduced to a level determined by the proximity of the permanent biasing magnet to the contacts of the reed switch.

In present-day electronics, where transistors are the building blocks for circuit designs and design concepts, sensitivity is a key feature. Transistors—generally low power devices when compared with vacuum tubes—require the use of high-sensitivity switching devices for proper switching action. Relays that are designed to energize with 4-mA drain on the circuit generally cost more than $10, whereas a reed switch, designed to operate at 2 mA, need not cost more than $2—if the energizing coil is home-wound.

**Perhaps the most important role** the reed switch has played to date is in the "No. 1 Electronic Switching System"* (ESS) developed by the Bell Telephone Laboratories at a cost of some $100-million for research alone. The No. 1 ESS is the world's most advanced switching system for telephone communications, and because of its high-speed/high-reliability requirements, reed switches are being used almost exclusively in place of relays.

The No. 1 ESS is so successful that over the next three decades it should become the telephone equipment standard throughout the United States. Solid-state devices and magnetic reed switches have made this new system possible.

The results obtained by Bell Telephone are just as easily applicable to your next relay project—if you use a reed switch. Immediately following are details for winding your own solenoid for a popular model of reed switch. -30-

*An article that goes into further detail about the "No. 1 ESS" appeared in the January, 1965, issue of POPULAR ELECTRONICS (The Great Immortal Machine, page 69).*

# MAKE YOUR OWN REED SWITCH-RELAY

## . . . AND GET "NEAR-ULTIMATE" OPERATING CHARACTERISTICS

**By NEAL P. JENSEN and ALEXANDER W. BURAWA**

REED SWITCHES are available in a variety of sizes and contact ratings. The correct reed switch for a given application is determined by two factors: the energizing circuit and the power consumption of the load to be controlled.

While many manufacturers supply solenoid coils for different switch sensitivities, you might want to wind the coil to suit the needs of your particular circuit. This is not as difficult as it may sound. Aside from the monetary savings you realize by winding your own coil, your switching device may more nearly approach the "ultimate" in efficiency.

**The Solenoid Coil.** The data given in this article and the Coil Winding Table on page 50 are typical for the operation of the General Electric DR series of dry reed switches. This series includes the DR101 (rated at 15 volt-amperes) and the DR113 (rated at 50 volt-amperes). For other models of reed switches, consult the manufacturer for coil information.

The coil form must be made from non-magnetic materials, using the dimensioned drawing shown in Fig. 1 as a guide. The hollow tube that forms the core of the coil form can be a short length of aluminum or plastic tubing with an inner diameter just large enough to accept the reed switch. The coil form ends should be cardboard, plastic, or phenolic board. Drill a small hole in one of the coil form ends to pass one end of the windings out for connection into the circuit. Glue the pieces together with epoxy cement.

Next, determine what sensitivity your circuit requires and whether or not a permanent (bias) magnet is needed. The Coil Winding Table will guide you. For example, if your circuit supplies 6 volts to the switch solenoid, and you want to close the contacts when 4.0 mA is flowing, you read down the columns under the headings "A" and "B" until you find both the voltage and current figures that come closest to your requirements. Keep in mind that the values in the columns under "A" are for use without a bias magnet, and those under "B" are for use with a magnet. A careful check will reveal that, in this case, your requirements can be met only by using the columns under "B" (6.0 volts and 2.8 mA) and that a bias magnet must be employed.

After locating this information from the voltage and current columns, read across the table to the left, and you will find how many turns of what number, or size, wire are needed. For the example given, 22,500 turns of #40 enameled wire are required.

After determining the number of turns needed, carefully chuck the coil form in a variable speed electric drill. Feed one wire end through the small hole in the coil form end. Tape the wire to the hollow tube and begin winding at a slow speed, evenly, up and down the length of the coil form until you have an overall diameter of ¾" (this overall diameter will yield the approximate number of turns indicated no matter what size wire is used).

After the coil is wound, tape down the free end. Then wrap a few layers of electrical tape over the entire winding to prevent unraveling. Solder appropriate hookup wires to each end of the switch, and slide the switch into the core of the coil form. Finally, center the switch in the coil form.

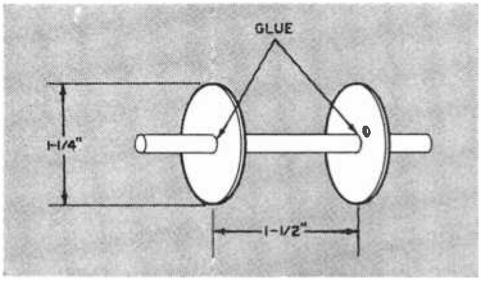



Fig. 1. The coil form used for a reed switch must be fabricated from nonmagnetic materials. Dimensions shown in this drawing are typical for the DR series of General Electric's dry reed switches. The inner diameter of coil form core should be ¼".

## COIL WINDING TABLE

| WIRE SIZE | TURNS | RESISTANCE IN OHMS | A NO BIAS MAGNET | | B WITH BIAS MAGNET | |
|---|---|---|---|---|---|---|
| | | | VOLTS | CURRENT (mA) | VOLTS | CURRENT (mA) |
| 18 | 311 | 0.38 | 0.13 | 335 | 0.08 | 210.0 |
| 20 | 460 | 0.9 | 0.2 | 228 | 0.12 | 140.0 |
| 22 | 700 | 2.0 | 0.3 | 150 | 0.2 | 85.0 |
| 24 | 1000 | 4.5 | 0.45 | 105 | 0.3 | 57.0 |
| 26 | 1600 | 11.0 | 0.7 | 66 | 0.4 | 43.0 |
| 28 | 2350 | 22.0 | 1.0 | 45 | 0.6 | 28.0 |
| 30 | 3500 | 50.0 | 1.5 | 30 | 0.9 | 19.0 |
| 32 | 5000 | 110 | 2.2 | 21 | 1.5 | 11.0 |
| 34 | 7000 | 200 | 3.0 | 15 | 2.0 | 8.5 |
| 36 | 10,000 | 450 | 4.5 | 10 | 3.2 | 5.0 |
| 38 | 15,000 | 1000 | 6.5 | 7 | 4.0 | 4.0 |
| 40 | 22,500 | 2000 | 9.0 | 5 | 6.0 | 2.8 |
| 42 | 34,000 | 5000 | 15.0 | 3 | 10.0 | 1.8 |
| 44 | 50,000 | 12,000 | 22.5 | 2 | 15.0 | 1.1 |

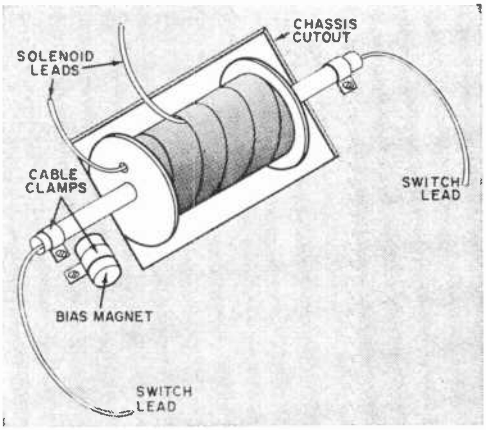



Fig. 2. If bias magnet is used, reed switch-relay assembly must be mounted over cutout in chassis to allow for positioning and orienting of the magnet.

**Installation and Setup.** If no bias magnet is used, the reed switch-relay can be simply mounted, using 1½"-long spacers and plastic cable clamps to support it on the chassis. Use of a bias magnet, however, requires that a hole be cut in the chassis and the reed switch-relay assembly located as shown in Fig. 2.

Locate the cable clamps as close to the coil form ends as possible to prevent them from interfering with the bias magnet. Bolt the switch assembly down tight, but leave the bias magnet loose to allow repositioning.

Now, connect an ohmmeter or other continuity indicating device to the switch leads. Determine what type of action you want from the switch assembly when an energizing voltage is applied to the solenoid—high sensitivity, normally-closed, or latching.

For high sensitivity, slowly move the biasing magnet close to the switch until the contacts close; then back off until the contacts just open again. Bolt the bias magnet down tightly in that position. (If the contacts do not close even when the magnet is touching the coil form, use a stronger magnet.) Apply power to the solenoid leads. If the closing action is not "snappy" or the contacts do not close, reverse the polarity of the connections.

A normally-closed action can be obtained with slightly more influence from the biasing magnet. Move the magnet close to the coil form until the switch just closes; then bolt it down. When the energizing voltage is applied to the solenoid, the magnetic fields should oppose each other. Therefore, if the contacts do not snap open—and stay open—reverse the polarity of the solenoid connections.

To obtain a latching-type action, apply power to the solenoid, and then experiment with the proximity of the biasing magnet until the contacts remain closed when the power is removed. By the same token, the contacts should remain open if the polarity of the solenoid connections is reversed when power is removed. It may take several attempts to locate the appropriate proximity of the biasing magnet.

The final step is to connect the switch contacts to the load and the coil windings to the energizing circuit. Be sure, however, to connect the solenoid into the circuit with the proper polarity.

That's all there is to it. You now have an extremely sensitive relay, a simple latching relay, or a normally-closed relay at only a fraction of the cost of a conventional relay. —30—

## EXPERIMENTAL REED SWITCH KIT

Many hobbyists like to experiment with a new electronic device before they proceed to design a circuit in which it might be used. The Wabash "Engineering Design Kit" (No. 67-001) was assembled for those who want to practice using dry reed switches without spending a lot of money in the process.

The kit contains fifteen dry reed switches, three solenoids—one of which is a logic coil, four permanent magnets, and a "how" and "why" instruction booklet. The switches come in two sizes and three sensitivities, to give you a well-rounded idea of the versatility of reed switch-type relays and proximity switching devices.

With this kit, you can test and evaluate proximity and position detectors, demonstrate sensitivity, latching relays, logic circuits, and matrix or crosspoint latches. The particular reed switches supplied are said to respond to a frequency of up to 2000 counts per second. That's about an average 0.5-millisecond open-or-close response time.

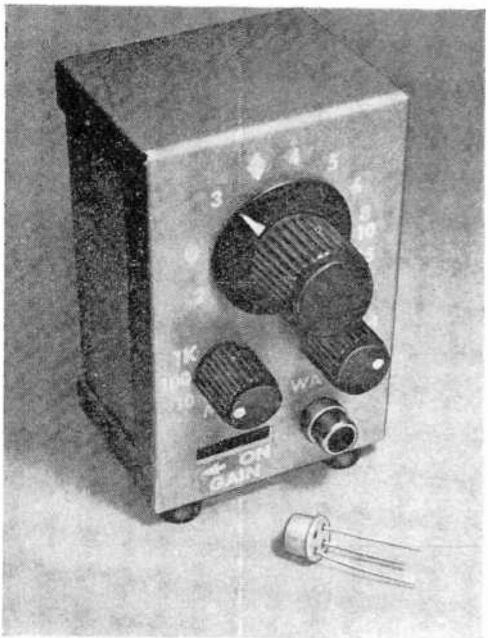
You can obtain your experimental reed switch kit by sending $10 to New Product Engineering, Incorporated, Wabash Magnetics, 812 Manchester Ave., Wabash, Ind. 46992.

BUILD

# MULTI-WAVEFORM GENERATOR

SIMPLIFY YOUR HI-FI TESTING THROUGH THE USE OF THIS CONTINUOUS-COVERAGE LOW-COST GENERATOR

**By MELVIN CHAN**




SERIOUS AUDIOPHILES with a good working knowledge of electronics are aware of the many types of test signal waveforms that can be used to check out audio amplifiers. Some signals, unlike sine waves, can perform a number of tests at one time. One of these signals is the square wave. This waveform will check out amplifier frequency response while simultaneously indicating any high- or low-frequency inadequacies, phase shift, and any ringing present in the system.

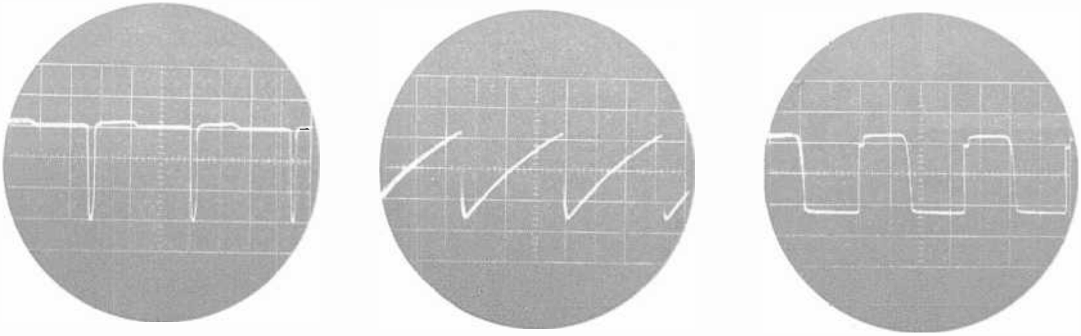
Some audio engineers prefer to use a sawtooth signal, instead of a square wave, to perform these tests, while others feel that a "spike" waveform is best. The use of these waveforms has been discussed in technical journals serving the hi-fi field. The simple, low-cost (under $10) multiple waveform generator described in this article can deliver a square, sawtooth or spike waveform test signal, at any fundamental frequency between about 200 and 20,000 Hz.

**How It Works.** The circuit for the test set is shown in Fig. 1. Transistor *Q1* is a unijunction unit operating as a relaxation oscillator. The frequency of oscillation is determined by front panel potentiometer *R2*, in conjunction with a charging capacitor (*C1*, *C2*, or *C3*) selected by switch *S1*. During oscillation, a sawtooth waveform will appear at the emitter of *Q1*, and a negative-going spike will appear at B2 of *Q1*. The sawtooth and spike waveforms are directly fed to waveform selector switch *S2*, and on to emitter follower *Q3*.

The sawtooth signal is also fed, through *R4*, to the base of transistor *Q2*.

**PARTS LIST**

*B1—9-volt battery*
*C1—0.02-μF capacitor*
*C2—0.2-μF capacitor*
*C3—2.2-μF electrolytic capacitor*
*C4, C5—30-μF, 6-volt electrolytic capacitor*
*C6—0.47-μF capacitor*
*J1—Phono jack*
*Q1—2N2646 unijunction transistor*
*Q2, Q3—2N2712 transistor*
*R1—1500-ohm, ½-watt resistor*
*R2—25,000-ohm linear potentiometer*
*R3—2000-ohm, ½-watt resistor*
*R4, R5—10,000-ohm, ½-watt resistor*
*R6—50,000-ohm miniature potentiometer (Lafayette 99 R 6145 or similar)*
*R7, R8—100,000-ohm, ½-watt resistor*
*R9—5000-ohm potentiometer (with S3)*
*S1, S2—2-pole, 5-position switch*
*S3—S.p.s.t. switch (part of R9)*
*Misc.—Small box (Premier 1001 or Bud CU-3001-A), printed circuit board, knobs, hardware, etc.*



The pulse (left), sawtooth (center) and square wave (right) waveforms as seen on an oscilloscope. The little step on the leading edge of the square wave will vary dependent on the transistor used for Q2.

This transistor is biased by *R6* so that it conducts only during a small portion of the sawtooth waveform. This produces a square wave at the collector of *Q2*. Transistor *Q3* is an emitter follower which accepts the signal selected by *S2* and supplies it, at relatively low impedance, through capacitor *C6*, to output jack *J1*.

**Construction.** Layout of the printed board is shown in Figs. 2 and 3, while Fig. 4 illustrates the method of mounting used by the author. The printed board is secured to the bottom of the case with three *2-56*, ½"-long bolts, using nuts to space the board far enough away from the case to preclude any possibility of shorting components. Figure 4 also illustrates one method of mounting the battery.

After mounting frequency control potentiometer *R2*, multiplier switch *S1*, waveform selector switch *S2*, and output jack *J1*, the printed board can be wired to these components as shown in Fig. 3. Looking at the rear of control *R2* (as mounted), the left-hand terminal goes to the PC board (near *R3*), and the center and right-hand terminal are connected together. One lead from this

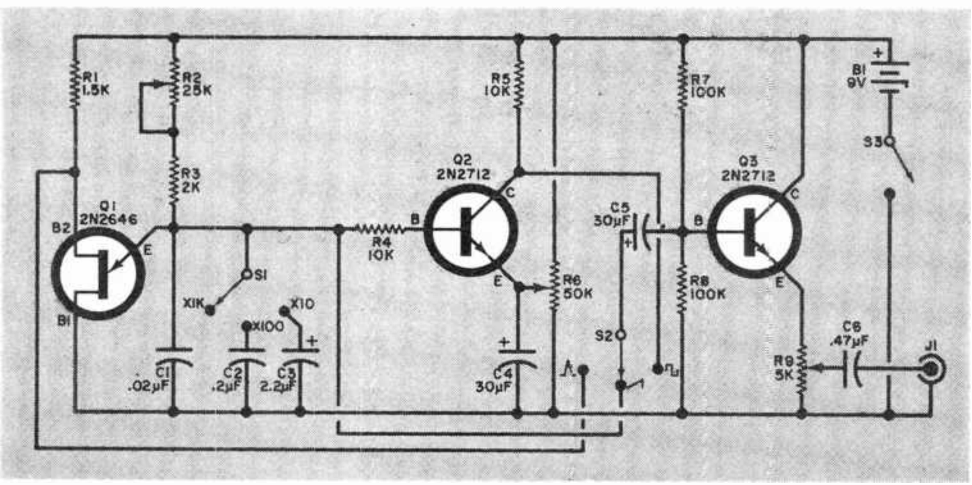



Fig. 1. As transistor Q1 oscillates, a pulse is generated at base-2 and a sawtooth waveform appears at the emitter. The sawtooth signal also produces a square wave via Q2. Signal choice is made by S2.

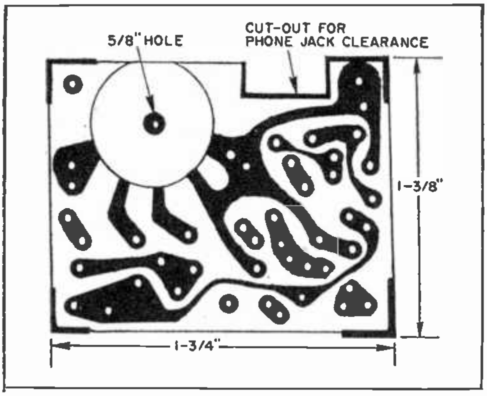



Fig. 2. Actual-size printed board. Potentiometer R9 (with S3 attached) is a printed circuit type (Lafayette 99 R 6019) and solders directly into board.

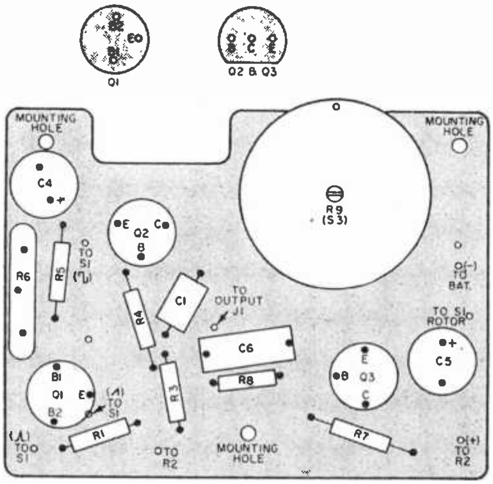



Fig. 3. Transistors Q2 and Q3 have in-line leads, although the PC board shows a triangular arrangement, so that other transistor types may be used. Drawing is oversize to show parts layout clearly.

pair goes to the PC board (near *C5*) and the other goes directly to the positive terminal of battery *B1*. The power switch (*S3*) is located in the negative lead of the battery.

**Calibration.** Connect an oscilloscope to the output jack, place *S2* in the pulse setting, turn the generator on, and you should see a pulse-type signal on the scope. Switch *S2* to the sawtooth position, and there should be a sawtooth waveform on the scope. Frequency of the waveforms is dependent on the setting of *R2* and *S1*.

When these waveforms are present, switch *S2* to the square-wave position, and adjust *R6* until a symmetrical square wave is obtained. Since this unit was not designed to rival precision instruments, there will probably be some discrepancy

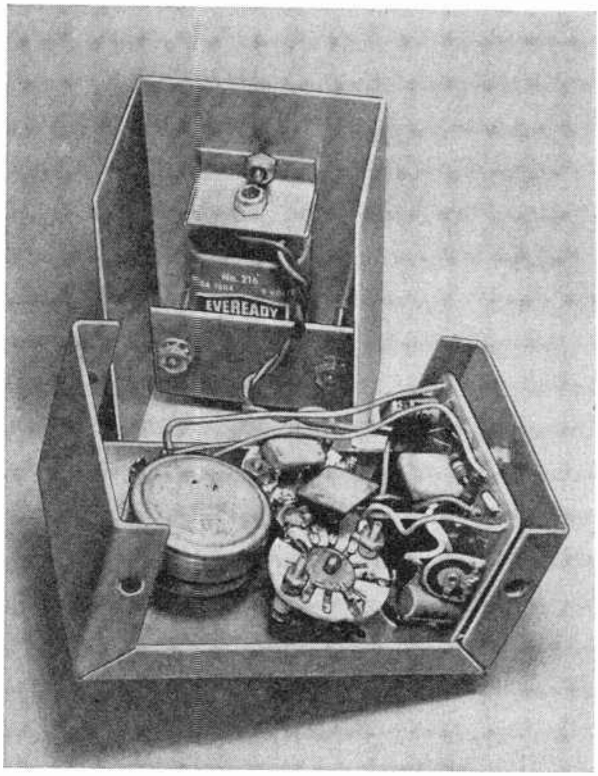



Fig. 4. In the author's unit, the battery is mounted on the rear cover so that, when the two sections are joined, it will not mechanically interfere with R2, S1, S2, or components mounted on printed board.

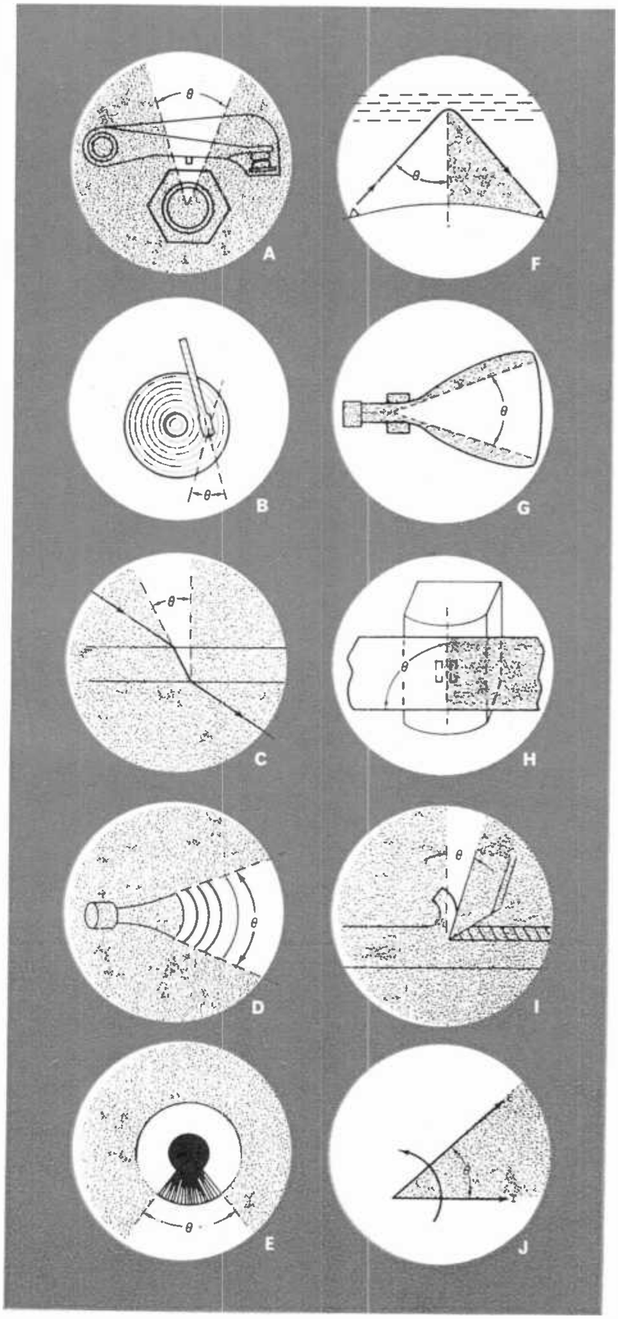
in the calibration scale for each range. However, as shown in the photo on page 52, exact scale markings are broad.

To calibrate the unit, a reasonably accurate audio generator as well as an oscilloscope is required. Start with the x10 range. Set *S1* to x10 and *S2* to square-wave output. Connect the external audio generator to the scope and set it for 20 Hz. Adjust the scope sync control until it locks and displays only one 20-Hz waveform. Now, without touching the scope,

(*Continued on page* 99)

# ELECTRONIC ANGLE QUIZ

By ROBERT P. BALIN




Electronics technicians use the term "angle" in a variety of fashions: it can describe the area of coverage, the shape of a mechanical component, or denote the phase relationship between voltage and current in an a.c. circuit. For example, you may have heard of the "firing angle" of a thyratron, or the "conduction angle" of a vacuum tube. To test your knowledge of electronic "angles," try matching the angles depicted in drawings A through J with the descriptive terms below (1-10).

(*Answers appear on page* 113)

1 Azimuth Angle ______

2 Critical Angle ______

3 Cutting Angle ______

4 Deflection Angle ______

5 Dispersion Angle ______

6 Dwell Angle ______

7 Phase Angle ______

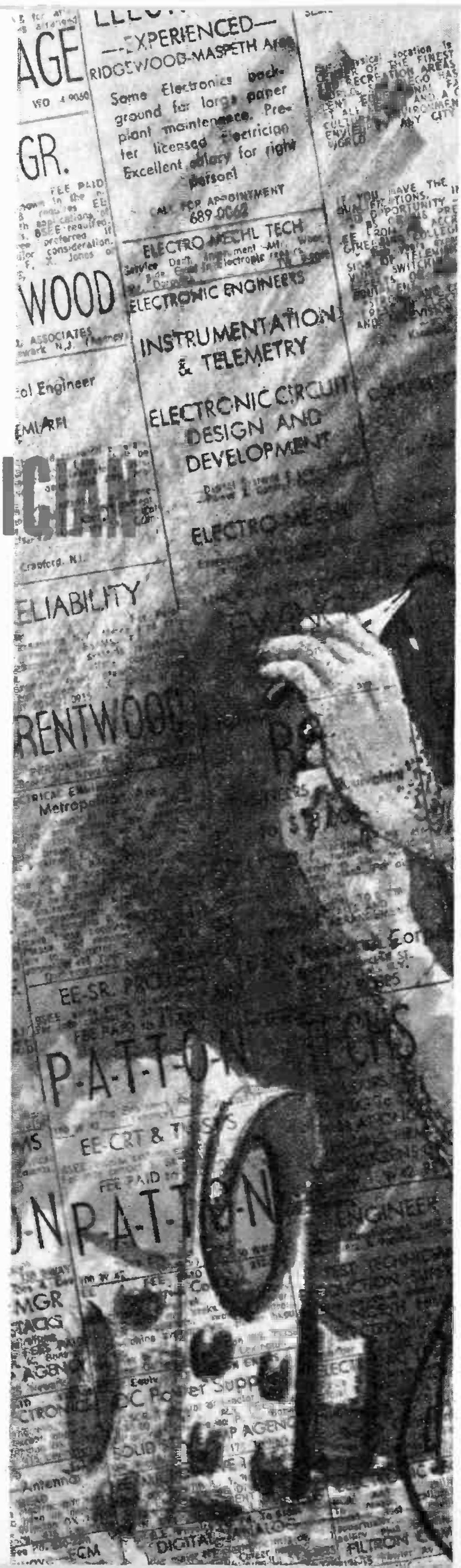
8 Refraction Angle ______

9 Shadow Angle ______

10 Tracking Angle ______

A STRAIGHT-FROM-THE-SHOULDER DISCUSSION OF HOW TO BE HIRED, HOW TO STAY EMPLOYED, AND WHO DOESN'T GET ANYWHERE

# THE ELECTRONICS TECHNICIAN SHORTAGE




THERE IS, according to almost any personnel manager, a serious shortage of electronics technicians. Perusal of the "Help Wanted" ads in almost any metropolitan newspaper reveals many openings for electronics technicians. Even such prestige employers as Bell Telephone Laboratories and Hewlett-Packard now seek out technicians whereas, not so many years ago, the waiting list for jobs at Bell Labs was longer than the personnel roster.

This shortage of electronics technicians is critical in many parts of the country. A few firms have even established training courses, tuition free, with guaranteed jobs for all who complete the course. Ads reading "Learn to be an Electronic Technician at our expense" offer a real opportunity to those with ambition, reasonable intelligence, and limited education, since some of these training courses are quite good.

**Why a Shortage?** The major cause of the electronics technician shortage is the enormous growth of the electronics industry. This growth includes not only the proliferation of the "amusement" part of the industry, but also the great expansion of military electronics, communication electronics, industrial controls, and the computer field. Medical


**By RONALD L. IVES**

electronics, geophysical electronics, navigational electronics, and meteorological electronics are other branches of the industry which are expanding at a rapid rate. Even law-enforcement agencies are now extensive users of electronics equipment.

But expansion of the electronics industry accounts for only part of the technician shortage. There is also continuous attrition in the ranks of electronics technicians. Most of the electronics and radio pioneers have now retired, died, or stepped up to administrative positions. Few, if any, of those who built the Paragon RA-10 receiver, once world-famous, are still working as technicians.

There is also a "loss off the bottom"—the lowest grade technicians, those who put the wires on the round gimmick with colored stripes through holes 6 and 7 of the printed-circuit board, work for a few months, or even a year, and then come down with "nerves," "the misery," etc., quit and go back on relief. Many of these jobs are being eliminated by automation.

The "loss off the top" is more serious, as it removes from the technician ranks some of the best workers. Often, these technicians, after working for a couple of years, leave to start businesses of their own. Some have saved up enough money to finish college; and some, after attending night classes for several years, earn a degree, and get hired as engineers by competitors. Also, many technicians graduate to better jobs as supervisors, field representatives, sales representatives, troubleshooters, computer programmers, etc.

... almost any competent technician can get a job ...

Although the combination of industry growth and the attrition of technicians gives the personnel office ulcers, it also keeps the pay of technicians at a healthy level and insures that almost any competent technician can get a job.

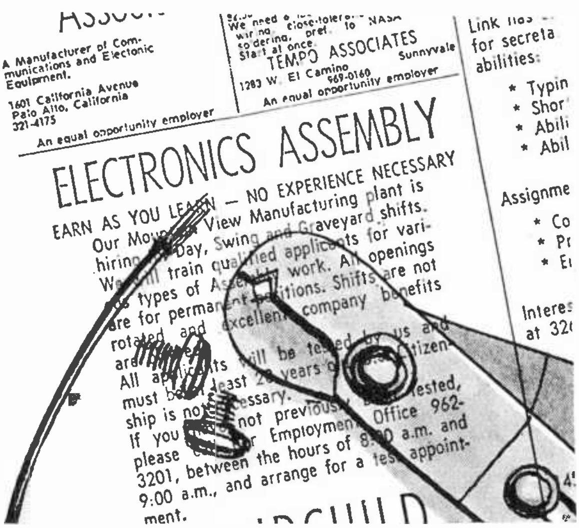
**Who Gets Hired.** When a firm advertises for electronics technicians, what do they actually want and who will they hire? Suppose the company of your choice has not advertised recently. Should you apply? If you belong to some minority group (almost everyone does), will it affect your chances of employment?

These questions are easy to ask but sometimes almost impossible to answer. Some companies have "secret" employment policies, interpreted by those in the personnel office. Although illegal, the department with the vacancy can be a closed corporation that will only accept applicants of a specific religion, race, political belief, or national origin. As a very general rule (there are exceptions), successful medium-sized to large companies have honest liberal employment policies. In many of them, you will find John Lowell, Seamus O'Hara, Ikey Cohenstein, Woe Sin Wong, Atanacio Tafoya, and Crispus Attucks Jones working harmoniously on the same project. In the Southwest, you may also find Luis Oacipicagigua on the project roster. He is familiarly called "Chief."

Despite stories that women are employed only on the production line and as equipment operators, many laboratories employ women as electronics technicians in all categories. Some of them do outstandingly good work.

Assuming that you have applied for a job, either directly at the personnel office or by mail, you will probably be interviewed by several people. The first interview will be quite short, in most instances, to determine only your general suitability for employment. If you look like a dissappointed beatnik or have applied for a chief engineer's job when you are only qualified for a position as assistant janitor (trainee), the first interview is as far as you will get.

Following this first interview, many companies give some sort of a written test. Most of these tests are quite fair and provide a pretty good evaluation of a man's ability; others are badly off the beam, being loaded with questions about




variometers, gravity cells, electrolytic interrupters, and other pieces of radio equipment that are now relegated to the museum.

A few firms give what purports to be a psychological test, its aim being to eliminate "undesirable types" from among the applicants. Some of these tests are successful in eliminating the "lunatic fringe" but others are so loaded with "Hobson's choice" questions ("The lost books of Sennacherib state that Jehu was Constantine's charioteer, yes_____ no_____") which *must* be answered, that no ordinary person can get a passing score. There is no place, on many of these questionnaires, for "don't know." If you get stuck with one of these, play it by ear, remembering that almost any statement containing *always* or *never* is likely to be false.

Because of Government contracts, most prospective employees must undergo a loyalty check of some sort, leading to a security clearance. This involves a fingerprint check and an investigation of the applicant's background. The loyalty "test" can be anything from a simple and straightforward outline of past experience and associations to a detailed questionnaire that might well make J. Edgar Hoover sweat. There is usually a lecture on security, sometimes given by an ex-FBI man who knows the score and at other times by a retired Army sergeant who "knows Communists."

After or while passing these hurdles, which may take from a few days to a few months, you will finally see the head of the department where the vacancy exists and get an idea of what the job will actually be. There may be a practical test at this stage of the game—soldering, reading wiring diagrams, using the oscilloscope, or something of the sort. Most of the questions are pretty straightforward and to the point, but watch out for a "stinker." If you are asked for the characteristics of an inverse bilateral frammistat or the circuit of a hypsometric depediculator, the correct answer might well be "I don't know." If you are qualified for the specific opening, this interview may be the shortest and simplest of them all.

Smaller companies usually have a shorter procedure in hiring but are often pretty demanding when it comes to qualifications and experience. Many non-electronic concerns have a semi-autonomous electronics department which maintains electronics equipment and fills the recurring demand "make me a widget that—".

**Who Doesn't Get Hired.** Many applicants for electronics jobs don't get hired. Folklore has it that they are not hired because they aren't competent. Actual reasons for "no hire" do include lack of training or experience, but most "no hires" are due to other things.

One of the surest ways of not getting hired is to have an overinflated resumé. Be sure that your statements of education and experience will stand checking. Even if you are pretty good, don't claim to "know *all* about electronics."

If, when applying for a job, you look like an exhibit from an anthropology museum, a fugitive from the barber shop, or are several months estranged from the laundry and the bathtub, the personnel manager is not going to be favorably impressed. Unless you want to be a geek in the sideshow, a little attention to personal appearance will help chances of employment.

Most employers have had sad and costly experiences with alcoholics, so don't show up for an interview smelling like a brewery. Likewise, if you are a hophead, weedhead, or acidhead, stay out of the personnel office.

Too many grievances about previous employers impress most personnel men unfavorably. Unless you are out of a job because of a contract termination or a company merger, you left your previous employment because of some unsatisfactory condition. This is understood. But if you left each of the last six places you worked (for two months each) because

ABOUT THE AUTHOR

Ronald L. Ives is a prolific author and has published hundreds of articles on electronics. Mr. Ives is currently associated with Metronics, Inc., Palo Alto, Calif. Born in 1909, he has a doctorate in geography, geology and anthropology. His long career in electronics—dating back to 1926—has kept him in close contact with technicians.

everyone there was a !$#--//!! the interviewer is going to be a bit skeptical. Sometimes he knows the facts about your previous employer and if your tale of woe and injustice disagrees with his knowledge, he may have reservations about your employability.

Although most electronics employers are fairly sophisticated, an applicant whose vocabulary is overloaded with four letter words is likely to find himself on the street again. Save the "blue" words for when you spill the solder pot into your right-hand pocket.

**Who Doesn't Stay Hired.** In any newly hired group of electronics technicians, some, or many, work out satisfactorily, remain on the job, and in the course of time get raises and promotions. In some of the older companies, we find senior technicians with twenty or more years of service and paychecks that make the Internal Revenue Service very happy. Many technicians who were trained during WW II are now section heads. A few have become engineers, chief operators, traveling troubleshooters, and customer contact men. A few are now either in business for themselves or have graduated "upstairs" to the board of directors. A technician's job is not usually a "dead end."

But, in any newly hired group, there are a number of technicians who don't stay hired because they are technically incompetent in one way or another. One of the most common failings is the inability to use technical knowledge. The sufferer from this fault can pass every written test, fill blackboards with correct formulas and wiring diagrams, discuss theory impressively, and generally act like a genius (junior grade)—but he can not make anything work.

Some relatively new employees are called to the security office after a few weeks of work and are seen no more. The trouble could be false statements on the employment application, concealment of a criminal record, or denial of security clearance for various reasons.

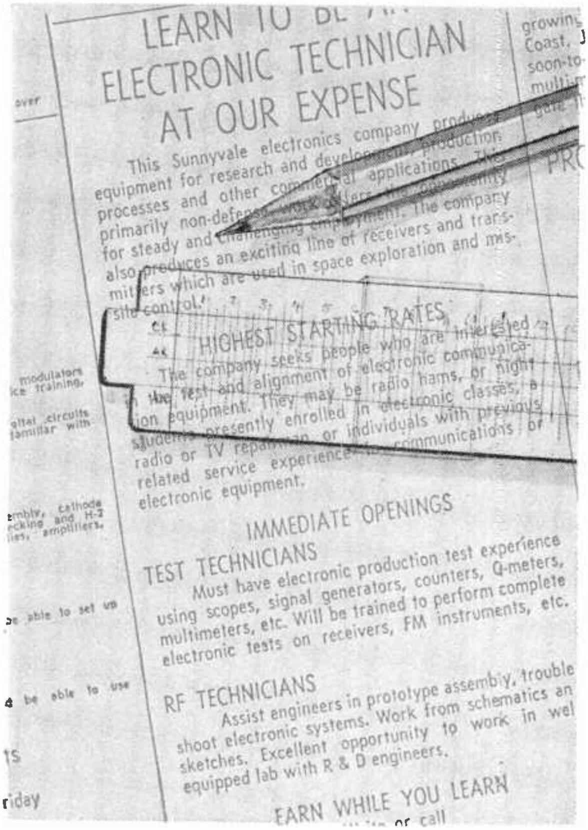
The technician who shows up for work under the influence of anything intoxicating or stupefying usually goes on permanent vacation rather suddenly. Absences every Monday morning, the day after every holiday, and the two days after each payday, usually make the section chief suspicious. So do shaky hands on return to work after each reported bout with "the virus." Filling your thermos full of "Old Bust Head" instead of coffee sounds like an excellent idea, but the foreman's grandfather knew about that one, too.

One sure way of getting plenty of leisure (without pay) is to try to force your religious or political beliefs on your fellow employees. If, while ostensibly employed by an electronics company, you spend a lot of time recruiting for the Charles Ash Society, organizing compulsory prayer sessions during coffee breaks, or bawling people out for not attending the Whoop and Holler Pentecostal Tabernacle, you are greasing the skids under your feet.

A related, but less serious evil, is taking off too many religious holidays. Most employers allow time off for religious observances, but if you take off on Good Friday, don't also take off for Yom Kippur and the first day of Ramadan.

Unreasonable friction on the job is a cause of many firings, as is intolerance of the reasonably normal traits of your fellow employees. A department where a number of the employees are "not speaking" is an unhealthy one and usually undergoes changes in personnel pretty regularly. Meddling in the personal affairs of your fellow workers just won't do, and loud personal criticism of the man at the next bench is completely out of line.

A very common employee trait, carried on the books as "stock shrinkage" or "pilferage," but more commonly known as stealing, causes a lot of technicians to change jobs involuntarily. This ranges from the occasional "borrowing" of a resistor to fix the home radio to wholesale thefts of expensive or scarce components for sale. Many employers are pretty liberal about a few




small parts but get downright "unreasonable" about recurrent disappearances of special integrated circuits, machine tool parts, or even oscilloscope plug-ins. Great care in keeping "company property" separate from "personal property" will not hurt your job tenure or chances for promotion.

There is also the recurrent and disturbing condition of a sterling character, of unquestioned competence and laudable diligence, who just doesn't fit in in a given department. Very often the reason for this cannot be determined and nobody seems to be at fault. Happily, most of these individuals recognize the situation, get jobs elsewhere before a crisis occurs, and frequently do well at the new job.

**Where Employers Fail.** Some "prestige" employers have an appreciable number of technical employees who stay with the company until retirement. However, a rather disturbing number of electronics employers have very high labor turnovers, so that anyone who has been on the job for as long as six months is regarded as a "veteran." Most of the stable electronics manufacturers and research laboratories fall somewhere between these extremes.

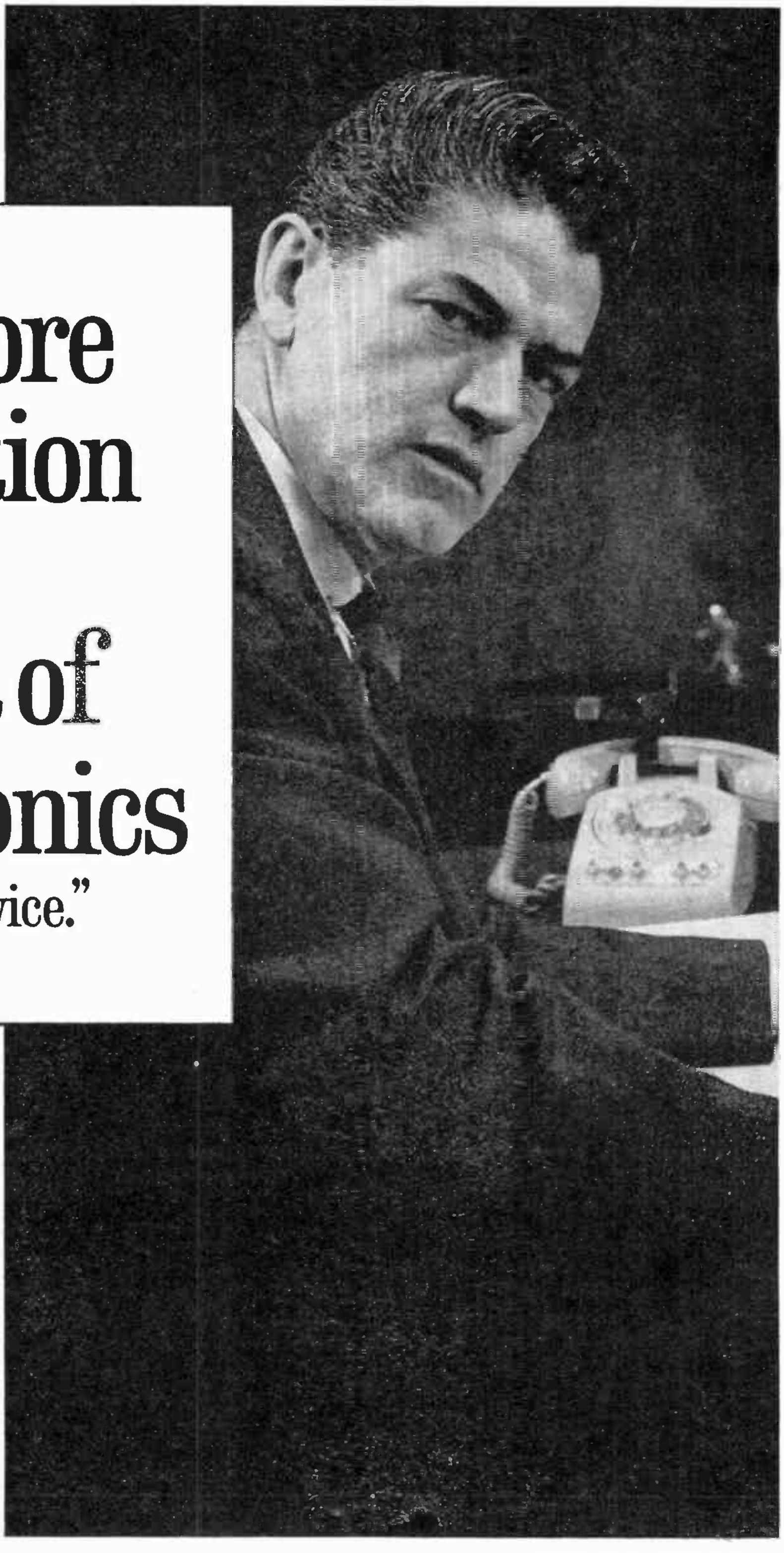
Almost any freshman student of economics can point out, with examples, an inverse relationship between company profits and labor turnover. But by the time he graduates, this student of economics will find that the situation isn't that simple; he will be firmly convinced that labor recruiting costs money and that excessive labor turnover indicates something wrong somewhere.

Many firms, usually the smaller and newer ones, start all applicants at minimum rate, regardless of training and experience; lay off whole departments indiscriminately at the termination of a contract; and then search madly for new help, a few weeks later, when they get a new contract. Such companies soon get a bad reputation in the community and the more competent and skilled workers will not apply there. New "hires," in consequence, are almost all from the bottom of the barrel—inexperienced, uneducated, or with bad records elsewhere.

(*Continued on page* 98)

# "Get more education or get out of electronics

...that's my advice."

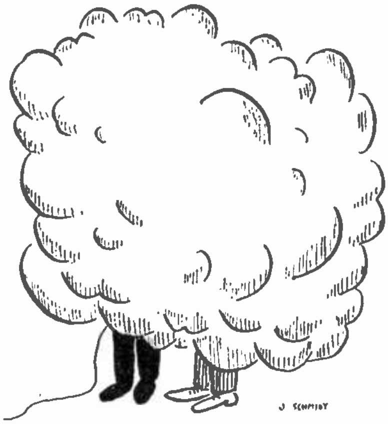


# DON'T FRET

## IT ONLY HERTZ!



"Hello, boss? About this radio repair job you sent me on——HELP!"



"There's your trouble!"

"Hey, Mom . . . place an ad in POPULAR ELECTRONICS: 'Rig for sale, never been used over 3 wpm.' "

## THE MYSTERY

*THE MANY ENGINEERS who attended the electronics show said it was a great success. One reason for its success was the exhibit of an old weather-beaten passenger conveyance set up in the center of the hall. A sign explained that 100 years ago it had belonged to a short-lived company called the Rimrock Freight. Viewers could still see the faint company initials on the coach door.*

*But while the engineers looked at the initials, one song or musical selection after another could be heard coming from the passenger compartment.*

*"I don't get it," said one mystified viewer.*

*"Of course, you do," commented his companion. "Think about what you're looking at."*

*"You mean," said the first man, "that this is a tuned R.F. stage!"*

—"Doc" Hurtado

# BUILD A "MAL"


## . . . THE LIGHTING CONTROL WITH A DIFFERENCE! EVERY HOME SHOULD HAVE A MANUAL AND AUTOMATIC LIGHT FADER FOR THAT COZY LIVINGROOM FEELING

**By IMRE GORGENYI**

IT'S SHOW TIME . . . lights . . . action . . . Hold on! What kind of lights do you have in your home? Can you create a mood in keeping with the program you are about to present? Be it movies, slides, or live action, when the house lights go down, they should go down gradually, and when they come on again, they should come on gradually—if the show is to be performed in a professional manner.

There may be times when you want the lights to be on only partially to create a special effect, or to allow some one to move about the room without stumbling and without completely interrupting your show. Or, there may be times when you might like to watch a TV program in subdued lighting to help improve picture contrast. There is much to be said for romantic settings for other occasions, too.

Whether you are dining or entertaining, you should find the *MALF*, a Manual and Automatic Light Fader, an interesting project to build and to use. Specifically, the *MALF* enables you to fade out your lights and to bring them on again in a gradual manner, either manually or automatically.

The values of the components that control the automatic timing provide about a 1-minute dimming cycle and about a 20-second brightening cycle. (You can change the values of some of the components to obtain different timing cycles.) In the manual mode you can obtain any level of brightness from mini-

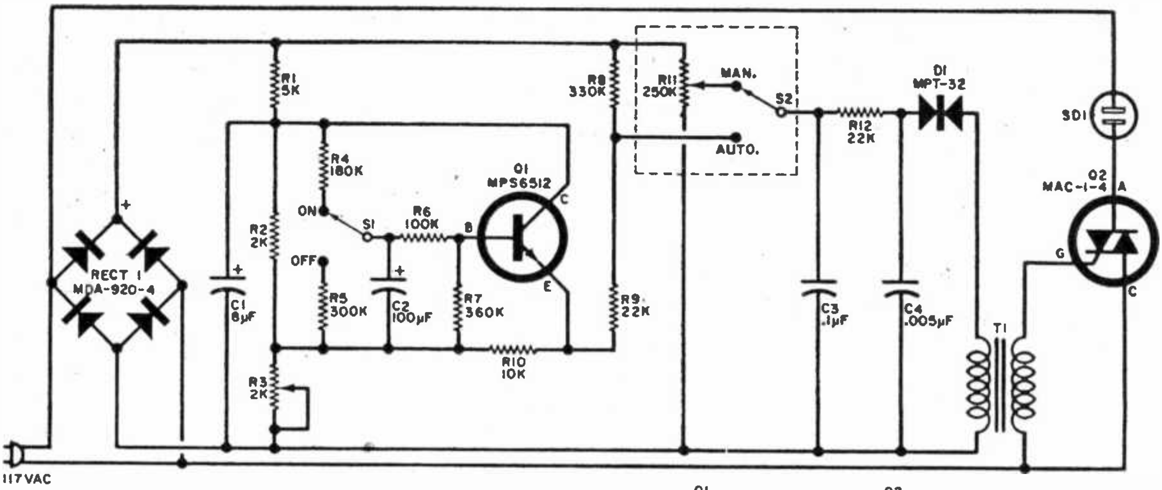
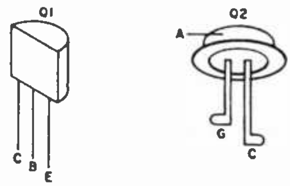



Fig. 1. When S2 is in the manual position, R11 controls the lighting. When S2 is in the automatic position, transistor Q1 has control. Lights up or down are then determined by the setting of S1.




mum to just about maximum from the lamps under control. And you can control any amount of lamp power up to more than 500 watts with this unit (*Q2* is rated at 5 amperes), but loads not exceeding 300 watts leave an ample margin of protection against overload. The unit itself draws very little power and it costs about $15 to build.

**How It Works.** In the manual mode, the 120-Hz ripple from the full-wave rectifier stack (*RECT 1*), in Fig. 1, is fed through potentiometer *R11* to *C3*, which in turn charges up *C4* via *R12*. A charge gradually builds up on *C4* which is applied across trigger diode *D1*. When the voltage level on *C4* reaches the breakdown voltage of *D1* (about 32 volts), *D1* conducts and produces a short-duration pulse across the primary winding of pulse transformer *T1*.

A pulse then appears across the secondary winding of *T1* and triggers thyristor *Q2*, which turns it "on." When *Q2* conducts, the lamps plugged into load socket *SO1* will light. Lamp brightness depends upon the amount of time *Q2* conducts during each alternation of the 120-Hz ripple voltage.

The sooner *Q2* starts to conduct at the beginning of each alternation, the higher will be the power applied to the lamps, and the brighter the lamps will be. Potentiometer *R11* varies this "timing" in

## PARTS LIST

*C1—8-μF, 150-volt electrolytic capacitor*
*C2—100-μF, 15-volt electrolytic capacitor*
*C3—0.1-μF, 200-volt paper or mylar capacitor*
*C4—0.005-μF, 200-volt ceramic capacitor*
*D1—Trigger diode (Motorola MPT-32, or similar)*
*Q1—Npn silicon transistor (Motorola MPS 6512, or similar)*
*Q2—Thyristor (Motorola MAC-1-4, or similar)*
*R1—5000-ohm, 4-watt resistor*
*R2—2000-ohm, 1-watt resistor*
*R3—2000-ohm, 2-watt wire-wound potentiometer (IRC-CTS 112-2000, Mallory MTC 23L1, or similar)*
*R4—180,000 ohms*
*R5—300,000 ohms*
*R6—100,000 ohms*
*R7—360,000 ohms*
*R8—330,000 ohms*
*R9, R12—22,000 ohms*
*R10—10,000 ohms*
(R4–R10: *¼- or ½-watt resistors*)
*R11—250,000-ohm, 2-watt linear potentiometer (Ohmite CU-2541, or similar)*
*RECT 1—200-volt PIV full-wave rectifier module (Motorola MDA-920-4, or similar)*
*S1, S2—S.p.d.t. switch*
*SO1—117-volt, a.c. panel-mounted outlet*
*T1—1-to-1 pulse transformer (Sprague 11Z12, or similar)*
*1—3¾" x 6¼" x 2" box and metal cover*
*Misc.—2½" x 4" perforated circuit board, push-in terminals (approx. 24), 6-32 x ¾" threaded spacer, line cord, knob, solder, etc.*

the manual mode, and can be set to provide the desired brightness level. This control can be rotated by hand in a continuous manner to fade the lights in or out.

Once *Q2* is triggered, it will conduct until the voltage on either anode goes through zero. This is a full-wave type of control and functions on both negative and positive halves of the cycle. Transformer *T1* also isolates the d.c. supply from the a.c. lines, and *C3* serves as a d.c. filter, as does *C1*.

For automatic operation, transistor *Q3* and its related components are substituted for *R11* simply by the flick of switch *S2*. Transistor *Q1* is hooked up like a series-type voltage regulator whose emitter-collector current flow depends upon its emitter-base voltage. However, the output voltage changes because the control voltage changes, and in this respect *Q1* is more of a follower than a regulator.

The more positive the base is in an *npn* transistor (with respect to the emitter), the more current will flow. When *S1* is in the *ON* position, a charge builds up on *C2*, gradually making the base more positive. More current flows through *R10* and makes the top end (junction of *R9* and *R10*) more positive. The higher the voltage at this point, the less time it takes to charge *C4* up to trigger *D1*, and the brighter the lights.

The charging rate of *C2* depends upon its value and that of *R4* as well as the applied voltage, which can be varied by adjusting potentiometer *R3*. However, the adjustment of *R3* affects the *ON* delay time. A different "turn-on" slope (Fig. 2) can be built into the unit by changing the values of either *R4* or *C2*, or both. Higher values will make the slope less steep and the lights will go on more gradually. Conversely, lower values will quicken the action.

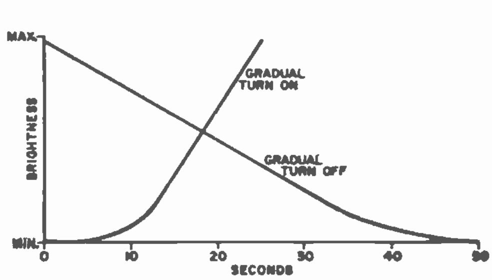



Fig. 2. Slopes of lamp turn on/off. The slopes can be altered by changing certain parts values.

To reverse the action and cause the lights to fade out, flip *S1* to the *OFF* position. This removes the voltage applied to *C2* and permits *C2* to discharge through *R5*, *R6*, and *R7*. When the voltage across *C2* drops, the voltage across *R10* drops accordingly, and the lights fade out. Resistor *R5* is optional: its addition merely helps to speed the discharge action and cause the lights to fade out faster.

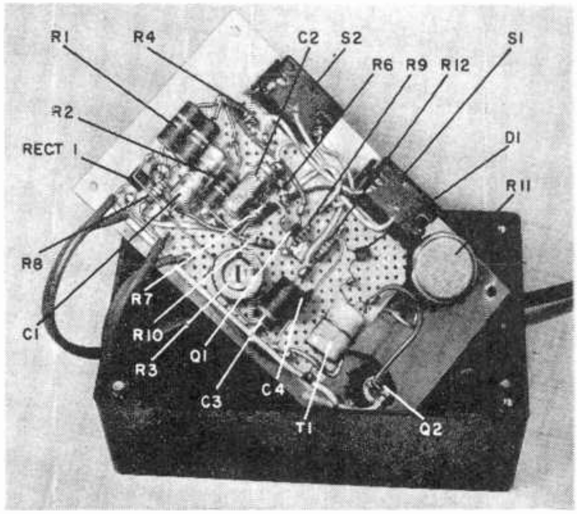



Fig. 3. As shown here, parts layout is not critical. However, make sure that Q2 is isolated from cover.

**Construction.** A Bakelite meter case and a metal cover were used to house the *MALF*. The metal cover serves as a heat sink for *Q2*. Use a nonconducting epoxy cement to attach *Q2* to the cover mechanically, but not electrically. To be sure that *Q2* does not make electrical contact with the cover, apply a thin layer of cement on the underside of the cover where *Q2* is to be located, and let it dry. When the cement is dry, apply another coat and then set *Q2* in place.

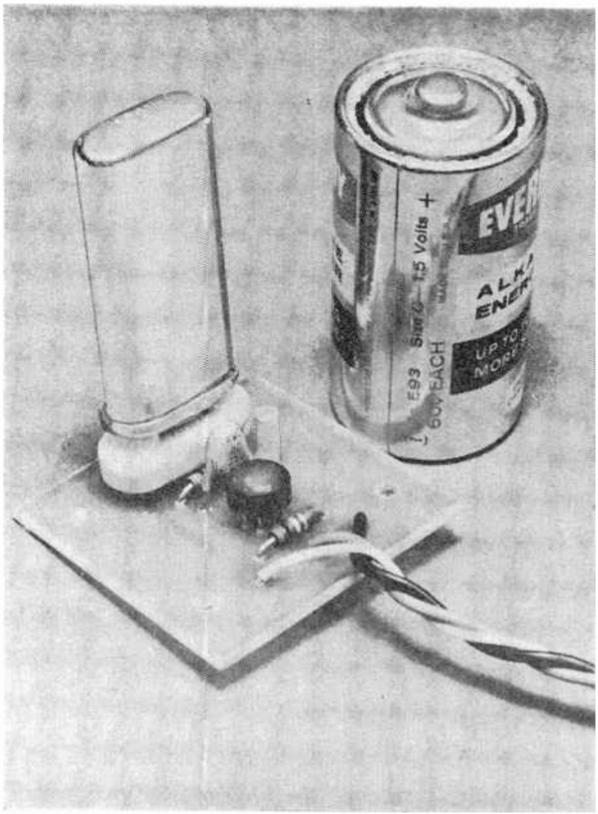
Use an ohmmeter to check the insulation of the epoxy joint. If you get a reading, remake the joint. An electrical contact at this point can put the cover on one side of the 117-volt a.c. line and

(*Continued on page* 102)

# L'IL RICHIE

SIMPLE, STABLE, HARMONIC-RICH CRYSTAL OSCILLATOR IS BUILT AROUND A LOW-COST INTEGRATED CIRCUIT

By DON LANCASTER



L'il Richie is a small one—it's shown here alongside a conventional "C" cell—but the crystal is a 100-kHz bar and is larger than most crystals.

TAKE ONE low-cost integrated circuit, two resistors, one capacitor, and one crystal—combine properly—turn on the power, and you can generate crystal-controlled sine or square waves at any frequency between 100 kHz and 3 MHz, and, with slight modification, the 3- to 10-MHz range. Uses of the "L'il Richie" are as varied as the user's imagination.

Amateur radio operators will find the harmonic-rich output useful as 100-kHz or 1-MHz crystal calibrators. As a bonus, the addition of an output tank circuit creates a flea-power transmitter for field days, antenna testing, and hidden-transmitter hunts.

For AM servicing, just insert a 455-kHz crystal, and you have an i.f. alignment generator. Switch to 500-, 1000-, or 1500-kHz crystals, and you have a handy signal generator for dial calibration, tracking adjustments, or antenna and r.f. stage tuning.

For TV or FM work, plug in the needed crystal—3.58, 4.5, or 10.7 MHz—and you have a marker or signal generator all set to go. And, finally, the advanced experimenter can use the "L'il Richie" as a stable, crystal-controlled reference clock for electronic counting circuits.

**How it Works.** The two independent gates in *IC1* (Fig. 1) are biased in their class A region using resistors *R1* and *R2*. These two gates are cascaded with *C1* to form a two-stage, RC-coupled r.f. amplifier. Feedback from output to input via *XTAL* produces the desired oscillation, in the form of a square wave very nearly equal to the crystal's series-resonant frequency.

## PARTS LIST

*C1—1000-pF disc ceramic capacitor—see text*
*IC1—µL914 epoxy micrologic dual gate (Fairchild)**
*R1, R2—10,000-ohm, ¼-watt carbon resistor*
*XTAL—Series resonant, first-overtone crystal, 100 kHz to 3MHz with C1 as listed; to 10.7 MHz with selected value for C1*
*Misc.—1½" x 1⅜" single-sided PC board,** socket to fit XTAL with mounting screw, solder terminals (3), solder*

*Data sheet and distributor list are available from Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, Calif.

**Complete kit, including printed circuit board, but less crystal and socket, is available from Southwest Technical Products Corp., Box 16297, San Antonio, Texas 78216, for $1.75, postpaid in the U.S.A.

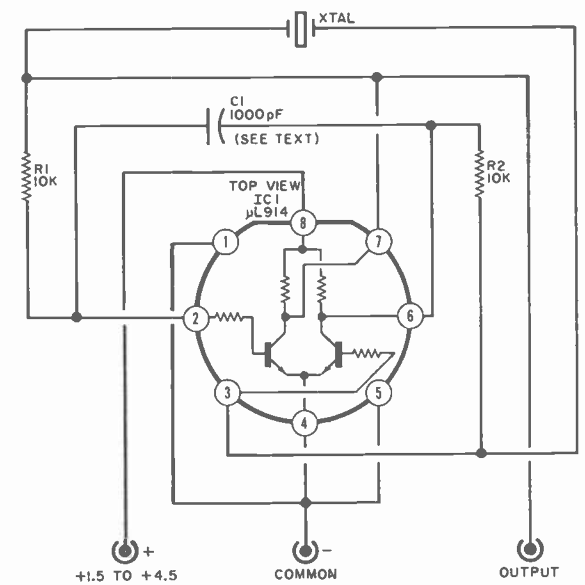



Fig. 1. The IC contains the bulk of the multivibrator circuit. The only external components are bias resistors R1 and R2, feedback capacitor C1, and the frequency controlling element, XTAL. Output is a square wave at the crystal frequency. The d.c. level required for operation is not critical—between 1.5 and 4.5 volts.

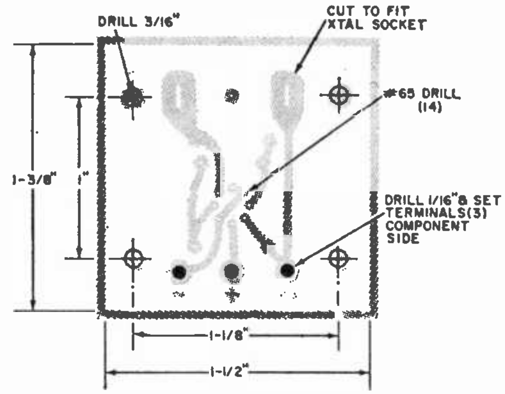



Fig. 2. Make the printed board as shown here. It is best to use a PC for this oscillator as stray capacitance found in most point-to-point assembly might cause spurious oscillation at frequencies other than that of the crystal.

The entire circuit requires only five low-cost parts and can be powered by any convenient supply from a single penlight cell (1.5 volts) up to 4.5 volts d.c.

**Construction.** Any neat construction technique can be used for this circuit, but long leads or sloppy construction can produce a device whose frequency may not entirely depend upon the crystal used. A complete kit, including the printed circuit board, is available from the source indicated in the Parts List, but if

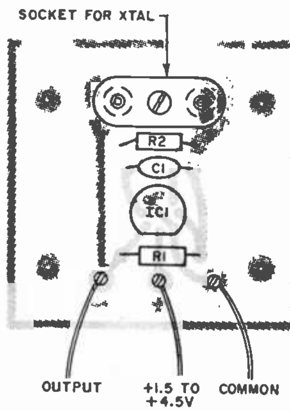



Fig. 3. Component assembly on the printed board. Note that the IC has one flat side and that pin 8 on this flat side is connected to the positive battery terminal.

you want to do your own PC layout work, just follow Figs. 2 and 3.

Note that *IC1* is mounted with the positive power lead centered on the flat of its epoxy case (pin 8). And be sure that the crystal holder pins and the crystal socket match, as some older crystal holders have different pin diameters and spacings.

After assembly and inspection, insert a crystal of below 3 MHz, and perform an initial checkout using 3 volts from two flashlight cells. If you're planning on using crystals from 3 to 10 MHz, you'll have to experiment to get the value of *C1* just right to suit your particular crystal's drive requirements. Higher frequency generators will require values of from 20 to 100 pF.

Some capacitor tinkering is required at these higher frequencies and a generator tailored in this manner will most likely work best with one particular crystal, and over a more limited power supply range. You might like to try a trimmer, or padder, for *C1* if you're planning high-frequency operation with multiple crystals. A 0.01-$\mu$F power supply bypass capacitor might also be required.

Occasionally, older surplus crystals or one with an unusual cut may take off on the second or third harmonic instead of the fundamental. Usually, a bit of capacitance shunting the crystal socket will settle things down. Values will be in the 50- to 200-pF range. Use discretion with

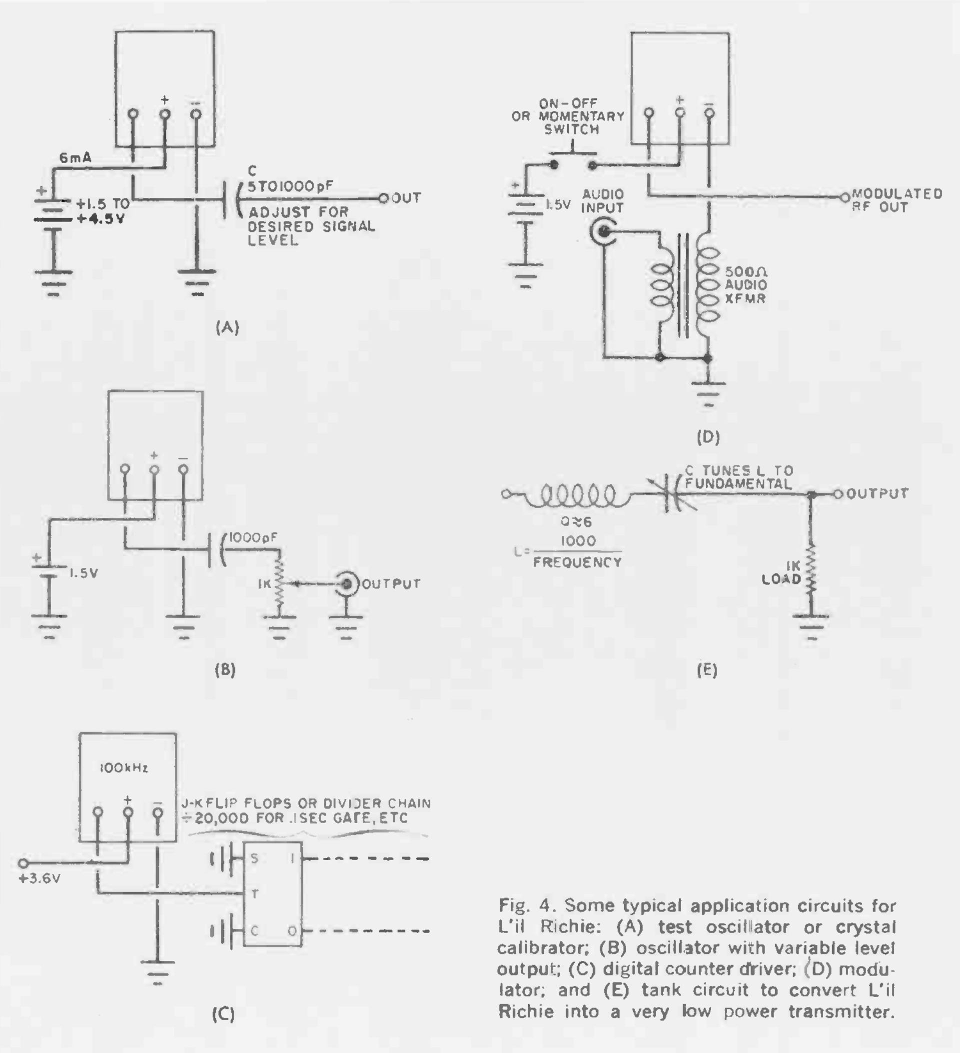



Fig. 4. Some typical application circuits for L'il Richie: (A) test oscillator or crystal calibrator; (B) oscillator with variable level output; (C) digital counter driver; (D) modulator; and (E) tank circuit to convert L'il Richie into a very low power transmitter.

this capacitive loading, for the generator will now oscillate either with or without the crystal in place.

**Operating Hints.** Figure 4 shows some circuits you might like to try. In the test oscillator or crystal calibrator in Fig. 4(A), an output capacitor (*C*) is selected to get the desired signal level. If you want a continuous output level adjustment range, use the circuit shown in Fig. 4(B). The digital clock and divider connection is shown in Fig. 4(C); a coupling capacitor is not required here.

On-off switching, keying, or audio modulation are added with the circuit in Fig. 4(D). Or, if you want a sinusoidal output instead of a square wave, just add a series-resonant tank circuit to the output, tuned to the crystal frequency, as shown in Fig. 4(E).

The generator's output voltage will be slightly less than the supply voltage. Expect around 1.2 volts peak-to-peak with penlight cell operation, and perhaps 4 volts for a 4.5-volt supply. Total circuit drain is less than 6 mA with the higher supply voltage. -30-

# INFORMATION CENTRAL

By CHARLES J. SCHAUERS, W6QLV

IF YOU INCLUDE pass-along readership, each issue of POPULAR ELECTRONICS is read by 900,000 to 1,000,000 electronics experimenters and hobbyists! You may find that hard to believe, but this columnist doesn't because incoming mail to *Information Central* is a veritable deluge!

Answering your questions takes time and people—not counting the man-hours spent opening and sorting the hundreds of postcards and letters. So far, *Information Central* has managed to keep abreast of the flood, but if your answer is delayed, don't be surprised. Also, please carefully consider your inquiry before putting it into the mail. Have you exhausted all of your local sources of information? If a project doesn't work, have you had a third party double-check the wiring?

If you want to modify a published project, please don't ask us to redesign it to your specifications—there just isn't time available for that sort of endeavor. Nor is there any method whereby *Information Central* can send you operating instruction books or construction manuals—please don't ask for them.

And please don't try to engage us in a long, involved correspondence exchange. Letters and postcards that are not returned to the sender—with our response—are destroyed; there just isn't enough space available to keep everything we receive.

Two final thoughts: first, you cannot reach this columnist by telephone—I am not based in the New York City editorial offices; second, don't put a "deadline" on your information request. Although everyone appreciates the fact that certain activities (school, business, etc.) must be completed within a given period, there is no guarantee that your letter will be at the top of the pile.

Be sure to address your request to the attention of *Information Central*.

**Excessive Motor Noise.** *I have a solid-state tape recorder and when I try to record signals on the VHF aircraft band the recorder motor noise ruins the recordings. Even placing the recorder 5′-6′ away from the receiver produces the same results. What can I do to get rid of this noise?*

If you have a wiring diagram of the tape recorder, see if the motor leads are bypassed to ground. If not—and they probably are not—try bypassing them with low-voltage 0.5-$\mu$F capacitors. If this lessens the interference, but does not totally eliminate it, you may find it necessary to substitute coaxial capacitors in each motor lead—be sure that the case of the coaxial capacitor is grounded to the common ground terminal of the recorder. You might also try a pair of VHF-type r.f. chokes in series with each motor lead and then connect two 0.01-$\mu$F ceramic capacitors in series across the motor leads with the center tap of the capacitors going to the common ground.

**Walkie-Talkie On 10 Meters.** *I have a pair of low-powered walkie-talkies and would like to convert them to the 10-meter ham band. I have seen your articles on converting 5-watt CB transceivers, but how do I go about it with walkie-talkies?*

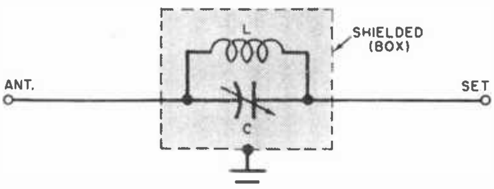
Most of the hand-held CB walkie-talkies can be used on the lower part of the 10-meter band without too many modifications. First, change the crystals; but be sure that your substitute crystal is the type that the walkie-talkie requires (generally in a HC-18/U holder). Secondly, be prepared to remove up to three turns of wire from the coils associated with the receiver front end, oscillator, and the final r.f. tank of the transmitter. The loading coil in the antenna circuit may also need modification to handle the higher frequencies with the same whip antenna. I had an article in the December 1961 issue of *CQ Magazine* which covered the conversion of the popular Lafayette HE-29B hand-held transceiver—take a look at it if you have the opportunity.

**Impedance Matching.** *I have a transmitter with an 829B in the output which has a balanced output tank with a centered link coupling to a 300-ohm antenna. Is there any way to convert this link coupling so that I can use 52-ohm coaxial cable?*

One way would be to build an antenna tuner from the plans that are contained in any of the ham radio handbooks. Another, simpler method would be to prune down the number of turns on the antenna coupling link until it reaches 52 ohms and matches both the antenna and transmission line.

**FM BCI.** *I bought a modestly priced VHF receiver to tune the aeronautical band between 108 and 136 MHz. Unfortunately, not only do I receive the airports and airplanes, but I also receive a variety of FM broadcasting stations. The manufacturer told me that this is due to the design of the receiver and he is unable to suggest a remedy. Is there anything that I can do?*

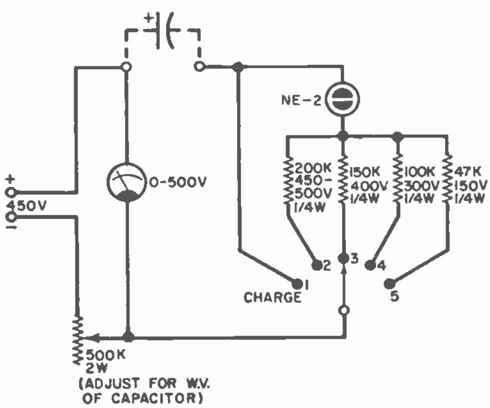
I will not mention the model or manufacturer of the receiver you are using inasmuch as it is well known that this receiver will not operate where there are strong FM signals. The receiver has a grounded-grid input circuit and the selectivity and cross-modulation characteristics are far from the best. You can try two things—although it is doubtful that they will completely cure your problem. Use a vertical antenna that has been cut to receive around 122 MHz, and use the trap shown above. Tune the trap for minimum FM interference.




L=4 TURNS #12 BARE COPPER WIRE 1/2"DIA, 3/4"LONG
C=10pF MIDGET VARIABLE OR COMPRESSION TYPE CAPACITOR

**Testing Electrolytics.** *I have acquired several dozen electrolytic capacitors ranging in value from 8 to 100 μF with voltage ratings between 150 and 450 volts. Is there any quick way I can check these capacitors?*

I would suggest the circuit shown below. Set the voltage of this tester to the working voltage printed on the side of the capacitor. If the neon bulb lights immediately and stays on, the capacitor is shorted. If there is no light whatsoever, the capacitor is open. If the neon flickers, you can be sure there is some leakage. On good capacitors, the neon light should go on; and when the capacitor has reached its full charge, the neon light will go out. Even a weak dull glow indicates leakage. But be sure that there is no a.c. ripple in the d.c. voltage used for this tester. Any a.c. will make a capacitor appear leaky.

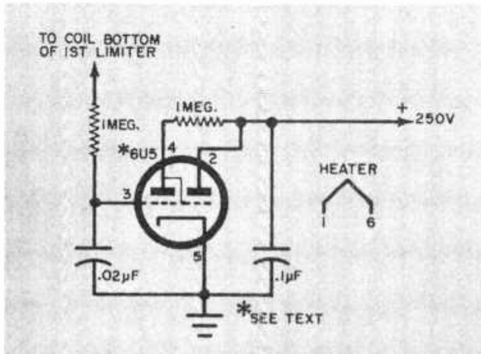



**Standby-Receive Switch.** *How do I add a standby-receive switch to my receiver?*

Very simply. Just insert a s.p.s.t. switch in the lead coming from the center tap of the high voltage secondary on the power transformer and ground. I am assuming that your receiver has a full-wave rectifier.

**FM Tuning Indicator.** *I have an early model FM receiver and would like to connect up a tuning indicator. How do I go about it?*

See the schematic below. The input to the indicator must come from the grid of the first limiter tube. The actual connection is made at the bottom of the coil whose top is connected to the limiter grid. The 250 volts can be "stolen" from the final audio stage if you use a proper dropping resistor.



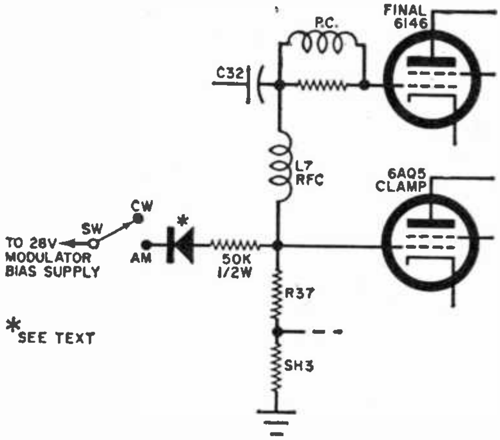

**TV Photos.** *When I take a photograph of a TV picture, my prints show a black diagonal bar which was not in the TV picture. Is this a hidden message?*

No, you're simply using the wrong type of camera—undoubtedly one with a focal plane shutter. You can take good TV photos with a leaf shutter camera, but not with a focal plane camera because the shutter opening will show the time the screen is dark with flyback. Try shooting with the speed at 1/15 second—it should help.

**Viking "Ranger" TR Noise.** *I am a new ham and have just acquired a used Viking "Ranger" transmitter. The unit seems to work okay, but when I wire in my electronic transmit-receive (TR) switch, the noise is terrible—when the transmitter is on standby.*

*How do I get rid of this terrific hash?*

I would suggest that you try increasing the bias on the final r.f. stage. If your "Ranger" has a biased rectifier, add the diode and resistor shown in the diagram below. This should cut off the diode noise being generated in the final amplifier tube.




Open the switch for CW operation to permit the clamp tube to operate. Use any diode similar to the 1N647, and adjust the value of the series resistor for best operation. You could use a 22½-volt battery, but this is not as effective as obtaining the bias from the —28 volts available in many "Rangers."

**GW-22A Squeal.** *My Heathkit GW-22A transceiver has an intermittent squeal. Changing channels has no effect and I have tested all of the tubes. I can sometimes jiggle the mike switch to make the squeal stop, however. What's going on?*

It sounds like a poor connection in the microphone switch. This transceiver has an electronic push-to-talk circuit and the switch connection must be good and of very low resistance. You can double-check by substituting a new microphone.

**Transistor Replacement.** *I own a power supply that uses 2N1518 transistors which keep popping. There certainly must be a replacement with a higher rating—is there?*

Yes, there is; and I would suggest the Delco 2N1520. This transistor is of the same family as the 2N1518, but has a higher current rating and should work better in a power supply application where there are wide voltage input excursions. I presume the supply you have is for mobile use. If so, try to keep the input voltage down below 14 volts.

**Walkie-Talkie Operation.** *I have just heard that the FCC is going to change the frequencies of the walkie-talkie transceivers. If I buy a pair of new ones now, must I give them up in a few months when the Rules are changed?*

No. The Rules change affecting walkie-talkie operation has not been finalized. Even so, the FCC will not curtail 27-MHz operation, but simply require manufacturers to build transceivers for the new channels.

**R/C Model Control.** *I have become interested in radio control of model boats and aircraft. Can I use the same frequency for controlling each of my models?*

As long as you have a Class C license, you can use any one of the six 27-MHz channels for model control. You don't need a separate channel for your airplane and a separate channel for the boat.

**Head Alignment.** *Why is there some spillover on the second channel of my stereo tape recorder? Is there anything I can do to cure this problem?*

It sounds like tape head azimuth alignment misadjustment. Check the instruction manual that came with your tape recorder and unless you find a recommendation to the contrary in it, adjust the tape head while playing back a special test tape especially recorded for this purpose.

**HT-46: No Audio.** *I own a Hallicrafters HT-46 transmitter and it has always worked beautifully, but when I returned from vacation recently, I found that I could no longer use it on voice. The mike seems okay and the transmitter works on CW. Where do I start looking for the trouble?*

First, check the mike preamplifier tube (12AT7), since this is the most likely culprit. Simultaneously, check the mike connections under the chassis and see if the mike gain control is properly set and operative. You may also have a bad triode section in tube V2a (another 12AT7) which is the third audio amplifier.

**BCB Station Guide.** *I want to DX the BCB this coming winter. Where can I get a list of all AM broadcasting stations and their frequencies?*

There are several lists available, but the best is the "North American Radio Guide" written by Vane Jones and published by Howard Sams; it sells for $2.50. All European BCB stations are listed in the "Medium Wave Guide" published in Denmark (but printed in English); this one sells for $2.75. Both books are available in many radio parts stores or can be ordered from major suppliers (Allied Radio, Lafayette Electronics, Radio Shack, etc.). Books on SWL'ing can also be bought from Gilfer Associates, Box 239, Park Ridge, N.J. 07656.

**Lightning Protection.** *Now that I have my Novice license, I'd like to get on 40 meters as soon as possible, but my father insists that any transmitting antenna I erect have "full lightning protection." I wanted to put up a simple dipole made of 300-ohm twin lead, but I guess that's out now. What do you suggest?*

Afraid so, since it's much too inconvenient to safely ground a folded dipole. I would suggest a half-wave antenna center-fed with 75-ohm coax cable. This immediately grounds one-half of the antenna and the other half can be grounded through a commercial product called the "Blitz Bug." It's a lightning arrester made for ham stations and costs around $5.00. The coax line and the "Blitz Bug" should more than satisfy your father's requirements.

**HO Train Interference.** *I am a model train enthusiast and my engine motors radiate radio and TV interference. My next-door neighbor can just about see a TV picture when my trains are running. Can you tell me how to eliminate this awful electrical noise?*

Your problem is similar to the first one in this month's installment (page 74). Try coaxial capacitors in the leads feeding the train track. Ground the capacitor jackets to a water pipe ground. If there is room in the engine model, put two 0.001-$\mu$F ceramic capacitors in series across the motor and ground the center connection to a metal part of the model frame. Since the noise is coming from commutator arcing, you might try "arc suppressors" if all else fails. These suppressors are manufactured by International Rectifier Corp., but are not too commonly available. You can experiment making your own with two silicon diodes mounted back-to-back like the ceramics mentioned above.

**Wireless Mikes.** *I've looked all over for plans to build a wireless mike but I can't locate any. How come?*

The FCC has vetoed the publication of construction plans for wireless microphones—especially those transmitting in the FM broadcast band. They created too much interference.

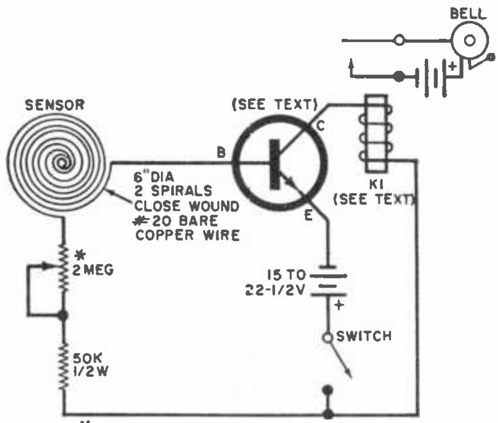
**Sticking S-Meter.** *My receiver S-meter appears to stick, or hang up. Is there anything I can do about it?*

You probably have a defective meter, which can either be repaired or replaced. You shouldn't attempt to repair this meter unless you are familiar with its operation and you have all of the necessary tools. It would probably be cheaper in the long run to replace it with a new meter from the receiver manufacturer.

**Automatic Rain Switch.** *I need a simple device that will sound an alarm bell or buzzer when it rains. Can you help me?*

Try the circuit in the diagram shown below. The selection of the transistor is a minor detail and you should be able to use almost anything including a 2N216, 2N445, 2N446, 2N532, 2N595, SK-7, SK-3011, or GE-5. The relay can be one of the Lafayette Electronics "Little Jewel" units selling for just under $2—it has a 5000-ohm coil.

Mount the closely spaced spiral coils on a wooden, plastic, or fiberboard base. When a raindrop "shorts" the coils, the collector current will flow and activate the relay. I suggest using an ordinary waterproof glue to hold the coils to the baseboard. After the




*ADJUST TO CLOSE RELAY WHEN SENSOR IS SHORTED BY RAIN DROPS

glue has set, lightly sandpaper the wire so that contact can be made by the raindrops between the conductors. You could also use two small pieces of copper screen assembled as a sandwich (1/16 inch air spacing) so that a raindrop might "short" out between the mesh.

**TV Information.** *Although "Operation Assist" is of tremendous value to a guy looking for a rare schematic or instruction manual, there must be a simple way of getting routine TV servicing data.*

Yes, there is. You can get radio and TV servicing information from two major sources. Try "Sams Photofacts" published by Howard W. Sams & Co., Indianapolis, Ind. 46206 for details on sets manufactured between 1946 and 1966. So-called "Sams Folders" are sold by most radio parts jobbers. Via mail order you can get diagrams of thousands of radio and TV receivers from Supreme Publications, 1760 Balsam Rd., Highland Park, Ill. The usual cost of a diagram is about $1.50, but it may vary, and the publisher should be checked before ordering. —30—

# ENGLISH-LANGUAGE BROADCASTS TO NORTH AMERICA

## FOR THE MONTH OF SEPTEMBER

**Prepared by BILL LEGGE**

TO EASTERN AND CENTRAL NORTH AMERICA

| TIME—EST | TIME—GMT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|---|
| 6:15 a.m. | 1115 | Melbourne, Australia | 11.71 |
| 7:15 a.m. | 1215 | Montreal, Canada | 9.625, 11.72 |
| 7:45 a.m. | 1245 | Copenhagen, Denmark | 15.165 |
| 9:30 a.m. | 1430 | London, England | 15.105, 21.61 |
| 6 p.m. | 2300 | London, England | 9.58, 11.78, 15.26 |
| | | Moscow, U.S.S.R. | 9.685, 11.96, 15.21 |
| 6:45 p.m. | 2345 | Tokyo, Japan | 15.135, 17.825 |
| 7 p.m. | 0000 | Peking, China | 15.06, 17.68 |
| | | Sofia, Bulgaria | 9.70 |
| | | Tirana, Albania | 7.263 |
| 7:30 p.m. | 0030 | Budapest, Hungary | 9.833, 11.91, 15.16 |
| | | Johannesburg, South Africa | 9.705, 11.875 |
| | | Kiev, U.S.S.R. (Mon., Thurs., Fri.) | 9.665, 11.755, 11.90 |
| | | Stockholm, Sweden | 11.805 |
| 7:50 p.m. | 0050 | Vatican City | 9.69, 11.76, 15.285 |
| 8 p.m. | 0100 | Berlin, Germany | 9.73, 11.89 |
| | | Havana, Cuba | 6.17 |
| | | London, England | 7.13, 9.58, 11.78 |
| | | Melbourne, Australia | 15.32, 17.84 |
| | | Moscow, U.S.S.R. | 9.685, 11.88, 11.96 |
| | | Prague, Czechoslovakia | 7.345, 11.99, 15.368 |
| | | Rome, Italy | 9.63, 11.81 |
| 8:30 p.m. | 0130 | Berne, Switzerland | 6.12, 9.535, 11.715 |
| | | Bucharest, Rumania | 11.94, 15.25 |
| | | Cairo, U.A.R. | 9.475 |
| | | Cologne, Germany | 9.64, 11.945 |
| | | Hilversum, Holland | 9.59 (via Bonaire) |
| 8:45 p.m. | 0145 | Copenhagen, Denmark | 9.52 |
| 9 p.m. | 0200 | Lisbon, Portugal | 6.025, 6.185, 9.68 |
| 9:30 p.m. | 0230 | Beirut, Lebanon | 11.965 |
| 10 p.m. | 0300 | Budapest, Hungary | 9.833, 11.91 |
| | | Madrid, Spain | 6.13, 9.76 |

TO WESTERN NORTH AMERICA

| TIME—PST | TIME—GMT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|---|
| 6 p.m. | 0200 | Melbourne, Australia | 15.32, 17.84 |
| | | Tokyo, Japan | 15.135, 15.235, 17.825 |
| 7 p.m. | 0300 | Moscow, U.S.S.R. (via Khabarovsk) | 15.14, 17.775, 17.88 |
| | | Peking, China | 9.457, 11.82, 15.095 |
| 7:30 p.m. | 0330 | Prague, Czechoslovakia | 5.93, 7.345, 11.99, 15.368 |
| | | Stockholm, Sweden | 11.805 |
| 7:45 p.m. | 0345 | Berlin, Germany | 11.92 |
| 8 p.m. | 0400 | Lisbon, Portugal | 6.025, 6.185, 9.68 |
| | | Sofia, Bulgaria | 9.70 |
| 8:30 p.m. | 0430 | Bucharest, Rumania | 9.57, 11.94, 15.25 |
| | | Budapest, Hungary | 9.833, 11.91, 15.16 |
| 8:45 p.m. | 0445 | Cologne, Germany | 9.735, 11.945 |
| 9 p.m. | 0500 | Berne, Switzerland | 9.695, 11.715 |
| | | Moscow, U.S.S.R. (via Khabarovsk) | 15.14, 15.18, 17.775 |
| 10:30 p.m. | 0630 | Havana, Cuba | 9.655 |

# SHORT-WAVE LISTENING

By HANK BENNETT, W2PNA/WPE2FT
Short-Wave Editor

## ARE YOU LISTENING TO STATIONS IN THE FAR EAST?

EVER SINCE the 1950's, the Far East has been of special interest to the American SWL. From Laos to Vietnam—here is where the news is made. Not only does this area abound with daily happenings, but it gives the DX'er a great chance to increase his "Countries Verified" list.

Some of the world's largest transmitters can be found in the Far East. *Radio Peking*, for example, operates on 6290, 7035, 9457, 9925, 9950, 11,600, 11,822, 12,015, 12,065, and 15,060 kHz. It can often be heard between 2000 and 0100 and around 1000 and 1300 GMT, and English is a regular part of the programming. Specifically, tune to 6290, 9950, and 12,065 kHz at 2000 (beamed to North America); 7035, 9457, and 9925 kHz at 1000; 11,600 kHz at 1300; and 15,060 kHz at 0000.

Another Communist-dominated station is *Radio Hanoi*, operating from North Vietnam. Although not as strong as its counterpart in Peking, it is being heard throughout the western area of North America and in some eastern areas as well. Programs in English are aired daily at 2300 on 9840 and 11,840 kHz, and at 1000, 1300, and 1530 on 9760 and 11,760 kHz. A new frequency reportedly also in use is 7215 kHz at 1000.

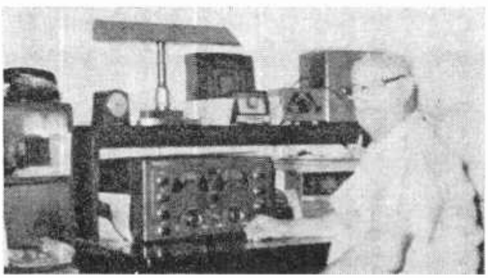
These are not, by any means, the only Far East stations that you can hear. English-language transmissions are beamed to North America by: *R. Australia* on 6140 and 6150 kHz at 1100 GMT; *R. Japan* on 9675 and 11,875 kHz at 1015 and on 9525 kHz at 1100; and *R. Thailand* on 6190 and 11,910 kHz at 0430. They are all "good bets."

The following stations also transmit in English: *Voice of Free Korea* on 9640 and 15,125 kHz at 0500; *Voice of America* relay in the Philippines on 7175 kHz at 1100; and the *Voice of Free China* in Taiwan on 7130, 7250, 11,825, and 15,345 kHz at 0230. And the Far East Broadcasting Company has transmissions beamed to North America on 9715, 11,890, 15,300, and 17,810 kHz at 0800. Happy listening!

**Bootleggers Beware!** From time to time your Short-Wave Editor receives reports that certain individuals are innocently (?) attempting to set up their own short-range AM broadcast station. Some of these attempts may possibly be the result of said individuals thinking that the WPE Monitor Registration Certificate is a license to transmit. *IT IS NOT!* The Certificate is given only in recognition of proven ability to *receive* radio transmissions.

(*Continued on page* 114)

Bernard Hughes, G2PE6D, who does his SWL'ing in Worcester, England, is shown here with his Eddystone 840-C receiver. He has a newer RCA AR88D. Bernard's current record is impressive: 128 countries, 39 states, and six continents verified.



A QSL from the U.S. Navy submarine "Quillback" is the most prized verification received by Mickey Knapp, WPE6EOG, S. San Gabriel, Calif. This gentleman has been around since the days of the loose coupler, spark gap, and honeycomb coils. Currently his listening post features a National 183-D receiver backed up by a Hallicrafters SX-110 with RME preselector. He has 103 countries verified.

# BROADCASTS IN ENGLISH FROM MIDDLE EAST AND AFRICA

**Prepared by ROBERT LEGGE**

In these days of rapidly changing foreign events, listeners may want to tune in broadcasts that originate directly from where the action is. Many countries transmit broadcasts in English intended for other areas than North America which can nevertheless be heard here with fair to good radio signals. Below is the schedule of broadcasts in English from the Middle East and Africa that can be heard in North America.

## MIDDLE EAST

| COUNTRY | CITY | TIME—GMT | BEAM | FREQUENCIES (MHz) |
|---|---|---|---|---|
| IRAN | Tehran | 2000-2030 | Europe | 11.730, 15.122 |
| IRAQ | Baghdad | 1930-2020 | Europe | 6.030, 6.095 |
| ISRAEL | Jerusalem | 0545-0600 | Europe | 9.009, 9.625 |
| | | 2105-2145 | Europe | 9.009, 9.625 |
| LEBANON | Beirut | 1830-1900 | Africa | 17.750 |
| TURKEY | Ankara | 1415-1445 | Europe | 17.822 |
| | | 2200-2230 | Europe | 15.160 |
| U.A.R. | Cairo | 1300-1430 | South Asia | 17.690 |
| | | 1930-2015 | Central Africa | 17.690 |
| | | 2045-2215 | West Africa | 15.135 |
| | | 2145-2315 | Europe | 9.475, 12.005 |

## AFRICA

| COUNTRY | CITY | TIME—GMT | BEAM | FREQUENCIES (MHz) |
|---|---|---|---|---|
| ALGERIA | Algiers | 2200-2230 | Europe | 6.175 |
| CONGO REPUBLIC | Brazzaville | 0515-0530 | Africa | 11.725, 15.445 |
| | | 0615-0630 | Africa | 11.725, 15.445 |
| | | 1915-1930 | Africa | 11.930, 15.190 |
| ETHIOPIA | Addis Ababa (ETLF) | 1330-1400 | South Asia | 15.400 |
| | | 1900-1945 | West Africa | 15.365 |
| GHANA | Accra | 1400-1430 | Africa | 17.910 |
| | | 1500-1545 | Africa | 17.910, 21.545, 21.720 |
| | | 1815-1900 | Africa | 15.285 |
| | | 2100-2215 | Europe | 9.545 |
| LIBERIA | Monrovia (ELWA) | 1900-1930 | Middle East | 15.155 |
| | | 2115-2145 | North Africa | 15.155 |
| MOROCCO | Rabat | 2030-2130 | Africa | 11.735 |
| MOZAMBIQUE | Lourenco Marques | 0400-0700 | Africa | 11.780 |
| NIGERIA | Lagos | 1700-1900 | Africa | 9.690, 11.915 |
| | | 2100-2200 | Africa | 9.690, 11.915 |
| RWANDA | Kigali | 1200-1245 | Africa | 17.765 |
| | | 1745-1830 | Africa | 17.765 |
| SOUTH AFRICA | Johannesburg | 0430-0445 | Middle East | 11.900, 15.220 |
| | | 1700-1755 | North Africa | 17.735, 21.495 |
| | | 1800-1855 | East Africa | 15.220, 17.805 |
| | | 1900-1955 | Europe | 15.285, 17.735 |
| | | 2100-2155 | Africa | 9.525, 11.900 |
| TANZANIA | Dar-es-Salaam | 1800-1810 | Africa | 15.410 |

# AMATEUR RADIO

By HERB S. BRIER, W9EGQ
Amateur Radio Editor

## TRANSOCEANIC 50-MHZ DX

ALL AMATEURS know that high-frequency radio propagation conditions are intimately related to the sunspot cycle—the higher the number of sunspots, the higher the maximum usable frequency. But how many know that we are rapidly nearing the peak of the present cycle?

This means that the 28- to 29.7-MHz band will be wide open from dawn to dusk almost daily starting early in the fall and continuing until next spring. In addition, the maximum usable frequency (MUF) should creep up to above 50 MHz to give alert 50-MHz operators a chance to work their share of transoceanic DX.

The big thing in working this kind of DX on 50 MHz is being in the right place at the right time. Keep an ear on 28 MHz; when 10 is especially hot, 6 may be open. Also, you might monitor the commercial frequencies between 35 and 45 MHz; when overseas stations start "clobbering" the locals, the chances are good that 6 is open to the same general area. And remember that this type of DX on 50 MHz is always a daylight proposition. Look for Europe and Africa in the morning and to the west in the afternoon. South Americans may come through either mornings or afternoons on good days.

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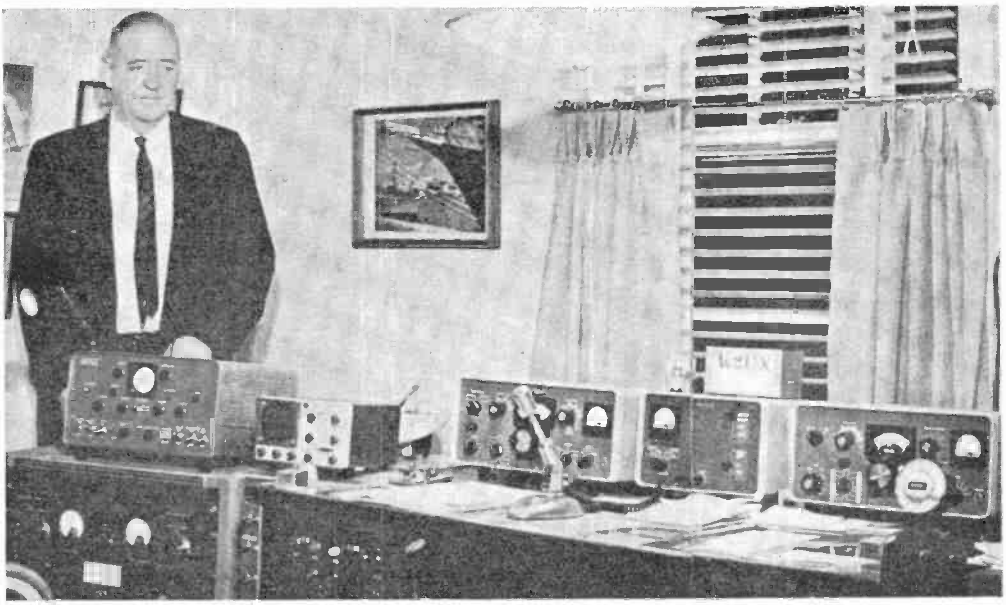
### AMATEUR STATION OF THE MONTH



Nils E. Segerdahl, W2UX, of East Patchogue, N.Y., has been an active amateur for over 40 years. Among the equipment he has accumulated are (from left to right) a home-built "mainliner" RTTY converter (on top of a home-built 1000-watt linear amplifier), Heathkit monitor scope, Collins 32S3 CW/SSB transmitter, station control unit, and Collins 75S3 receiver. His antennas include a Mosley TA-33 tribander, and a 5-element, 2-meter beam, both on a 65' tower. W2UX will receive a one-year subscription for submitting the winner for September in our Amateur Station of the Month photo contest. To enter the contest, send a clear picture of your station with you at the controls and some details on the equipment you use and your ham career to Amateur Radio Photo Contest, c/o Herb S. Brier, Amateur Radio Editor, Box 678, Gary, Ind. 46401.


Jim Roper, W9JSW, News Editor for Channel 32 TV station WFLD in Chicago, is shown here operating amateur radio station WA9RTP located in the studios of the TV station. In background is Patrick Muldowney, WFLD News Announcer. See text below.

Edwin Knox, WN7GNR, of Harrisburg, Oregon, has worked Japan and the U. S. East Coast with a Heathkit DX-60 transmitter and National NC-98 receiver.

According to W6SAI's *Amateur Radio Facts,* a good clue as to when the 28-MHz band is open to Japan and Asia is provided by the beacon transmitter of the Japanese Amateur Radio League, Tokyo. Its call letters are JA1IGY, its frequency is 28,997.5 kHz, and the station is on the air 24 hours a day.

**Amateur Radio and Commercial TV.** Amateur radio station WA9RTP, located in the studios of TV station WFLD, Chicago, is frequently used to bring on-the-spot reports from amateurs in disaster areas to WFLD viewers. The first cooperative effort between the amateur radio station and the TV station occurred during the disastrous snowstorm in the Chicago area starting January 27, the second one in May when a series of tornadoes brought death and destruction to several communities in that area.

Station WFLD also features a prime-time TV program on amateur radio from 5 to 5:30 p.m. each Saturday afternoon.

**Can Loose Lip Sink Ship?** A recent item in the national press reported on the U.S. Navy's concern over amateurs operating on Navy ships sailing in or towards sensitive areas unintentionally jeopardizing ship se-

Walter J. Kania, WN8TKA, Dearborn, Mich., worked 29 states and Canada with his Heathkit DX-40 transmitter and RME-45 or Lafayette KT-340 receiver. Walt is probably signing his General call by now.

curity by mentioning ship positions, destinations, and arrival dates on the air. According to a knowledgable Navy officer who has operated amateur stations on Navy ships all over the world, there is a dual problem involved here.

First, FCC regulations require maritime mobile stations to give the names of their ships and their positions when they sign their call letters, thereby revealing information that the Navy wants to keep quiet. Our informant admits that he "forgets" this regulation when in sensitive waters at the risk of receiving an FCC citation. He thinks, however, that the Navy and the FCC should get together and decide what they want instead of making the maritime mobile operator the "fall guy."

The other part of the problem shows up when members of the ship's crew talk back home over the ship's amateur station. The first things the home folks want to know are: "How are you? Where are you? Where are you going? When will you get there?"

(*Continued on page* 104)


# ON THE CITIZENS BAND

By **MATT P. SPINELLO,** KHC2060, CB Editor

LAST MARCH Fred W. Hawe, driver for the Marathon Oil Company in the Detroit area, witnessed an accident in which two vehicles collided and a woman was thrown through the windshield of her auto. Hawe's truck was equipped with commercial two-way radio, and he immediately contacted his dispatcher, reporting both the nature of the accident and the location. An ambulance and patrol car were sent to the scene, and the woman was rushed to the hospital. She has since recovered, possibly owing her life to Hawe's quick thinking.

On April 19, three dangerous criminals who were being driven to a pre-trial meeting in Springfield, Virginia, overpowered their guards and drove off in the official vehicle. Alva D. Shillingburg, driver for the Alban Tractor Company, was flagged down by the guards as he came along in his truck, and Shillingburg used his two-way radio to report the incident to his dispatcher. Within minutes, police had sealed off all exits in the area. The escapees were captured about one mile from one of the exits.


On April 27, Fred Hawe was presented with the first Community Radio Watch Distinguished Service Award—a plaque and a $200 U.S. Savings Bond—for helping the accident victim through the use of two-way radio. The award was presented by Detroit Mayor Jerome A. Cavanaugh and Police Commissioner Ray Girardin. Twenty-four hours later, Alva D. Shillingburg was presented with a duplicate Distinguished Service Award by his Congressman, Joel T. Broyhill of the 10th Virginia District.

These two awards were the first to be issued through the Community Radio Watch program, sponsored nationally by Motorola Communications and Electronics, Inc., Chicago, Ill. The program was initiated last December with the basic purpose of encouraging citizens, especially those who use two-way radio, to support the police in their efforts to maintain law and order. It was designed to recruit drivers of radio-equipped vehicles to serve as "eyes and ears" for the police throughout their communities so that human life and property could be protected more effectively and the crime rate reduced substantially.

Cincinnati, Ohio, and Rockford, Illinois, were the first two communities to initiate the Community Radio Watch program in the country. From Motorola's public relations heads, Bruce Robertson and Herb Swan, your CB Editor learned that Citizens Radio users were quick to volunteer their services to the program. As soon as the news media had announced the adoption of the program in both areas, more than 100 CB'ers asked to be included in the Cincinnati program, with 150 CB'ers eager to be of service in the Rockford area.

Since Community Watch was introduced, over 200 cities have started a local program, 37 of them with populations over 100,000, and representing 45 of the 50 states. As of May 1, an estimated 16,000 companies, with over 200,000 personnel driving radio-equipped vehicles, had pledged their support. Examples of the support in individual communities are: Pittsburgh, Pa., 3000 members; Detroit, Mich., 4000; Atlanta, Ga., 5000; Tacoma, Wash., over 2000; and Fort Worth, Texas, 3500 members.

Community Radio Watch awards are given to any individual who makes an extraordinary contribution through the use of two-way radio. A statement of facts is made on a CRW award application, submitted by a participating company or governmental agency, within 90 days after the act has been performed. Anyone who uses two-way radio to report a situation which results in the saving of life or property (even though he may not be participating in the Community Radio

The first Community Radio Watch kit was presented by Col. Jacob Schott, Cincinnati Chief of Police, to Jerry Hurter of the Cincinnati Gas & Electric Company. Pictured (left to right) are: Ken Wisenbaugh, co-ordinator of the program: Col. Schott; William C. Wichman, Cincinnati City Manager; Mr. Hurter; John Kuhnell, Hamilton County Police Association; and John Dooley, Manager of Transportation for the CG&E Company.

Watch program) is eligible for an award. Motorola's CRW Award Committee reviews each application, makes any necessary investigation, and issues a final decision on the award.

Motorola suggests three plans for establishing and operating a Community Radio Watch on a local basis. The company proposes that the program be handled (1) through the mayor's office, or (2) by a mayor's committee (police chief, sheriff's department, etc.), or (3) by a local organization such as the Junior Chamber of Commerce.

The program is open to anyone who uses two-way radio. Licensed CB'ers, clubs, or emergency groups interested in participating should contact local authorities. If they are not familiar with the program, they can write for full details to Community Radio Watch, Motorola Communications and Electronics, Inc., 4501 W. Augusta Blvd., Chicago, Ill. 60651. They will receive a complete kit which explains the program and its objectives and how to put it to work. As a membership roster is established, Motorola will supply membership certificates for each participating company or group, bulletin board notices, instruction booklets for each driver, decals for each vehicle (see illustration on previous page), special dispatcher's cards, and driver I.D. cards. It is hoped that CB'ers throughout the U.S. will participate.

**Hint to the Mobiles.** One of the readers of this column, who occasionally repairs CB transceivers, has encountered a unique problem. He reports that several CB'ers have dispensed with an AM BCB/CB coupler and are connecting AM radios to the CB antenna —perhaps because the wife doesn't want so many antennas on the family car.

One lashup like this developed a parasitic (an unwanted radio signal) right in the middle of the broadcast band. This signal (with CB modulation) was being "broadcast" and, needless to say, the FCC frowns on that sort of thing.

If you use your CB antenna for your AM radio, do so with an appropriate coupler, or better yet, use one of those specialized combination BCB/CB mobile antennas.

**CB Chatter.** The Midwest CB'ers, The Channel 19 Horizontal Club, and The 11-Meter Channel Busters Club, Inc., will sponsor a CB Jamboree on September 10 at the Smith Auditorium Memorial Park, State Road 3, North. Trophies will be awarded the largest caravans and those that come from long distances, door prizes will be given all day, and there will be grand prizes consisting of a color TV set, a CB transceiver, etc. Overnight campsites are available. For more information, contact Mrs. Adelene Waters, R.R. 1, New Castle. Indiana.

*The Citation,* monthly publication of the Macomb CB'ers, Mt. Clemens, Mich., recently published a list of Michigan law enforcement agencies, complete with call-signs and monitoring channels, that are actively engaging CB radio facilities to supplement their own communications systems. Would you believe 12 city police departments, 15 sheriff departments, 19 state departments, and 2 fire departments? If *your* state boasts a heftier list, we'd like to see it!

REACT Metropolitan Squad Headquarters, 39-23 58th St., Woodside, N.Y. 11377, needs squad members to supplement the present team of 40. This group, which was organized three years ago, serves the Queens County area with search and rescue operations,

(*Continued on page* 112)

# SOLID STATE

By LOU GARNER, Semiconductor Editor

QUITE A STORM has been blowing up around a miniature TV antenna which, it is claimed, can be built into a TV set and yet outperform antennas many times its size. The hullabaloo is about the SIA (subminiature integrated antenna) which uses a short vertical antenna and a built-in transistor stage. According to inventor Edwin Turner, who is conducting tests on SIA's at Wright-Patterson Air Force Base, and his associate, Hans Meinke of the Institute for High-Frequency Research, Technical University, Munich, integrating a transistor circuit into the antenna allows the system to operate over a wide frequency range—at least 2:1 and possibly up to 50:1, a feat beyond most current antennas.

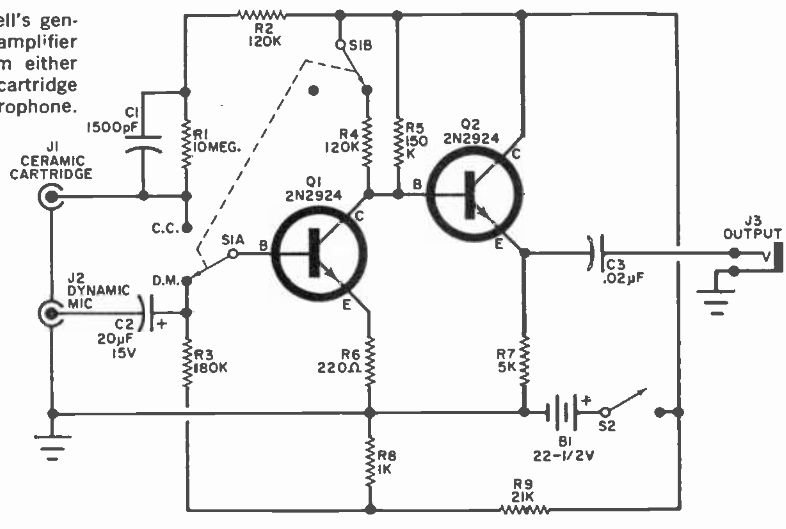
Many competent antenna designers and manufacturers claim that the SIA is not much better than ordinary rabbit ears, while some question the SIA's ability to deal with such problems as signal-to-noise ratio, crossmodulation, and directivity. Still others claim that the transistor does not have to be built into the antenna, and that a low-noise outboard transistor amplifier will do the job.

To complicate the situation, Turner has demonstrated three different SIA's. One covers a wide frequency range with an omnidirectional beam pattern in the horizontal plane. The second is similar but operates over a narrow band; however, according to Turner, by controlling the transistor's d.c. current, the acceptance band could be moved over a wide range, making it possible to combine antenna and front end in one device. The third SIA operates over a 2:1 band and is designed to be used in an array to produce a controllable, directional beam pattern.

**Reader's Circuit.** Tom Studwell (42 Bethpage Drive, Bethel, Conn. 06801), who submitted the general-purpose audio preamplifier circuit shown in Fig. 1, says he developed the design by adapting and modifying a circuit he found in GE's popular "Transistor Manual." According to Tom, this circuit gives excellent results when used with ceramic phono cartridges and dynamic microphones. He suggests that it might be suitable for use with magnetic cartridges, although he hasn't tried it in this application.

The circuit features a common-emitter amplifier, *Q1*, direct-coupled to emitter-follower stage *Q2*. Two inputs are provided . . . one (*J1*) for a ceramic cartridge and the other (*J2*) for a dynamic microphone. Selector switch *S1* not only selects the desired

Fig. 1. Tom Studwell's general purpose preamplifier can be driven from either a ceramic phono cartridge or a dynamic microphone.



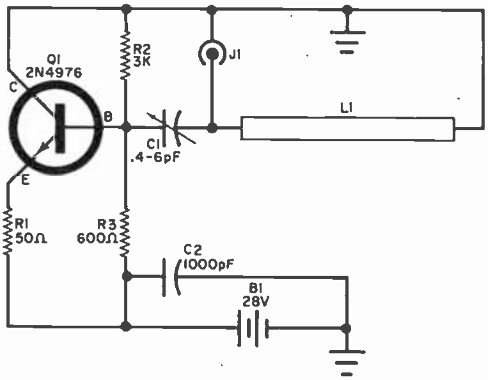



Fig. 2. TRW Semiconductors, Inc., claims operation at 1.6 GHz at 400 mW output for this oscillator.

input signal, but also adjusts *Q1*'s base bias and collector load for optimum performance.

When *S1* is in the microphone (D.M.) position, the input signal is applied to *Q1*'s base through d.c. blocking capacitor *C2*, while base bias is obtained from voltage divider *R8-R9* and applied through isolation resistor *R3*. *Q1*'s load consists of parallel resistors *R4* and *R5*. When *S1* is switched to the cartridge (C.C.) position, the input signal (from *J1*) is applied directly to *Q1*'s base, while base bias is furnished through series resistors *R1* and *R2*, with *R1* bypassed by *C1* to adjust overall frequency response. *R5* serves alone as *Q1*'s collector load.

In either switch position, unbypassed emitter resistor *R6* acts to stabilize amplifier operation, while *Q1*'s amplified output signal is coupled directly to *Q2*'s base. The final output signal is developed across *Q2*'s emitter load, *R7*, and applied to output jack *J3* through coupling capacitor *C3*.

Tom has specified readily available components in his design. And, because neither parts arrangement nor wiring dress is overly critical, you can follow your own inclinations when assembling the circuit. For example, you might want to employ chassis-type construction, assembling the preamp for use as an "outboard" addition to an existing amplifier. Or you may wish to use the basic circuit as part of an overall amplifier design. Or you might prefer to assemble it on a perforated board, mounting the completed assembly in a small box as a self-contained accessory amplifier.

**Manufacturer's Circuit.** As a general rule, low-frequency r.f. oscillator circuits are comparatively simple. At higher frequencies, circuits may become somewhat more complex, as phase-compensated feedback arrangements and additional bypass and isolation networks may be required. At extremely high frequencies, however, the circuits may once again become relatively simple, as, for example, the 1.6-GHz, 400-mW r.f. oscillator shown in Fig. 2.

Featuring a 2N4976 *npn* silicon planar power transistor, this circuit was abstracted from the transistor's specification sheet as issued by TRW Semiconductors, Inc. (14520 Aviation Blvd., Lawndale, Calif. 90260). The 2N4976 is a unique transistor. With a maximum power dissipation rating of 5.0 watts, and a maximum collector to emitter rating of 30 volts, the unit can deliver as much as 1.0 watt as a Class C common-emitter amplifier at 2 GHz. The device is assembled in a special UHF *stripline* package, with ribbon-like electrode leads and a heat-sink mounting stud.

Although the basic circuit shown is suitable for use in a variety of experimental and practical applications, it is definitely *not* a project for the beginner, or, perhaps, even the average hobbyist. It should be of interest, however, to advanced experimenters and hams, to engineering students, technicians, and practical engineers.

In Fig. 2, note that *Q1* is used in a modified common-collector arrangement, with emitter isolation provided by *R1* and stabilized base bias established by voltage-divider *R2/R3*. There is a series-tuned circuit consisting of trimmer capacitor *C1* and stripline inductance *L1* (copper *stripline* 4-mm wide and 8-mm long). Feedback is provided through the tuned circuit as well as *Q1*'s interelectrode capacities. Coaxial output jack *J1* is coupled to the *C1-L1* juncture point to provide a 50-ohm output impedance.

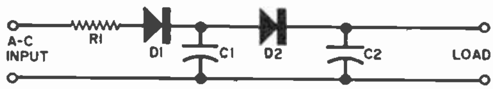



Fig. 3. George Garvin's filter uses an extra diode.

**Filter Follow-Up.** Our discussion of basic d.c. power supply ripple filters back in the May, 1967, issue (in the *Transitips* section) sparked a good deal of interest. A number of readers forwarded their comments and observations, and several even submitted "pet" circuits. Although most of these circuits were variations of standard designs, a few represented clever new approaches. One of the more interesting ones is shown in Fig. 3.

Submitted by reader George L. Garvin (10384 E. Jefferson, Osceola, Ind. 46561), this filter network features a *second* rectifier diode (*D2*) in place of a choke or resistor as part of a pi-filter. There are several ad-

(*Continued on page* 103)

# LAFAYETTE "PRIVA-COM" IMPROVEMENT

CAPACITOR CHANGE REDUCES FALSE OPERATION OF SELECTIVE-CALLING SYSTEM

AS THE CB channels become more and more crowded, it is necessary to use better squelch circuits to screen out unwanted calls. One of the most successful methods devised is the selective-calling system which depends on the simultaneous reception of two audio tones (transmitted by the calling station), to open the squelch of the called station. An example of this kind of equipment is the Lafayette "Priva-Com III Dual-Tone Encoder/Decoder," sold as a matching unit for several Lafayette CB transceivers.

As good as this system is, there is an insufficient time delay built into the "Priva-Com" to prevent beat frequencies between interfering stations on busy channels from opening the squelch. To solve this problem, change the values of capacitors *C7* or *C15* (each a 30-μF, 6-volt unit) in the "Priva-Com" to at least 160 μF. Raising the value to 320 μF will completely prevent false squelch openings with no decrease in receiver sensitivity. The "turn on" time is increased to 2 seconds when a 160-μF capacitor is used, and to 3.5 seconds when a 320-μF capacitor is used. —*G. Neal*

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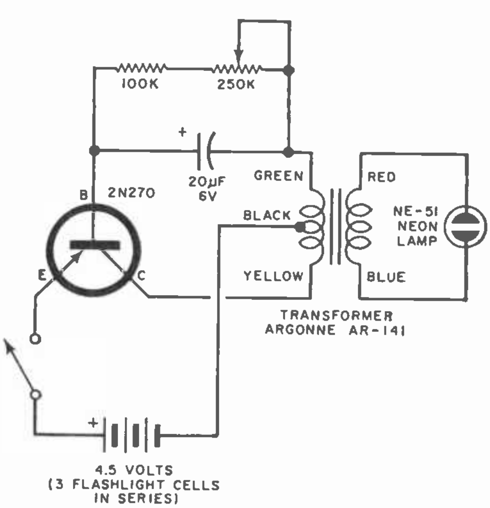
# BLINKING DARKROOM TIMER

FOR THE HARD OF HEARING, OR THOSE WHO LIKE MUSIC WHILE THEY WORK




Adjust potentiometer until the blocking oscillator causes the neon lamp to glow once each second.

A METRONOME-TYPE timer, which produces an audible click at one-second intervals, is commonly used in the photographic darkroom for many developing and enlargement operations. While such a timer is useful, it is of little value to a photographer who is hard of hearing or one who likes to have a radio playing while he's working.

The timer shown in the schematic diagram at left uses pulses of light, rather than audible clicks, to mark the timing interval. The slight orange-red glow from the neon lamp will not affect most enlargement papers. However, always allow the unit to operate for several minutes before calibration and at least a minute before actual use.

Calibration consists of adjusting the potentiometer until the neon lamp flashes once per second. —*Frank H. Tooker*

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**Television Servicing.** Prepares you for a career as a TV Technician/Serviceman; Master Antenna Systems Technician; TV Laboratory Technician; Educational TV Technician.

**FCC License Preparation.** For those who want to become TV Station Engineers, Communications Laboratory Technicians, or Field Engineers.

**Automation Electronics.** Gets you ready to be an Automation Electronics Technician; Manufacturer's Representative; Industrial Electronics Technician.

**Automatic Controls.** Prepares you to be an Automatic Controls Electronics Technician; Industrial Laboratory Technician; Maintenance Technician; Field Engineer.

**Digital Techniques.** For a career as a Digital Techniques Electronics Technician; Industrial Electronics Technician; Industrial Laboratory Technician.

**Telecommunications.** For a job as TV Station Engineer, Mobile Communications Technician, Marine Radio Technician.

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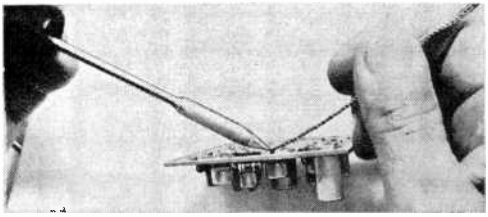
# TIPS & TECHNIQUES

PARTS · METHODS · IDEAS · GADGETS · DEVICES

## CABLE SHIELD SPEEDS AND SIMPLIFIES DESOLDERING

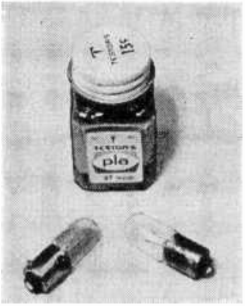
If you've ever soldered shielded cable into a circuit, you are aware of the fact that the shield absorbs quite a bit of solder before the job is done. This ability of the shield to soak up solder comes in handy when you're desoldering components from a printed circuit board, solder lugs, etc. When placed over the connection to be desoldered and heated with a soldering iron or gun, the shield will usually soak up all but a thin film of the solder. The residue of solder left on the connection will not hamper easy removal of the component.



—*Donald E. Hammack*

## COLOR INDICATOR LAMPS AND LENSES WITH MODELER'S PAINT

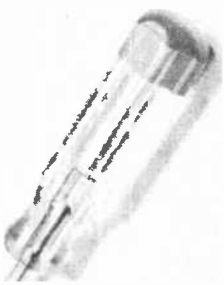
In projects where several different color indicator lamps are used to indicate the unit's various functions or modes of operation, the glass envelopes of the bulbs can be colored to save time and money. A metal flake type of paint, used for painting model cars, is available in several colors (each costing about 15 cents) and makes an ideal coloring agent. Before you use the paint, however, let it stand undisturbed for a day or two to allow the metal flakes to settle to the bottom. Then all you need do is dip the envelope of the bulb into the upper layer of clear lacquer, being careful not to disturb the metal flakes. Let the first coat dry, and dip the bulb into the lacquer again. Two



coats will suffice in most cases. If you prefer, you can paint the inside of clear lenses to obtain the same effect. *—Frank G. Palesh III*

## COLOR-CODING SAVES TIME WHEN YOU'RE LOOKING FOR A SPECIFIC TOOL

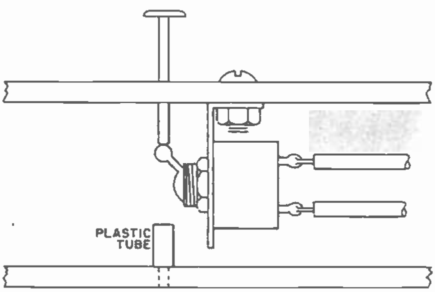
Nutdrivers and screwdrivers often have similar sizes and shapes; so locating the correct tool for a given piece of hardware can be time-consuming. However, a simple color-code system, similar to that found on some nutdriver sets, will speed things up. All you need are several different colors of enamel paint. Select the tools that have been giving you trouble, dip their handles into different color paints, remove and let dry. Two or more color bands can be used to identify special features; one to identify the type of tool, another to identify its size, and a third to tell whether or not the tool is magnetized. Each successive band of color is produced by dipping the tool handle into the paints and varying the depths by about ¼″. If three bands are desired, the first band would extend about 1″ from the end of the handle, the second about ¾″, and the third about ½″ from the end.



*—Jerome B. Koons*

## HIDDEN SWITCH PREVENTS UNAUTHORIZED USE OF ELECTRONIC DEVICES

If you are bothered by unauthorized people turning on your equipment, here is a way to hide the power switch so that it cannot be readily switched on. As shown in the drawing, mount the switch inside the device you want




it to control the power to, and position the toggle (or slide) between two holes, one in the chassis cover and one in the chassis. A piece of plastic rod protrudes through the cover hole and rests on the toggle. To turn on the switch, insert another plastic rod through the hole in the chassis and the plastic tube and press until the switch clicks on; then remove this rod. The switch is easily turned off by depressing the permanently mounted plastic rod on the chassis cover. Because this rod only touches the switch toggle, it cannot be used to reactivate the switch.—*Richard Rylander*

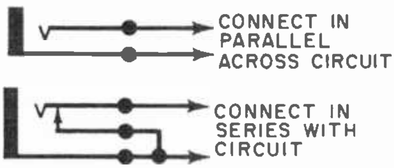
## USE TWO ISOLATION TRANSFORMERS TO ELIMINATE SHOCK HAZARD

One isolation transformer eliminates much of the shock hazard so far as the electrical chassis ground in a given electrical device is concerned. But if two transformerless devices are plugged into the same outlet, the chassis of one can be 117 volts "hot" with respect to the other. This is true whether or not an isolation transformer is connected between the devices and the outlet. To completely eliminate electrical shock hazards between two transformerless devices that are plugged into the same outlet, each device should be powered by its own isolation transformer.

*—Frank H. Tooker*

## PHONE JACKS PROVIDE EASY ACCESS FOR METERING ELECTRONIC CIRCUITS

Many electronic circuits require periodic metering to determine whether or not they are operating according to specifications. If you are tying up one or more meters for this purpose, or have to remove the cover from a chassis every time you make a current or voltage reading, try a few strategically wired phone jacks. If a standard phone jack is wired into a circuit for voltage readings (upper drawing) and a closed-circuit phone jack is




wired for current readings (lower drawing), only one ammeter and voltmeter are required (or a single VOM). Neither jack will affect the operation of the circuit. The closed-circuit jack allows the circuit to be interrupted momentarily and an ammeter placed in the circuit to make current checks. Mount the jacks in an easily accessible place—either on the front or the rear panel of the instrument case. *—Henry R. Rosenblatt*

### HAM HISTORIANS MEET

Amateur radio historians and collectors will meet at the Ford Science Museum on September 23 for a full day of programming devoted to the early days of radio. Grote Reber, pioneer radio astronomer, is scheduled to speak, and the guest of honor will be Mrs. Edwin Armstrong, widow of the famous inventor. Climax of the event will be a swap session/auction of early broadcast sets, magazines, and books. For more information, write: Link Cundall, 69 Boulevard Parkway, Rochester, N.Y. 14612.

# OPERATION ASSIST

*Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information, write him directly—he'll appreciate it. If you need help, send a postcard to Operation Assist,* POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name, model number, year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

**Radio Craftsman** Model RC200 TV receiver, circa 1951. Output and power transformers needed. (Wm. Strole, 1415 S. 49 Ct., Cicero, Ill. 60650)

**C E S Electronic Products** Model 402D "Micro Mixer." Schematic and operating manual needed. (David N. Amiden, 650 Moutecito, Sierra Madre, Calif. 91024)

**Precision** Model T60 tube tester. Roll chart and tube testing data needed. (Matthew J. Socha, Rt. 1, Box 420, Summerfield, Fla. 32691)

**RCA** Model 18 T receiver. R.F. coil needed. (Charles Durke, 103 W. Phoenix Ave., Normal, Ill. 61761)

**LaSalle** receiver, series B-52260; has 4 tubes. Schematic needed. (Larry Crail, Box 296, Kingsford Heights, Ind. 46346)

**Western Electric** Model 4B receiver, circa 1917. Type 215A tube needed. (Jim Hoffman, 105 Sherman Ave., Glen Ridge, N.J.)

**Ampro** Model YSA 16-mm. sound projector; has 6 tubes. Schematic and operating manual needed. (Jerry Raye, 413 N.E. 32, Grand Prairie, Tex. 75050)

**BC-455-B** receiver, made by Western Electric, ser. 88501. Schematic and operating manual needed. (Eugene Light, 15008 Stanleaf Dr., La Mirada, Calif. 90638)

**Sonar Radio Corp.** Model R9 receiver; tunes 27.25 to 30 MHz. Schematic needed. (Howard T. LaMunion, 1109 Mathews Ave., Utica, N.Y. 13502)

**Silvertone** Model 107-A-450-S receiver; tunes s.w. from 1.2 to 65 MHz on 6 bands; has 9 tubes. Schematic, operating manual, and alignment data needed. (K.J. Tucker, 1162 N. Viceroy Ave., Covina, Calif. 91722)

**Waterman** Model S-14-A "Pocketscope." Schematic and operating manual needed. (S. Curilly, 8115 Langley Ave., Chicago, Ill. 60619)

**Wilcox Gay** Model A 93 floor cabinet disc recorder and phono; has 10 tubes. Tube layout needed. **National** Model NC98 receiver. Narrow-band FM adapter needed. (L. K. Slama, 613 Barker St., Racine, Wis.)

**Hallicrafters** Model R45ARR7 receiver, circa 1945; tunes BC and s.w. from 550 kHz to 42 MHz. Operating manual for BC 1031 "Panadapter" needed. (Stewart H. MacKenzie, 16182 Ballad Ln., Huntington Beach, Calif. 92647)

**APA-38** "Panoramic" adapter, surplus, circa 1953; input, 30 MHz. Technical manual needed. (Robert Laag, 7405 Kingsley Way, Riverside, Calif. 92504)

**RCA** "Radiola 25", circa 1935; has 6 tubes. Schematic and source for tubes needed. (Lewis W. Thompson, 33 Nichols, St., Lewiston, Me. 04240)

**Link** Model 1905 ED2A mobile radio receiver, ser. 71882; circa 1954; tunes 152-174 MHz. Crystal frequency information, schematic, tuning instructions, and service manual needed. (Richard D. Strosnider, 5316 Ivyhurst Dr., Columbus, Ohio 43227)

**Atwater Kent** amplifier, type TA; has 2 tubes. Operating manual needed. (Jeffrey Lee, 10 Foxcroft Rd., Albertson, N.Y. 11507)

**R-105A/ARR-15** receiver, surplus; 26.5 volts d.c., 2 to 18 MHz. Schematic and operating manual needed. (Frank Calabrese, 477 N. Eigleberry St., Gilroy, Calif. 95020)

**Moleo Insulation Co.** Model T-435A/AMT-4B "Radiosonde" transmitter. Schematic and operating manual needed. (Cliff Frommer, 251 Marcus Ave., New Hyde Park, N.Y. 11040)

**Grunow** Model 1171 receiver, chassis 11C, circa 1935; tunes 4 bands; has 11 tubes. Schematic needed. (Kenneth Pfitzer, 2700 Countryside Dr., Florissant, Mo. 63033)

**Hickok** Model 288X signal generator, circa 1947; tunes 100 to 110 MHz on 7 bands; has 6 tubes. Operating manual needed. (Robert L. Koffler, 3516 Courtleigh Dr., Baltimore, Md. 21207)

**Western Air Patrol** Model 377 receiver; tunes BC and s.w.; has 7 tubes. Schematic needed. (Bobby Ennis, 9322 Laurel, Fontana, Calif. 92335)

**Webster-Chicago** Model 18-11R "Electric Memory" (wire recorder). Schematic, operating manual, and source for parts needed. (Lee Kuperstein, 8503 Temple Rd., Philadelphia, Pa. 19150)

**Goldak** Model 203 scintillation counter, circa 1952. Schematic and operating manual needed. (J. Michael Phillips, 1420 Volney Dr., Los Angeles, Calif. 90063)

**Zenith** Model 9-S-365 receiver; tunes 550 KHz to 18 MHz on 3 bands; has 9 tubes. Schematic needed. (David W. DuBois, 22711 14 St., Apt. D, Newhall, Calif. 91321)

**National Radio Institute** "Multitester"; has 1 tube. Schematic and source for parts needed, especially AC-RF head. (Robert Margiotta, 4201 Taylor St., Hollywood, Fla. 33021)

**Westinghouse** Model H105A receiver; tunes on 2 bands; has 7 tubes. Schematic, operating manual, and parts list needed. (C. Douglas Towne, 5 Salt Box Lane E., Darien, Conn. 06820)

**BC-348K** receiver, ser. 1187, made by Belmont Radio; tunes 200 kHz to 18 MHz on 6 bands. Schematic and operating manual needed. (Robert Ganshirt, 48 Fletcher Ave., Lexington, Mass. 02173)

**Akai** Model M-5 tape recorder. Operating manual needed. (Harry C. Nance, 148 W. 10 St., New York, N.Y. 10014)

**RCA** "Radiola III" receiver; has 4 tubes. Schematic and source for tubes needed. (C.J. Lyman, 519 N. Summit Ave., Sioux Falls, S. D. 57104)

**BC-639** receiver, surplus; tunes 100 to 155 MHz. Alignment and service data needed. (A.C. Lewis, Box 100, Humboldt, Tenn. 38343)

**Challenger** Model CH18 amplifier, series Q-24; has 7 tubes. Schematic needed. (Scott Flanagan, 115 Coolidge Ave., Columbus, Ohio 43228)

**Majestic** Model 8S473 receiver-phono combination; tunes BC and 5.7 to 17.2 MHz; has 8 tubes. Schematic, alignment data, and source for glass dial plate #117-69 needed. (Keith Christensen, Box 88, Vaughn, Mont. 59487)

**National** Model HRO-7 receiver; tunes 50 kHz to 30 MHz. Source for coils A, B, E, F, G, H, and J needed. (Louis H. VanLandingham, 650 N. Xenophon, Tulsa, Okla. 74127)

**Howard Radio Corp.** Model D-L receiver, circa 1935; tunes 550 to 1600 kHz; has 14 tubes. Schematic and source for parts needed. (Jeff Bush, 5 Peace Way, Red Bank, N.J. 07701)

**Link** Model 1905A receiver and 1906A transmitter. Schematic needed. (Ed Lankford, 511 Purnell Dr., Nashville, Tenn. 37211)

**Supreme** Model TV-7/U tube tester. Schematic and current test data cards needed. **Dumont** Model 350-R oscillograph. Operating and maintenance manuals needed. (C.W. Thorn, 2028-B Hibiscus, APO, San Francisco, Calif. 96334)

**Raytheon** Model 2008 E fathometer; measures up to 120 fathoms; has 6 tubes. Schematic needed. (Jeffrey R. Louden, Box 672, Friday Harbor, Wash. 98250)

**BC-645** transceiver, surplus; tunes 460 to 490 MHz; has 15 tubes. Schematic, operating manual, and conversion data needed. (Allen Windhorn, Rt. 2, St. Peter, Minn. 56082)

**RCA** Model SC-88 receiver, ser. 233; tunes 540 kHz to 32 MHz. Schematic and operating manual needed. (Thomas M. Zane, 950 S. Garfield St., Apt. 30, Lodi, Calif. 95240)

**Hickok** Model 955 VOM. Selector switch or diagram of same needed. (Calvin Rossman, Box 127, Marcus, Iowa 51035)

**Bendix** radio compass, MN-26-Y, circa 1943, surplus; tunes 150 to 1500 kHz on 3 bands. Schematic and operating manual needed. (Bob Porter, Box 18 "E", Bolton, Ontario, Canada)

**Philco** Model 41-295 receiver, code 121, circa 1941; tunes BC and s.w. to 15 meters; has 11 tubes. Schematic and parts list needed. (Bruce D. Henderson, 3761 G Watkins Dr., Riverside, Calif. 92507)

**Precision** signal generator, series E-200, ser. 8646; covers 90 kHz to 44 MHz on 7 bands; has 3 tubes. Schematic and operating manual needed. (Allen Harmon, 4357 Park, Indianapolis, Ind. 46205)

**Supreme** Model 504A tube and set tester. Socket adapters needed. (John F. Cherico, 953 Rosewood Ave., Bricktown, N.J. 08723)

**BC-669-C** transceiver, surplus, circa 1944. Schematic, operating manual, and BC-669 crystals needed. (Dave Jacobs, 1172 N. 10 St., Corvallis, Oreg. 97330)

**Hallicrafters** SX-24 "Skyrider Defiant" receiver; has 9 tubes; tunes 540 kHz-43.5 MHz. Schematic, sources for parts and matching SX-23 speaker, and technical data needed. (Ian Caasell, Fanton Hill, Weston, Conn. 06880)

**Link** FM 1905A and 1906A transmitter-receiver; hi-band taxicab unit. Schematic needed. (Ed Lanford, 511 Purnell Dr., Nashville, Tenn. 37211)

**Hallicrafters** SX-28 receiver. Source for bandswitch shaft and detent assembly needed. (Dow E. Evelyn, 6761 Bison St., Springfield, Va. 22150)

**Harvey Wells** Model R-9 "Bandmaster" receiver; circa 1955; tunes 10 to 80 meters on 5 bands; has 9 tubes. Schematic and operating manual needed. (William J. Bigoss, 81 Washington Ave., Hawthorne, N.J. 07506)

**American Scientific Development** Model TV20 tube tester, ser. A-8552. Tube testing and updating data needed. (Gene R. Mattoozi, Manito Radio, E. 1011 36 Ave., Spokane, Wash.)

**Minerva** Model W-11T "Tropic/Master" receiver; has 8 tubes; tunes BC and s.w. Schematic and technical data needed. (William C. Cathcart, 15713 Deblynn Ave., Gardena, Calif. 90247)

**Supreme Instruments** Model 503 audio oscillator. Operating instructions and schematic needed. (Edward F. Sbardella, 4 Saint Louis Dr., Biloxi, Miss. 39531)

**Sparton** receiver, ser. 2701; has 8 tubes. Schematic needed. (Arne Hoff, 969 Walnut Ave., Sonoma, Calif. 95476)

**Precision Radiation** Model 117B "Scintillator." Operating manual needed. (L.A. Truetken, 10601 Dunkeld Circle, St. Louis, Mo. 63137)

**Bell** Model 2200B audio amplifier, ser. 4334. Operating manual needed. (Chuck Morton, 29-530 Tylehurst St., Winnipeg 10, Manitoba, Canada)

**Waterman** Model S-10 "Pocket Scope." Instruction book and schematic needed. (L. Olson, 1510 S. Dunsmuir, Los Angeles, Calif. 90019)

**Link** 2975 transceiver. Schematic and/or source of parts needed. (M. Anthony, 308 Ege Ave., Jersey City, N.J. 07304)

**Abbott** Model MRT-3 short-wave receiver. Schematic and operating manual needed. (Cpl. T.F. Warren, 4 B Silver, MCB, 29 Palms, Calif. 92278)

**Pierson** KP-81 communications receiver; tunes 540 to 40,000 kHz on 5 bands. Schematic or tube type location diagram needed. (William J. Gyorgy, 1628 Van Buren Ave., San Mateo, Calif. 94403)

**Philco** Model 38-60 receiver; tunes BC and s.w. on 2 bands; has 5 tubes; code 125. Schematic and alignment data needed. **Zenith** Model R959539 receiver; tunes BC and s.w.; has 14 tubes. Schematic needed. (George Bennett, Rt. 3, Box 27, Sumrall, Miss. 39482)

**Stromberg-Carlson** Model C362695 receiver; tunes 14 to 49 MHz, 520-4200 kHz on 4 bands. Schematic needed. (K. P. Becker, 319-B West Main St., Patchogue, N.Y. 11772)

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### INTRODUCTION TO ELECTRONICS

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*Published by Business Publications, Ltd. Distributed in the United States by TAB Books. 18 Frederick Rd., Thurmont, Md. 21788. Hard cover. 296 pages. $8.95.* -30-

# NEW LITERATURE

*To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15.*

Things you can do with a tape recorder, how to select a tape recorder, and how to select the proper microphone for your particular needs are the main subjects of "The Tape Recording Omnibook" published by *Elpa Marketing Industries, Inc.* In addition, tape splicing and editing is discussed, and the ReVox Mark III G-36 tape recorder is illustrated and described in detail in this 16-page, 2-color brochure.

Circle No. 88 on Reader Service Page 15

Hams and CB'ers will be interested in the new 6-page catalog put out by *Gold Line Connector, Inc.* It describes and shows the following special accessories: a direction-finding antenna, a 2-position and a 5-position coaxial switch, alternator filter, CB generator filter, antenna matching network, and a lightning arrester.

Circle No. 89 on Reader Service Page 15

*Xcelite Incorporated*'s 2-page Bulletin N567 contains information and specifications on two sets of nutdrivers featuring special plastic cases which keep the tools properly organized for bench work and have tight-fitting, snap-lock covers. Set HS6-18 consists of ten hollow shaft nutdrivers, and Set 77 has seven drilled shaft nutdrivers.

Circle No. 90 on Reader Service Page 15

Entitled "A Microphone For Every Purpose," *Sonotone*'s new 12-page catalog features its new dual-impedance, dynamic cardioid mike and the slim-line DM70 dynamic model. The catalog also lists Sonotone's complete line of ceramic microphones—low impedance and high impedance—for p.a. systems, talk sessions, home taping, emergency communications, and learning laboratories.

Circle No. 91 on Reader Service Page 15

More than 50 new items are offered for the first time in *Conar's* Summer 1967 Catalog. They include electronic organs, hi-fi tape equipment, multiplex auto radios, an adapter for channeling TV sound through a hi-fi amplifier, and a home intercom system. Also presented are several new pieces of test equipment, plus some automotive test gear.

Circle No. 92 on Reader Service Page 15

## THE TECHNICIAN SHORTAGE

(*Continued from page* 61)

Some employers, as a matter of policy, regard all technicians as second-class citizens and flood them with advice and admonitions on the intellectual level of the third grade in a school for retarded children. They sometimes even meddle in the personal affairs of their employees, usually in the guise of "security." These policies often alienate the more competent and experienced employees who begin "looking around" and usually find jobs where there is no meddling.

Employing (and usually paying) technicians at levels far below their competence also accelerates labor turnover. A frozen table of organization, with promotions only by seniority (if at all), leads to employee losses "off the top."

Employee irritation is also increased by a book of company rules as thick as a telephone directory, worded by a shyster lawyer, so that no matter how hard the employee tries to do the job right, he is in hot water. If the supervisor also gives hourly public bawl-outs, he will soon be calling on personnel for more technicians.

Incompetent supervision of various sorts also reduces the effectiveness of the technician staff and leads to either less than optimum production or increased labor turnover, or both. One of the chief problems, in many places, is an administrative section head who doesn't know how long it takes to do a given job. This same man is also prone to giving vague and unclear instructions and then complaining about incompetence when he doesn't get what he thinks he might have wanted.

A surprising number of companies do not supply adequate work space, sufficient tools in good order, and proper materials for their technician staff. Although a good technician can produce pretty good equipment with a box full of junk and some garage-type tools, the work will be better done, at much lower cost, if the tools and equipment are adequate. Most technicians get heartily sick of unnecessary "Goldberging" and soon go looking for jobs in places which are better equipped.

**What Can Be Done.** The shortage of competent electronic technicians has been with us for some time and will worsen in coming years. There just aren't enough people entering the profession to make up for normal attrition and the expansion of the electronics industry. This shortage may retard industry growth and make maintenance and repairs of electronics equipment inordinately costly.

The electronics industry is not alone in having technician shortages. Good automobile mechanics, medical technicians, nurses, secretaries, engineers, etc. are also in short supply. As one personnel man remarked recently "there just aren't enough brains to go around." Lunkheads, it is true, are still plentiful, but there aren't many jobs available for the man who can't learn to pick up both handles of the wheelbarrow at the same time.

Part of the technician shortage can be alleviated by increasing training programs, provided people can be persuaded to respond. Most technician jobs today require high school graduation plus some additional training or experience. The Associate in Science (E.E.) programs in some of our junior colleges are a step in the right direction, but are hampered by a shortage of teachers. Some of the military training programs are quite good. Several of the correspondence schools give excellent theoretical background, but are unavoidably weak in practical applications. There are still a few self-taught electronics men of respectable competence, but most of them are not only already employed but are nearing retirement age.

There is a small reservoir of competent technicians which has not been tapped because of various company regulations and prejudices. For example, is it necessary for electronics technicians to pass an "Air Force" physical exam? This will eliminate the man with a wooden leg, but may not detect another man's wooden head. Does the use of bifocals bar a technician from employment? Why? Do all technicians have to be less than 35 years old? Should a minor juvenile record bar a man from employment permanently? Is the "male only" restriction valid? Should a "solid citizen" of a neighboring country, such as Canada or

Mexico, be barred from employment in most places because he is not a U. S. citizen? Is security being overused? Are the psychological tests given by a few companies valid or do they work against experienced personnel? Just how important is fluent English, especially in bilingual areas of the country?

Judicious relaxation of some of these regulations and prejudices could put a large number of technicians to work at all levels, not only ameliorating the technician shortage but reducing the relief rolls. In addition, company policies leading to upgrading of technical personnel would lessen the shortage at the upper levels, where it is reported to be most acute. A few manufacturers subsidize further study and profit by it in many instances. Company training programs also help in many cases.

There is, however, one "stinker" in the whole situation. Many of those who can become good technicians do so, but also have the ability to become good engineers, and do that too. The net result is that the economy has gained an engineer but lost a competent technician! -30-

## MULTI-WAVEFORM GENERATOR

(*Continued from page* 54)

remove the audio generator from the vertical input, and apply the output from *J1* to the scope. Rotate *R2* until exactly one waveform is displayed. This position of *R2* can then be pencil-marked as the "2" position.

Repeat the above procedure for as many dial markings as desired. Then proceed to the other multiplier scales, and make sure that the calibration points are reasonably accurate for the higher frequencies. In the event of serious mistracking, select the multiplier range that is most accurate, and use it as a reference. Then either select, or trim, the capacitor values (*C1*, *C2*, or *C3*) until a reasonable accuracy is obtained.

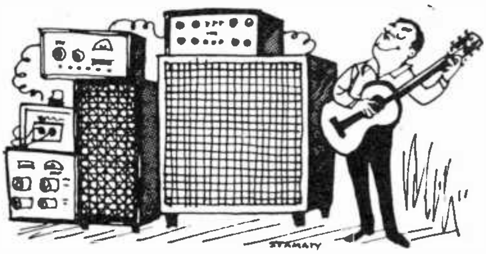
If desired, the lower end can be reduced down to 2 Hz if a good-quality 20-μF capacitor is used for *C3*. If this is done, the value of *C4* will have to be increased in order to produce a good square wave. -30-

## LETTERS (*Continued from page 16*)

*specified in a project, the builder's test voltages may not conform to those obtained from an author's prototype. Where voltages are critical, the potential amplitudes and polarities are called out in the "Construction" section of the text. Cumulative deviations from specified values can in some cases cause as much as a 20% higher or lower voltage than might be specified.*

### "WAY OUT" GUITAR AMPLIFIER

I had been searching for a good guitar amplifier, and POPULAR ELECTRONICS came to the rescue. What I did was combine the mono version of the "Brute-70" amplifier (February, 1967), the "Two-By-Two" stereo preamplifier (March, 1967), the "Reverb For Your



Car" (February, 1966), the "Mixed Twelve" speaker system (March, 1967), the "Fuzzbox" (January, 1967) and an Eico-Craft tremolo into one big amplifying system. It's quite a monster. But it cost less than $150 and is comparable to a $350 unit.

B. E. SOLOMON
Whittier, Calif.

*A word of advice, B.E.; don't practice in a neighborhood where people like peace and quiet. Your "monster" should be able to produce some "interesting" sounds, though.*

### ADD 15-VOLT A.C. RANGE TO HEATHKIT VOM

In your "Tips & Techniques" column (April, 1966), you had an item about adding a 15-volt d.c. range to the Heath-kit Model MM-1 VOM. The author said nothing, however, about how to install a setup that can give a 15-volt d.c. range. The way to do this is to use a 50,000-ohm, ½-watt, 1% resistor in series with the 5-volt a.c. shunt resistor. Then terminate the added resistor at a suitable front-panel-mounted test jack.

SSgt. A. P. TIMMERMAN
APO San Francisco, Calif. 96274

### "SEQUENCE OPERATED LOCK"

I was fascinated by the "Sequence Operated Lock" (January, 1967), but I discovered that the device could be tampered with. If you open *S7* and depress each of the other switches in the circuit, you are bound to deliver power to the load when you eventually press *S6*. However, if you eliminate *S7* and *S8* and connect only one s.p.s.t., normally-closed push-button switch in series with one of the input power lines and the relays, the lock will not only be tamperproof, but the new switch will also serve as a reset for *K1* and *K2*.

SIDNEY WILSON
Santa Ana, Calif.

I made some changes in the "Sequence Operated Lock" circuit that I feel make it even more secure. First I placed only the switches outside the door, leaving the relays safely behind the locked door. Even if an intruder understood how to trace out a circuit, he wouldn't have access to the important parts.

Next, I put extra switches on the door. These switches play no part in the combination circuit, but if depressed they will energize lock-out relay *K1*. For a finishing touch, I used a double-pole relay for *K1* with the extra contacts connected to a bright light. If the wrong combination is selected or one of the switches not in the combination circuit is depressed, the lock-out circuit comes into play and the bright light begins flashing.

FRED A. SMITH
El Paso, Texas

Your "Sequence Operated Lock" is good but not impossible to pick. If an intruder placed a flat piece of wood against the buttons and exerted pressure evenly—depressing all the switches simultaneously—power would be delivered to the load. But if you place two normally-closed push-button switches in series with each other and *K2*, the lock cannot be opened when all the switches are depressed at the same time.

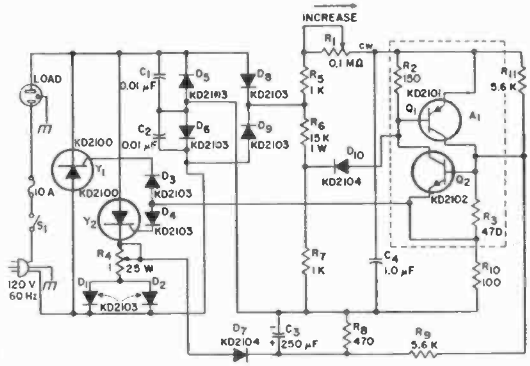
DAVID LISSNER
Chicago, Ill.

*Sid and Fred, you both came up with good, workable ideas for tamperproofing the "Sequence Operated Lock" circuit. Both of your suggestions, combined into one unit, would undoubtedly frustrate a would-be burglar. David, if someone were to place a flat piece of wood over all of the switches and apply pressure, no power could be delivered to the load. If this trick were tried, S8 would also be open and K2 could not be energized. If we assume that S8 is located in another place—say inside the door—then Fred's extra switches might be an even better idea than yours.* —30—

# OUT OF TUNE

**Build $6 Electronic Tachometer** (April, 1967, page 61). To improve the stability and reading accuracy of this tachometer, replace *R3* (listed as a 1000-ohm potentiometer) with a 10,000-ohm pot, and change *R7* (listed as 120 ohms) to a 47-ohm, ½-watt resistor (*R7* determines the Schmitt trigger point and the proper value may vary depending on the transistors used). —30—

# Build your own motor speed control with RCA experimenter kits

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# BUILD A "MALF"

*(Continued from page 69)*

create a possible shock hazard. Before you use cement on the cover, remove any grease, oil, or dirt with alcohol or other suitable cleaner.

Parts layout is not critical. However, the layout shown in Fig. 3 is easy to follow. A 2½" × 4" perforated phenolic board and about 24 push-in terminals will hold the components in place. If you cannot get a 5000-ohm, 4-watt resistor for *R1*, you can use two 10,000-ohm, 2-watt resistors in parallel as shown. A single ¾"-long centrally-located threaded spacer holds the board on the cover with adequate clearance. Observe the usual precautions when hooking up *RECT 1*, *Q1*, *Q2*, and the electrolytic capacitors for proper polarity or connections. Also, heat-sink the semiconductors when soldering. Excessive heat can destroy these components.

Drill a number of ¼" holes on the sides of the case to allow air to circulate in the unit while it is in operation. The only part mounted on the case is *SO1*. All other parts are either on the cover or on the perforated board.

**Checking It Out.** After you complete the construction, plug a load (one or more lamps totaling less than 500 watts) into *SO1*, and plug the *MALF* into a 117-volt outlet. First check for shock hazard . . . use an a.c. voltmeter (VOM on the 150-volt range) to see if there is an a.c. voltage between the cover and a suitable ground, such as a water pipe. You should get no voltage reading. Then reverse the plug and repeat the test.

To adjust the delay-on time, first set *R3* in its mid-position and time the action. You can then increase or decrease the time simply by rotating the control in one direction or the other. The more resistance in the circuit, the longer it will take for the lights to come on.

Should you run into problems with radio interference on a nearby AM radio, such interference can be minimized by filtering and shielding, and by increasing the distance between the radio and the *MALF*. Interference on FM or TV isn't likely. —30—

## SOLID STATE

(*Continued from page* 86)

vantages to this arrangement. First, the d.c. drop across the series element (*D2*) remains essentially the same regardless of load. With a choke or resistor, the d.c. voltage drop increases as load current increases. Second, space requirements are reduced, for a high-current rectifier diode is generally much smaller than a choke or resistor capable of handling similar currents. And finally, costs are reduced, as a typical diode is less costly than a high-power resistor or heavy-duty filter choke.

From a performance viewpoint, the "diode filter" circuit is, perhaps, less effective than a resistor or choke arrangement. However, a considerable reduction in ripple voltage is possible, even where the network (*D2-C2*) is added to an existing well-filtered power supply circuit. In practical tests in our lab, we found that ripple voltages could be cut approximately in half (under full load) by adding a diode and shunt capacitor as an "outboard" filter to a commercial power supply. Further reductions in ripple might be achieved by cascading additional sections.

**Product News.** Named, appropriately, the "Twilite Sentry," a new transistorized auto accessory offered by Dynamic Development (P.O. Box 2084-D, Pasadena, Calif. 91105) automatically turns auto headlights ON when ambient light levels fall below a preset value, as at twilight or during inclement weather, and OFF when light levels are normal. Designed for operation on 12-volt systems, the unit also turns the headlights OFF automatically when the ignition switch is opened, reducing the chances of a "dead" battery caused by forgetfulness. With a list price of $32.95, the "Twilite Sentry" is being offered, for a limited time, for only $19.95 on a direct order basis.

Solid-state devices for operating fluorescent lamps on low-voltage d.c. power sources are being manufactured by The Bodine Company, Inc. (P.O. Box 67, Germantown, Tenn. 38038). Dubbed "TRANS-BALS," the new units consist of a d.c./a.c. inverter and current-limiting ballast combined into a single package. Models are available for all conventional fluorescent lamps and for d.c. supplies from 12 to 48 volts.

Readers in the medical and biological research fields may be interested in a new line of implantable transmitters now offered by The Barrows Company (465 Calderon, Mountain View, Calif. 94040). With a useful transmitting range of about 3 feet, these units are compact enough to be implanted in animals as small as a 200-gram rat, and will permit remote monitoring of body temperature and EKG.

**Transitips.** Disappointed by short battery life? Perhaps you are abusing your batteries . . . or perhaps you are choosing them on the basis of size and voltage, rather than by current rating and service life.

No matter how efficient your circuit, you must put in *more power* than is delivered. An audio amplifier furnishing, say, 100 mW, requires at least 14 mA at 9 volts d.c. (126 mW). This is nearly 75% greater than the recommended discharge rate for the popular 2U6 (or 216) transistor battery. A CB transceiver with a 100-mW rating may require 20 mA, or more, when used as a transmitter.

If you want a reasonable battery service life, first determine the d.c. drain of your equipment, then choose your battery type accordingly. Afterwards, *take care* of your batteries, observing the following tips:

*Don't* store your equipment (or batteries) where very high temperatures may develop, as, for example, in the glove compartment of a car during the summer.

*Do* turn your equipment off when it is not in active use. A battery will provide more hours total service when used intermittently than when subjected to continuous discharge.

*Don't* allow moisture or corrosion to accumulate on battery terminals or connectors, for this may establish a leakage path, causing a steady current drain.

*Do* keep the volume control adjusted for the *minimum* level needed for comfortable listening. A Class AB or B audio amplifier requires more (d.c.) power as the output level is increased.

*Don't* try to operate pilot lamps with ordinary "transistor" batteries. These batteries are not designed to furnish the relatively high currents required by lamp bulbs.

*Do* remove the batteries if you plan to store your equipment for an appreciable period.

*—Lou*

## AMATEUR RADIO

(*Continued from page* 82)

Forgetting that he is talking over the air, the sailor usually answers the questions and "blows" security. But on shipboard or anywhere else, the operator is responsible for what goes out over the air from his station. He does this by keeping his hand on the control switch, and cutting the transmitter off the air whenever necessary to keep forbidden material inside the radio room.

Incidentally, this year's annual International Amateur Radio Club (4U1ITU) Convention in Geneva, Switzerland, will take place on September 23 and 24. It is timed to coincide with the "World Administrative Radio Conference to deal with matters relating to the maritime mobile service" at the International Telecommunications Union headquarters in Geneva. For details, contact IARC, 1211, Geneva 20, Switzerland.

**VHF QSO Party.** If you operate on the amateur bands above 50 MHz, ARRL's annual VHF QSO Party is for you. The Party starts at 2 p.m., local standard time, Saturday, September 9, and continues until 10 p.m., September 10. You earn one point per contact on 50 and 144 MHz, two points per contact on 220 and 420 MHz, and three points per contract on the higher frequencies. Multiply your contact points by the sum of the different ARRL sections worked on each band to get your score.

The American Radio Relay League, Inc., will award certificates to the winners in each ARRL section, with separate certificates for Novice winners in any section with three or more Novice participants. Obtain official score sheets from the ARRL Communications Department, 225 Main St., Newington, Conn. 06111, and send your score to the same address after the Party.

**Colorado Amateurs On the Job.** With the recent move of WWV to Boulder, Colorado, it is no news that the National Bureau of Standards and ESSA (its parent organization) have several important research facilities located in the state. According to the *Round Table* bulletin of the Denver Amateur Radio Club, House Bill #1570 was introduced in the Colorado General Assembly to protect the ESSA Research Facility on Table Mountain from radio interference.

Claude Maier, WØIC, saw the bill on the house calendar and realized that it was so broadly written that the radiation from almost any piece of electronic gear was above the maximum level permitted by the bill. In addition, almost any organization could classify itself as a communications research facility and would be entitled to the protection of the bill. Claude alerted Carl Smith, WØBWJ, ARRL Rocky Mountain Division Director, and other Colorado amateurs, as well as representatives of commercial and government services of the inherent dangers of the bill.

Representatives of these groups were in almost daily attendance at the Colorado Statehouse for the next several weeks, as the

(*Continued on page* 110)

bill was rewritten and amended until a workable bill was placed on the Governor's desk for his signature. The final bill excludes amateur radio and some other services from its provisions.

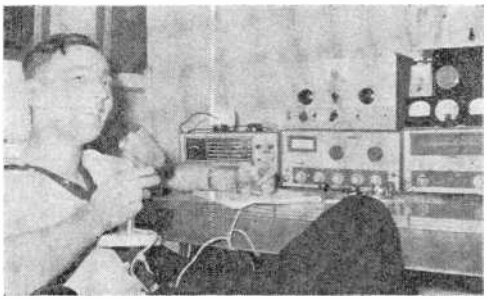
**Snow Rescue in Sunny California.** In his amateur radio column in the Los Angeles *Herald-Examiner* for April 29, Ray Meyers, W6MLZ, described how Alvin Lewison, W6KAO, and his wife, Ruth, K6KLN, used amateur radio to escape from a nasty predicament. The Lewisons were traveling in their automobile last April 1 on State Highway 2 in the California foothills near Mt. Wilson, when suddenly a snow avalanche tore down the mountainside and buried three cars, including the Lewisons'.

Calling the West Coast Amateur Radio Service Net on 7255 kHz over his mobile station, Al reported the problem to the highway department. W6KAO kept in contact with the net for six hours before the rescue snow plow and sheriff's unit reached the stranded group. But after traveling a few miles further, the whole party—including the rescuers—was again stalled in snow banks. All good things must come to an end, however, and twelve hours after they started out, Al and Ruth were back in their own home—in sunny southern California.

## News and Views

**Dennis Hennigan, WN1HOG,** 226 Pollard St., N. Billerica, Mass., has worked 12 states—11 confirmed—in four weeks. His 80-40 meter dipole is driven by an EICO 720 running 75 watts, and he receives on a National NC-98. In the process of assembly is a Heathkit "Twoer." In addition, Denny is studying hard for his General Class ticket . . . **Stan DePue, WN9TCW,** 497 Brookside Rd., Barrington, Ill., works the three low-frequency Novice bands with a Knight-Kit T-150A transmitter. His record so far is 42 states and 13 countries. Stan rates New Zealand and the Cape Verde Islands as his best DX. A Hy-Gain 18-V vertical antenna and a 40-meter doublet do the radiating at WN9TCW, and a Hallicrafters SX-101A receiver and a Knight-Kit R-55A split the receiving chores . . . **Allan Rabinowitz, WN2AOT,** 575 East 79th St., Brooklyn, N.Y., receives on a Hallicrafters SX-110 and transmits on a Heathkit DX-40. A Hy-Gain 14-AVQ vertical antenna does the yard work and has radiated a signal into 14 states and Canada on the 7- and 21-MHz Novice bands. Allan is a member of the RagChewer's Club, too. He is a photographer by trade, but wouldn't you know it? He has no pictures of his station. Maybe this will encourage him to take some.

**Gary L. Carlson, KL7FRZ,** P. O. Box 185, Haines, Alaska, started out as WN7WPR back in August, 1954, and got his General three months later. Gary has been at Haines, Alaska, since June, 1966, and needs Vermont for his Worked All States certificate. He hopes to make DXCC some day, even though he has a long way to go. His all-time record is 66 countries worked; and from Haines, he has 15 worked. An EICO 753 CW, SSB transceiver driving a Heathkit SB-200 amplifier, a Windom antenna, and a Hammarlund SP-600 receiver cover all the amateur phone and CW bands from 80 through 10 meters. He reaches 15 and 10 meters by multiplying frequency in the amplifier . . . **Terry Tyrone Steeden, WN5RLC,** 1919 Currie Lane, Amarillo, Texas, is using a 1940 regenerative receiver, a home-built, 12-watt transmitter, and a 40-meter "inverted-V" antenna. Total cost to him: $8.73. He has worked 20 states on 40 meters in two months. Terry is a college student studying for the ministry and will sked you for any reason . . . **Randy Drescher, WN4FGW,** 3520 Monica Parkway, Sarasota, Fla., has worked 26 states, four Cubans, two Hawaiians, and Bermuda in four weeks—all on 40 meters. Not bad for a Johnson "Ranger" transmitter exciting a 40-meter dipole only 12 feet high. Randy's receiver is a war-surplus BC-348J.



Keith Densmore, VE3CEM, operates out of Toronto, Canada. For details on equipment, see text below.

**Steve Brandt, WB6VVS,** 4384 Bel Aire Drive, La Canada, Calif., had to visit the FCC twice to convince the "man" that he could copy the code at 13 wpm. He had no trouble the second time, because he copied W1AW's code-practice transmissions until he could copy 15 wpm "solid." Steve now works 20 meters with a home-brew transmitter running 300 watts to a pair of 1625 tubes. (A 4:1 overload!) A converted "Command-Set" transmitter serves as a VFO, and a Hallicrafters SX-111 does the receiving. A home-brew, "all-band" vertical antenna completes the installation, except for the station log, which shows 20 states and Canada worked . . . Talking about code-practice transmissions, the Philmont Mobile Radio Club, in cooperation with the Franklin Institute, Philadelphia, Pa., transmits code practice at 2000, local time, Monday through Friday, on 29.626 kHz.

**Keith Densmore, VE3GEM,** 1806 Queen St., East, Toronto 8, Ont., Canada, was first licensed in August, 1965. He started with a Heathkit DX-60 transmitter running 90 watts, a Heathkit HG-10 VFO, and a Heathkit HR-10; to this gear he has now added a 300-watt, home-brew amplifier. The VE3GEM antenna farm sprouts horizontal dipoles for 80, 40, and 20 meters, plus a ground-mounted Hy-Gain V-27 vertical. For the past year or so, Keith has divided most of his time between ragchewing on 80-meter phone and 80- and 40-meter CW. Nevertheless, he has 47 states, 9 Canadian provinces and 19 countries worked. Keith's future plans include SSB phone—when his pocketbook can stand the strain (amateur gear is much more expensive in Canada than it is in the U.S.A.) . . . **Edwin Knox, WN7GNR,** Route 2, Box 104, Harrisburg, Ore., splits his operating time between the 80-, 40-, and 15-meter Novice bands. Eighty- and 40-meter dipoles fed from the same transmission line insert his signals into space and capture incoming signals. A Heathkit DX-60 transmitter supplies the outgoing signals, and a National NC-98 receiver processes the incoming ones. Together they have put 17 states and Japan into the WN7GNR logbook.

Will we read your "News and Views" or see your picture in next month's column? The first step is up to you and the mailman. Write to Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P. O. Box 678, Gary, Ind. 46401.

73, *Herb, W9EGQ*

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## ON THE CITIZENS BAND

*(Continued from page 84)*

mobile patrols, and 24-hour monitoring, and is negotiating with the City of New York to further aid N.Y.C. police and their auxiliary units. Interested CB'ers should contact director Richard T. Moran at the address given above.

Cook County CB Civil Defense Director Robert Lorenz needs volunteers in the Chicago area. Bob says that his group has too much ground to cover and too few operators. For more information and an application blank, midwesterners can contact him at 4316 Home Avenue, Stickney, Ill. 60405.

A Fall Festival CB Jamboree sponsored by the Emergency Citizens Band Monitors, Inc., will be held on September 16 and 17 at the Madison County Coliseum in Huntsville, Alabama. The grand prize will be a 7-day trip for two to the Bahama Islands, or a 1968 national brand 23" color TV set—winner's choice; and there will be more than $3000 worth of other prizes. Camping facilities are available; also special CB motel rates. For additional information, write to R. M. Lewis, KDD7237, Jamboree Chairman, Emergency Citizens Band Monitors, Inc., P.O. Box 1542, Huntsville, Alabama 35807.

Sergeant Robert P. "Bob" Holmes, and several other CB'ers stationed in Vietnam, would like to hear from stateside communicators. How about sending them a copy of your club publication with a note attached? Write Bob in care of Headquarters, Force Logistic Command, c/o FPO, San Francisco, Calif. 96602.

The Allied Louisiana Emergency Radio Team, Inc. (ALERT), Baton Rouge, La., was called into action last April when the area was threatened by the worst flood conditions to plague Louisiana since 1953. Monitor stations handled communications traffic for two and a half days. At least 45 mobile units were put into operation, patrolling the area to give assistance where needed and making reports on flood conditions. By early evening of the first day, 14 inches of rain had been recorded. ALERT Control, operating on channels 1 and 21, manned Red Cross Headquarters communications between eight shelters that had been set up. The ALERT members were highly commended for their help—many of them worked day and night.

**Congress Asked to Review CB Radio.** Four Congressmen (F.T. Bow, F. Clark, H.R. Kornegay, and J.W. Stanton) have submitted a resolution to the House of Representatives asking that the Congress direct the FCC to review CB radio. The resolution advocates the expansion of CB and the provision for more frequencies for personal use.

Congressman Bow is well known for his intense interest in CB and has been a staunch critic of the FCC. The fate of this resolution is an unknown quantity at press time, but very probably—as in the past—it will be sidetracked into "committee" and therein die a slow death. At least, the interest on the part of the four Congressmen is appreciated.

I'll CB'ing you,

*—Matt, KHC2060*

## ANGLE QUIZ ANSWERS

(*Quiz appears on page* 55)

1 — H The AZIMUTH ANGLE of a tape recorder is the angle between the running axis of the tape and the gap in the recording head.

2 — F The CRITICAL ANGLE of a transmitted radio signal is the minimum angle which the wavefront, as it enters the ionosphere, can make with a line extending to the center of the earth, and still be reflected back to earth.

3 — I The CUTTING ANGLE of a recording stylus is the angle between the longitudinal axis of the stylus and a line perpendicular to the plane of the disc.

4 — G The DEFLECTION ANGLE of a cathode-ray tube is the angle swept by the maximum peak-to-peak deflection of the beam.

5 — D The DISPERSION ANGLE of a speaker defines the limits of sound radiation possible from a given cone design.

6 — A The DWELL ANGLE of an automobile distributor cam and point assembly is the number of degrees through which the cam rotates while the ignition points are closed.

7 — J The PHASE ANGLE of an alternating current is the number of electrical degrees by which the current leads or lags the applied voltage in an a.c. circuit.

8 — C The REFRACTION ANGLE is the angle which a light ray traveling through two different mediums makes with a line perpendicular to the interface of the mediums.

9 — E The SHADOW ANGLE of an electron ray (tuning eye) tube defines the target area (shaded) present under minimum signal conditions.

10 — B The TRACKING ANGLE of a phonograph is the angle between the longitudinal axis of the cartridge and a tangent to the needle groove.

# FET REGEN RECEIVER

(*Continued from page 46*)

The back view of the completed receiver is shown in Fig. 8. The battery holder is mounted on the side of the cabinet with small wood tacks, while small brass wood screws are used to mount the Fahnestock clips. One clip is used for the antenna connection and the other for the ground connection.

**Alignment and Operation.** For best reception, use an end-fed antenna between 50 and 75 feet long, mounted as high as possible, and a good ground. But the receiver will operate satisfactorily on shorter lengths of antenna because of its excellent sensitivity. For camping, picnics, and other portable applications, a short length of insulated wire tossed into the nearest tree will suffice.

If you have never played with a regenerative receiver, it will not take you long to get the "feel" of tuning it for best results. Control *R1* will have to be reset from one end of each band to the other. When scanning large segments of the band, it is best to "back off" on *R1* until a station or group of stations is found. Then advance the control to the point just before the receiver "pops" into regeneration. At this point, the received signal will increase in strength and selectivity.

If you duplicate the receiver exactly as outlined here, the calibration markings shown in Fig. 9 will fall right into place. The receiver can be calibrated precisely by adjusting the tuning slugs on the plug-in coils and tuning in on stations of known frequency. This is easy enough to do on the broadcast band—if the station frequencies are unknown, you can always use another broadcast radio to correlate the frequencies. On the short-wave bands, the WWV time-signal stations can be used as "frequency standards." WWV stations will be found on 2.5, 5.0, 10, and 15 MHz.

On the short-wave bands, reception will usually be very limited and spotty during the day. It will begin to improve late in the afternoon, however, and by evening the bands will be "crawling" with stations! —30—

# SHORT-WAVE LISTENING

(*Continued from page 79*)

Also, I have been receiving mail from a person, or persons, allegedly living in the Greater New York area, giving frequency, schedule, and sketchy location of "a new broadcast station." They even had QSL cards printed. All of this information has been turned over to the Federal Communications Commission.

**VOA QSL Cards.** Last month we mentioned that the *Voice of America* had discontinued issuing QSL cards to U. S. listeners ("It is diverting staff funds and time from our basic mission which is to provide programming for audiences in foreign countries"). One of our readers, dismayed at having been refused a QSL for his logging of the Tangier relay, wrote a polite note to one of the QSL card signers requesting more detailed information on the new policy of the VOA. His reply: the Tangier relay QSL!

### CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports are as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to SHORT-WAVE LISTENING, P.O. Box 333, Cherry Hill, N. J., 08034, in time to reach your Short-Wave Editor by the fifth of each month; be sure to include your WPE identification, and the make and model number of your receiver. We regret that we are unable to use all the reports received each month, due to space limitations, but we are grateful to everyone who contributes to this column.

**Albania**—*R. Tirana* is heard well in Eng. at 0230 on 9715 kHz, and from 0000 to 0025 to close on a new frequency of 11,905 kHz.

**Austria**—*Austrian Radio*, 15,360 kHz, was logged at 2315-2345 with light opera, to 2350 with pop music. The ID's are generally multilingual.

The current schedule to N. A. (all xmsns to Eastern N.A. only) is: 6155 kHz (Deutsch Alterburg—10 kW) at 2300-0430; 9770 kHz (Moosbrunn—100 kW) at 2300-0200; and 9770 kHz (Fleckendorf—20 kW) at 0200-0400.

**Bolivia**—A new station is *R. Guayaramerin*, Guayaramerin, operating on 4964 kHz with the usual Latin American programming around 0100. Verification is by letter.

**Brazil**—*R. San Carlos*, 2420 kHz, was noted weakly at 0201 in Portuguese. This is a difficult one to log.

**Canada**—The latest CBC schedule to N.A. is: 1215-1313 on 11,720 and 9625 kHz (Eng.), and 1316-1342 on 11,720 kHz (French). Other loggings include: CKZU, 6160 kHz, Vancouver, at 2330 and at 0500-0600 relaying CBU; CFVP, 6030 kHz, Calgary, noted at 2214 with music and commentary.

**Cape Verde Islands**—Station CR4AC, *R. Barlavento*, Sao Vicente, 3910 kHz, is often noted around 2300-0000 when the channel is clear of ham radio xmsns.

**Cuba**—The current schedule for Eng. from Havana is: to Northern Europe at 2010-2140 on 15,285 kHz; and to N. and S. America at 2050-2150 on 15,270 and 15,300 kHz, at 0100-0450 on 6170 kHz, at 0100-0600 on 11,760 kHz, at 0330-0600 on 6135 kHz, and at 0630-0800 on 9655 kHz.

**Czechoslovakia**—*R. Prague* has Eng. to N.A. at 0100-0155 on 7345, 11,990, 15,368, and 17,840 kHz, and at 0330-0425 on 5930, 7345, 11,990, and 15,368 kHz. "Magazine of the Air" is broadcast on Sundays at 1400-1455 on 15,448, 17,705, and 21,450 kHz.

**Denmark**—Eng. from Copenhagen is broadcast: to N.A. at 0145-0215 on 9520 kHz; to the Far East at 0745-0815, to N.A. at 1245-1315, to S. Asia at 1445-1515, and to Africa at 1915-1945, all on 15,165 kHz. The weekly DX bulletin is now given on Wednesday instead of Tuesday during the Eng. half hour on weekdays at 0145 on 9520 kHz, and at 0745, 1245, 1445, and 1915 on 15,165 kHz. There are also tests in Eng. on Saturdays at 1015 on 9520 kHz.

**Dominican Republic**—Station HIMS, *R. Cristal*, Santo Domingo, continues to hold to 5007 kHz, and is heard in Spanish from 0150 to 0405 s/off, with Latin American pop tunes and time checks. Station HIRL, *R. Exitos*, listed as inactive, is being heard on 3365 kHz at 0200. The address, not positively copied, seems to be Apartado 70, Santiago de los Caballeros.

**Egypt**—Cairo is being reported on 11,695 kHz at 0415, on 15,048 kHz at 1350-1500, and on 17,865 kHz with news from 2350 to 0000 s/off; all-Arabic. Eng. is scheduled to N.A. at 0130-0300 on 9475 kHz, and to N. Africa at 0630-0700 on 7075 kHz.

### SHORT-WAVE ABBREVIATIONS

| | |
|---|---|
| anmt—Announcement | QRN—Atmospheric disturbance |
| B/C—Broadcasting | QSL—Verification |
| CBC—Canadian Broadcasting Corporation | R.—Radio |
| Eng.—English | s/off—Sign-off |
| GMT—Greenwich Mean Time | s/on—Sign-on |
| ID—Identification | V—Voice |
| kHz—Kilohertz | VOA—Voice of America |
| kW—Kilowatts | xmsn—Transmission |
| N.A.—North America | xmtr—Transmitter |

**England**—London's World Service to N.A. is now on 17,790 kHz at 2115-2315, on 15,260 kHz at 2115-0030, on 11,780 kHz at 2300-0330, on 9580 kHz at 2300-0330, and on 6110 kHz at 0000-0330. Another new and unlisted xmsn to N.A. has been noted at 1600-1630 on 15,300 kHz. Plans call for the BBC to have its own "World Radio Club" with a quarter hour weekly program; more details will be forthcoming when available.

**Finland**—Pori is strong to N.A. in Eng. at 2300-2315 and in Finnish to 0000 on 15,185 kHz.

**Formosa (Taiwan)**—*V. of Free China*, Taipei, has Eng. at 0250-0350 on 7130, 11,825, 15,125, 15,345, 17,720, 17,775, and 17,890 kHz; at 1800-1900 on 9685, 9765, 11,725, 11,825, 15,125, and 17,890 kHz; and at 1030-1100 ("The Dragon Show") on 7130, 9655, 9685, 11,825, and 17,890 kHz.

The listening post of Victor Lipinski, WPE4HTV, Alexandria, Va., is well equipped with (left to right) an RCA cartridge recorder, on top of a Garrard 1000 symphonic stereo; a Conar audio-color, on top of a Lafayette HA-520 FM receiver, on top of a Hallicrafters S-118; a Lafayette "Comstat-25" (for CB), on top of a Lafayette HA-230; and an RCA AM-FM receiver, on top of a Voice of Music speaker. Under the desk: an Airline amplifier. His record to date is 50 states and 60 countries verified.

**Germany (West)**—The *VOA*'s low-powered xmtrs in Munich are scheduled at 0300-0730 and 1400-2345 to Europe on 3980 kHz and at 1645-1730 to the Middle East on 11,880 kHz, both using 8 kW.

*Deutsche Welle*, Cologne, is scheduled to N. A. in Eng. at 0130-0250 (with some French) on 9640 and 11,945 kHz, at 0445-0545 on 9735 and 11,945 kHz, at 1045-1055 on 11,905 and 15,315 kHz, and at 1900-1910 on 15,245 and 17,785 kHz.

**Guatemala**—Station TGNA, *R. Cultural*, Guatemala City, is audible on the West Coast on both 5955 and 720 kHz in Eng. from 0300 to 0400 s/off. Another station, on 6100 kHz, is believed to be TGOA, *La Voz de las Americas*, noted at 2330-0000 with "Pepsi" commercials and constant mention of "America Central."

**Haiti**—Station 4VHW, *R. Haiti*, Port-au-Prince, can be heard in French at 2120-2140 on 6195 kHz, with pop music.

**Hungary**—*R. Budapest* is beamed to Europe in Eng. at 1930-2230 on 21,685, 17,890, 15,160, 11,910, 9833, 7220, 7100, 6234, and 3995 kHz; and to N.A., Australia, and New Zealand at 0030-0130, 0300-0400, and 0430-0500 on 15,160, 11,910, 9833, 7220, and 6234 kHz.

**Iraq**—*R. Baghdad* has Eng. to Europe at 1730-1820 on 6030 and 6095 kHz according to their schedule. Can anyone confirm?

**Kuwait**—This country broadcasts in Eng. at 1600-1900 on 4967.5 kHz, with 10 kW. Some reports also indicate that there is Eng. at 0500-0600 on the same frequency although this time is listed only for medium-wave service on 1130 kHz.

**Lebanon**—A registered mail schedule gives the following new information: to N.A., U.S.A., Canada, Mexico, Antilles, and Europe in French at 0130-0200; to Western U.S.A. in Arabic at 0200-0230 and in Eng. at 0230-0300; to Eastern U.S.A. in Arabic at 0300-0330 and in Spanish at 0330-0400; all on 11,965 kHz.

**Malawi**—Malawi B/C Corp., Blantyre, has been unusually good from 0345 s/on with drums and a cock crowing; the broadcasts include pop and native music with vernacular anmts. Despite a good signal, however, the 3380-kHz frequency used is likely to have plenty of late summer QRN.

**Mauritania**—*R. Mauritanie,* Nouakchott, has the following schedule, according to a recent QSL: weekdays at 0700-0800, 1300-1530, and 1800-2230; Sundays at 0800-1400 and 1700-2300. Frequencies: 1349 kHz, with 1 kW, all times; 7245 kHz, with 4 kW and 9610 kHz, 30 kW, at 1330-1530; 3222 or 4855 kHz, 30 kW, at 0700-0800 and 1700-2300.

**Mexico**—Station XEQM, *R. Frecuencia Juventud,* Merida, 6105 kHz, is noted at 2030-2100 with few ID's but frequent mention of Yucatan and some beer commercials. You may hear a cuckoo clock on the half hour. This broadcast is all-Spanish, and the power rating is only 250 watts.

**Navassa Island**—This island, located between Haiti and Jamaica, and thought by some to be the actual location of *R. Swan,* will soon have a commercial station with a 50-kW xmtr on the medium waves and a 20-kW xmtr on the short waves, according to an overseas source. No specific frequencies have been given as yet.

**Nepal**—*R. Nepal,* Kathmandu, was heard on the East Coast with Eng. and pop music at 1245 on 4600 kHz. Very weak, this station should prove exceptionally difficult for most monitors to log.

**Netherlands**—*R. Nederland,* Hilversum, has a special news xmsn in Eng. and Spanish at 2310, followed by another in Dutch at 2330, on 15,320 kHz.

**Norway**—Here is *R. Norway*'s complete Eng. schedule, with all xmsns listed being 30 minutes in length and on Sundays only except as noted: at 0800 to the Pacific, Far East, Australia, and Africa on 11,850, 15,175, 17,775, 21,655, and 21,730 kHz; at 1200 to N. Europe, Australia, New Zealand, the Far East, and W. Africa, on 7240, 15,175, 17,825, 21,655, and 21,730 kHz; at 1400 to the Americas, Indonesia, Australia, and S. Africa on 15,345, 17,825, 21,655, 21,670, and 21,730 kHz; at 1600 to the Americas, Middle East, and S. Africa on 15,345, 17,825, 21,655, 21,670, and 21,730 kHz; at 1800 to U. S. West Coast, the Pacific, Africa, and S. America on 11,850, 17,825, 21,655, 21,670, and 21,730 kHz; at 2000 to N. and S. America and E. Africa on 15,345, 17,825, 21,655, and 21,730 kHz; at 2200 to W. Europe, Caribbean, and S. America on 15,345, 17,825, 21,655, and 21,730 kHz; Mondays at 0000 to the Americas and N. Europe on 11,735, 15,175, 15,345, and 21,655 kHz; and Mondays at 0400 to N. and C. America, the Pacific, and N. Europe on 9645, 11,735, and 11,850 kHz. The last two xmsns are also on 1578 kHz.

**Paraguay**—Station ZPA5, *R. Encarnacion,* Asuncion, was good at times as noted on 11,947 kHz at 2245-2330 and 0015-0030, with Latin American music, home and world news, talks, and many commercials, all-Spanish.

**Philippines**—The *VOA*'s low-powered xmtrs in Malolos are scheduled to S. China on 7275 kHz at 1315-1600, on 11,850 kHz at 2145-0200 and on 11,865 kHz at 0845-1630; to S. Asia at 2200-0200 on 15.165 kHz; to S. E. Asia at 1000-1300 on 15,335 kHz; and to Indonesia and N. E. Asia at 0900-1630 on 15.345 kHz. The 7275- and 15.335-kHz xmtrs operate with 7.5 kW, the others with 15 kW.

The Far East B/C Co., Manila, is using 11.770 kHz at 1630-1736 for Russian religious programs to the Soviet Union, dual with 11,890 kHz. The former channel evidently has replaced the usual frequency of 11.855 kHz.

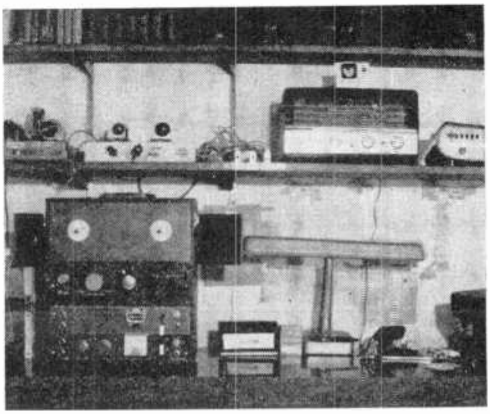
**Rumania**—Eng. to N. A. is scheduled at 0130-0230 on 15,250, 15,225, 11.940, 11.810, 11.725, and 9590 kHz, and at 0300-0330 and 0430-0500 on the same channels plus 9570 kHz.

**Ryukyu Islands**—The *VOA*, Okinawa, has a 15-kW xmtr on 15,240 kHz at 1000-1600 beamed to S. E. Asia.

**Sweden**—Here is *R. Sweden*'s complete Eng. schedule: to Europe at 0900-0930 and 1100-1130 on 9625 kHz and at 2015-2045 on 6065 kHz; to the Middle East at 0900-0930 and 1900-1930 on 21.690 kHz; to the Far East at 1100-1130 and 1230-1300 on 15.240 kHz and 2245-2315 on 11,810 kHz; to Africa at 1230-1300 on 21,690 kHz and at 1900-1930 on 15.240 kHz; to S. Asia at 1400-1430 on 21,585 kHz and at 0515-0545 on 17,840 kHz; to S. America at 2245-2315 on 11,705 kHz; to Eastern N. A. at 1400-1430 and 1600-1630 on 17,840 kHz and at 2015-2045, 0030-0100, and 0200-0230 on 17,840 kHz; and to Western N. A. at 1600-1630 on 15,240 kHz and at 0330-0400 on 11,705 kHz.

**Tanzania**—Dar-es-Salaam was noted briefly on 5050 kHz with soft African music mixed with a few U.S. pop tunes at 0325-0355. The International Service has been picked up on a new frequency of 4915 kHz with Eng. and Swahili to Nigeria, Ethiopia, and E. Africa around 1755; Eng. has also been heard at 1600 on 4785 kHz. Has anyone definitely heard either of *R. Tanzania*'s Swahili networks operating at 0300-2000 on 5985 kHz and at 0900-1500 on 9550 kHz?

**Vietnam (South)**—Saigon's complete overseas schedule reads: Vietnamese at 2200-0000 on 6165 and 9620 kHz and at 0000-1600 on 4877 kHz; Cantonese at 0000-0115, 0500-0615, and 1430-1530 on 7245 kHz; Mandarin at 0115-0200 and 1400-1430 on 7245 kHz; French at 1100-1200, Eng. at 2330-0000 and 1230-1300, Cambodian at 0430-0500 and 1015-1100, and Thai at 0000-0030, all on 9755 kHz. Reports go to The National Broadcasting System of Vietnam, 3, Phan-Dinh-Phung Str., Saigon.



The listening post of Philip Horkin, WPE6GXA, Sherman Oaks, Calif., contains a National NC-77X receiver, preselector, a Roberts 1040 tape recorder, home-built transmitting equipment, and an intercom connected to the shack of another SWL in his area.

**Yugoslavia**—*R. Belgrade* can be heard in Eng. at 1830-1900 and 2200-2215 on 6100 kHz and in Spanish at 0000-0030 and 0100-0130 on 7200 kHz.

**Zambia**—*R. Zambia* now broadcasts its General Service on 3295, 4911, 6165, 7240, and 9505 kHz, and the Home Service on 3346, 4965, 6060, and 7220 kHz. This station is also testing on 9505 kHz with low power at 0700-1400 and would welcome reports—send them to the Chief Engineer, Mr. J. Allerton.

**Clandestine**—*Peyk-ye-Iran* (the station frequently jammed by another clandestine station more popularly known as the "Kiss Me Honey" station although the latter no longer uses that particular recording) is the *Voice of the Communist Party of Iran* (*TUDEN*). The station gives a mailing address of Box 4176, Stockholm 4, Sweden (although its actual location is reportedly East Berlin), has a mailing list, and dispenses Marxist literature. Listeners' letters are answered on Wednesdays. When last heard, this station was operating on 11,695 kHz around 1600-1740.

An overseas source states that the Kurds of northern Iraq also have a xmtr operating on 11,695 kHz but that it cannot be heard in Europe (and presumably not in N.A. either. —Ed). —30—

## SHORT-WAVE CONTRIBUTORS

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Ricky Weber, Levittown, N. Y.
Canadian Broadcasting Corp., Montreal, Que. Canada
*Deutsche Welle*, Cologne, Germany
International Short-Wave Club, London, England
*R. Sweden*, Stockholm, Sweden
*Sweden Calling DX'ers Bulletin*, Stockholm, Sweden

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## SEPTEMBER 1967
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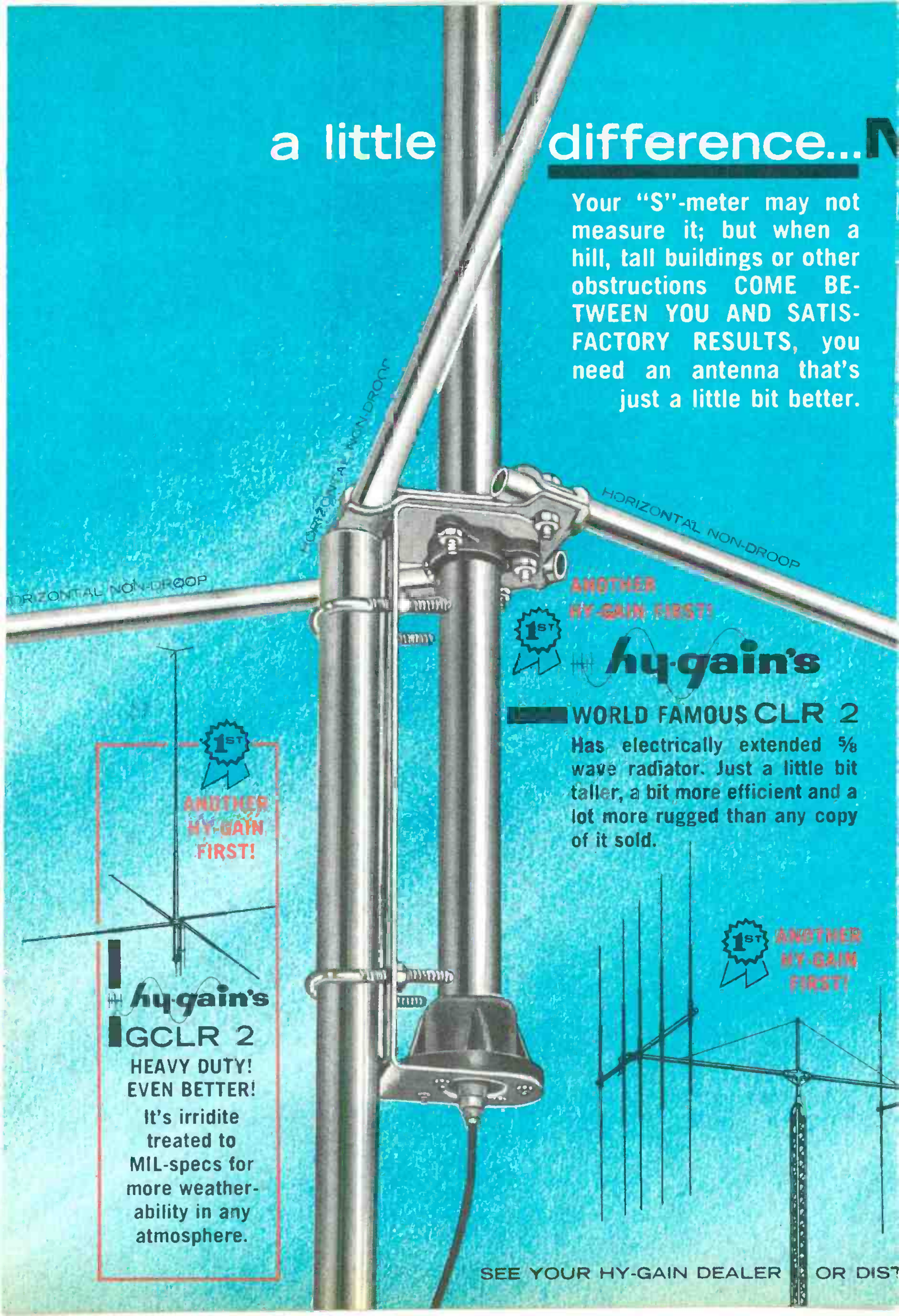

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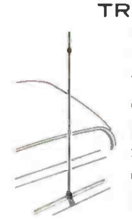

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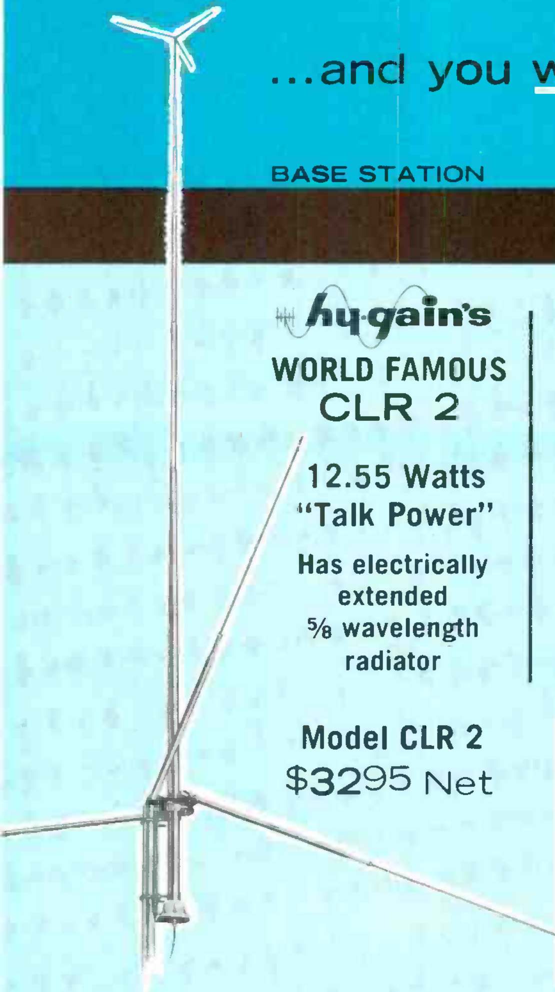

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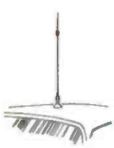

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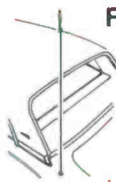

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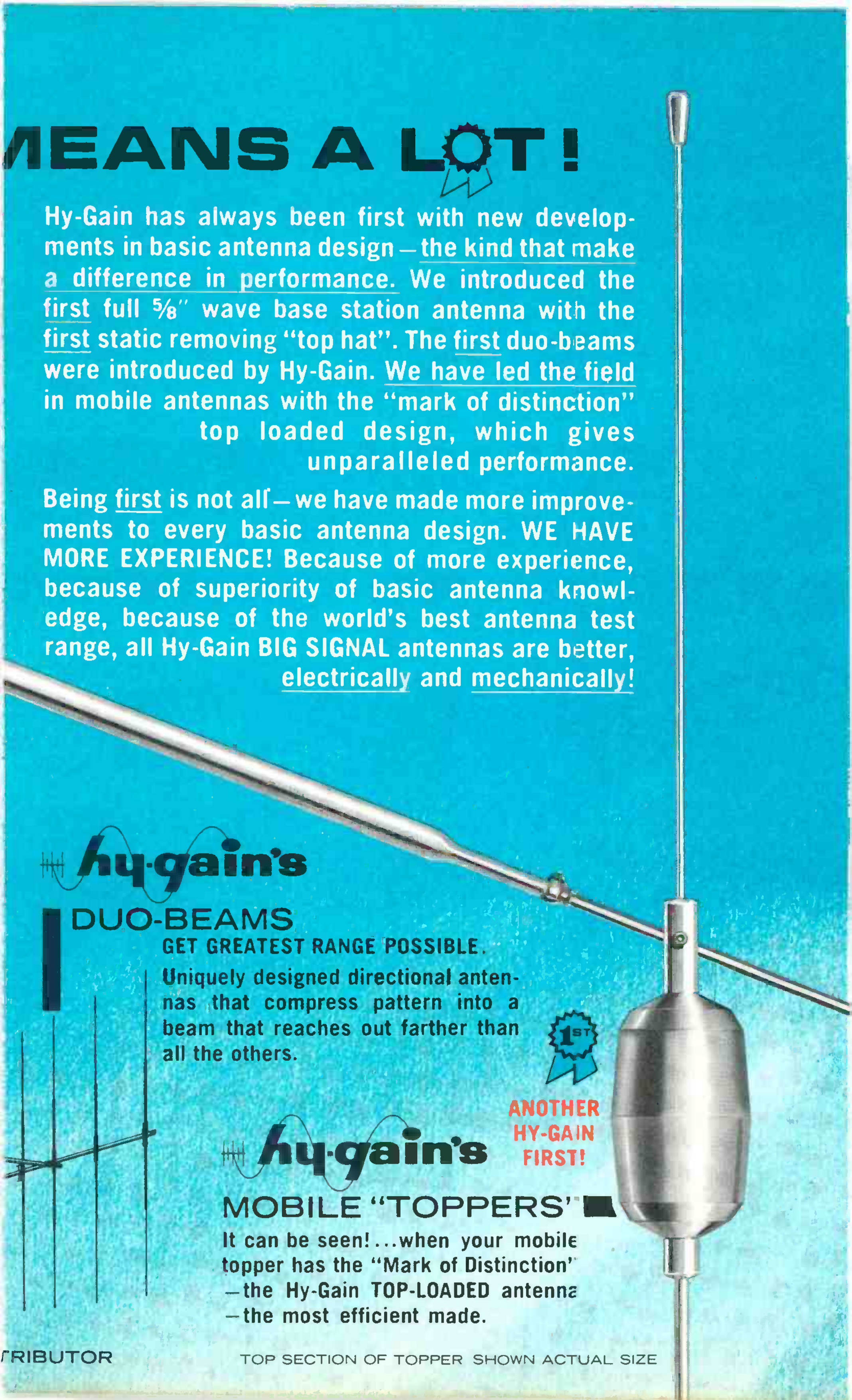

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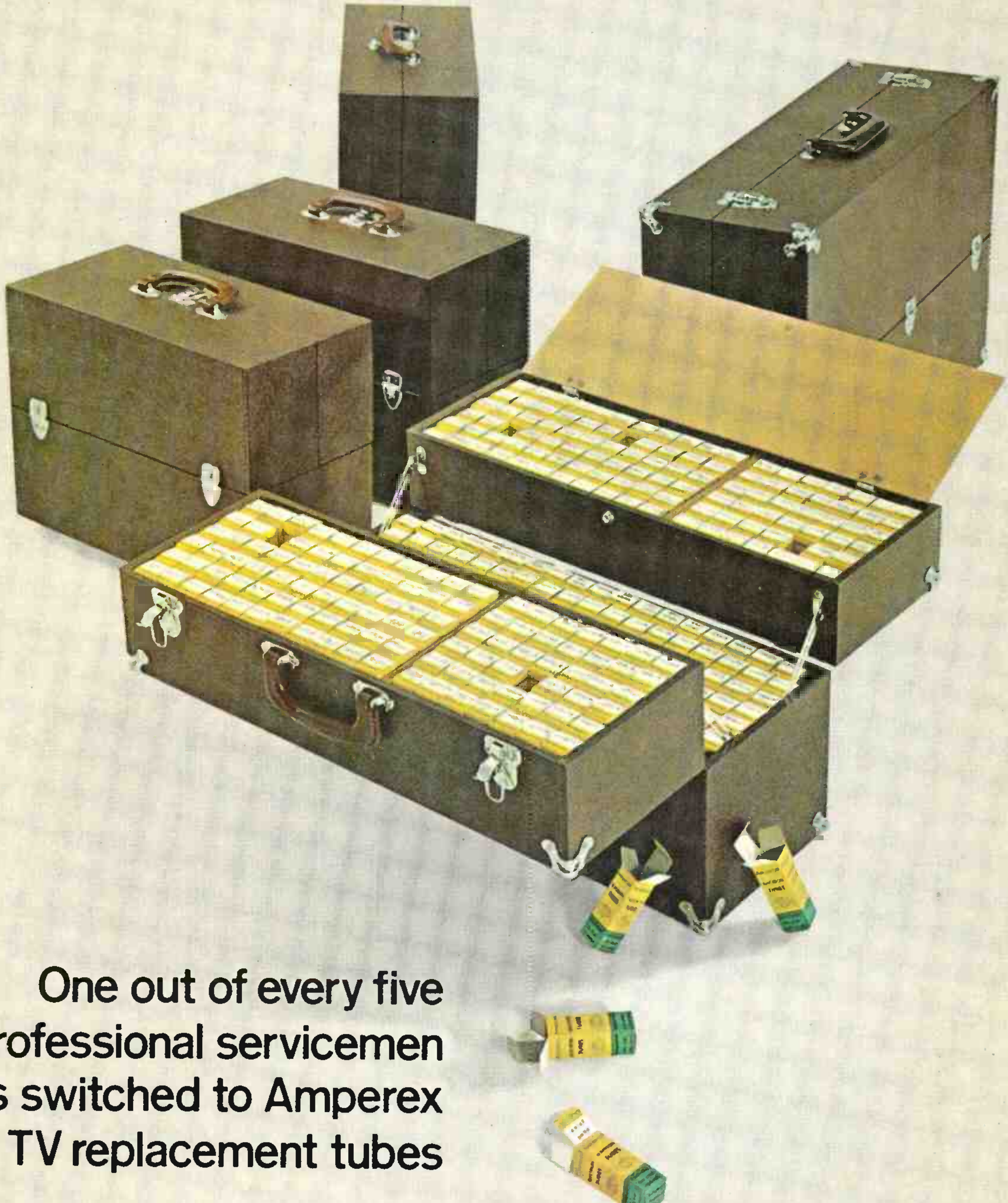
TOP SECTION OF TOPPER SHOWN ACTUAL SIZE



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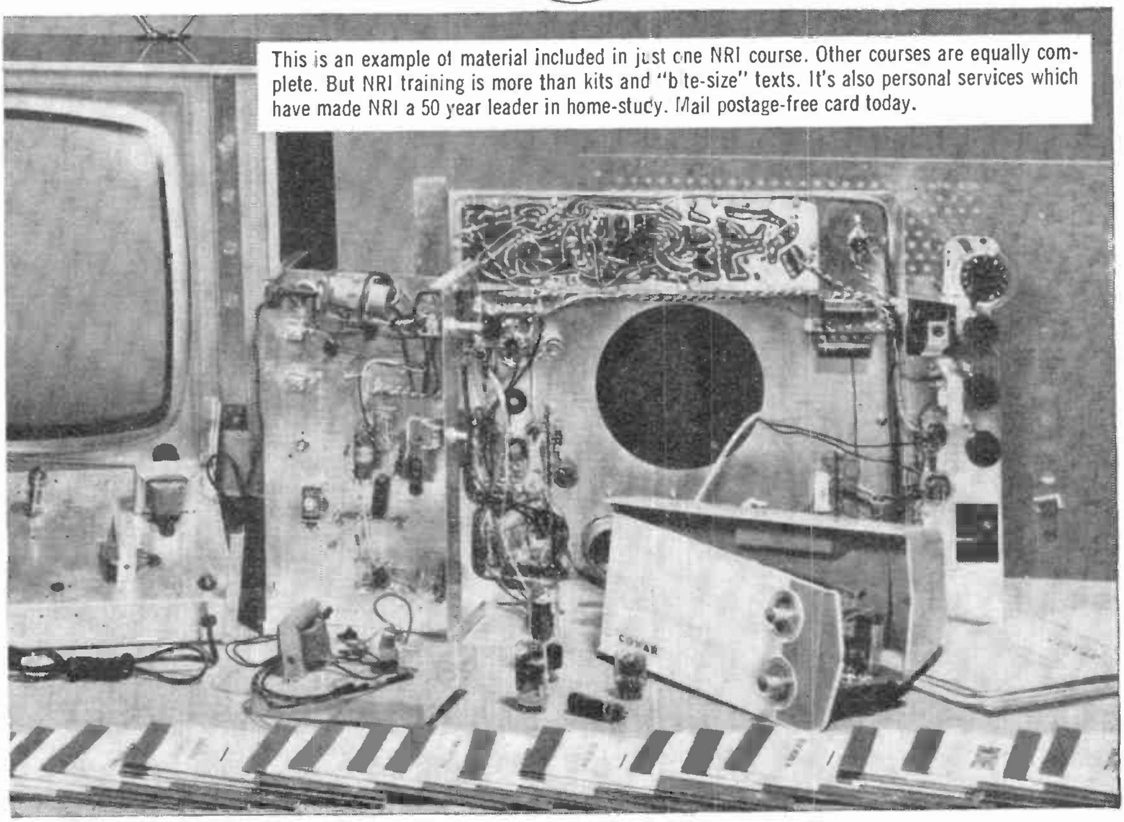

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# POPULAR ELECTRONICS

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

VOLUME 26 **MAY, 1967** NUMBER 5

## SPECIAL CONSTRUCTION FEATURE



## FEATURE ARTICLES



## DEPARTMENTS



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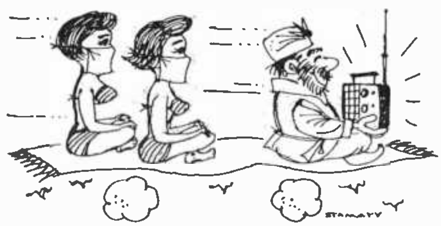
# LETTERS FROM OUR READERS

*Address correspondence for this department to: Letters Editor,* POPULAR ELECTRONICS *One Park Avenue, New York, N. Y. 10016*

## FOREIGN AID

I am very thankful to you for publishing my letter (November, 1966) regarding the difficulty in obtaining parts for projects here in India. Experimenters located all over the U.S.A. have written to me, offering me a variety of components. The writers included mechanical engineers, doctors, and students. I was really moved by this response and have deep feelings of satisfaction about the way



all of these Americans reacted so promptly to help someone in need. I am sending my correspondents Indian novelties and curios as gifts.

K. B. TENDULKAR
Bombay, India

## PROPAGANDA: TWO VIEWPOINTS

In two years I have QSL'd almost 50 countries, and only Cuba and Red China have continued to send anything more than program schedules (without my asking to have propaganda discontinued). But from the information sent from these two countries, one feels like a cell mate to Fidel and Mao. I asked Havana to discontinue mailing but two months later, I received a listener-survey questionnaire; either they disregarded my plea, or U.S. customs haven't sent the note on yet. One of my friends has a simple solution—he sends anything besides the QSL received from a communist nation straight to the FBI office.

Prague discontinues all mailings if you don't write once a year (heard on their Listener's Mailbag Show). *Deutsche Welle* sends "Hallo Friends" and other publications to all listeners, but does ask in questionnaires if the listener wants them continued. *R. Nederland* sends a program schedule to all who write for QSL's or request a schedule (in several languages—I get Spanish and English); they will send almost anything but a windmill on request.

DOUGLAS B. MEYER, WPE2OUS
New Rochelle, N.Y.

## LETTERS (*Continued from page 8*)

Those SWL's who don't want any propaganda are missing half the fun. Whenever I write to a station, I ask them to send me some material about the station, country, or any other miscellaneous literature they wish. I have received all sorts of interesting information: from program schedules to postcards, sports magazines to antenna construction pamphlets, and some propaganda—even from U. S. stations.

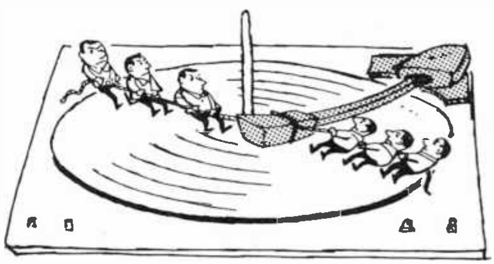
Whenever I "show off" my QSL's to people, I also show them my accumulated pile of literature; and they are sometimes more interested in the literature, especially the propaganda, than my QSL's! This propaganda also makes for very interesting discussions or reports in a history class. I don't believe any of this flow of foreign materials will jeopardize my future military service because I have had only one of my many packages opened—and that was because the original envelope fell apart!

Although I received quite a bit of propaganda from *Radio Havana*, Cuba, after asking for it, I now get only a program schedule about every five months. I have never received any propaganda from Moscow or Kiev in the U.S.S.R., or from Albania, and very little from W. Germany, Czechoslovakia, Hungary, Rumania, and Bulgaria. (I have received sports magazines from Czechoslovakia, and tourist information from Rumania and Bulgaria.) Communist China does send a lot of propaganda, however.

BOB HUBER, WPE3GUN
Wilmington, Del.

### ANTI ANTI-SKATE

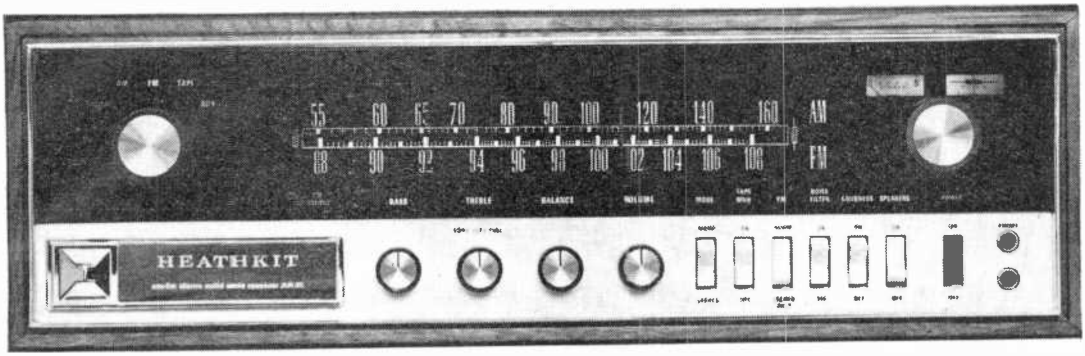
After reading your article on "The War on Skating" (September, 1966), I did some experimenting. When a record is played, the tone arm travels from the outer edge of the disc toward the center of the disc. If the tone arm is set on a grooveless disc, the same thing happens, but the tone arm travels far too rapidly. When an anti-skating device is



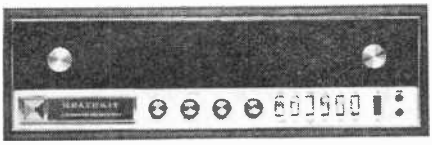
installed, the tone arm is reduced to a dead weight—it no longer moves over the record by itself. The stylus in the record groove is subjected to an opposite force. Side groove pressure has not been eliminated; rather, it has been transferred from the inner groove wall to the outer groove wall. In my opinion, the solution to the problem is not to eliminate

(*Continued on page* 14)

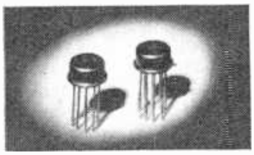
# New Heathkit® AR-15 Solid-State Stereo Receiver



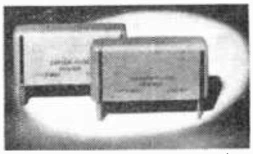

## 150 Watts . . . AM-FM Stereo . . . $329.95†



**"Black Magic" Panel Lighting** A touch of the power switch and presto! . . . The black magic panel lights up with a slide-rule dial for easy tuning, and instant identification of all controls.



**Integrated Circuits** . . . two are used in the IF amplifier for hard limiting excellent temperature stability, increased reliability. Capture ratio is 1.8 db. Each IC is the size of a tiny transistor, yet each contains 10 transistors, 7 diodes, and 11 resistors.



**Crystal Filters** . . . two are used in the IF amplifier to replace the usual transformers . . . Heath hi-fi exclusive. Provide near-perfect bandpass characteristics, (70 db selectivity) yet no adjustment is ever needed!

Now From The World's Most Experienced Solid-State Audio Engineers Comes The World's Most Advanced Stereo Receiver . . . The New Heathkit AR-15. There's nothing like it anywhere in the transistor stereo market place. Besides the use of space-age integrated circuits and exclusive crystal filters in the IF section, it boasts other "state-of-the-art" features like these:

150 Watts Dynamic Music Power . . . the highest power output of any transistor stereo receiver . . . delivers the coolest, most natural sound you've ever heard.

All-Silicon Transistor Circuitry . . . a total of 69 transistors, 43 diodes and 2 IC's for maximum reliability.

Positive Circuit Protection . . . four Zener diodes and two thermal circuit breakers protect the driver and output transistors from overload and short circuits of any duration.

Field Effect Transistor FM Tuner . . . cascode 2-stage FET RF amplifiers and an FET mixer provide high overload capability, excellent cross modulation and image rejection. Sensitivity 1.8 uv. Features 4-gang variable capacitor and 6 tuned circuits for extreme selectivity under the most adverse conditions. Completely shielded . . . completely assembled.

Two Calibrated Tuning Meters . . . for signal levels, for center tuning — doubles as a VOM for check-out during or after kit assembly. Plus automatic switching to stereo, transformerless design, filtered outputs and a host of other deluxe features. Full details in FREE catalog.

† **Kit AR-15,** (less cabinet) 28 lbs. . . . . . . . . . . . . . . . . . **$329.95**
**AE-16,** assembled wrap-around walnut cab., 7 lbs. . . . . **$19.95**

**AR-15 SPECIFICATIONS — AMPLIFIER SECTION: Dynamic Power Output Per Channel (Music Power Rating):** 8 ohm load; 75 watts. **Continuous Power Output, Per Channel*:** 8 ohm load; 50 watts. **Power Bandwidth For Constant 0.5% Total Harmonic Distortion*:** 6 Hz to 25 kHz. **Frequency Response (1 watt level):** ±1 db, 6 to 50,000 Hz. ±3 db, 4 to 70,000 Hz. **Harmonic Distortion:** Less than 0.5% from 20 to 20,000 Hz at 50 watts output. Less than 0.2% at 1,000 Hz with 50 watts output. Less than 0.2% at 1,000 Hz with 1 watt output. **Intermodulation Distortion (60 Hz: 6,000 Hz=4:1)** Less than 0.5% with 50 watts output. Less than 0.2% with 1 watt output. **Damping Factor:** 45. **Hum & Noise:** Volume control at minimum position; —80 db. PHONO; **Channel Separation:** PHONO; 45 db. TAPE & AUX.; 55 db. **Output Impedance (each channel):** 4, 8 & 16 ohms. **FM SECTION (Mono): Sensitivity:** 1.8 uv*. **Frequency Response:** ±1 db, 20 to 15,000 Hz. **Antenna:** Balanced input for external 300 ohm antenna, unbalanced, 75 ohm. **Volume Sensitivity:** Below measurable level. **Selectivity:** 70 db*. **Image Rejection:** 90 db. **IF Rejection:** 90 db minimum*. **Capture Ratio** 1.5 db*. **AM Suppression:** 50 db*. **Harmonic Distortion:** 0.5% or less*. **Intermodulation Distortion:** 0.5% or less*. **Hum & Noise:** 65 db*. **Spurious Rejection:** 100 db*. **FM SECTION (Stereophonic): Channel Separation:** 40 db or greater. **Frequency Response:** ±1 db, 20 to 15,000 Hz. **Harmonic Distortion:** Less than 1% at 1,000 Hz with 100% modulation. **19 & 38 kHz Suppression:** 55 db or greater. **SCA Suppression:** 50 db. **AM SECTION: Sensitivity:** 12 microvolts at 1,000 kHz. **Image Rejection:** 60 db at 600 kHz. 40 db at 1400 kHz. **IF Rejection:** 70 db at 1,000 kHz. **Harmonic Distortion:** Less than 1.5% at 400 Hz, 90% modulation. **Hum & Noise:** 45 db. **Power Requirements:** 105-125 or 210-250 volt 50/60 Hz AC. **Dimensions:** Overall, 16⅞" wide x 4¾" high x 14½" deep.

*Rated IHF (Institute of High Fidelity) Standards.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CIRCLE NO. 12 ON READER SERVICE PAGE

# Learn, Enjoy And Save . . . Build

## Heathkit Rectangular Color TV's With Exclusive Self-Servicing

Kit GR-295
$479⁹⁵*

(295 sq. inch viewing area)

Kit GR-180
$379⁹⁵**

(180 sq. inch viewing area)

**Exclusive Features That Can't Be Bought In Ready-Made Sets At Any Price!**
All color TV sets require periodic convergence and color purity adjustments. Both Heathkit Color TV's have exclusive built-in servicing aids, so *you* can perform these adjustments anytime . . . *without* calling in a TV serviceman . . . *without* any special skills or knowledge. Just flip a switch on the built-in dot generator and a dot pattern appears on the screen. Simple-to-follow instructions and detailed color photos in the manual show you exactly what to look for, what to do and how to do it. Results? Beautifully clean and sharp color pictures day in and day out . . . and up to $200 savings in servicing calls throughout the life of your set.
**Exclusive Heath Magna-Shield** . . . surrounds the entire tube to keep out stray magnetic fields and improve color purity. In addition, **Automatic Degaussing** demagnetizes and "cleans" the picture everytime you turn the set on from a "cold" start.
**Choice Of Installation . . . Another Exclusive!** Both color TV's are designed for mounting in a wall or your own custom cabinet. Our you can install either set in a choice of factory assembled and finished Heath contemporary walnut or Early American cabinets.
**From Parts To Programs In Just 25 Hours.** All critical circuits are preassembled, aligned and tested at the factory. The assembly manual guides you the rest of the way with simple, non-technical instructions and giant pictures.
**Plus A Host Of Advanced Features** . . . a hi-fi rectangular picture tube with "rare earth" phosphors for brighter, livelier colors and sharper definition . . . **Automatic Color Control** and **Gated Automatic Gain Control** to reduce color fading and insure jitter-free pictures at all times . . . deluxe **VHF Turret Tuner** with "memory" fine tuning . . . **2-Speed Transistor UHF Tuner** . . . **Two Hi-Fi Sound Outputs** for play through your hi-fi system or connection to the special limited-field speaker . . . **Two VHF Antenna Inputs** — 300 ohm balanced and 75 ohm coax . . . **1-Year Warranty** on the picture tube, 90 days on all other parts . . . plus many more deluxe features. For full details, mail coupon for FREE Heathkit catalog.

***Kit GR-295,** everything except cabinet, 131 lbs. . . . . . . . . . . . . . . . . . . . . . . . . . . . **$479.95**
**GRA-295-1,** walnut cabinet (shown above) 56 lbs. . . 19" D. x 31" H. x 34½" W. . . . . . . **$62.95**
Deluxe contemporary walnut & Early American cabinets also available at $94.50 & $99.95
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Early American cabinet available at $75.00

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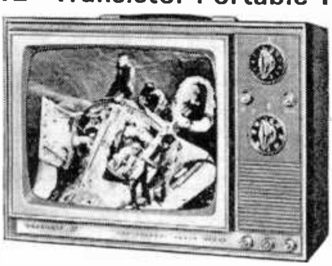

Kit GR-104
$119⁹⁵

Unusually sensitive performance. Plays anywhere . . . runs on household 117 v. AC, any 12 v. battery, or optional rechargeable battery pack ($39.95); receives all channels; new integrated sound circuit replaces 39 components; preassembled, prealigned tuners; high gain IF strip; Gated AGC for steady, jitter-free pictures; front-panel mounted speaker; assembles in only 10 hours. Rugged high impact plastic cabinet measures a compact 11½" H, x 15¾" W x 9⅜" D. 27 lbs.

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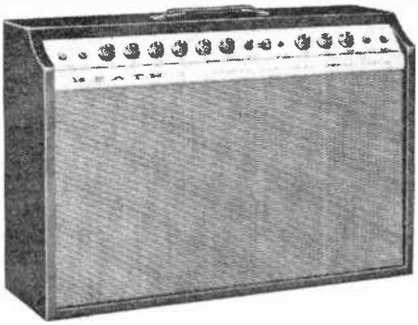

Kit TA-16

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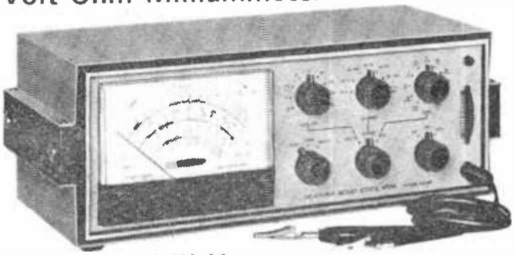

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CIRCLE NO. 12 ON READER SERVICE PAGE

## LETTERS (*Continued from page 10*)

skating but to put it to controlled use. I feel that the tone arm could be damped just enough to allow the skating force to move the arm at the proper rate of speed. Then the stylus would be free to work on the "wiggles" in the disc without having to move the tone arm. Anti-skating devices defeat this ideal situation, and actually introduce another form of distortion.

STEVEN PAUGH
Audio-Visual Crew Chief
Portage Senior High School
Portage, Wis.

### BACK ISSUES AVAILABLE

It is with great regret that I write this letter. Due to a space problem, I have to dispose of my back issues of POPULAR ELECTRONICS. I have all but ten issues from the first to the present one. Rather than have the junkman turn them into tinder, I would appreciate it if you would publish my name and address so that someone will have an opportunity to make better use of them. The first person to send me $20, plus postage, will receive them as soon as possible.


NORMAN ROSENSPAN
180 Lenox Rd.
Brooklyn, N.Y.

I have an almost complete set of P.E., from Volume 1, Number 1, to the present (it's minus two or three issues) that I would like to sell for $20, plus shipping.

ELROY MAREZ
4039 Southmont Dr.
Montgomery, Ala. 36105

Volume 1, Number 1, to present (complete set). Price, open for bids.

ROMAN RUCINSKI
3832 Bristow St.
Detroit 12, Mich.

*Think twice before you decide to sell your back issues, fellows. All copies prior to November, 1963, are out of print, as well as some recent ones. However, if you get any calls for individual issues you don't have, tell your correspondents to contact Ziff-Davis Service Division, 595 Broadway, New York, N.Y. 10012. Issues that sold on the newsstand for 35 cents will cost 50 cents; those that sold for 50 cents will cost 65 cents.* —30—

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**VOID AFTER JUNE 30, 1967** 5

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### TV TROUBLESHOOTER'S HANDBOOK

Derived from material that has appeared in *Electronic Technician* magazine, this handbook is made up of service hints, circuit descriptions, production changes, field service notes, etc., for various makes and models of TV receivers which have been manufactured during the last four years. Although both black-and-white and color receivers are covered, emphasis is on the former—probably because there are more of them. The content is arranged by make and model for easy reference, as is the comprehensive index at the back of the book.

*Published by Tab Books, 18 Frederick Rd., Thurmont, Md. 21788. Hard cover. 192 pages. $6.95.*

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The fantastic involvement of electronics in medical diagnosis and treatment is evident from this new book in the "Advances in Science Series." Written at an elementary level, but abundantly illustrated, this book is an up-to-date summary of how ultrasonics, laser beams, computers, microminiature radio transmitters, etc., assist doctors in saving thousands of lives. The book is factual and does not dwell on the "miraculous" or Sunday-supplement type of medical report.

*Published by Sterling Publishing Company, Inc., 419 Park Avenue South, New York, N.Y. 10016. Hard cover. 144 pages. $3.95.*

### 101 WAYS TO USE YOUR OSCILLOSCOPE, Second Edition

*by Robert G. Middleton*

Oscilloscopes have changed in the years since this book was first published: wide-band scopes are now standard equipment, and the triggered-sweep scope can be found in the better-equipped service shops. This well-known handbook has been updated to cover the newer scopes. Much of the book is related to testing TV receivers; trouble-shooting the various sections of both black-and-white and color sets is discussed in detail. The use of square waves to evaluate circuits and components is explained, and time-constant charts for some of the common circuits have been added.

*Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206. 192 pages. $2.95.*

-30-

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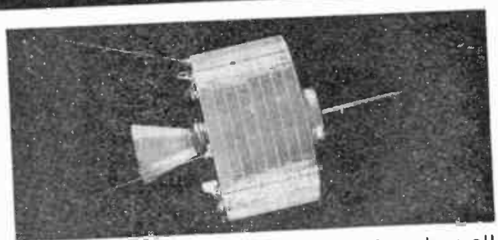

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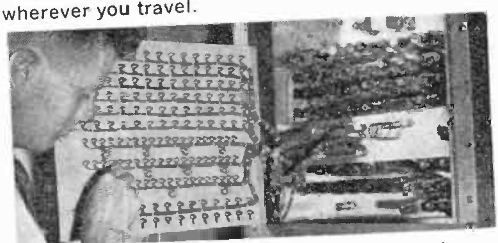

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# NEW PRODUCTS

*Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15.*

### "BOOKSHELF" FM STEREO RECEIVER

Said to be the first bookshelf-size solid-state hi-fi stereo receiver, the ADC 606 announced by *Audio Dynamics* measures only nine inches deep (17" wide and 5" high). It delivers 30 continuous watts per channel. Usable FM sensitivity is rated at 1.6 μV; FM frequency response is virtually flat to 20,000 hertz; and the FM stereo separation is over 35 dB. Total harmonic distortion: 0.3%. Among the many front panel features of the ADC 606 are a "log scale" dial face, stereo indicator light, tape monitoring facilities, and a stereo headset outlet.

Circle No. 75 on Reader Service Page 15

### "SILENT SECRETARY"

You simply place your telephone in the proper position on *Sonar's* Model JAM-2 "Silent Secretary" as shown, plug the latter into a 117-volt outlet, and the JAM-2 will answer your phone automatically. It will greet callers in your prerecorded voice, and record and store accurately all information received. Other things the "Silent Secretary" can do are take dictation, monitor calls, and inform callers where you can be reached in an emergency. It can be used as a paging system, and as a telephone amplifier. Completely solid-state, the JAM-2 is self-contained, lightweight, and portable. And it works 24 hours a day.

Circle No. 76 on Reader Service Page 15

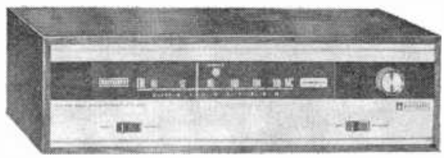
### "PROFESSIONAL" VTVM

Accurate measurements down to 0.01 volt are possible with EICO's Model 235 "Professional" vacuum-tube voltmeter. Operation of the instrument is made easier by the use of color coding to match the function and range switches with the arcs of the easy-to-read 6" meter, and by use of a dual-purpose a.c./d.c. "Uni-Probe." Both p-p and r.m.s. voltages are read on separate scales in seven overlapping a.c. ranges—up to 1500 volts r.m.s., 4200 volts p-p. Frequency response is 30 Hz to 3 MHz (to 250 MHz with optional probe). Measurements can be made from 0.01 to 1.5 kV in eight overlapping d.c. ranges—up to 30 kV with optional probe. The 11-megohm input makes for negligible loading.

Circle No. 77 on Reader Service Page 15

### SOLID-STATE STEREO FM TUNER

All-silicon transistors are used in the Knight Model KN-290 stereo FM tuner, now being offered by *Allied Radio*, for reliable performance. Features of the KN-290 include a built-in tuning meter, a.f.c., a stereo indicator light, and automatic multiplex switching. Sensitivity is 1.5 μV for 20 dB quieting; frequency response, 50 to 15,000 hertz ± 1.5 dB; signal-



to-noise ratio, 55 dB; distortion, less than 1%. The KN-290 is compact—it measures 13" wide by 10" deep by 3⁵⁄₁₆" high—and a handsome oiled walnut wood case adds just $1 to the price of the tuner.

Circle No. 78 on Reader Service Page 15

### "QUICK-GRIP" CB TRUNK MOUNT

No holes need to be drilled for a mobile CB antenna with the new type of trunk mount developed by *Antenna Specialists*, yet the setup looks like a conventional permanent antenna installation. The Model M-161 "Quick-Grip" mount consists of a specially designed clamp that slips over the edge of the trunk lid, and is locked in place on the underside of the lid. The mount is encased in an inverted cone-shaped chrome-plated housing that overlaps the edge of the trunk lid slightly, permitting the connecting cable to be snaked through to the trunk interior without showing. Surface marring is prevented by a rubber

# PRODUCTS *(Continued from page 22)*

grommet, which also keeps surface water from entering the housing. The "Quick-Grip" mount will accept any existing antenna with a ⅜"-hole requirement; adapters are available to accommodate other hole sizes.

Circle No. 79 on Reader Service Page 15

## SOLID-STATE PRIVATE TONE CALLER

For use with *Lafayette* 12-volt solid-state CB transceivers, the new "Priva-Com III" transistorized private tone caller employs ceramic and resonant tuning fork circuitry instead of conventional reed relays. Features include: 9-transistor, 2-diode circuitry; simple to operate push-button switches for standby, normal, call and reset; volume control and indicator light. It is supplied with


mounting bracket, two plug-in tuning fork filters, and connecting cable with plug for the Lafayette HB-500A, HB-555, HB-525A, HB-600, and HE-20T. The "Priva-Com III" is compatible with the "Priva-Com IV," which is intended for use with Lafayette HB-444/25 and Comstat 25 units. There is also a "Priva-Com V" tone caller for tube-type transceivers.

Circle No. 80 on Reader Service Page 15

## BEAM ANTENNA KITS

Interested in stacking CB beam antennas to obtain additional gain? *Mosley Electronics* has kits available which include two "Scotch-Master" beams, stacking harness, guy rope, boom, necessary hardware, and concise assembly instructions. The antennas in the STACK'IT 3, SKT-3 are 3-element beams; those in STACK'IT 4, SKT-4 have 4 elements; and those in STACK'IT 5, SKT-5 have 5 elements. Up to 13 dB gain, compared to a reference dipole, can be obtained.

Circle No. 81 on Reader Service Page 15

## STEREO HEADPHONE CONTROL CENTER

*Olson Electronics'* Model PH-127 stereo headphone control center permits the use of two sets of stereo headphones, with a separate volume control for each. It comes with a 5' cable with a three-circuit plug to allow connection to your amplifier; this plug can be re-


moved for connection to amplifiers that do not have a phone jack. The Model PH-127 measures 5¼" wide by 3¾" deep by 3¼" high.

Circle No. 82 on Reader Service Page 15

## COAXIAL SWITCH

A new single-pole, two-position coaxial switch for amateur radio and CB use is available from the *Gold Line Connector Company.* Designated as the Model 2 P, the switch has a current-carrying capacity of 9 amperes and a power-carrying capacity of 1000 watts. Clips and rotor contacts are silver-plated brass, and the switch is insulated with


electrical grade laminated phenolic—which provides protection against voltage breakdown of critical parts to 1000 volts r.m.s.

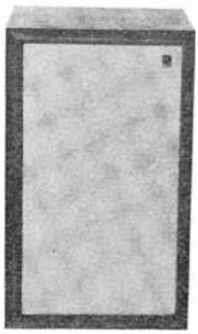
Circle No. 83 on Reader Service Page 15

## PHILLIPS SCREW LAUNCHER

Starting Phillips screws in hard-to-get-at locations is said to be an easy matter with a new launcher tool made by *Vaco Products Company.* By means of a simple push-pull operation of a sliding aluminum sleeve which is part of the tool, the tough spring-steel blades of the launcher expand in the cross-slot of the screw head and grip it firmly. Screw removal is equally easy. The Phillips screw launcher is available in four lengths: 3, 5, 7, and 9 inches.

Circle No. 84 on Reader Service Page 15

## CONTROLLED IMPEDANCE SPEAKER SYSTEM



Since solid-state components are believed to give best performance over a narrow range of load impedance, *H. H. Scott's* new S-11 three-way speaker system has an impedance range carefully limited, by integrated engineering development of both speakers and crossover, for optimum performance with today's solid-state receivers and amplifiers. Measuring 24" x 14" x 11¼", the S-11 system features a walnut-finish air-suspension type of enclosure.

Circle No. 85 on Reader Service Page 15

## COAXIAL "CABLEMATCH"

Something new in coaxial cable has been put on the market by *JFD Electronics.* Called the "Color-Shield-82 Coaxial Cablematch," it is a low-loss 82-channel cable which comes with a 300-75 ohm matching transformer attached—the transformer ties directly to the 300-ohm output of the antenna. Available in three lengths (50, 75, and 100 feet), the cable is equally effective for color and black-and-white TV reception, VHF, UHF, and FM stereo.

Circle No. 86 on Reader Service Page 15

# Squires Sanders

# 23'er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If you are interested in limited channel capability, see the S-5-S, 5 channel twin to the 23'er. It has all of the bonus performance features of the 23'er for five channel operation. $185 for mobile; use same power supplies. Set of channel 9 crystals included.

S-S 23

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CIRCLE NO. 33 ON READER SERVICE PAGE

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The first quick change converts the Messenger 100 to field operation in just a few seconds. You simply add the accessory Power Pack and get up to 8 hours of operation on one charge. The nickel cadmium battery can be recharged several times—at any standard AC outlet.

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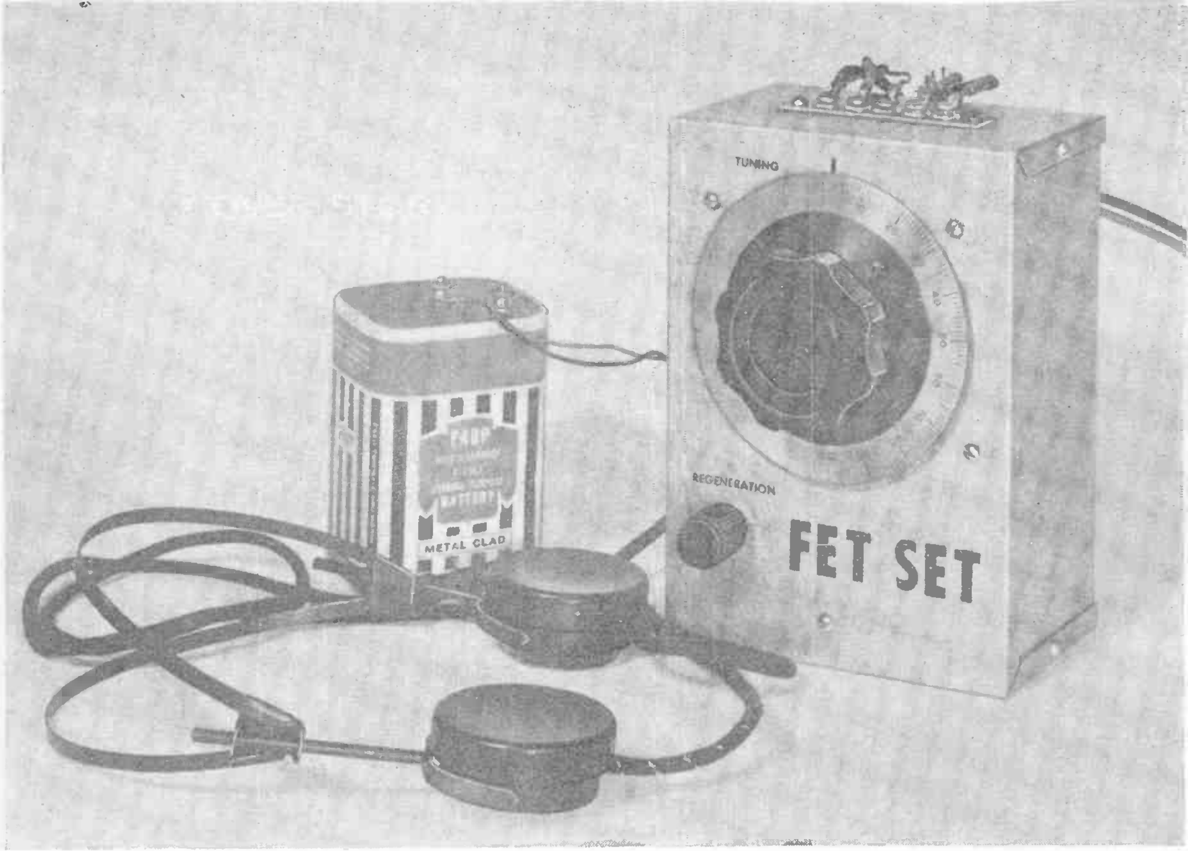



By JACK ALTHOUSE

# INTRODUCING
# THE FET SET

## A RADIO RECEIVER WITH A POWER DRAIN SO LOW THAT IT PLAYS FOR A YEAR ON A 6-VOLT BATTERY

WHAT IS a FET set? It is an ultra-modern version of the once-popular tube-type regenerative receiver, with the vacuum tubes directly replaced by field-effect transistors—the high-impedance solid-state devices that "think" and act like tubes. The FET set is battery-operated and able to pull in BCB DX stations with more selectivity and sensitivity than you would expect from such a simple circuit.

So, if you have an evening or two to spare, and the $10-15 required for all the parts, you'll be in for a rewarding experience building the FET set. And you'll have the satisfaction of knowing that you are working with the very latest member of the transistor family—the FET.

**How It Works.** The theory of operation of the field-effect transistor is discussed in detail in the February, 1967, issue of POPULAR ELECTRONICS (page 47) and is summarized on page 30 of this issue.

The circuit for the FET regenerative receiver is shown in Fig. 1. Field-effect transistor *Q1* functions as a regenerative detector in a Hartley circuit arrangement, while *Q2* operates as an audio amplifier.

Signals at the antenna appear across *L1*, and the desired frequency selected by tuning capacitor *C1* is induced in *L2* and applied to the gate of *Q1*. Since the circuit is regenerative, a portion of the signal at the drain is fed back to the gate. The amount of feedback is controlled by *C3*. The gate is self-biased by *R1*, bypassed by *C2*. Coil *RFC1* eliminates r.f. from the output circuit.

The detected audio is developed across *R2* and is coupled to the gate of *Q2* through capacitor *C4*. Transistor *Q2*'s gate is returned to ground through *R3*, while *R4*, bypassed by *C5*, provides self-biasing for this transistor. The amplified audio at *Q2*'s drain is reproduced by the magnetic headphones.

**Construction.** The author's FET set is housed in a 7" x 5" x 3" aluminum box, with the tuning and regeneration controls mounted on the front panel. If you like this arrangement, begin construction by first laying out and drilling mounting holes for the tuning dial (*C1*), regeneration control (*C3*), and *L1-L2* coil form, and the circuit board, following the general arrangement shown in Fig. 2.

Then cut out a suitable sized slot through the top of the box to mount the terminal strip (*TS1*) that serves to connect the battery, headphones, and antenna to the receiver. Make sure there is enough clearance so that *TS1*'s terminals won't ground out against the chassis. Now lay the box aside temporarily.

Secure a 1"-diameter by 4"-long plastic or cardboard coil form and drill the holes called for in Fig. 3; two holes are required at each end of the *L1* and *L2* windings. Following the instructions giv-

## PARTS LIST

*B1—6-volt lantern battery*
*C1—Midget 409-pF variable capacitor (Allied Radio 43 A 3524 or similar)*
*C2, C5—10-µF, 10-volt miniature electrolytic capacitor*
*C3—50-pF variable capacitor (Hammarlund MC-50-S or similar)*
*C4—0.01-µF paper capacitor*
*L1, L2—See Fig. 3*
*Q1, Q2—2N4360 p-channel FET (Fairchild)**
*R1, R2—22,000-ohm, ½-watt resistor*
*R3—470,000-ohm, ½-watt resistor*
*R4—10,000-ohm, ½-watt resistor*
*RFC1—10-mH r.f. choke (National Radio R-50 or similar)*
*TS1—5-lug terminal strip*
*1—Pair of magnetic headphones, 2000 ohms or higher*
*1—7" x 5" x 3" aluminum box (LMB TF-782 or similar)*
*1—2½" x 3" perforated unclad circuit board*
*22—Push-in terminals (Vector T-28 or similar)*
*Misc.—Coil form (4" long x 1" dia.), knobs (2), 1"-long 6-32 threaded spacers (2), ¾"-long 6-32 threaded spacers (2), ground lugs (2), 6-32 x ¼" screws (10), 6-32 nuts (2), #26 enameled wire, solder*

*Available from Glassman Electronics, 20 Hampton Rd., Massapequa, N. Y. 11758, at $1.25 each. Minimum order is $5; postage paid in U.S.A.

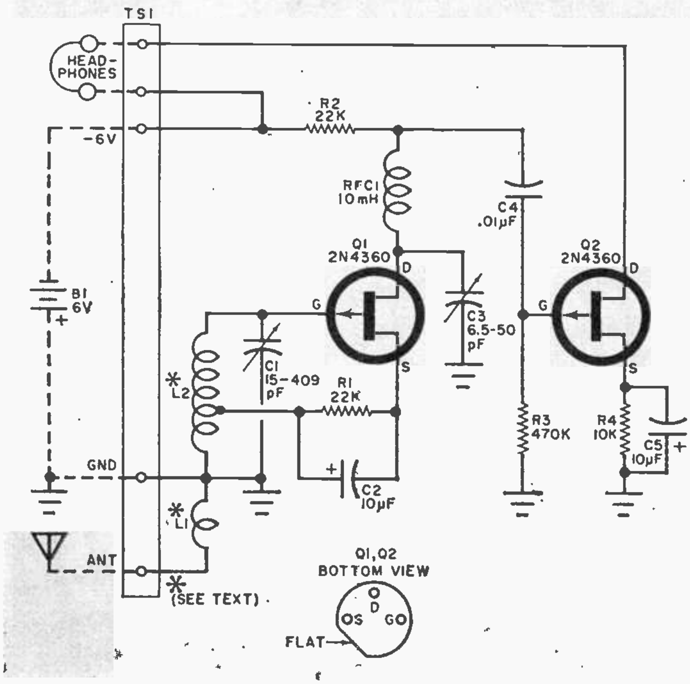
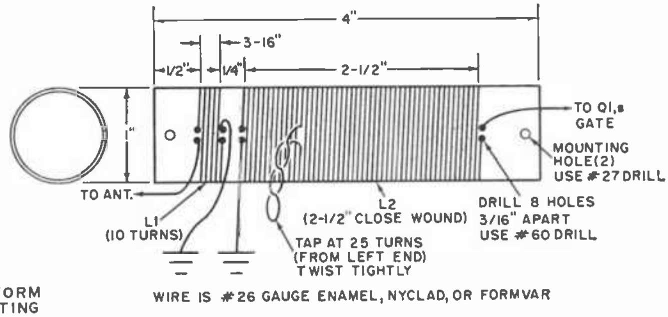



Fig. 1. This FET set schematic shows an updated version of one of the most popular radio receivers of the '30's—the regenerative receiver. Here, field-effect transistors are used to replace the once mighty vacuum tubes.

Fig. 3. To fabricate the antenna/oscillator coil (L1-L2), close-wind the indicated number of turns of #26 Formvar enameled wire on a 4" length of 1"-diameter polystyrene, phenolic or cardboard form.



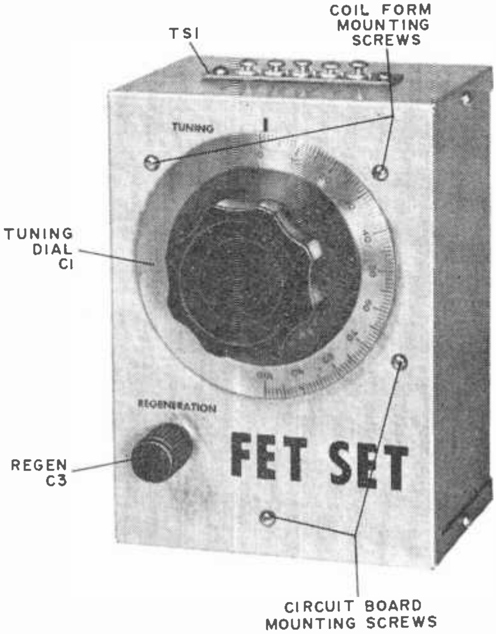




Fig. 2. Start construction by drilling holes in the aluminum box to accommodate the tuning dial shaft and regeneration control. Then drill mounting holes for the circuit board and coil form as shown here.

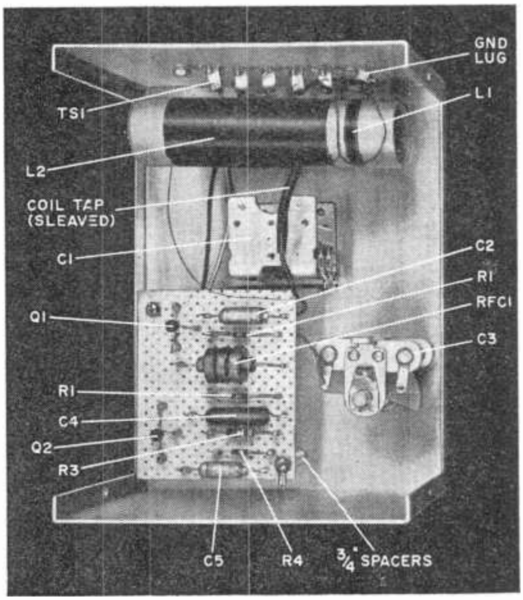



Fig. 4. The parts layout for the FET set is not critical, but the coil should be mounted at least 1 inch away from the metal box to avoid upsetting circuit Q. Mount the circuit board on 3/4" spacers.

en in Fig. 3, wind *L1* and *L2* on the form. Thread the free end of each lead down through one hole and back up through the other to hold the wire in place. When winding *L2*, form a loop about an inch long and twist it together at the 25th turn from the left end; this is your coil tap. Finish winding the coil.

Now refer to Fig. 4 and install the coil in the box, using 1"-long threaded spacers to support it. Do not use any shorter spacers, since the coil must be kept at least this distance from the metal box. Mount the tuning (*C1*) and regeneration (*C3*) controls on the front panel and set the unit aside.

Using Fig. 4 as a guide, assemble the small parts on a 2¼" x 3" perforated circuit board. Flea clips can be used to interconnect the leads. Once completed, mount the board on two diagonally-placed ¾" threaded spacers. Place a #6 grounding lug under the head of one of the mounting screws, and connect the common bus from the circuit board to this point.

Complete the remaining point-to-point wiring, using the schematic diagram (Fig. 1). After carefully checking your work, connect the battery (observe polarity), headphones, and antenna lead to *TS1*. As with any regenerative-type receiver, a good antenna and ground are a must. Use an inverted-L antenna—at least 75 feet long—placed as high as possible above the ground. The set's ground connection should be to a water-pipe.

Since no power switch is provided for the battery, you can only disconnect it by removing its leads from the terminal strip. However, if you use the recommended 6-volt lantern battery, you can get about a year's play out of the radio before having to change the battery. Of course, you can also use a regular 9-volt transistor battery if you wish, but this battery will not last nearly as long. Do *not* operate the FET set at potentials over 9 volts.

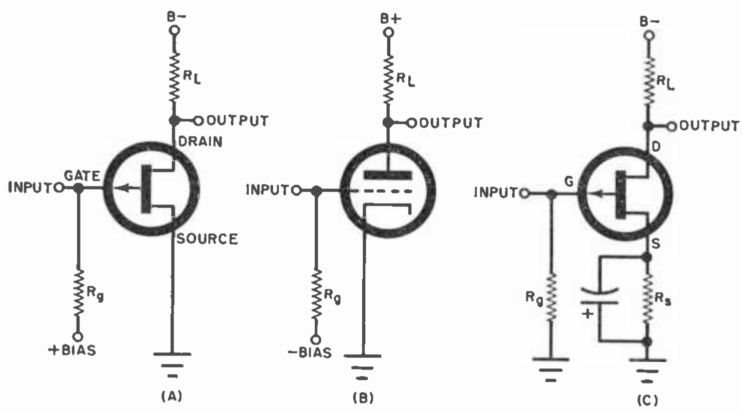
Be sure to use the recommended magnetic-type headphones and not a crystal type, since *Q2*'s drain current must return to the source through the headphones. Low-input headphones will not provide adequate volume.

**Operation.** To tune for a station, turn the *regeneration* control fully clockwise while setting your tuning dial. Then slowly turn the control counterclockwise to reduce the amount of regeneration until the detector quits oscillating. At that point, your station will come in. Now retune the dial slightly to peak the station.

As you tune across the band, the regeneration control will have to be readjusted slightly. On strong local stations, it will have to be turned down considerably to act as a volume control.

**Possible Modification.** After you have become well acquainted with the operation of your FET set, you may want to change *L1* to optimize it for your particular antenna, its location, and reception requirements. For example, if you are getting interference from a strong station over most of the band, remove three or four turns from *L1*. This reduces overloading while increasing the selectivity of the set. If you live in a poor signal area, you can increase the receiver gain by adding about five turns or so to *L1*, or making the antenna longer. —30—

## HOW A FET OPERATES

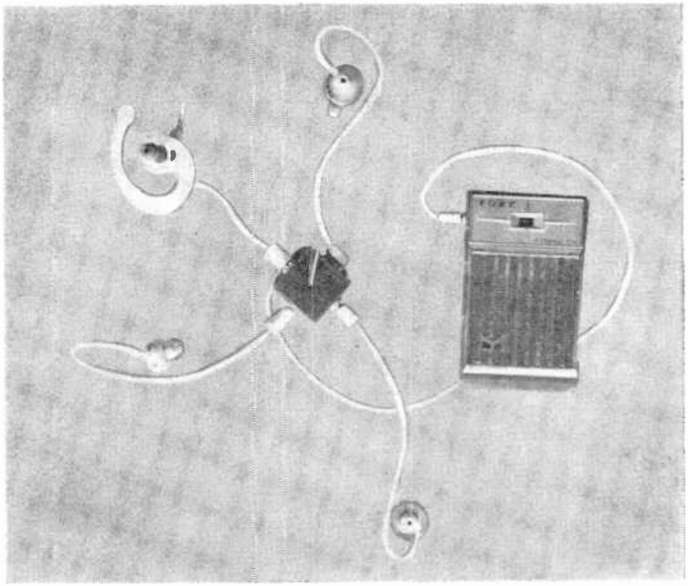



A field-effect transistor, variously called FET, JFET, IGFET and MOST or MOSFET, does not operate like a conventional bi-polar transistor. Rather, it controls current flow by means of an electrostatic field, and operates more like a vacuum tube—but requires no heater power. It has high-input impedance like a tube, and less circuit loading than a conventional transistor. Other advantages of the FET include lower inherent noise, and greater sensitivity to weak signals.

In the diagram above, observe the similarity between a p-channel FET amplifier (A) and a comparable vacuum-tube amplifier (B). Note the difference in the polarity of the operating voltages. The vacuum tube always requires a plus (+) voltage on its plate, while the p-channel FET requires a minus (−) voltage on its drain, the corresponding electrode.

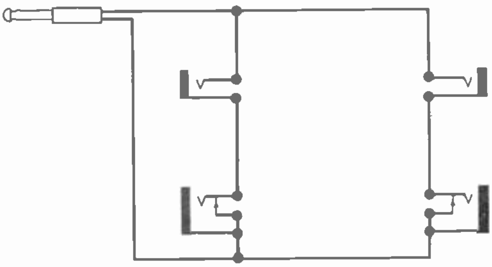
Observe, also, that the tube operates with a negative grid bias while the p-channel FET operates with a positive gate bias. To avoid the use of a separate bias supply, a self-biasing arrangement can be substituted as shown in (C). This is the scheme employed in the "FET SET" circuit.

FOUR-WAY ADAPTER LETS UP TO FOUR PEOPLE LISTEN TO A TRANSISTOR RADIO AT THE SAME TIME



# THE "PENNANT RACE" SPECIAL

DO YOU enjoy a good ball game more if, at the same time you are watching it in the ball park, you can hear the commentary on the plays and players over your transistor radio? If you do, you probably use the earphone rather than the speaker, so as not to disturb your neighbor. Since hardly anybody goes to a ball game alone, the fact that most radios have only one earphone jack presents a problem. You can solve the problem by making an inexpensive, easy-to-build four-way earphone adapter.



One to four earphones can be plugged into this transistor radio adapter. Use either open-circuit jack for one phone, any two jacks for two; do not use one of the closed-circuit jacks for three; use all jacks for four. You may have to turn up the volume control a bit to compensate for the split load.

The circuit for the adapter, shown in the diagram, is simple. You can mount the four miniature phono jacks on the sides of a small 1⅛" x 1⅛" x ⅞" plastic box. Two of the jacks are open-circuit types, and two are closed-circuit types. This arrangement helps to keep the impedance of the earphones matched to the radio.

When one earphone is used, it should be plugged into one of the open circuit jacks. When two earphones are used, any two jacks will do—whichever way the sound is best. If both earphones match the radio individually, there will be a 2 to 1 mismatch—not enough to cause any trouble. If three earphones are used, one of the closed-circuit jacks should be left empty; the mismatch will then be less than 2:1.

When four earphones are used, they will be matched to the radio, but since the radio will be supplying so many earphones, the volume in each will be less than would ordinarily be the case. However, if the radio has a fresh battery, there will be enough reserve signal volume to supply everybody's needs.

*—Alex. F. Burr*

# POPULAR ELECTRONICS "Callithump"

## A DUBIOUS TALE

ALTHOUGH history books are replete with accounts of the Spanish exploration of America, few books tell of a small colony that settled on the Scandinavian shores. This colony was called "El Ektrik."

The Spanish had chosen a poor site and the only means of survival was to harvest and live off the currants that grew in the surrounding forests. But this was not easy, for Norsemen raiding parties forced the colonists to fight for their crops. The colonists needed a battery of vaults to protect their harvest.

The currants were perishable, but the leader of the colonists, who had been schooled in England, had a good idea. "Let's store the 'arvest in our cool 'omes."

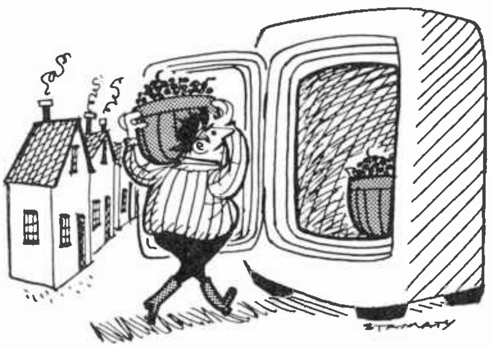
And so they did, with such success that in a few years the leader began to worry about the inadequate vaultage and the unpredictable alternating currant production.

Two brilliant El Ektricians, Al Gebra and Geo. Metry discovered that the vaultage required was proportional to the currant production and to the number of homes in the settlement. Thus, they convinced the leader of the colonists to pass a new law that enumerated the maximum number of homes per vault, or:

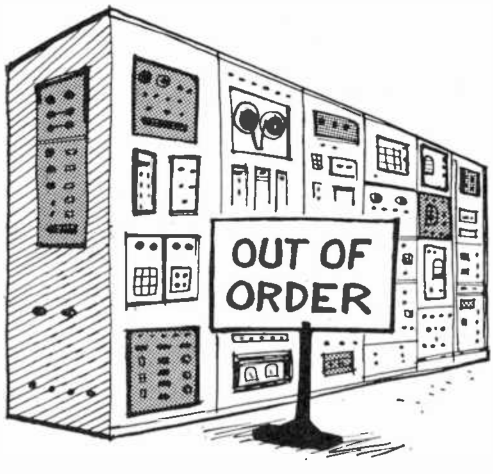
*vaultage = currant times 'omes*

Of course, you and I know that this law came down through the ages as 'omes law.

—*Errol J. Queen*



## A DAY IN A 1985 SCHOOL




"WELL, son," I said to my weary looking offspring, "it's a beautiful day, but you look like you had a rough one."

"Yeah, pop, it was pretty miserable. Those moving sidewalks between classrooms are on the fritz and I had to walk all over the building. And, when I finally got to my advanced bio-physics class, I found that the computer center had sent over a substitute teacher. A real cornball with field-effect transistors and all that old junk. I didn't know they kept anything older than large-scale IC's on the premises."

"I can see why you're tired," I commented in unfeigned understanding of his plight.

"That was nothing. You should have seen what I was stuck with in my astrophysics calculus class."

"What?"

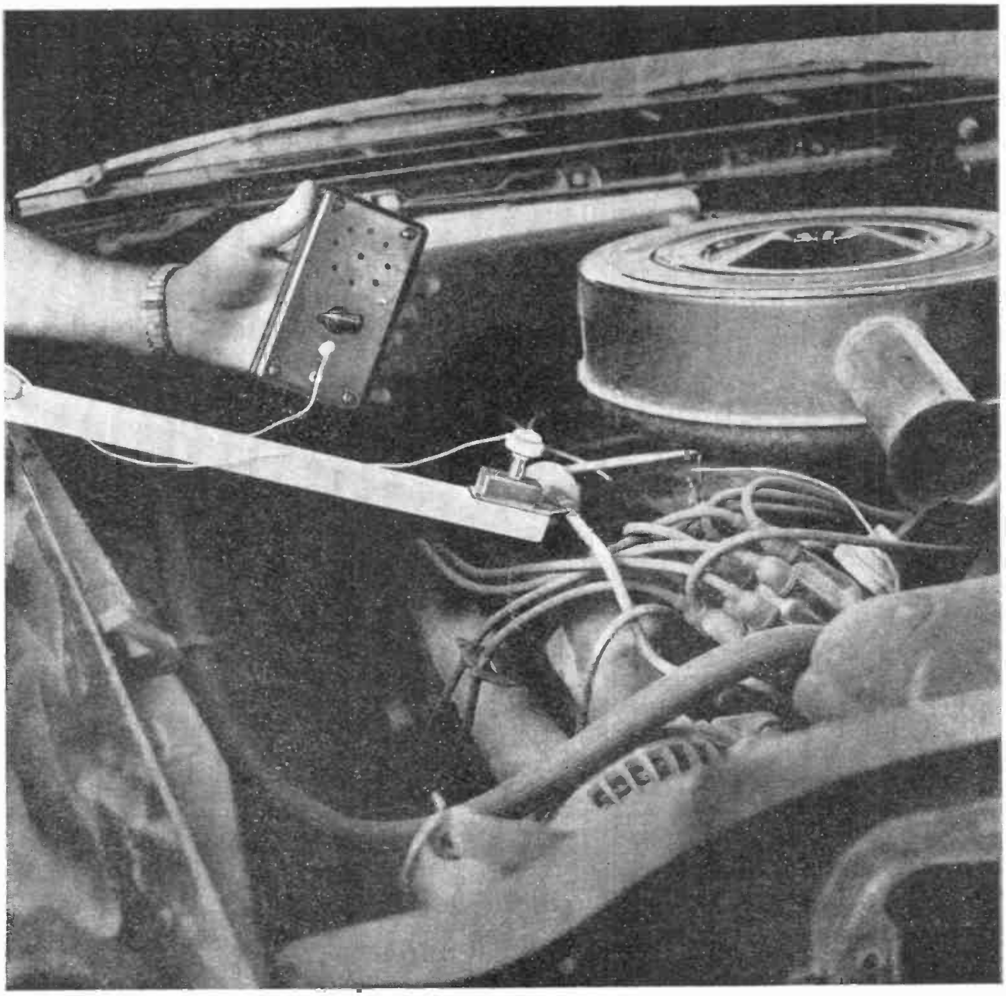
"My ILLIAC Mark XXXV had to go for maintenance and I did all of my logarithms on an analog computer. I'll bet even you had it easier back in the 60's."

"We sure did," I answered, feeling a twinge of self-reproach. "The only things I remember breaking were pencil points. But, then, our math was so simple we always did it in our heads . . .

"By the way, son," I added, "how are your grades this quarter?"

"Oh, they're okay. With my A-plus in muscular cytology and my B-minus in Babylonian cuneiforms, I'm a cinch to pass the fourth grade."

—*Jerry Kruczek*



# BUILD THE "ELECTRONIC STETHOSCOPE"

SOUND AMPLIFIER HELPS PINPOINT TROUBLES IN MACHINERY, TRACK DOWN MECHANICAL VIBRATIONS, AND LISTEN TO WEAK SOUNDS

**By SAL STELLA**

WITH THE "Electronic Stethoscope" to help sharpen your hearing, you can quickly trace a trouble in a car's engine to its source, locate a faulty bearing in an electric motor, or check the flow of liquids through pipes, feed lines, and valves. As a matter of fact, the applications of the unit are limited only by your imagination.

The stethoscope is used to amplify weak sounds or other mechanical vibrations. As the pickup end of the stethoscope approaches the sound source, the output "signal" from the pickup becomes stronger. Because the signal is strongest at the closest point to the source, it is

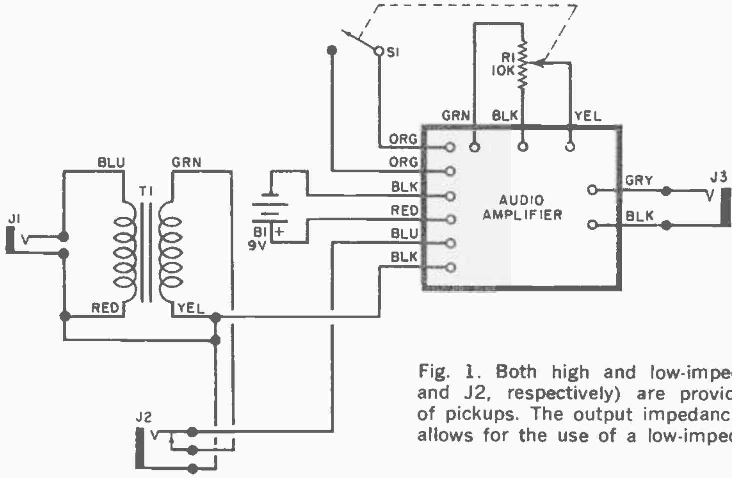



Fig. 1. Both high and low-impedance inputs (J1 and J2, respectively) are provided for a variety of pickups. The output impedance of 8 ohms (J3) allows for the use of a low-impedance headphone.

| PARTS LIST |
|---|
| *B1—9-volt battery* |
| *J1, J3—Miniature open-circuit phone jack* |
| *J2—Miniature closed-circuit phone jack* |
| *R1—10,000-ohm potentiometer (with switch)* |
| *S1—S.p.s.t. switch (mounted on R1)* |
| *T1—Impedance-matching transformer (Lafayette Radio Electronics 99 C 6034 or similar)* |
| *1—Five-transistor audio amplifier module (Lafayette Radio Electronics 99 C 9037 or similar)* |
| *1—Under-the-chin low-impedance dynamic headphone* |
| *1—High-impedance headphone for pickup—see text* |
| *1—Crystal or dynamic phono cartridge* |
| *1—5" x 3" x 2" (approx.) plastic or metal box* |
| *Misc.—Sheet metal, wood, magnet, solder, flat piece of iron or steel, nuts, bolts, spacers, etc.* |

easy to pinpoint a noisy or defective mechanical component.

Construction time for the "Electronic Stethoscope" shouldn't be longer than three hours. And the cost of the unit is only about $10—a considerable saving over the prices of many commercially available electronic stethoscopes.

**How It Works.** As shown in Fig. 1, the "Electronic Stethoscope" is built around an audio amplifier module. Power for the amplifier is supplied by a 9-volt battery, *B1*; potentiometer *R1* functions as a volume control; and jacks *J2* and *J1* serve as inputs for a low-and a high-impedance signal source, respectively. The purpose of transformer *T1* is to match a high-impedance source to the amplifier's low-impedance input. In order to obtain a continuous circuit when the low-impedance input is not in use, *J2* must be a closed-circuit jack.

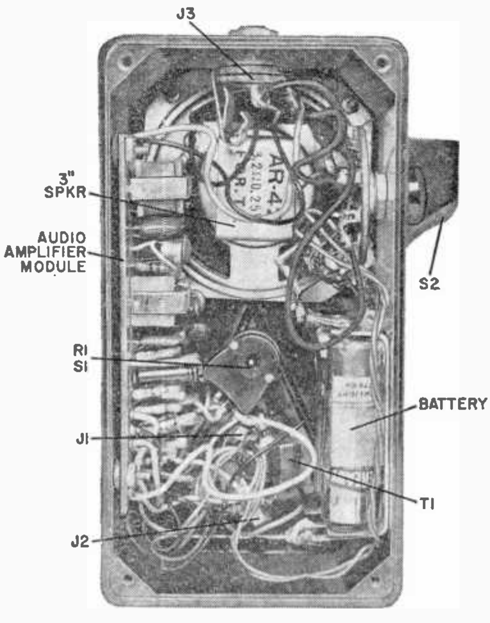



Fig. 2. A miniature 8-ohm speaker and a selector switch can be mounted on the case to provide a choice of either headphone or speaker output.

The device used as a microphone to pick up sound is a small crystal head-spacers or some washers to maintain a suitable clearance between the amplifier and case. Another small case can be used to store the pickups and magnets.

To make a hands-free mount for the sound pickup (microphone), attach the small headphone unit to a magnet. Cut the head off a 1½"-long #6 or #8 machine screw (whichever will make a better fit), and insert the screw into the earpiece as shown in Fig. 3. Secure it in place with a drop of cement. Bolt the earpiece assembly to the magnet, being careful not to overtighten it. The magnet shown can be obtained from most hardware and department stores.

You can make a suitable probe for getting into hard-to-reach places with the pickup by attaching a small flat piece of steel or iron to one end of a 24" x 1" x 1" piece of wood (see Fig. 3). The size of the metal is not important, but it should be large enough to accommodate the magnet. The end of the metal should be cut to a point to obtain maximum resolution of the trouble area.

An inexpensive crystal or ceramic phono cartridge connected to the amplifier's high-impedance input can be used to pick up mechanical vibrations. Attach the cartridge to another long piece of wood to make a convenient probe.

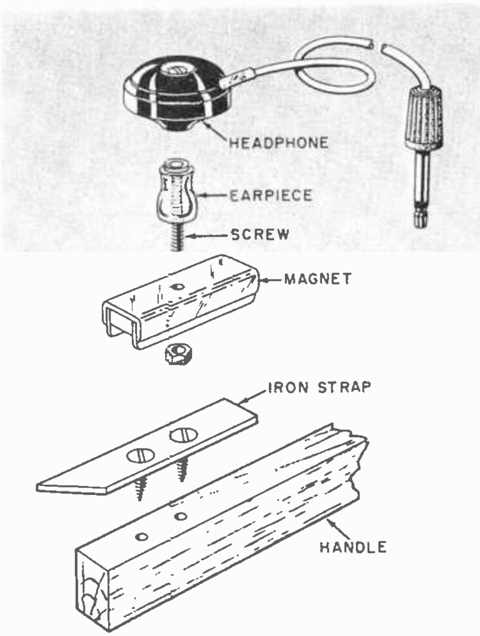
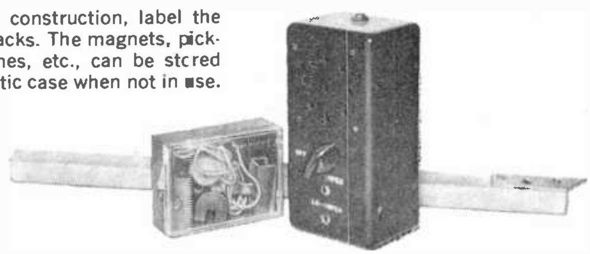


Fig. 3. The pickup should be mounted on a small but strong magnet. The probe consists of a wood handle with a flat piece of iron bolted to one end.


After finishing construction, label the controls and jacks. The magnets, pickups, headphones, etc., can be stored in a small plastic case when not in use.

phone of the type used with pocket-sized portable radios. An old crystal or ceramic phono cartridge will make a relatively inexpensive mechanical vibration sensor. Sounds or other mechanical vibrations sensed by the pickup are amplified and fed through *J3* to a low-impedance under-the-chin headphone.

**Construction.** Either a plastic or a metal case measuring about 5" x 3" x 2" can be used to house the battery and amplifier module. Transformer *T1* can be mounted by soldering one of its mounting tabs to the outer conductor lug of *J2* as shown in Fig. 2. Use ½"-long

If you attach a metal clip to the stethoscope, you'll be able to hang the unit on your belt. The clip can be made from a 1"-wide by about 3"-long piece of 22-gauge sheet metal that has been bent to a shape roughly resembling a money clip. In fact, you can use a money clip. Mount the clip on the back of the amplifier case.

With only a little practice, diagnosing mechanical troubles with the "Electronic Stethoscope" should be second-nature to you. -30-


Better than 9 out of 10 CIE men win their "ticket" the very first time they try (NATIONAL AVERAGE IS ONLY 1 OUT OF 3)

## Cleveland Institute of Electronics

# WARRANTY

## of success in obtaining a Government FCC License

The Cleveland Institute of Electronics hereby warrants that upon completion of the Electronics Technology, Broadcast Engineering, or First-Class FCC License course, you will be able to pass the FCC examination for a First Class Commercial Radio Telephone License (with Radar Endorsement);

OR upon completion of the Electronic Communications course you will be able to pass the FCC examination for a Second Class Commercial Radio Telephone License;

AND in the event that you are unable to pass the FCC test for the course you select, on the very first try, you will receive a FULL REFUND of all tuition payments.

This warranty is valid for the entire period of the completion time allowed for the course selected.

G. O. Allen

G. O. Allen
President

BUILD A

# STACKED-ANTENNA AM RADIO

## TWO ANTENNAS CAN BE BETTER THAN ONE

**By ART TRAUFFER**

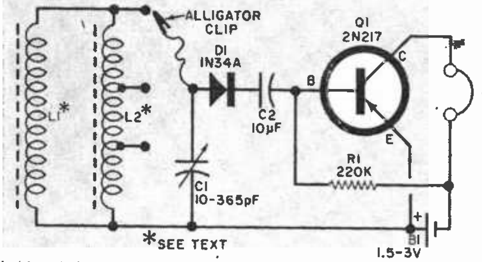
IT IS a well-known fact that you can increase a radio's sensitivity simply by using a better antenna. The technique of stacking two or more antennas in parallel is also well known. Since the ferrite loopstick has taken the place of outdoor antennas, particularly for local reception of AM broadcast programs, why not try stacking two loopsticks?

You can't just connect two loopstick antennas in parallel, however, because these antennas are also used to form the tunable tank circuit at the head end of the radio. When you connect two coils in parallel, you decrease their total inductive reactance and shift the band of frequencies covered. But, with a little do-it-yourself activity, you can make them work for you. It is necessary only to double the inductive reactance of each antenna, so that the total reactance of the two when in parallel is the same as for the one that would ordinarily be used.

You can build a small two-loopstick radio in about an hour, and at a cost of less than $5.00.

**PARTS LIST**

*B1—1.5- or 3.0-volt battery*
*C1—10- to-365 pF miniature tuning capacitor*
*C2—10-µF, 10-volt electrolytic capacitor*
*D1—1N34A diode*
*L1, L2—Antenna coils—see text*
*Q1—2N217 transistor*
*R1—220,000-ohm, ½-watt resistor*
*Misc.—Headphones, battery holder, hookup wire, etc.*




Stacked ferrite core antennas (L1 and L2) provide an AM radio with increased sensitivity to incoming signals. Since the antennas also form part of a tunable tank circuit, they must be specially wound.

**How It Works.** The circuit shown here is that of a simple crystal type radio with one stage of amplification. Coils *L1* and *L2* act as the antennas, and connected across *C1*, they form a resonant circuit that can be tuned across the AM broadcast band.

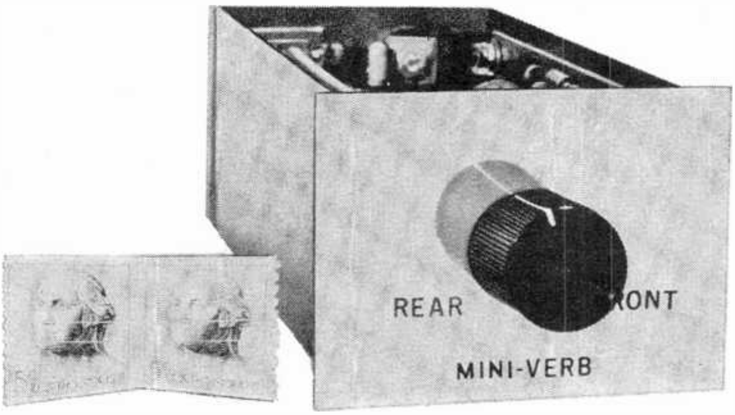
When a signal is picked up by *L1* and *L2*, it is detected by *D1* and capacitively coupled to amplifier stage *Q1*. After amplification, the demodulated signal is fed to the headphones.

Power for the circuit is supplied by a ½- or 3-volt battery, *B1*. Resistor *R1* provides forward bias for *Q1*, and allows it to operate as a simple Class A amplifier.

**Construction.** The best way to build this circuit is to breadboard it. Parts layout is not critical, except for *L1* and *L2* which must be mounted two or three inches apart and parallel to each other for best results.

The antennas, *L1* and *L2*, are wound on 7½″-long by 0.33″-diameter ferrite rods using #24 enameled and cotton-covered wire. Wind 125 turns of wire evenly spaced along the length of the rods. Both coils must be wound in the same direction. As you wind *L2*, strip back the cotton and enamel insulation at several places along the rod and "break out" into small loops, to make the taps. Then use wax or coil dope to hold the wire in place.

No power switch is needed since all you have to do to break the circuit is unplug the headphones from the radio. However, if you decide to wire the headphones directly into the circuit, connect an s.p.s.t. switch in series with either connection to *B1*. Use the alligator clip to select the tap that gives you best reception. —30—




# BUILD THE "MINI-VERB"

By DANIEL MEYER

IMPROVED AUTO REVERB CIRCUIT USES NEW MINIATURIZED UNIT; SUITABLE FOR ATTACHMENT TO STEREO HI-FI RIGS

REVERBERATION systems are offered as "accessory" equipment with many cars, included in many high fidelity systems or electronic organs, and even in public address amplifiers. Reverb systems give music a warmer tone and add a feeling of spaciousness by simulating the reverberation—or echo—effect of large concert halls. A car—or even the average living room—is not big enough to have an audible natural reverberation. So adding electronic reverberation makes the reproduction more pleasant and gives a feeling of concert-hall space.

The "Mini-Verb," an improved and updated version of the system described in POPULAR ELECTRONICS, Feb., 1966, was originally built for use in a car. It was miniaturized by using a smaller delay line than the one in the older system. However, it is also usable with your home hi-fi installation and can be hooked up to most stereo systems with little trouble. Quality and output power have been kept high in spite of the fact that the size has been brought down.

A standard high-fidelity solid-state circuit is used in the amplifier. The transformerless class-B output stage will deliver at least 3 watts into a 3.2-ohm speaker with less than 1% distortion. Silicon transistors are used throughout for maximum temperature stability.

The small delay line reverb unit (Gibbs Type VII) makes possible a compact system that can be installed almost anywhere. The case measures 2" x 2¾" x 6" and includes the fader control and power switch. If you have room in your

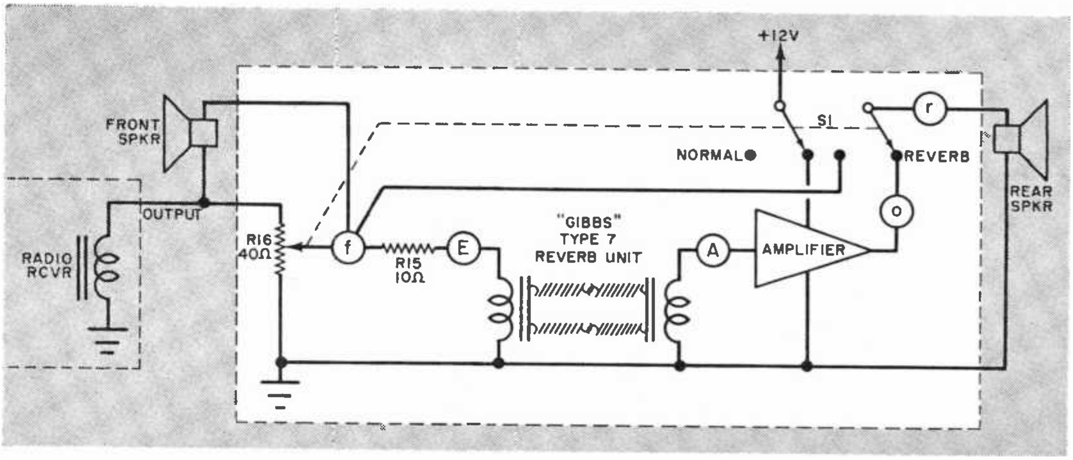



Fig. 1. In an automobile installation, reverberation is achieved by delaying and "reverb'ing" the sound from the rear seat speaker. The delay of sound fools the ear into believing the sound is in a large concert hall.

## PARTS LIST

| | |
|---|---|
| *C1, C7—10-μF, 15-volt electrolytic capacitor* | *R9—100-ohm, ½-watt resistor* (All resistors 10% tolerance) |
| *C2—30-μF, 6-volt electrolytic capacitor* | *R11—1000-ohm, ½-watt resistor* |
| *C3, C4—5-μF, 15-volt electrolytic capacitor* | *R12, R13—220-ohm, ½-watt resistor* |
| *C5—200-μF, 6-volt electrolytic capacitor* | *R14—470-ohm, ½-watt resistor* |
| *C6—500-μF, 25-volt electrolytic capacitor* | *R15—10-ohm, ½-watt resistor* |
| *C8—100-μF, 15-volt electrolytic capacitor* | *R16—40-ohm, 5-watt wire-wound potentiometer with slide actuator* |
| *D1, D4—1N645 silicon diode, 600-mW* | *Rb—220-ohm, ½-watt resistor—see text* |
| *D2, D3—1N3754 single-ended diode (RCA)* | *S1—D.p.d.t. slide switch* |
| *F1—½-A Slo-Blo fuse* | *1—Gibbs Type VII reverberation unit* |
| *Q1, Q2, Q3—MPS-3708 transistor (Motorola)* | *Misc.—Case, printed circuit board, fuse holder, nuts, bolts, knob, wire, solder, etc.* |
| *Q4—MPS-3638 transistor (Motorola)* | |
| *Q5, Q6—TIP-24 transistor (Texas Instruments)* | |
| *R1, R3, R6, R10—4700-ohm, ½-watt resistor* | |
| *R2, R7—22,000-ohm, ½-watt resistor* | |
| *R4—1000-ohm miniature trimmer control (Mallory MTC-1 or similar)* | |
| *R5—2200-ohm, ½-watt resistor* | |
| *R8—25,000-ohm, ½-watt resistor* | |

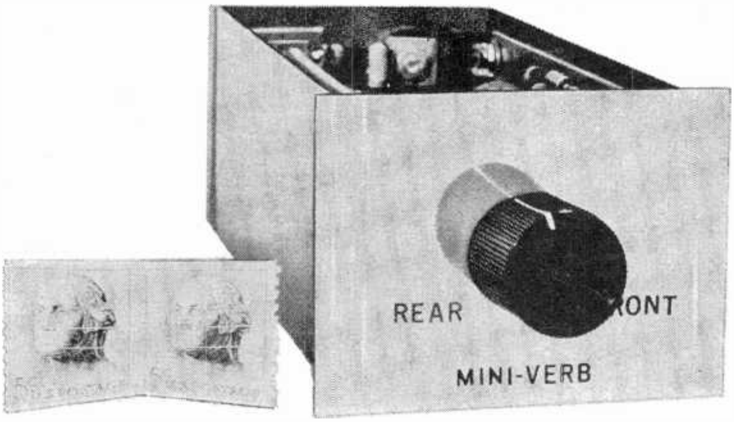
A complete kit of parts including a special case is available from DEMCO, 219 W. Rhapsody, San Antonio, Texas 78216, for $16.74 (postpaid). Prices of individual components are available on request.

car to mount a speaker selector switch, you will probably have enough room for the reverberation system.

**How It Works.** The heart of any reverberation system is the audio delay line. It consists of two electromagnetic transducers and a pair of different-diameter springs coupling them. Audio frequency signals drive the input transducer, which twists the springs slightly. This mechanical motion travels down the springs and creates an electrical signal in the output transducer. Not all the mechanical energy is reconverted to an electrical signal—some energy continues to travel back and forth and gradually decays, resulting in both a delay and a decay of the original sound, as with natural echoes.

The audio signal is split between the speakers through a fader control (*R16*) and selector switch *S1* (Fig. 1). When the selector switch is in *normal* position, the same signal is applied to both front and rear speakers. The fader serves as a variable divider to balance or shift the sound output from each speaker as desired. When the fader control knob is pulled out, *S1* switches the power onto the reverb amplifier and connects the rear speaker to the amplifier's output.

The signal from the radio now drives the front speaker and the input transducer through *R15*. The output transducer of the reverb unit is connected to a high-gain amplifier (Fig. 2). The amplifier makes up the 40 to 45 dB loss in the delay line reverb unit. In this circuit, *Q1* drives voltage amplifier *Q2*, which is directly coupled to a pair of complementary driver transistors, *Q3* and *Q4*. The driver transistors drive the class-B output pair on alternate half cycles.

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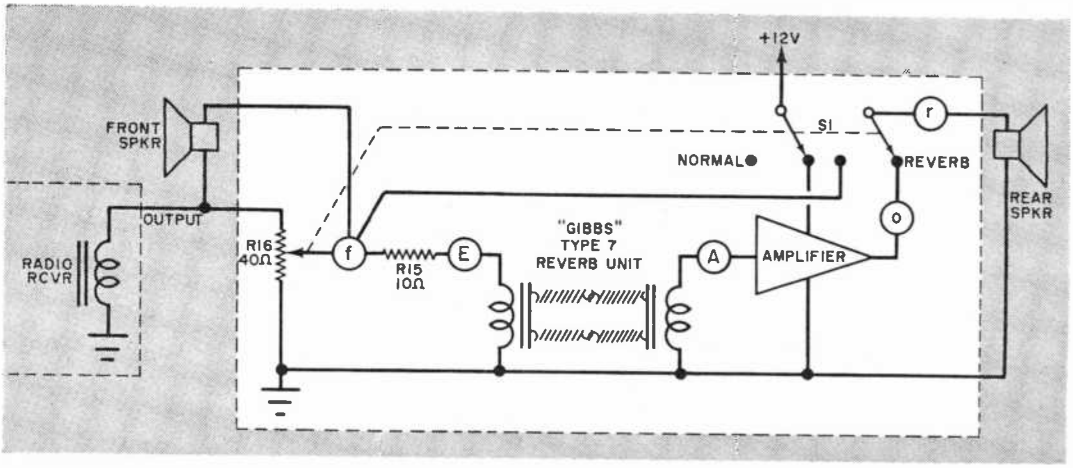


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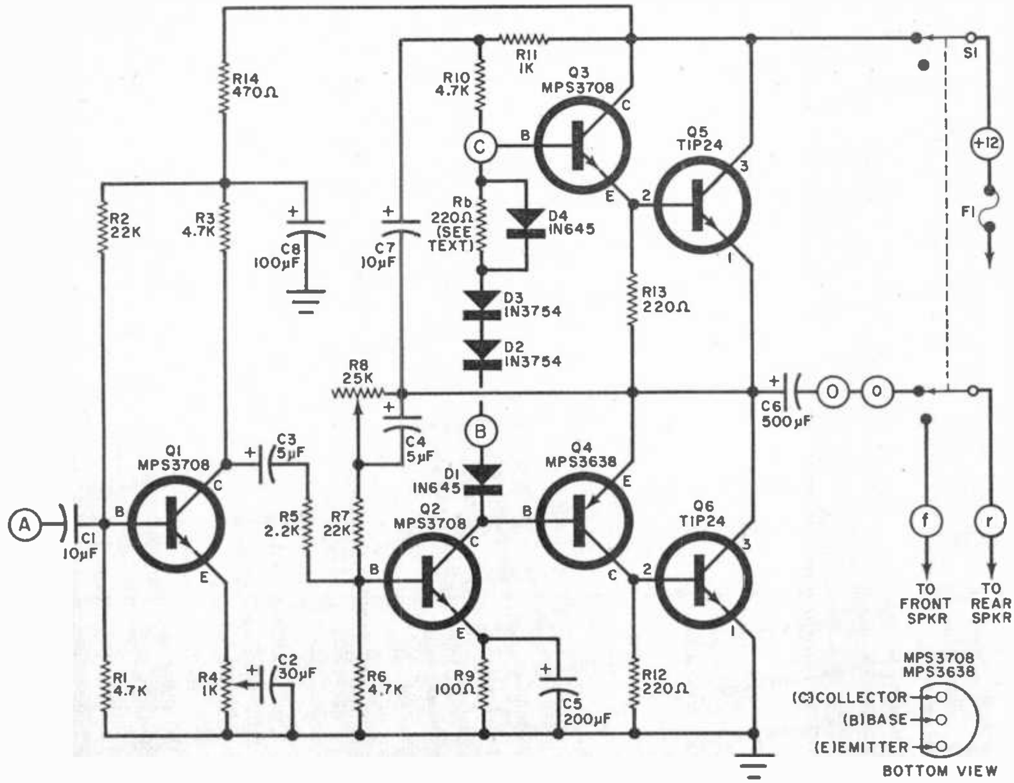



Fig. 2. Schematic diagram shows the simple solid-state high-gain amplifier required to compensate for the audio signal in the reverberation springs. The amplifier has a 3-watt output and is powered by 12 volts d.c.

The diodes between the base of *Q3* and the base of *Q4* provide a small forward voltage bias to prevent crossover distortion and also provide temperature compensation. Diodes *D2* and *D3* are in direct physical contact with the output stages, as shown in Fig. 3. Any heating which would increase output transistor idle current is quickly sensed by the diodes. The heat reduces the diode voltage drop, reducing the transistor forward bias and idle current.

The reverb system's gain is controlled by *R4* and the fader (*R16*)—*R4* for the coarse settings and the fader to make variations to suit the taste of the listener. The amplifier is efficient and draws only about 10 mA with no signal input. At full 3 watts output, the current is 0.4 to 0.5 ampere.

**Construction.** To make the system small but still easy to assemble, the amplifier is built on an etched board and the whole system is housed in a specially designed case. (See Fig. 4). If you follow the instructions, there should be no construction problems.

Begin by mounting the power transistors and diodes in the rear of the case. Use a 6-32 x ½" screw, with a shoulder washer on the outside of the case and a mica spacer between the inside of the case and the transistor mounting flange. Be sure to coat both sides of the mica washer with silicone grease to insure good heat transfer.

The 1N3754 bias diodes are pushed into their clips and mounted with the same screw that holds the transistors. The diode leads are insulated from the case, so the clips can contact the transistor mounting tab. Turn the diodes so that the red cathode identification dots are opposite each other. Cut the lower leads and solder them together—cathode of one to anode of the other—as shown in Fig. 3. Mount the terminal strip next

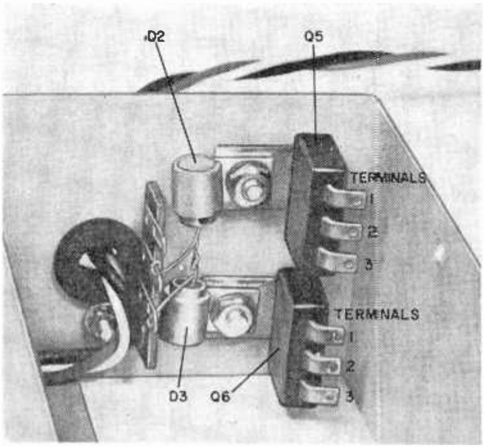



Fig. 3. The npn output transistors are of unusual construction and have not previously appeared in POPULAR ELECTRONICS projects. Each transistor is bolted to the chassis wall along with biasing diodes D2 and D3. You must follow this plan.

to the diodes and connect the remaining two leads to the center and lower lugs. Check for possible shorts between the transistors and case.

Now mount the fader control and reverb unit. Wire the leads for the front speaker, radio input, and ground to the fader control. Dress the wires behind the reverb unit and to the case bottom, install the grommet, and bring the wires out through the grommet.

Mount the various parts on the circuit board (Fig. 5) as indicated by the printed part numbers (see p. 46). Be sure the electrolytic capacitors and diode are mounted with correct polarity. Solder leads to *Q5* and *Q6* as shown in Fig. 3. Connect wires to points *+12V* and *r*, for the power and rear speaker, and to *B* and *C* for the bias diodes. Use a piece of lamp cord or equivalent to wire the rear speaker.

Connect the ground side of the rear speaker to the board's ground strip near the output transistor connection. Do *not* attempt to use the frame of the car for the ground lead to the rear speaker—this can result in noise and even circuit oscillation. Connect a short piece of hookup wire to point *f*. Connect the green lead from the reverb unit's output (red coil) to point *A* and the green lead from the input to point *E*. Be sure all wires and connections are soldered.

Mount the circuit board on the side of the case (Fig. 6) with *4-40* x ⅜" machine screws. Be sure the switch knob slides between the plates at the rear of the fader control. Use quarter-inch spacers between the case and the circuit board. Connect the wire from point *f* to the

Fig. 4 (below). Due to the intense interest in this project, the author in conjunction with POPULAR ELECTRONICS offers a special mounting case.

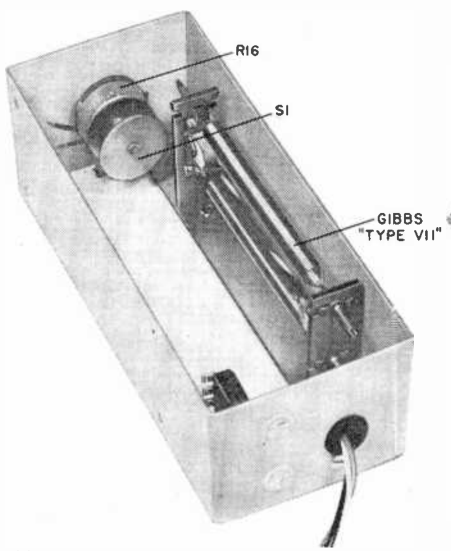



Fig. 5 (below). View of partially completed printed circuit board shows location of some of the components. The numbers alongside C6 pertain to connections to transistor Q6.

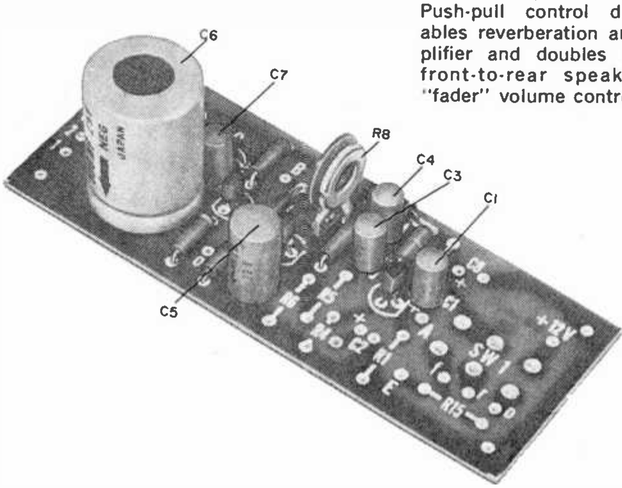
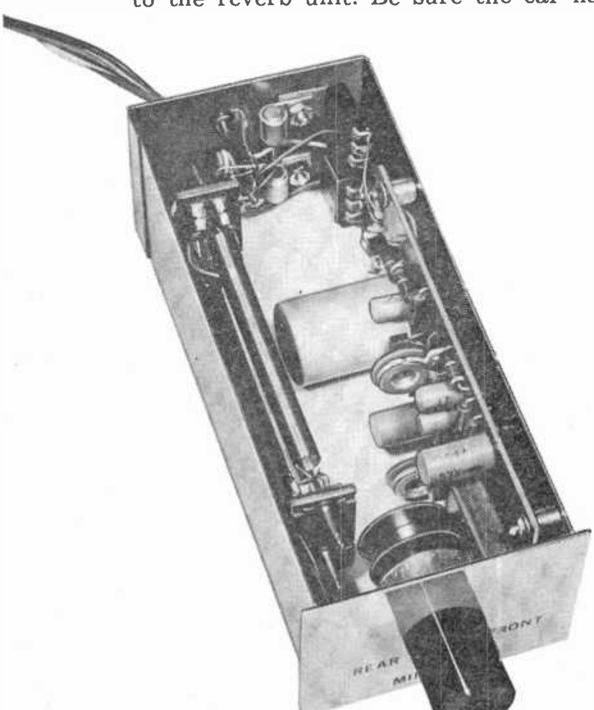



Fig. 6 (right). Photo of the completed unit. Push-pull control disables reverberation amplifier and doubles as front-to-rear speaker "fader" volume control.

arm of the fader control. Mount a soldering lug under the mounting screw at the bottom front of the board, and connect it to the black wires from the reverb unit coils and to the ground side of the fader control, using a short piece of bare wire.

Connect the leads from the board to the power transistors. The numbers on the board and the transistors must match: 1 to 1, 2 to 2, etc. Connect the wire from point *C* to the upper (unused) lug on the terminal strip. Install *D4* and *Rb* on the terminal strip and, observing polarity, the other end to *D3*'s anode. Connect a wire from point *B* to the cathode side of *D2* on the terminal strip. Connect a lead at *+12V* and run it out through the grommet in the rear of the case to the fuse holder. (This in-line type holder can be picked up at an auto supply house, and is used with a half-ampere Slo-Blo fuse.) Label the leads—to protect the transistors.

**Installation.** The circuit is designed to work with an ungrounded front speaker. If one side of your speaker is grounded at the speaker frame rather than at the radio, simply clip the ground lead and splice on a piece of wire for connection to the reverb unit. Be sure the car has 4- or 8-ohm speakers. (There are some 40-ohm systems around which require a matching transformer from the radio to the reverb unit.) Also, be sure the speaker is not "hot." Some speakers have 12 volts on the leads.




Connect the +12-volt lead from the fuse holder to the radio, or connect it to the accessories terminal on the ignition switch. Connect the ground lead to an unpainted screw or to some other point that you are sure is a good ground on the car's frame. Connect the lead from point *f* on reverb input to the front speaker. Run the two rear speaker wires to the rear speaker.

Turn the radio on, with the reverb unit knob pushed in. The control should vary the volume of the front and rear speakers as it is turned, with near-zero volume on the front speaker at the extreme rear position, and vice versa. Now pull the fader knob out. You should have about the same volume as before with *R4* set for full gain (the resistor is partially bypassed by *C2*). Sound will probably be best with a bit less volume on the rear speaker when the system is in the reverb position. Set the fader control in the center position and adjust *R4* for the most pleasing rear speaker level.

The reverb unit cover can be fastened under the dash with sheet-metal screws, or mounted through the dash and held by the fader control bushing.

**Testing.** The system will work quite well without exact circuit adjustments. You can, however, get lower distortion and slightly greater output if you have the proper equipment to make a few tests.

Resistor *Rb* is specified as 220 ohms. This is slightly lower than the best value but safe in all cases. A slightly higher value may reduce crossover distortion. To check for the proper value, connect a milliammeter (VOM) in the +12-volt lead. Short the meter leads and turn on the amplifier. Unshort the meter leads and read the idle current. Now short *Rb* with a clip lead and watch the meter reading. If it drops between 5 and 10 mA, the value of *Rb* is okay. If the drop is less, increase the value of *Rb* to 270 ohms, and check again. The initial current reading should not be more than 15

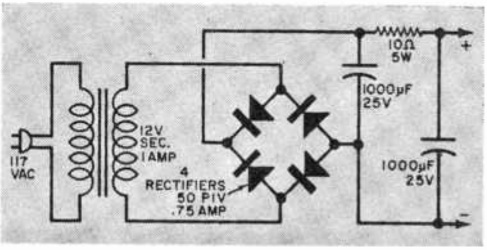



Fig. 7. This simple power supply will enable the builder to operate his Mini-Verb off the 117-volt a.c. lines. All components are easily purchased.

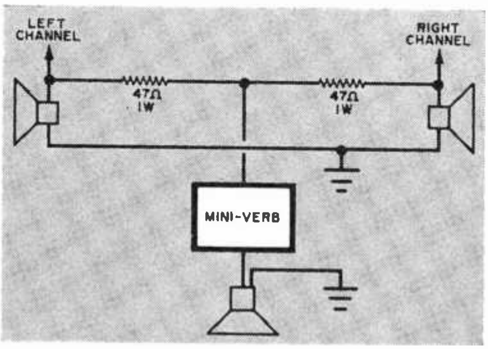


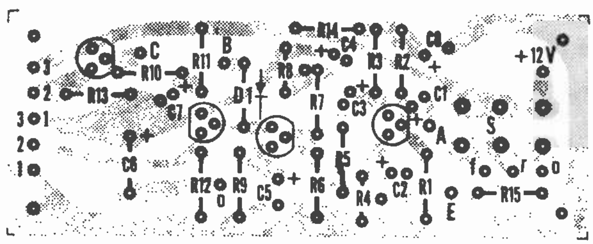

Fig. 8. Reverberation in your home calls for using the Mini-Verb as a third channel. Mixed signal from the right and left channels is derived as shown in this diagram. See text at right for more information.

mA, and *Rb* must not be increased past the value that gives a 10 mA increase in current.

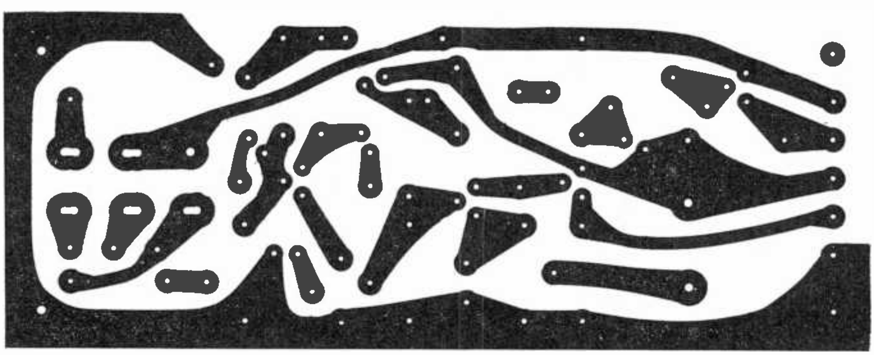
You can adjust *R8* in either of two ways. If you have only a voltmeter, it can be set for a reading of +6 volts at the emitter (terminal 1) of *Q5*. If an oscilloscope and signal generator are available, drive the amplifier to full output (clipping level) with a 4-ohm load at about 1 kHz and adjust *R8* for symmetrical clipping of the observed waveform.

**"Stationary" Applications.** To use the "Mini-Verb" with your high fidelity system (or public address equipment), you will need a 12-volt power supply that can deliver 500 mA with good regulation and low hum. A typical circuit is shown in Fig. 7.

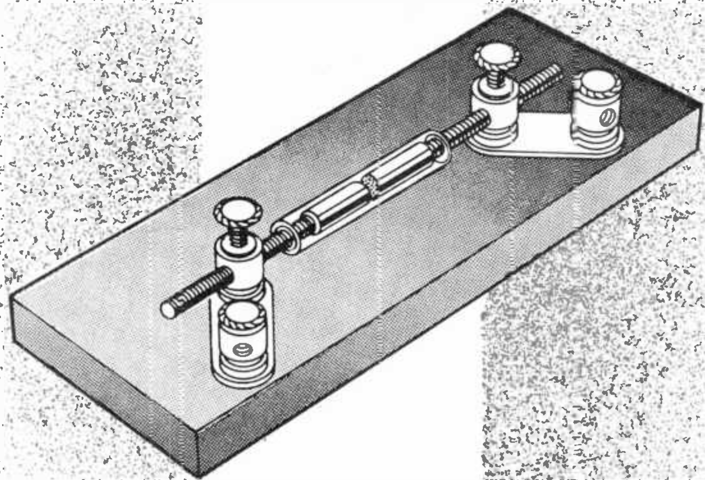
To use the "Mini-Verb" with your stereo system, follow the circuit of Fig. 8. (The resistors should be about 47 ohms, 1 watt; reduce the resistance if reverb volume is too low.) This circuit will give you a driving signal that contains information from both channels. Little separation remains in reverberation sound, so two channels are unnecessary in the reverb system. —30—



Actual-size printed circuit template—for those who like to make their own—is given below. Component location is shown on the unwired side of the board in the diagram at the left.



# The "Coherer"



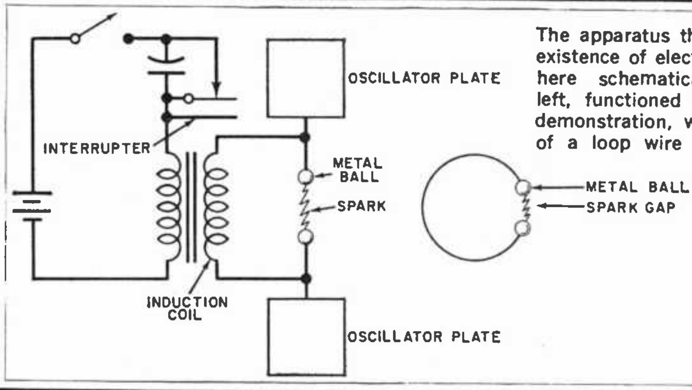
## THE EARLY HISTORY OF RADIO COMMUNICATIONS AND THE MEN AND DEVICES THAT MADE IT POSSIBLE

**By HENRY B. DAVIS**

WHILE MOST HISTORY BOOKS date the birth of radio from Marconi's invention of wireless, this is only a half-truth. Like many scientific discoveries, the radio phenomenon was known as a "paper theory" many years before its actual existence was proven.

As early as 1845, Michael Faraday observed that the characteristics of light and electricity were basically similar. It was this observation that spurred James Clerk Maxwell, a brilliant British physicist, to dig deeper into the phenomenon.

In his paper "On A Dynamical Theory Of The Electromagnetic Field," written in 1864, Maxwell noted that a change in a magnetic field could bring about a change in an electrical field, and vice versa. This led to his conclusion that electromagnetic energy could be propa-




The apparatus that Hertz used to prove the existence of electromagnetic waves is shown here schematically. A crude oscillator, left, functioned as the transmitter for the demonstration, while the receiver consisted of a loop wire bent into a ring (center).

gated into space from a wire conductor, and that the energy traveled at the speed of light. He failed, however, to present physical proof of his theory.

**In the years that followed,** a great deal of scientific thought was given to Maxwell's theory. But it was 1887 before Heinrich Hertz, a German physicist, demonstrated a device which proved that the Maxwell theory was correct.

To generate electromagnetic energy (really radio waves), Hertz used a spark transmitter, operating around 4 meters (75 MHz). His "receiver" consisted of a length of wire with a small metal ball at each end; the wire was bent to form a ring with a small air gap between the metal balls. When the transmitter switch was thrown, the spark generated electromagnetic energy and this energy was induced into the wire "receiver," causing a spark to jump the gap between the receiver's metal balls. Thus, a spark produced by the transmitter induced a spark in the "receiver." No physical contact between the transmitter and the "receiver" existed.

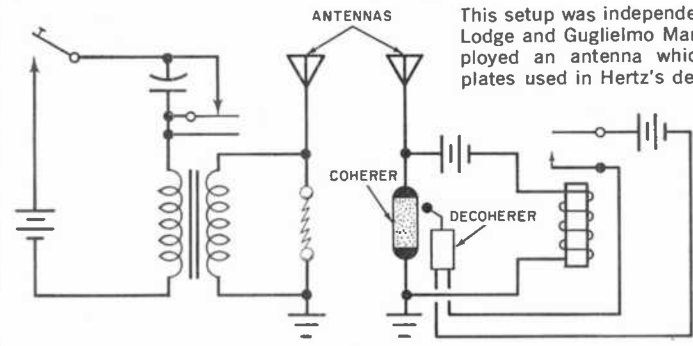
Although the distance between the two units was limited to a few feet, it was soon learned that this range could be increased to about 50 feet simply by limiting the size of the "receiver" wire to the wavelength of the oscillator's frequency and carefully adjusting the gap between the metal balls at the wire's ends.

Hertz's demonstration encouraged new interest in electrical waves—which came to be called "Hertzian" waves. Attempts to conduct radio waves through earth and water were carried out. Then experiments were made with large coils of wire to try and find a method of transmitting and receiving electromagnetic radiation by induction alone. But it was the introduction of the first sensitive radio wave detector—the "Coherer"—that made it possible to use radio waves as a means of demonstrating intelligent communications.

**Back in 1850** the French scientist, Pierre Guitard, had discovered that dust particles in the air *cohered,* or collected together, when electrified. Later, in 1879, David E. Hughes, an American electrician and the inventor of the carbon microphone, while investigating the resistance properties of loose carbon granules, discovered that the granules *cohered,* going from a high-resistance to a low-resistance state, when a current was passed through them.

Dr. Edouard Branley, another French physicist, perhaps borrowing from Hughes' elementary discovery, built the first "Coherer." His Coherer consisted of a glass tube partially filled with iron filings and plugged with corks through which wire electrodes had been forced. In operation, the iron filings *cohered* when a strong radio signal was impressed across the electrodes. Branley did not use his instrument for the reception of radio waves, but he did find that the Coherer had to be tapped manually to *decohere* the filings in order to return the unit to a high-resistance condition.

A British physicist, Sir Oliver Lodge, was the first to use the Coherer in place of Hertz's wire loop, for the detection and pen recording of Morse code signals.




This setup was independently designed by Sir Oliver Lodge and Guglielmo Marconi. The transmitter employed an antenna which replaced the oscillator plates used in Hertz's device. The receiver consisted of Branley's Coherer, a Popov decohering device, and a receiving antenna. Operation was essentially the same as in Hertz's setup, but there was an enormous increase in sensitivity.

Because the Coherer had to be *decohered* after detecting each pulse of electromagnetic energy, it was suitable only for a Morse code type of communications setup. Sir Oliver, understanding this to be the case, used a "trembler" to *decohere* the iron filings.

In 1895, when the Russian physicist, Aleksandr Stepanovitch Popov, employed the armature of an electric bell to *decohere* the particles, practical transmissions of pulses at a reasonable rate of speed became possible. The bell did away with the need for necessarily slow manual *decohering*. But an even more significant achievement attributed to Popov is the fact that he was the first person to consider using an antenna with the Coherer circuit. The addition of the receiving antenna increased the radio range to more than 900 feet.

**At this point,** Marconi enters the picture. Sir William Crookes, in the British publication *Fortnightly Review,* predicted in 1892 that wireless [radio] telegraphy would replace all other means of rapid communications. It is likely that this prediction inspired Guglielmo Marconi, the Italian inventor, to make the dream come true.

Marconi took the crude Coherer Branley had designed and made improvements on it. He replaced the corks with silver plugs. And by using a mixture of silver and nickel filings in place of iron filings and evacuating the air from the tube, Marconi succeeded in producing a device many times more sensitive than the original Coherer.

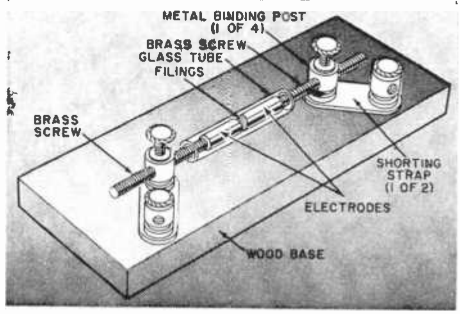
With his own improved version of the Coherer, the Popov method of *decohering,* and a receiving antenna, Marconi attained results that can be described as only slightly less than spectacular. Signals of from 2 to 9 miles were observed almost immediately, and by early 1901 the figure had increased to 200 miles. About the same time, at the suggestion of Sir Oliver Lodge, Marconi incorporated an "oscillation transformer" in his radio system which permitted the system to be tuned to a given resonant frequency.

Marconi's crowning achievement, however, came about when, on December 12, 1901, he succeeded in proving that radio waves could be intercepted around the curvature of the earth. On that day, he received a signal transmitted from England—some 2000 miles from where he waited on the coast of Newfoundland, Canada.

**It is not really clear** when radio was actually born. But it certainly was not in existence before Hertz demonstrated his apparatus, and just as certainly it came about not later than Sir Oliver Lodge's demonstration. Both of these events took place prior to Marconi's historic adventure into the new technology.

The achievements of these early pioneers were monumental considering the fact that most of the work was accomplished before the advent of the electronic amplifier. Just how incredible these achievements were can be fully realized only by building and using a Coherer yourself. The diagrams and text on the following page provide all the necessary details. —30—

# MAKE YOUR OWN COHERER




Parts must be solidly mounted on the wood base. Screw-type metal binding posts will facilitate easy mounting of the electrode assembly and will also provide convenient circuit connections.

THE DRAWING at right is more or less self-explanatory. Most of the dimensions will depend on the materials you use, but keep the inner diameter of the glass tube down to about 3/16" and the lengths of the electrodes to about ½". Also, file the ends of the electrodes opposite the screws at a slight angle to facilitate tuning.

Rub both electrodes in mercury until they take on a bright metallic coating, then attach the screws as shown. If you run into any problem trying to mate the electrodes to the glass tube, file or sand the electrodes down to fit before rubbing them in mercury.

Use a medium file to prepare a mixture of 5% silver and 95% nickel. Sift the filings through fine cheesecloth to remove all unwanted metal dust that might gum up the works.

Slide one of the electrodes into the glass tube. Pour just enough of the filings into the tube to fill the space about halfway when the electrodes are spaced 1/16" apart. Then assemble the unit. —30—

# TUNING AND USING YOUR COHERER

AFTER ASSEMBLING the Coherer, connect it up as shown below (left). Use a relay that will pull in below 60 milliamps to prevent burning the filings or electrodes.

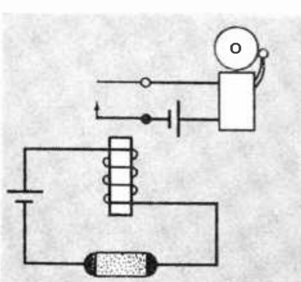
Decrease the spacing between electrodes until the relay pulls in, then slowly increase the distance between electrodes until the relay de-energizes. Do this several times until you have the Coherer set at the point just before the relay pulls in.

When properly adjusted, the Coherer should close the relay when a 1" spark coil is energized at a distance of 25 or more feet. For this test, no antenna should be connected to the Coherer. Between tests, tap the Coherer to get ready for the next pulse from the spark coil.

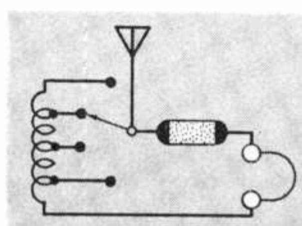
When you're satisfied that the Coherer is properly adjusted, tighten the screws on the binding posts connected directly to the electrode screws. Then connect your Coherer up to a circuit like that shown below (right), and it's ready for use.

A spark coil can be used for your experiments, but if you're planning any prolonged experiments, it is suggested that you use a high-voltage capacitor instead. The rapid discharge of the capacitor will have almost the same effect as that of the spark coil, and will not cause any interference on your neighbors TV's and radios.

You might want to experiment with the Popov method of decohering. If so, refer to the circuit on page 49. —30—



After tuning the Coherer, connect it up to a circuit like that shown at right, below. The circuit can be provided with a degree of selectivity if you tap the choke in several places. A decoherer can also be added.



The tuning circuit for the Coherer is shown at left. A relay that will draw no more than 60 milliamperes is needed to prevent damaging the filings.

PART I OF 2 PARTS

# Amateur Radio for CB'ers

## HOW TO CONVERT YOUR CB RIG TO TEN METERS AS AN INEXPENSIVE START IN AMATEUR RADIO

**By WALTER F. LANGE,** W1YDS*

MISTER CB'ER, why not become a ham? This is an ideal time to get your license. Signals are popping in from all over the world on both the Citizens Band and the adjacent 10-meter amateur band. With sunspots on the increase, world-wide communication will soon be possible on these frequencies. But, as a CB licensee, you can only listen to DX (distant stations). Contacting—or even attempting to contact—DX stations is a violation of the FCC's CB rules. Qualifying as a ham—not a difficult process—makes it possible for the CB'er to engage in unrestricted DX communication. If you want to get in on the fun and adventure of amateur radio, start studying today for your General Class ticket.

In order to pass the ham license examination, you must have a basic knowledge of electronics and FCC amateur regulations, and be able to send and receive International Morse code. For some people these requirements are a "breeze." For others a bit more study and practice is in order. For anyone, a little application of time and effort will certainly win the coveted license. Many teen-agers have passed the ham exam (there's no age limit), so surely *you* can do it! The American Radio Relay League, 225 Main Street, Newington, Conn. 06111, will be glad to fill you in on all the details.

As far as equipment goes, you are really lucky: most of your CB gear can be easily and inexpensively converted to 10 meters. In many cases, the cost of going from the Citizens Radio Service to amateur radio will be less than $10, including a $4 license fee and $3 transmitting crystal.

Once you have received your General Class ticket, there are only two tasks you will need to perform in order to go on 10 meters: slightly reduce the length of your antenna elements and make a simple hookup conversion to your CB transceiver. Since antenna data is given

**Technical Staff, American Radio Relay League*

in several manuals and handbooks published by the A.R.R.L. and other organizations, the subject will not be treated here. However, the 10-meter conversion of a dozen popular CB transceivers will be described in detail, as there has been little information published on this topic.*

If you convert your CB transceiver to 10 meters, remember that the transmitter section cannot be legally retuned and used on CB, unless the adjustments are made by the holder of a first- or second-class commercial license. Also, don't forget that it's against the law to use the transmitter portion of your converted CB transceiver on the air unless you have a General Class ticket. This is *very* important. Not only does the FCC chase bootleggers, but amateurs have their own lookouts. If they track down your illegal transmissions, you might as well forget about communicating by radio for many years to come.

**This article is an expanded version of the author's article published in QST, February 1967, page 20.*

## CONVERSION DETAILS

In the material that follows are details on individual CB transceiver conversions. The units discussed are known to be in common use and are representative of the problems that may be encountered. Hams should find this material of interest if they are looking for an inexpensive 10-meter AM mobile transceiver.

**EICO 770.** The EICO Model 770 is an eight-tube CB transceiver designed for 117-volt a.c. operation. Only a new transmitting crystal and realignment are required to convert this unit to 10 meters. Set the channel selector switch in any position except the extreme counterclockwise spot. This latter position is for fixed-channel operation only.

The receiver is a single-conversion superhet with an i.f. of 1750 kHz. Begin the receiver alignment, once the main tuning capacitor has been set at maximum capacitance, by tuning oscillator coil *L6* (see Fig. 1), to 26.750 MHz or to a frequency 1.75 MHz below the low-frequency end of the desired tuning range. Turn the tuning capacitor to the center of its range and apply a 10-meter signal to the antenna connector. Tune grid coil *L4* and plate coil *L5* of the r.f. amplifier for maximum response. This completes the receiver conversion. The transceiver that was converted by the author tuned from 28.500 to 28.710 MHz after being adjusted as described above.

Before aligning the transmitter, replace the transmitting crystal, located next to the channel selector switch, with a third-overtone FA-5 type crystal whose frequency is in the 10-meter phone band. Next peak oscillator coil *L1*. Then alternately tune amplifier plate capacitor *C9* and loading capacitor *C10* for maximum output. Start with the plates of compression trimmer *C10* screwed down. Go back and forth between the two capacitors, gradually decreasing the capacitance of *C10* while peaking *C9*, until maximum output is obtained.

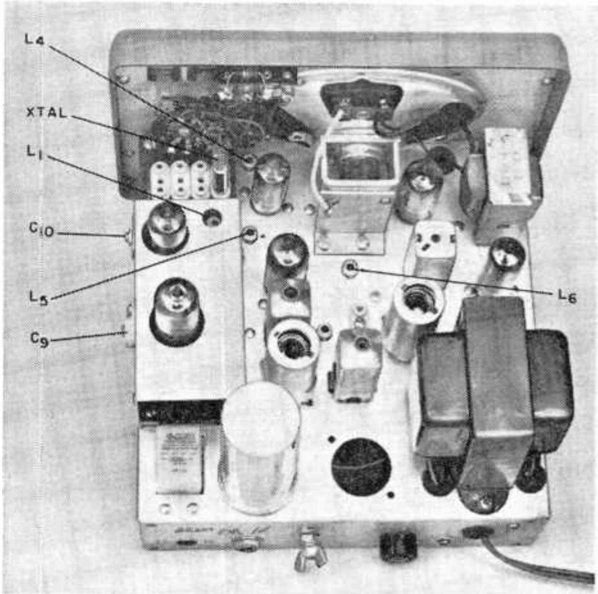



Fig. 1. The EICO Model 770 transceiver can be converted to 10 meters in a jiffy. This base station rig needs only a new crystal and r.f. alignment.

**EICO 777.** The EICO Model 777 CB transceiver is an eight-tube unit that can be operated from 117 volts a.c., 12 volts d.c., or 6 volts d.c. As with the Model 770, only a new transmitting crystal and realignment are necessary for the 10-meter conversion. Before aligning the receiver, put the *Tune-Xtal* switch in the *TUNE* position.

The receiver is a double-conversion superhet with a first i.f. of 1750 kHz and a second i.f. of 262 kHz. Start receiver alignment by fully meshing the plates of the receiver tuning capacitor. Adjust oscillator coil *L6* shown in Fig. 2 to 26.750 MHz or to a frequency 1.75 MHz below the low end of the desired tuning range. If you align the receiver for the bottom end of the phone band, it will cover from 28.500 to approximately 28.820 MHz. Using a signal in the middle of this range, peak r.f. amplifier grid coil *L4*. Then adjust the amplifier plate coil and the mixer grid coil (top and

**General Instructions.** Twelve different CB transceivers were converted by the author to 10 meters. They are typical examples of much of the CB gear that has appeared on the market during the past few years. Although the conversion details vary from transceiver to transceiver, there are several areas common to all.

All the transmitters and eleven of the

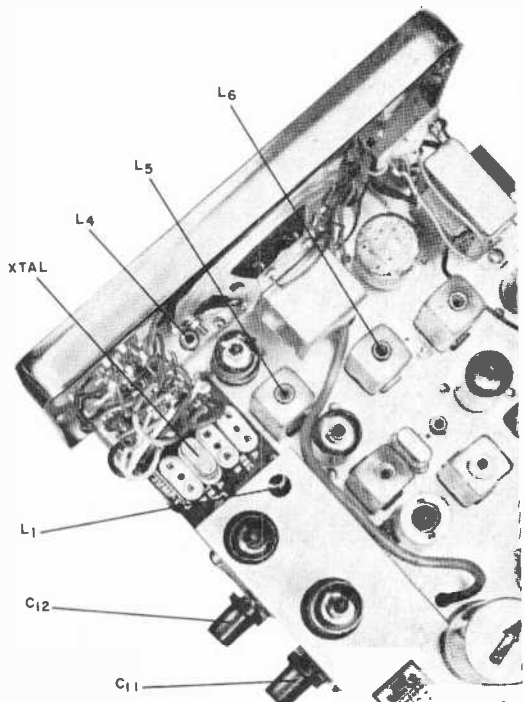



Fig. 2. Another easy rig to modify is the EICO 777. This transceiver has a dual power supply (12 and 117 volts). Replace the transmitting crystal and follow the simple alignment instructions given here.

bottom slugs of *L5*) for maximum response.

Start the transmitter conversion by replacing the transmitter crystal with a third-overtone FA-5 unit in the 28.5- to 29.7-MHz range. Tune oscillator coil *L1* and final plate and loading capacitors *C11* and *C12* for maximum output. Initially set compression trimmer *C12* at maximum capacitance. Then, after tuning *C11* for maximum output, decrease the capacitance of *C12* a little bit. Continue peaking *C11*

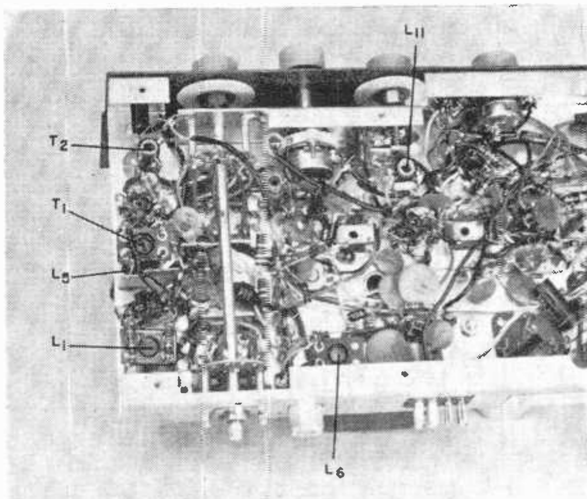



Fig. 3. To get the Hallicrafters CB-19 transceiver on 10 meters, you must remove 5-pF capacitor C13 from the right side of the coil. Substitute a new crystal and this unit can be tuned on 10 meters.

and decreasing the capacitance of the loading capacitor until maximum output is achieved.

**Hallicrafters CB-19.** Designed to operate from either 117 volts a.c. or 12 volts d.c., the Hallicrafters Model CB-19 is a compact seven-tube CB transceiver. Before making any adjustments, put the *VFO-OFF* switch in the *VFO* position.

The receiver is a double-conversion superhet with a first i.f. of 1650 kHz and a second i.f. of 262 kHz. With the receiver tuning capacitor set at maximum capacitance, begin aligning the receiver by tuning oscillator coil *L11* (see Fig. 3) to 26.850 MHz or to a frequency 1.65 MHz below the bottom end of the desired tuning range. If you align the receiver for the low end of the phone band, it will cover from 28.500 MHz to approximately 28.860 MHz. With a mid-range signal applied to the antenna connector, peak the r.f. amplifier plate coil and the mixer input coil (top and bottom slugs of *T2*). Since the receiver's input coil *T1* is also the output inductor for the transmitter, align it when adjusting the transmitter section of the transceiver. Of course, if you only intend to convert the receiver, go ahead and adjust *T1* after modifying it as described below.

Before tuning the transmitter, remove 5-pF capacitor *C13* from across the two inside terminals of *T1*. Replace the transmitting crystal with a third-overtone FM-9 unit in the 10-meter phone band. The transmitter crystal board is located on top of the chassis at the rear near the power transformer. Tune oscillator plate coil *L1* for maximum output. Adjust the final by tuning *T1* with a screwdriver or alignment tool and varying the position of the output link *L5* with respect to *T1*. Alternately peak *T1* and move *L5* until maximum output is obtained. If necessary, adjust second harmonic trap *L6* for minimum interference to television Channel 2.

receivers must be realigned. To retune the transceivers, three alignment tools are needed. An ordinary screwdriver will handle all variable capacitor adjustments, and a GC Electronics No. 9302 3-in-1 hex core alignment tool will take care of most of the slug-tuned coils. The remaining coils, which have very tiny alignment slots, can be adjusted with a homemade alignment tool. A suitable tuning tool can be constructed by filing down a small screwdriver to the desired size.

The transceivers can be realigned without test equipment, but the job is rather tedious and time-consuming. A general-coverage short-wave receiver (3 to 30 MHz) and a grid-dip meter or signal generator will make receiver alignment easy. And an SWR bridge and dummy load are useful for transmitter tune-up.

During alignment, be very careful not to damage the tuning slugs or coil forms. Do not try to turn any core beyond the point where binding resistance is encountered. If you do, you will probably strip the alignment slot in the core. In most cases, it will then be impossible to replace the core without damaging the coil form itself. Also note that many of the coil forms are sealed with wax or other material; this gunk should be scraped away before any attempt is made to turn the slugs.

**Receiver Conversion.** The CB receiver will be considered first. Converting your receiver will give you an opportunity to listen to 10-meter signals and get an idea of some of the interesting stations you might possibly work once you obtain your General Class license. Usually, this conversion consists of realignment only—so you can put your receiver on

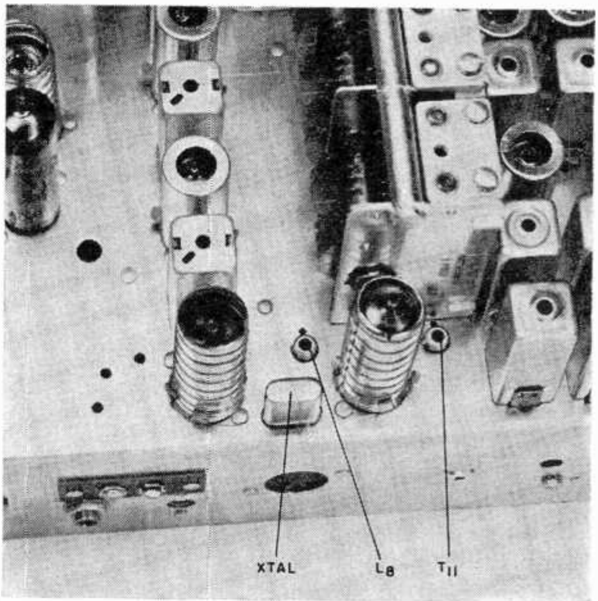



Fig. 4. Converting the Hammarlund HQ-105TR is simplicity itself. Besides changing the transmitting crystal, you only adjust two coils to get on 10.

**Hammarlund HQ-105TR.** Of all the transceivers described in this article, the Hammarlund HQ-105TR is the easiest unit to convert. Actually the HQ-105TR is a general-coverage communications receiver with a CB transmitter installed in the same cabinet. Since the receiver section covers the entire 10-meter amateur band in its unmodified state, the only part of the transceiver that requires attention is the transmitter.

Replace the CB crystal shown in Fig. 4 with an FA-5 third-overtone unit in the 10-meter phone band. Peak oscillator coil *L8* and final amplifier tank *T11*. You can, if you wish, use the receiver's S-meter as an output indicator for these adjustments.

**Heath MW-34.** The Heath MW-34 CB transceiver is a nine-tube unit that can be operated from 117 volts a.c., 12 volts d.c., or 6 volts d.c. Realignment, a new transmitting crystal, and the substitution of a 15-cent capacitor are required to convert this unit to 10 meters. Before adjusting the receiver, set the channel selector switch in any position under *VARIABLE*.

The receiver is a single-conversion superhet with a 455-kHz i.f. Depending on which part of the band you wish to cover, set the oscillator above or below the desired tuning range. To tune the low end of the band, set the receiver tuning capacitor at maximum capacitance and adjust oscillator coil *L3* shown in Fig. 5 to 28.045 MHz. Your receiver will cover from 28.500 to about 28.945 MHz, the exact range depending on the setting of *C18*. Apply a mid-range 10-meter signal to the input of the receiver. Peak r.f. amplifier "antenna" coil *L1*. Then adjust the amplifier plate coil and the mixer grid coil (top and bottom of *L2*) for maximum response.

Start work on the transmitter by installing a new transmitting crystal in one of the crystal sockets next to the power transformer or the crystal socket on the front panel. Use a third-overtone FA-5 crystal in the 28.5- to 29.7-MHz range. Replace 2.2-pF capacitor *C49* across *L7* with a 1-pF disc ceramic or mica capacitor. See Fig. 6 for its location. Tune oscillator plate coil *L5* and driver plate coil *L6* for maximum output. Then peak final amplifier plate coil *L7*.

the 10-meter amateur band, and if you don't care for what you hear, you can tune it back to the Citizens Band. In those cases where components have to be removed or changed, make the necessary modifications before starting the realignment procedure.

The first step in realigning most of the receivers described in this article is to retune the oscillator coil to a higher frequency. In each case, this will permit the receiver to tune from 28.5 MHz, which is the bottom end of the 10-meter phone band, to some higher frequency (the range varies from transceiver to transceiver). Set the receiver tuning capacitor at maximum capacitance (CB channel 1 end of the dial) and adjust the oscillator coil until the difference between 28.5 MHz and the tunable oscillator frequency is equal to the receiver's first i.f. For example, if the receiver has a first i.f. of 1.75 MHz, the oscillator will be operating at 25.215 MHz when the receiver is tuned to CB channel 1 (26.965 MHz). To align the receiver for 28.5-MHz reception, tune the designated oscillator coil to 28.5 MHz minus 1.75 MHz, or a frequency of 26.75 MHz.

Once the oscillator has been adjusted, the receiver will tune on the average about 350 kHz of the 10-meter phone band. It's not possible to satisfactorily cover the entire band (with one exception) without making some elaborate and expensive modifications, including the installation of a new dial mechanism and tuning capacitor. Actually, there is no great disadvantage in this limited coverage, since most of the contacts you will be making, once you get your amateur license, will be on or near your transmitting frequency.

If you want to cover a different portion of the 10-meter band (other than the low end), it's easy to calculate a new tunable oscillator frequency. Simply subtract the first i.f. from the lowest 10-meter frequency you want to tune. For instance, if the lowest frequency you'd like to copy is 29.00 MHz and the first i.f. is 1.75 MHz, the tunable oscillator frequency will be equal to 29.00 minus 1.75, or 27.25 MHz.

There are several ways you can realign the oscillator. Probably the best method is to adjust the oscillator coil while listening to the oscillator signal on a calibrated general-coverage receiver. If you aren't able to get hold of a receiver, you can check the oscillator frequency with a grid-dip meter. A third technique is to adjust the oscillator coil until you hear the output from an r.f. signal generator tuned to 28.5 MHz. The output level of the generator must be turned up as the input stage will still be tuned to the Citizens Band.

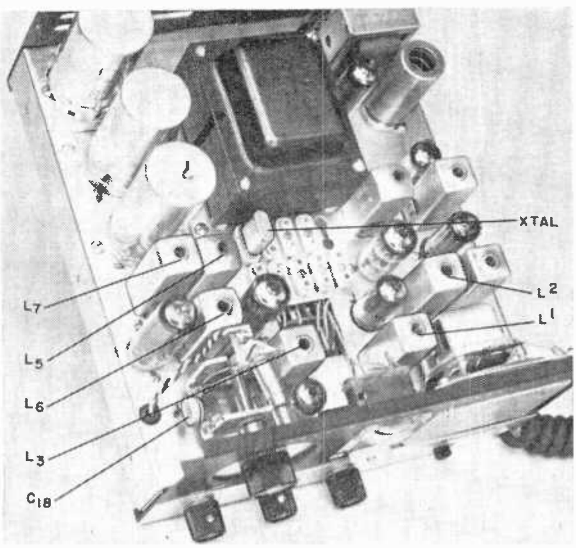
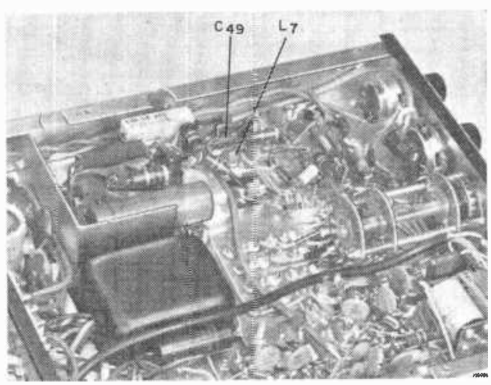



Fig. 5 and Fig. 6. The Heathkit MW-34 is another CB rig easily converted to 10 meters. You can use the panel-mounted crystal socket (Fig. 5, at left) or one of the seven sockets behind the panel for the new transmitting crystal. You must reduce C49 (Fig. 6, below) from 2.2 to 1.0 pF to enable the final amplifier to tune to the low end of 10 meters.



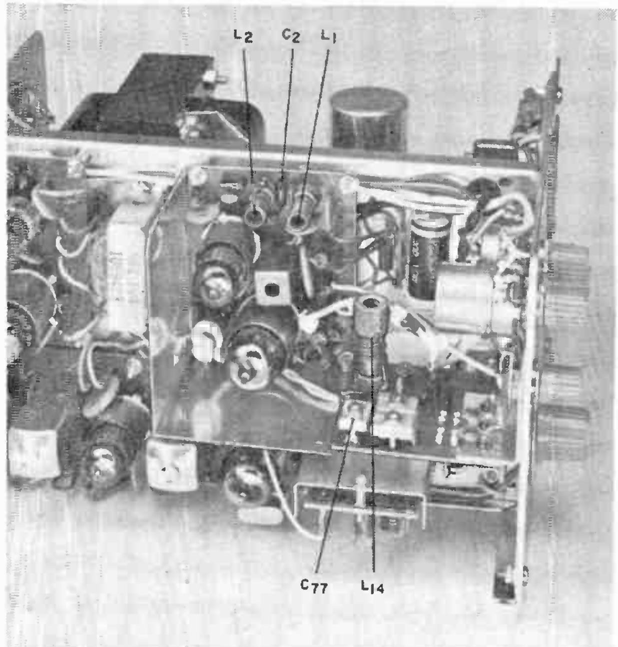
Once the tunable oscillator has been adjusted, the receiver's r.f. input stage can be aligned. There are several ways of doing this. One method is to apply a mid-range 10-meter signal (from a signal generator) to the receiver and tune all the input circuits for maximum response or best signal-to-noise ratio. A receiver adjusted in this manner will be most sensitive at the center of its tuning range, becoming less sensitive on either side. Another method is to stagger-tune the input circuits, which is accomplished by tuning, for example, the input r.f. coil to the low end, the mixer to mid-range, and the r.f. output to the high end. This procedure is repeated several times until the receiver appears to have the same sensitivity across its entire tuning range. A receiver so adjusted will not be as sensitive at mid-range as it would have been had it been tuned by the first method, however. Finally, the receiver can be adjusted without any test equipment at all, provided there is

**International 50AN.** The International Model 50AN CB transceiver is a nine-tube unit that will operate from 117 volts a.c., 12 volts d.c., or 6 volts d.c. Put the *Receive Selector* switch in the *TUNE* position.

The receiver is a single-conversion superhet with an i.f. of 10 MHz. Look at Fig. 7 and locate the circuit board on which *L14* and *C77* are mounted. Remove *C81*, an 18-pF capacitor in parallel with *L14*. No difficulty should be encountered, as there aren't any other 18-pF units on this board. Then, replace *C2*, the 18-pF capacitor located between *L1* and *L2*, with a 10-pF silver mica capacitor. Be careful not to burn the wires located between the board and the chassis when making this modification.

With the plates of the receiver tuning capacitor fully meshed, tune oscillator coil *L14* to 18.5 MHz. If this frequency can't be reached, tune *C77* as required. A receiver converted to the low end of the phone band will cover from 28.500 to approximately 28.905 MHz. To tune a different portion of the band, adjust the oscillator to a frequency 10 MHz below the bottom end of the desired tuning range. Finish the receiver alignment by applying a mid-range signal to the receiver and peaking double-tuned input circuit *L1-L2* and plate coil *L3* of the r.f. amplifier.

Replace the transmitter crystal, located above the *Transmit Selector* switch (see Fig. 8), with an FA-5 fundamental crystal whose frequency is half the desired output frequency. For example, if you want to transmit on 28.6 MHz, use a 14.3-MHz crystal. Tune oscillator plate coil *L8* and final amplifier grid



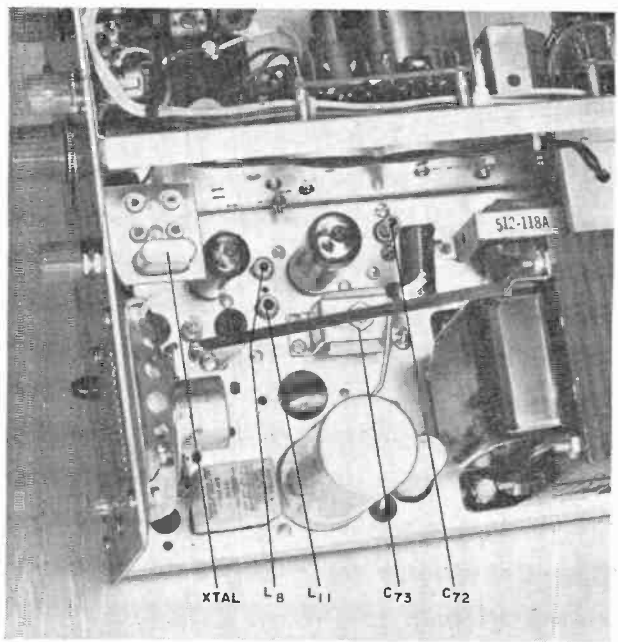




Fig. 7 and Fig. 8. Be careful when removing C2 and C81 from the circuit board of the International Model 50AN. In top view, C81 has been removed from L14. Bottom photo shows crystal and coil locations.

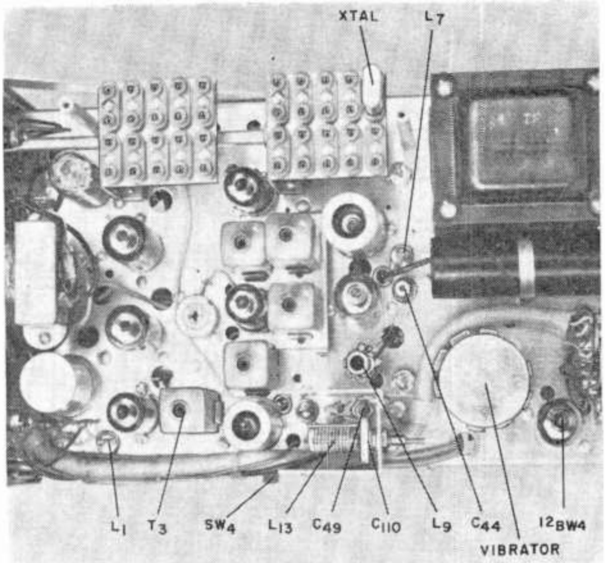



Fig. 9. Some instruction manuals for the Johnson "Messenger Two" refer to coil L13 as L113. In any case, they are the same. Before realigning this coil, remove the gunk that seals the core in place.

10-meter activity at the time you do the realigning—you simply tune the input circuits for maximum response to a 10-meter signal in the new range.

Only conversion information for tunable-receiver operation has been given below, since few amateur receivers are channelized. Once a CB receiver has been converted as described previously, its fixed-channel receiver facilities will no longer function on the Citizens Band even though they haven't been tampered with, since the receiver's input stage will have been tuned to 10 meters. If 10-meter fixed-channel operation is desired, the receiver crystals will have to be replaced with suitable crystals in the tunable oscillator range. Also, the fixed-channel oscillator coil will have to be retuned.

**Transmitter Conversion.** Do not convert your CB transmitter to 10 meters until after you have received your General Class license. Once you have your ama-

coil *L11* for maximum output. Starting with final loading capacitor *C73* at maximum capacitance, alternately decrease the capacitance of *C73* and peak plate tuning capacitor *C72* until the transmitter is fully loaded.

**Johnson "Messenger Two."** The Johnson "Messenger Two" is a ten-tube CB transceiver designed to operate from 117 volts a.c., as well as from 6, 12, or 24 volts d.c., depending upon the model. Only a new transmitting crystal and realignment are necessary to convert this unit to 10 meters. Make sure slide switch *SW4* on the side of the chassis is pushed to the rear; this control determines whether the receiver operates in the fixed or tunable mode.

The receiver is a single-conversion superhet with an i.f. of 455 kHz. Depending on which portion of the 10-meter band you want to cover, the oscillator may be set either above or below the desired tuning range. Before oscillator coil *L13* can be adjusted, some work must be done on it. Sufficient gunk has been used inside the form to make it impossible to tune the adjustment screw without breaking the form. To prevent the oscillator coil from being ruined, it is necessary to clean out the form and tune it from the inside. This method of tuning is possible because a grooved brass slug has been employed rather than one of ferrite or powdered iron.

Look at Fig. 9 and remove the 12BW4 and the vibrator at the rear of the unit, as well as the four screws which bolt the oscillator coil's supporting bracket to the chassis. Tilt the form slightly outward and clean out the gunk with a probe. A little alcohol might help to loosen the slug. Using a screwdriver inside the form, carefully tune the slug in and out several times. After the core has been sufficiently loosened, replace the four bracket screws, vibrator, and tube. The adjustment screw may now be used to turn the core.

Set the receiver tuning capacitor at maximum capacitance and adjust *L13*, and *C110* if necessary, until the oscillator is tuned to 28.045 MHz. The receiver will now cover from 28.500 to 28.825 MHz. Set the receiver tuning capacitor at mid-range and apply an appropriate 10-meter signal to the antenna connector. Tune input circuit *L1* on the r.f. amplifier for maximum response. Also peak the r.f. amplifier plate coil and the mixer grid coil (top and bottom slugs of *T3*).

Remove the plastic crystal cover and replace the transmitter crystal with an FA-5 third overtone crystal in the 10-meter phone band. Peak oscillator plate coil *L7*. Then adjust final amplifier output network *L9-C49* for maximum output. Starting with loading capacitor *C49* at maximum capacitance, alternately decrease the capacitance of *C49* and peak *L9* until the amplifier is fully loaded.

Although the final uses a neutralizing capacitor *(C44)*, no neutralizing adjustments are normally required. If the final amplifier happens to become unstable, it can be stabilized by adjusting *C44* until the grid voltage of the final amplifier stays constant, or nearly so, when *L9* is tuned through resonance. The grid voltage can be measured with a d.c. VTVM at pin 3 or pin 6 of the final amplifier by using an r.f. choke in series with the meter lead. If it becomes necessary to adjust *C44*, be sure to retune the output network after the amplifier is neutralized.

teur ticket, start the transmitter conversion by replacing the transmitter crystal with an appropriate unit for 10-meter operation. Although the replacement crystals listed are made by International Crystal Mfg. Co., other brands with the same mode, pin spacing, etc. can be employed. Next, make any component changes that are required. And before realignment is initiated, borrow or build an output indicator, such as an SWR bridge, and a 50-ohm, 5-watt (or more) dummy load.*

After the output indicator and dummy load have been attached to the transmitter, tune the oscillator coil for maximum output. Then open and close the microphone button or transmit switch a few times to be sure the oscillator always starts. If the oscillator stops working, detune the coil a little bit at a time until the oscillator operates every time the transmitter is turned on. Now adjust the driver stage, if there is one, and the final amplifier stage for maximum output.

**Your CB output meter will work on 10 meters without conversion.*

Check the modulation of the final amplifier. The output should increase with modulation. If it doesn't, go back and check all the circuits to be sure they are tuning correctly. A coil that appears to be on frequency may, in fact, be tuned only to a point of minimum or maximum inductance. If the stages are tuning as they ought to be, and the output drops when you talk into the microphone, perhaps the final amplifier is too heavily loaded for the amount of available drive. In this case, detune or unload the final amplifier until upward modulation is obtained.

Finally, it should be mentioned that, if you tune the transmitter for a frequency in the center of the transceiver's typical 350-kHz operating range, you will normally not have to readjust the transmitter for other frequencies in the same range.

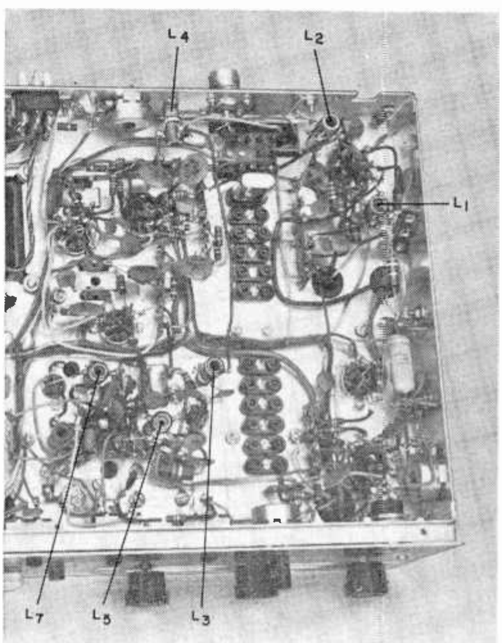


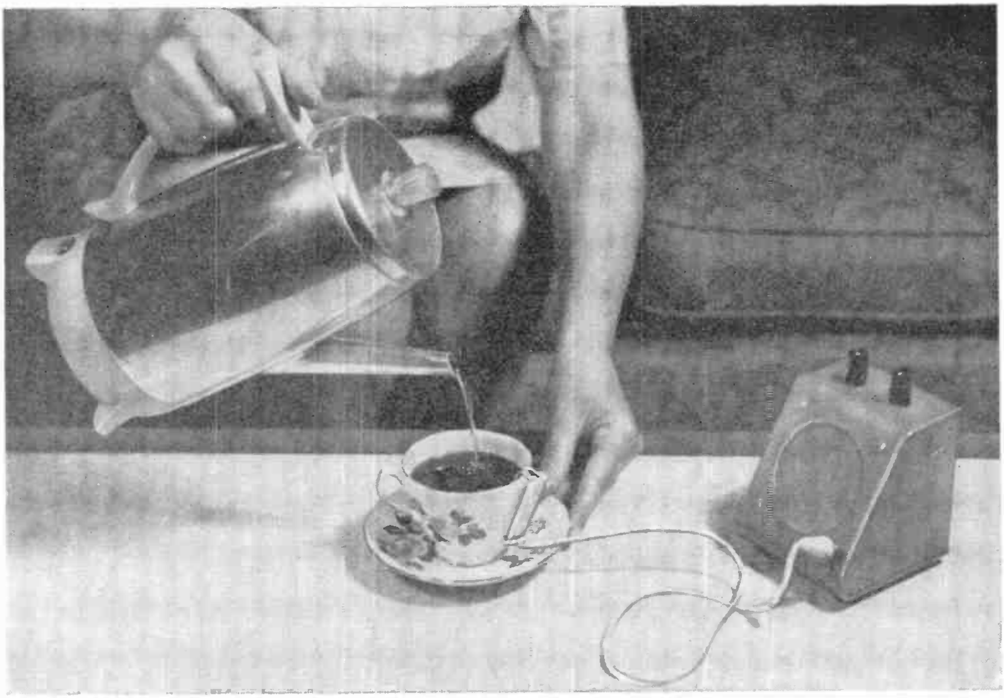
Fig. 10. It is really unnecessary to take the wraparound cabinet off the Knight C-560—all of the adjustments required to convert this unit to 10 meters can be made through holes and removable panels.

**Knight-Kit C-560.** Designed to operate from 117 volts a.c. or 12 volts d.c., the Knight-Kit C-560 CB transceiver is one of the easiest rigs to put on 10 meters. In fact, all adjustments of this nine-tube rig can be made without removing the unit from its cabinet. This is possible due to the fact that there is a hole in the bottom of the case for each coil that needs to be retuned. For information purposes, the transceiver's innards are shown in Fig. 10. Before aligning the receiver, put the *Tune-Xtal* switch in the *TUNE* position.

The receiver is a single-conversion superhet with an i.f. of 1650 kHz. Set the receiver tuning capacitor at maximum capacitance and tune oscillator coil *L7* to 30.150 MHz. Note that the oscillator operates 1650 kHz *above* the desired tuning range. When tuned for the low end of the phone band, the receiver covers from 28.500 to about 28.820 MHz. Set the receiver tuning capacitor in the middle of its range and apply an appropriate signal to the antenna connector. Tune input and output coils *L3* and *L5* of the r.f. amplifier stage for maximum response.

Remove the crystal cover from the bottom of the transceiver and replace the transmitting crystal with a third-overtone FA-5 unit in the 10-meter phone band. Tune oscillator coil *L1* and final amplifier plate coil *L2* for maximum output. Adjust second harmonic trap *L4* for minimum interference to television Channel 2. This completes the rather simple conversion of the C-560.

*(To be continued next month)*



# LIQUID LEVEL INDICATOR FOR THE BLIND

ELECTRONIC DEVICE LETS BLIND PEOPLE POUR COFFEE, SOUPS, AND OTHER HOT OR COLD LIQUIDS—WITH CONFIDENCE

By **T. V. CRANMER,** K4MMB

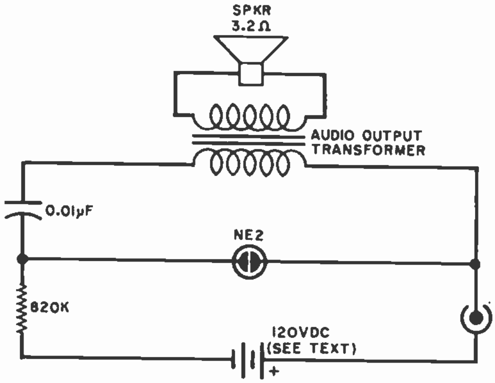
WHEN YOU POUR steaming liquids into a cup or bowl, you know when to stop—unless you happen to live in the perpetual darkness of the blind. A continuity checker, rigged up with a suitable liquid-sensing probe which gives an audible signal when the cup is full enough, solves the problem admirably.

The simple neon lamp relaxation oscillator circuit presented here was devised by the author and has been used with much success by blind clients of the Bureau of Rehabilitation Services in Kentucky.* This level indicator is not only suitable for use with hot liquids, but with cold liquids such as milk or carbonated drinks—and even with spirits.

*The author serves as Director, Division of Services for the Blind, Bureau of Rehabilitation Services, Department of Education, Frankfort, Kentucky.*

The first circuit tested for this application was suggested by L. W. Butler of Milwaukee, Wisconsin. Mr. Butler used a single transistor in a conventional Hartley oscillator circuit with the sensing probe connected in the battery lead. This circuit worked well, but the audio level of the output was insufficient to permit its use in noisy surroundings.

Mr. Butler has since made a clever modification of a conventional pocket-size radio which gives a much better output. To make this modification, you need only feed the output from one side of the speaker transformer through a 100-pF capacitor through the probe to the center connection or wiper of the




The value of the resistor can be either increased or decreased to respectively raise or lower the pitch or frequency of the tone heard at the speaker.

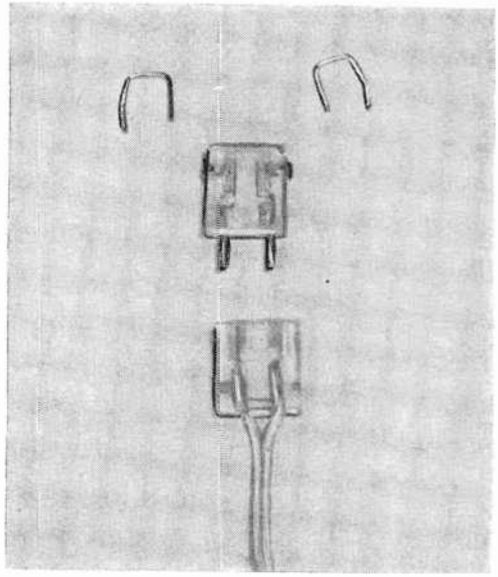
volume control. When the probe is in contact with a liquid, the feedback circuit is completed and the transistor radio goes into strong oscillation.

**The neon oscillator circuit** shown in the drawing has the advantages of low cost, high reliability, excellent output signal and negligible battery drain. Value of the resistor can be changed to vary the pitch of the sound output. Four small 30-volt batteries (Burgess U-240, or similar) can be used in series to power the circuit. The unit is housed in a 4″ x 4″ x 5″ sloping panel meter case.

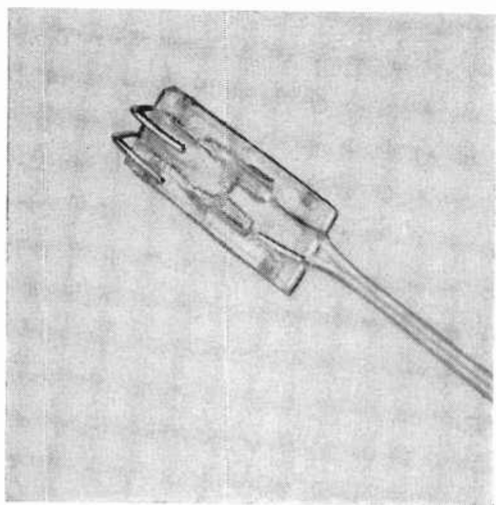
The probe can be made with a twin-lead Mosley 301 and 311 connector. One-half of the connector is attached to a flexible cord. A phono plug on the other end of the cord fits into a jack on the oscillator's case. The other half of the connector holds two horseshoe-shaped pieces of stainless steel rods having a diameter of about 0.050″.

Suitable stainless steel wire for the probe can be obtained from dental supply stores. Two 2¼″-long pieces of this wire are needed. When each one is bent into the correct shape, the dimensions are: long leg, about ⅞″; short leg, about ¾″; crown (or width), about ½″. You insert the short legs into the connector, and tighten the connector's setscrews. Then complete the assembly by plugging the two halves of the connector together.

This arrangement allows removal of the "business" end of the probe for occasional washing. In use, the probe is hung over the side of the cup or bowl.



Two lengths of non-corrosive stainless steel wire make up the probe. These wires should be fitted into a suitable connector as shown and the whole assembly connected to two-conductor flexible wire.



**Some of the blind hams** in Kentucky have built this equipment for themselves. There are many blind people, however, who have no technical background and would need help in building a liquid level indicator. If you have a blind friend, why not offer your assistance? Besides the satisfaction you would derive from such a gesture, you would help instill in your friend the one thing most needed by the handicapped—confidence. -30-

# SHORT-WAVE LISTENING

By **HANK BENNETT,** W2PNA/WPE2FT
Short-Wave Editor

## BROADCASTING STATION NEWS AROUND THE WORLD

THE SOVIET UNION has resumed full-time jamming of Red China's Russian-language broadcasts to Russia for the first time in two years—according to *Radio Liberty*, a privately owned organization which broadcasts in 17 languages to Russia. *Radio Liberty*, whose main studios are in Munich, Germany, stated that virtually all of the Communist Chinese broadcasts in the direction of Russia were affected. The Soviet Union's previous jamming campaign had ended soon after Nikita Khrushchev's fall from power in October, 1964.

A letter QSL from VSI8, Cable & Wireless, Mercury House, Grand Turk Island, notes that this station has a voice broadcast daily except Sunday at 1830 on 4560 kHz. Usually of 10-minute duration, the broadcasts cover local news and relay messages to the peoples of Turks & Caicos Islands. On Saturdays the transmissions run longer since there is a review of the week plus an occasional address by the Island Administrator. This station is listed as being 100 watts "on phone," which implies that it may also operate on CW at about 200 watts.

*Radio 247*, the British Broadcasting Corporation's answer to the pirate stations operating off the English Coast, was expected to begin operations "early in 1967," but plans now call for the new station to go on the air "when all of the pirate stations are silenced." *Radio 247*, with a tentative schedule of 0530-0200, will operate on 247 meters (1214 kHz). Future plans call for additional transmitters in the same service for coverage of the Midlands and southwestern portions of England.

*All India Radio* may be going commercial for the first time in its history. An Indian source has revealed that the Ministry of Information & Broadcasting has accepted the recommendations of the Chanda Committee relative to the introduction of commercial broadcasts on the station. These recommendations have been sent to the Cabinet for approval. If they are accepted by the Cabinet, the commercials will be introduced gradually through the "Vividh Barati" program.

The Swedish weekly publication *Vi* has a

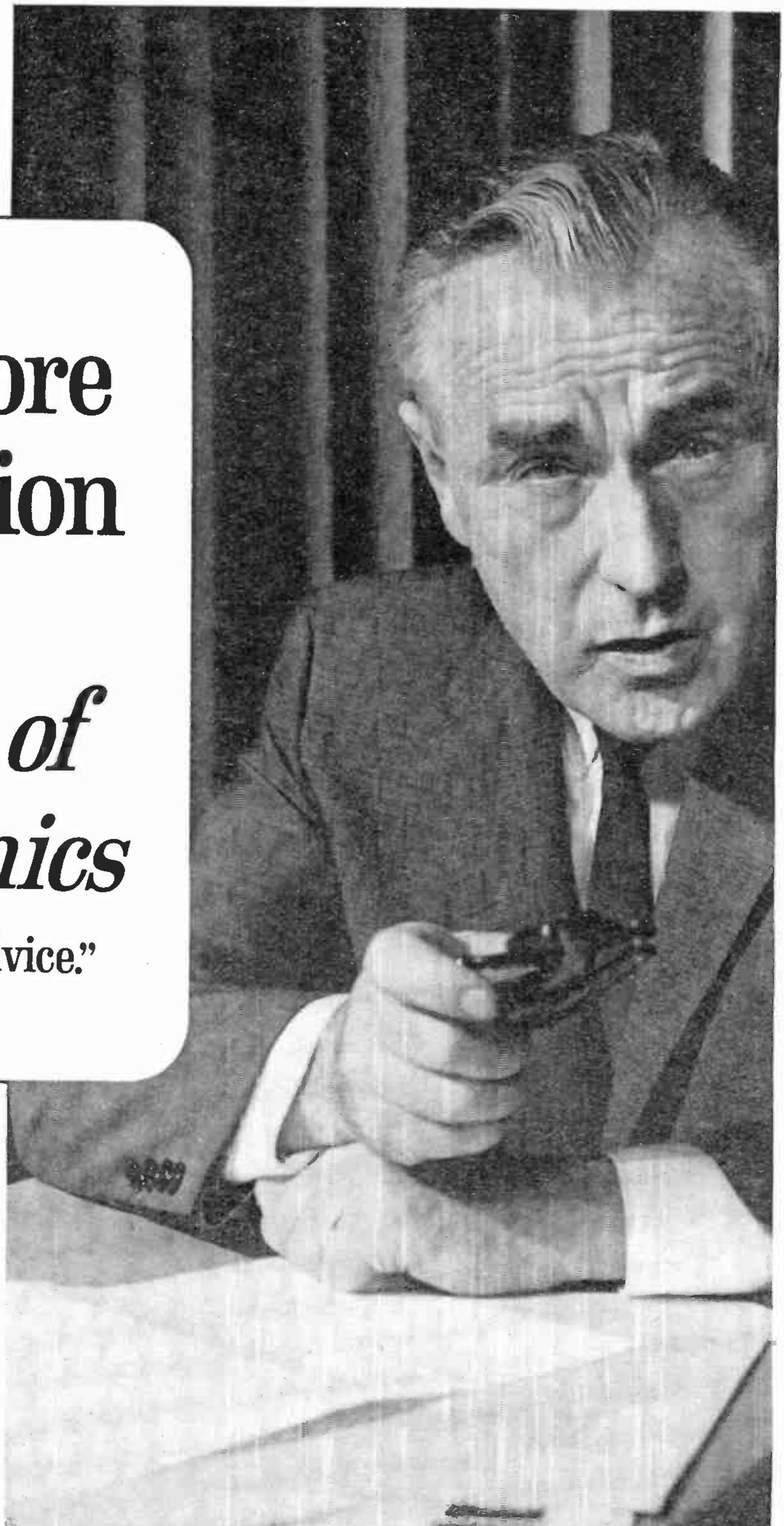
(*Continued on page* 115)

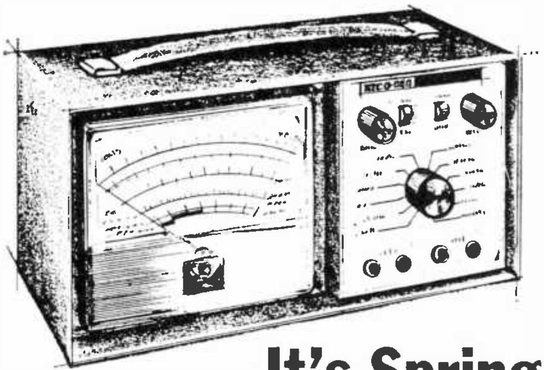
John Zaharek, WPE1GUM (above), of Torrington, Conn., DX'es with a Lafayette HA-230 receiver. At the present time he has 44 countries verified (out of 64 logged) and 31 states and seven provinces verified. John's antenna is 100' long, 25' high.

As a retired seaman, Lester Nichols, WPE6IP, San Francisco, Calif., has the unique distinction of having visited most of the 20 countries he has verified to date. Lester's equipment includes a brace of E. H. Scott receivers, the SLR-F and the SLR-12-B, plus a Hallicrafters S-77A and a Drake SW-4.

"Get more education or *get out of electronics*

...that's my advice."





# It's Spring Tune-Up Time

## EICO* AUTO ANALYZER KIT CAN DIAGNOSE ILLS OF YOUR OLD CLUNKER

IF the above title sounds as if you've picked up another Ziff-Davis publication, CAR and DRIVER, don't be alarmed; you're still tuned to POPULAR ELECTRONICS. The month of May is usually associated with automotive spring tune-ups, and you can do the job easier and better with an electronic engine analyzer.

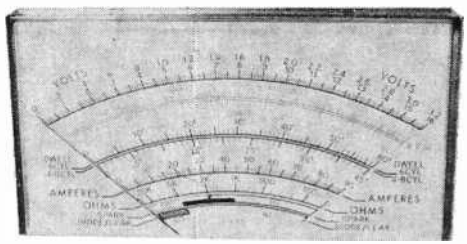
The EICO 888 "Solid State Universal Engine Analyzer" is a prime example of what you'll need to spot those ignition and carburetion problems. The 888 is sold as a kit for $44.95, and a wired and tested model is available for $59.95. The $15 saving that results from wiring it yourself is worthwhile, since the kit can be assembled in about two evenings of casual soldering.

Of course, buying an engine analyzer presupposes that you know something about automobile engines, and know the difference between a needle valve and the alternator regulator. If so, be advised that the 888 reads dwell angle, r/min (two ranges—one range for setting the idle and the other range to check acceleration), voltage drop, alternator diode leakage, and spark output. It will also do some other things, like cutout relay checking, substituting a built-in capacitor for a possible defective "condenser" across the points, etc.

If you wire the kit, calibration is easy and direct (using either the 50- or 60-hertz a.c. power lines) because of a special probe supplied by EICO. In the POPULAR ELECTRONICS test, we found that the r/min calibration was slightly high at 500 r/min (our model read 520 r/min) and slightly low at 2500 r/min (our model read 2250 r/min).

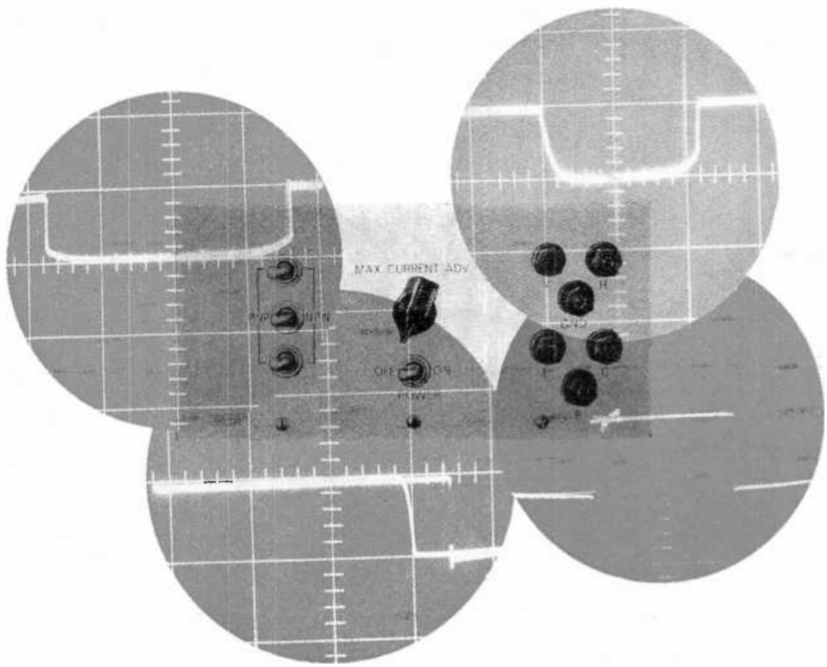
We would be remiss not to compliment EICO on the inclusion of hundreds of car specifications in the 888 operating manual. This immediate, handy reference volume contains dwell, manual shift and automatic transmission idle specs on both American and foreign cars. -30-


Control functions of the EICO 888 are grouped on the right-hand side of the sturdy instrument. The "FWD-REV" switch is for checking alternator diode leakage. The low voltage range (3.2 volts) comes in handy when you're looking for a voltage drop created by a poor electrical connection or excessive voltage drop across a cable.



The multiple scales on the 888's meter may appear confusing at first, but the 6-inch breadth offers amazing readability even from three or four feet away. The scales are multi-colored.

*EICO Electronic Instrument Co., Inc., 131-01 39th Ave., Flushing, N.Y. 11352.



# BREAKDOWN REVERSE VOLTAGE TRANSISTOR AND DIODE TESTER

NONDESTRUCTIVE "ONE-SHOT" SCOPE TECHNIQUE USED TO REVEAL SEVERAL CHARACTERISTICS AT ONCE

By CHARLES D. RAKES

FOR EACH different transistor parameter, there is a test procedure that can be set up and followed in order to predict a transistor's ability to live up to its specifications. While there are many different specifications for a transistor, not all of them must be up to par in any one application. For most applications, it is usually sufficient to know that a transistor will work in a given circuit, without being too concerned about the transistor's capabilities in excess of the circuit's requirements. Quite often you can take advantage of the commercially accepted tolerance of ratings by going through a batch of less expensive transistors and selecting those that will work in your circuit.

For example, if a transistor is rated to withstand a reverse voltage across the collector and base elements of, say, 100 volts, you wouldn't care whether or not the transistor breaks down at 75 volts when the most voltage it will see in a

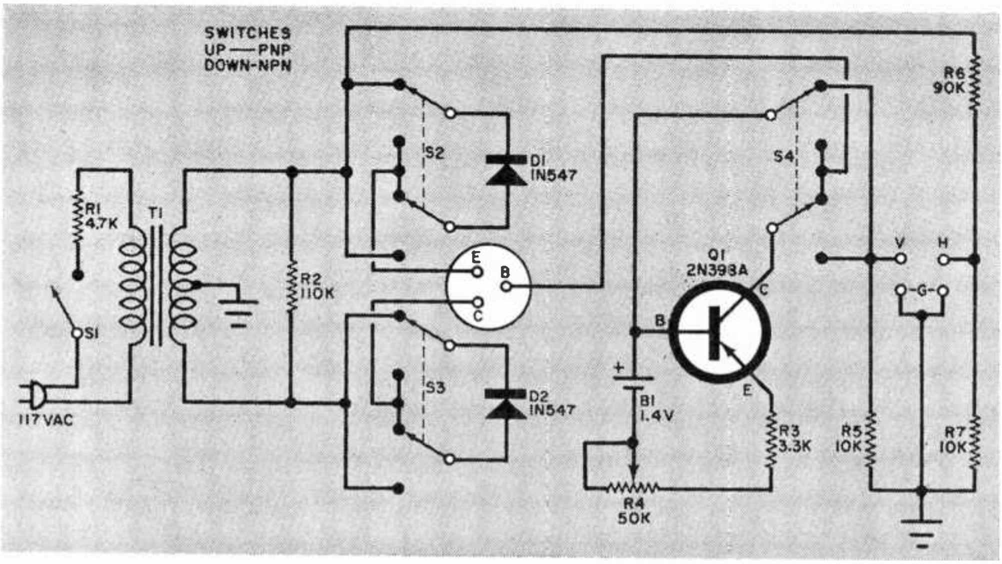



Fig. 1. Reverse voltage is applied alternately across the emitter-base junction and the collector-base junction of the transistor under test by the combined action of diodes D1 and D2 on the a.c. voltage from the transformer. Transistor Q1 acts as a current limiter. Potentiometer R4 can be adjusted to limit maximum current flow to a predetermined value. Zener diodes and other diodes as well as neon lamps can be checked out with this adapter. Output voltages are fed to an oscilloscope for interpretation.

given circuit does not exceed 9 volts. But you wouldn't want to put this transistor into a 90-volt circuit. By the same token, if the transistor checked out at 120 volts, there's no reason why you couldn't insert this component into a 110-volt circuit.

Many fine, inexpensive transistor testers are available that can predict gain and leakage, but none of them can tell you anything about the figure for reverse breakdown voltage. One way to check reverse breakdown voltage is to gradually apply an increasing amount of voltage until the transistor breaks down. Once you do that, you will know what the breakdown voltage is, and you will also have to junk the transistor. It's like testing a fuse to find out how much current it will take to make it pop. There is no trick to a destructive-type test and there *is* a point of no return that most of us would object to. The way to avoid destruction of solid-state components even in the presence of potentials in excess of the breakdown voltage is to limit the amount of current to prevent thermal runaway.

If you have an oscilloscope, you can take a page out of a transistor manufacturer's notebook; and if you build the simple, low-cost circuit presented here, you can perform a non-destructive test to check both emitter-to-base reverse breakdown voltage, and collector-to-base reverse breakdown voltage. With this circuit, you will also be able to determine emitter cutoff current and collector cutoff current. All four of these parameters can be ascertained from a single scope trace, in a "one-shot" type of test. The procedure is rapid and lends itself to mass production techniques.

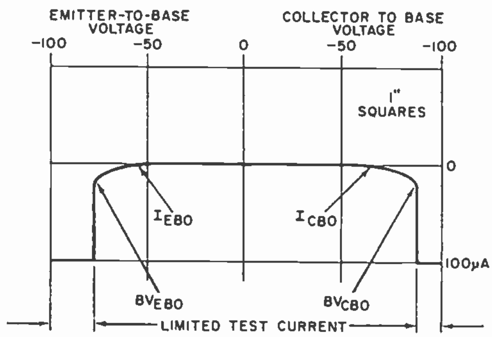



Fig. 2. Trace obtained when testing a good transistor can be analyzed as follows: left portion of curve shows what happens when reverse voltage is applied across emitter-base junction; right side indicates collector-base junction characteristics. Trace also shows cutoff and reverse current.

As a sort of bonus feature, this same

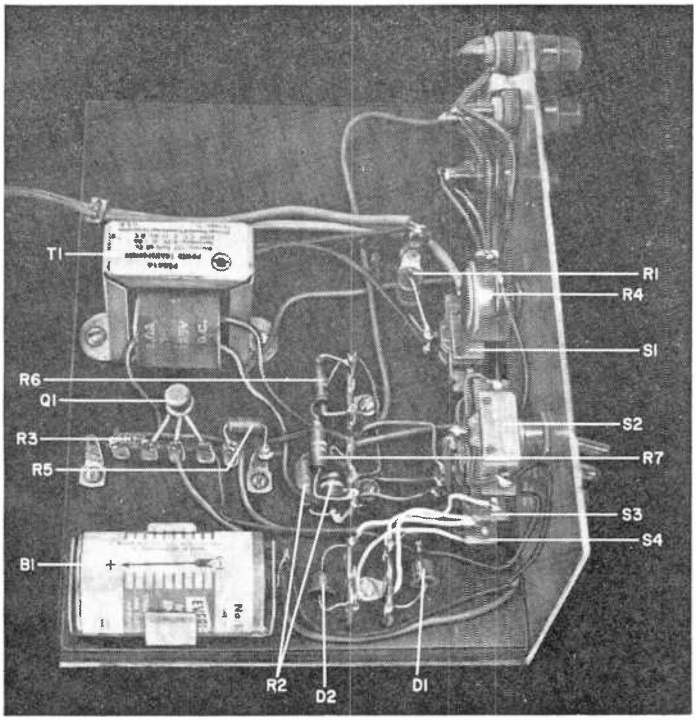



Fig. 3. Layout of components is not critical. Two resistors are shown connected in parallel to obtain proper value for R2. A 3-gang d.p.d.t. switch can be used instead of separate switches for S2, S3, and S4. Observe polarity of B1, D1 and D2.

**PARTS LIST**

*B1—1.4-volt mercury battery*
*D1, D2—1N547 diode*
*Q1—2N398A transistor*
*R1—4700-ohm, 2-watt resistor*
*R2—110,000-ohm, 4-watt resistor—see text*
*R3—3300-ohm, ½-watt resistor*
*R4—50,000-ohm potentiometer*
*R5—10,000-ohm, ½-watt resistor*
*R6—90,000-ohm, ½-watt resistor*
*R7—10,000-ohm, ½-watt resistor*
*S1—S.p.s.t. switch*
*S2, S3, S4—D.p.d.t. switch*
*T1—Power transformer: primary, 117 volts; secondary, 250 volts with center tap (Stancor PS8416, or similar)*
*Misc.—Terminal strips, binding posts, chassis, hardware, etc.*

test procedure will let you determine the zener voltage of zener diodes, the reverse breakdown voltage for low-peak-inverse-voltage diodes, and both the firing and holding voltages of neon lamps.

**How It Works.** With this test circuit, units under test are subjected to a maximum reverse voltage of about 100 volts. The "maximum-current" range is adjustable from approximately 20 $\mu$A to 500 $\mu$A. The amount of maximum current that can be safely passed through the transistor under test depends upon the power that can be safely dissipated in the tested unit. If a large number of units are to be checked, the voltage and current limits can be grease-penciled on the oscilloscope screen for a quick go-no-go selection.

As shown in Fig. 1, switches *S2, S3,* and *S4* are in the *PNP* position, and the anodes of diodes *D1* and *D2* are connected to the emitter and collector test jacks respectively. The base test jack is returned to ground through current sampling resistor *R5*.

The voltage developed across *R5* is fed to the vertical input of the scope through test jacks marked *V* and *G*. The scope's horizontal sweep is controlled by the voltage that appears across the 10 to 1 voltage divider resistors *R6* and *R7* and which is fed out through the terminals marked *H* and *G*.

**Emitter-To-Base Reverse Voltage.** When the top of *T1* goes negative with respect to ground, *D1* conducts, and sends the emitter voltage (with respect to base) of the transistor under test in the nega-

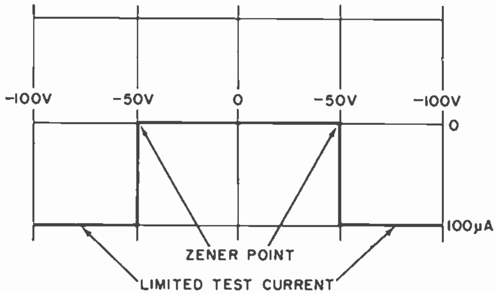


Fig. 4. Typical scope trace of good zener diode is shown here. Right half reveals same information as left half, and is actually redundant. Single-sided patterns can be just as easily obtained. See text.

tive direction and causes a downward deflection of the scope's trace when this voltage breaks through the emitter base junction. Keep in mind that this potential across the emitter and base is reverse voltage. Also, the voltage at the top end of *R6* and *R7* at this time is negative with respect to ground. As the voltage swings in the negative direction, the scope's spot travels from the center of the screen towards the left to display a horizontal trace.

The action of the scope's trace can be understood by an examination of Fig. 2. Note that as the negative horizontal voltage increases the reverse voltage across the emitter and base is also increasing, and at about 75 volts the curve drops sharply—this is the point of voltage breakdown.

During the time that the emitter-to-base-junction is subjected to this reverse voltage, *D2* blocks the collector current of the transistor under test and leaves the collector in an essentially open-circuited condition. This open-circuit condition satisfies one of the requirements for determining the specification for reverse voltage breakdown.

During the time that the applied voltage is in excess of the breakdown voltage, current is limited to prevent destruction of the component under test by the action of circuit *Q1*, *R3*, *R4*, and *B1*. Potentiometer *R4* can be adjusted to increase or decrease the maximum current.

As the voltage across the secondary of *T1* swings back to zero, the spot on the screen retraces its path, and returns to its central point on the zero reference line.

**Collector-To-Base Reverse Voltage.** When the polarity of the a.c. voltage across *T1* reverses, a positive voltage appears across *R6* and *R7* and pulls the spot horizontally from the center of the screen to the right. The positive voltage on the cathode of *D1* also blocks the emitter current of the transistor under test, effectively opening the emitter circuit. The negative voltage on the anode of *D2* now completes the collector-to-base circuit through *Q1*. The trace on the right side of the scope indicates the collector-to-base reverse voltage breakdown. Here again the requirement for the third element in a transistor to be open-circuited when checking for reverse voltage breakdown is satisfied.

The same action takes place for an *npn* type of transistor except that the polarity of the reverse voltage is reversed and the deflection of the trace will be upward. Of course, switches *S2*, *S3*, and *S4* are simultaneously flipped to the *NPN* position.

While the vertical deflection of the scope's beam is a function of the voltage drop across *R5*, the extent of this voltage drop depends upon the current through *R5*, the collector-to-base of *Q1* and the transistor under test. If the vertical input of the scope is calibrated for 1 volt per inch, a 1-inch high trace represents 100 $\mu$A of current (100 $\mu$A $\times$ 10,000 $\Omega$ = 1 volt).

The tilt on the left side of the trace (Fig. 2) shows emitter-to-base reverse

## REVERSE VOLTAGE AND CURRENT CUTOFF PARAMETERS

$BV_{CBO}$: Collector-to-base d.c. breakdown reverse voltage with the emitter circuit open. Collector current ($I_C$) should be specified.

$BV_{EBO}$: Emitter-to-base d.c. breakdown reverse voltage with the collector circuit open. Emitter current ($I_E$) should be specified.

$I_{CBO}$: Collector d.c. current cutoff when the collector junction is reverse-biased with the emitter circuit open. Collector base voltage ($V_{CB}$) should be specified.

$I_{EBO}$: Emitter d.c. current cutoff when the emitter junction is reverse-biased with the collector circuit open. Emitter base voltage ($V_{EB}$) should be specified.

current while the tilt on the right side shows collector-to-base reverse current. In this idealized trace, reverse current becomes evident at about −60 to −70 volts, and increases gradually until the breakdown voltage point is reached. The breakdown point is also commonly referred to as the zener point.

(Note that the 0 to −50 volts per inch along the horizontal scale represents the inverse voltage across the transistor under test when the scope's horizontal input sensitivity (through the test circuit) is calibrated at 50 volts per inch. The voltage across the horizontal input has a linear relationship and is in step with the inverse voltage applied to the test transistor.)

**Construction.** Parts placement and layout is not critical. In Fig. 3, the test circuit is shown breadboarded on an 8½" x 6" piece of ¾" plywood. The front panel is an 8½" x 4½" piece of 16-gauge aluminum. More compact construction can be obtained by using a 6" x 5" x 4" aluminum utility box. Ground only those points shown in the schematic (Fig. 1). Use spaghetti to insulate *Q1*'s leads.

A 2N398A transistor was chosen for *Q1* because of its high collector-to-base reverse breakdown voltage rating. The transistor used in the project is rated at −105 volts, but actually checked out at −150 volts.

Although individual switches are used for *S2*, *S3* and *S4*, you can substitute a suitable two-position rotary switch or stacked slide switch. The binding posts for the test transistor's connections and for the connections to the oscilloscope can be of any design. You may find it more convenient to add another ground post, or eliminate the terminals altogether and connect the leads that go to the scope directly to the circuit.

All parts used in the tester are standard. If you have any difficulty in locating a 110,000-ohm, 4-watt resistor for *R2*, you can connect two 220,000-ohm, 2-watt resistors in parallel.

**Zener Diode Test.** The curve shown for the zener diode (Fig. 4) can be obtained by connecting a jumper between the emitter and collector terminals (*E* and *C*) of the test circuit, and connecting the zener diode between one of these terminals and the base terminal (*B*). The cathode lead of the diode goes to ground, and the switches are in the *PNP* position. If you reverse the diode's connections, and flip the switches over to the *NPN* position, the trace will go upward instead of downward. The test can be made either way.

If you do not use the jumper and connect only one side of the diode either to the emitter or the collector terminal, the left half or the right half of the trace will be obtained. Both halves of the trace contain the same information.

**Neon Lamp Test.** If a good neon lamp is connected between the base and collector test points, the curve shown in Fig. 5 will be displayed. Reading this curve is more or less self-explanatory. Here *S2*, *S3*, and *S4* were set to the *PNP* position.

The accuracy of the test readings depends upon how accurately you calibrate the oscilloscope. Once the oscilloscope is correctly calibrated, no further scope adjustments are required.

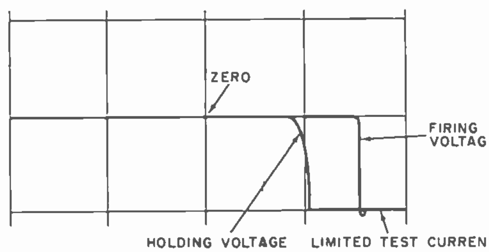



Fig. 5. Firing and holding voltage of a neon lamp can be predicted. If the scope's horizontal sweep is calibrated at 50 volts per inch, the neon lamp depicted here ignites at about 75 volts and stays lit until the potential drops to about 50 volts.

**Scope Calibration.** To adjust vertical sensitivity, apply a 1-volt peak-to-peak a.c. signal directly to the scope's vertical input, and adjust the vertical gain for a 1"-high pattern. This is all there is to the vertical calibration for a deflection of 100 microamperes per inch.

Horizontal sensitivity can be calibrated by applying a 5-volt peak-to-peak a.c. signal directly to the horizontal input terminals and adjusting the horizontal gain for a 1"-long trace. Because of the 10-to-1 voltage divider network in the test circuit, actual horizontal sensitivity will be 50 volts per inch. —30—

# THE ELECTRONICS COUNTERMAN

**By WALT MILLER**

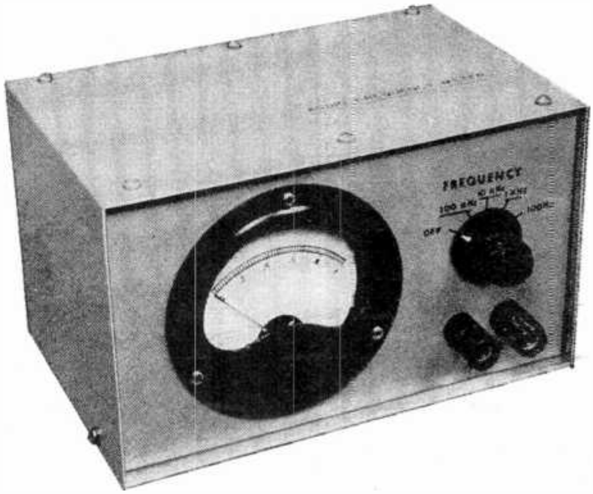
"Pardon the sneeze, Harry—I must be catching cold—you say there's a short count in that resistor order?"


"I foolishly suggested he try it out first—that was three days ago."

"Nope, I can't sell it to you . . . a ham operator of your calibre deserves the quality and performance of this deluxe unit."


"We'll give you the best possible trade-in allowance on your old equipment—let's see, used copper wire is worth 30¢ a pound . . ."


"Would you like to use our installment plan or do you prefer to take the receiver with you?"




# BUILD THE
# ELECTRONIC FREQUENCY METER

### . . . AN IDEAL INSTRUMENT FOR THE ACCURATE MEASUREMENT OF AUDIO AND ULTRASONIC FREQUENCIES

**By WALT HENRY**

HERE'S AN ACCURATE, low-cost electronic frequency meter that's sure to delight the hearts of engineers, technicians, and experimenters alike. Direct reading, the instrument measures the frequency of audio and ultrasonic voltages from 100 hertz to 100 kHz, over wide ranges of input signal levels, and displays the frequency count on a front panel meter.

To measure an unknown frequency, you simply connect the signal source to the instrument's binding posts, rotate the frequency switch to the desired range, and presto! You read off the frequency from an expanded scale meter. Nothing could be simpler.

Fully transistorized and battery-operated, the audio frequency meter counts sine waves, square waves, or pulses. You can build it for less than $30!

**How It Works.** The circuit (Fig. 1) consists essentially of a two-stage, high-gain squaring amplifier (*Q1* and *Q2*), a regenerative switch (*Q3* and *Q4*), a single-stage meter amplifier/driver (*Q5*), and a milliammeter (*M1*).

An input signal at binding posts *BP1* and *BP2* is limited by diodes *D1* and *D2* before it is applied to the base of *Q1*, the first squaring amplifier. The limiter operates at signal levels between 0.5 volt peak-to-peak (0.17 volt, r.m.s.) and 85 volts peak-to-peak (30 volts, r.m.s.), thereby protecting the amplifier in the presence of large input signals, eliminating any need for an input level control.

Transistor *Q1* is biased by *R5* bypassed by *C3*, and its high-gain characteristics alternately drive *Q2* into saturation and cutoff, even with relatively low input signals. Thus, the waveform at the collector of *Q2* is essentially a square wave.

The square wave is then differentiated by the combination of resistor *R13* and capacitor *C4*, *C5*, *C6*, or *C7*, depending on the frequency range selected. The differentiator output is a series of alternately positive and negative spiked pulses that are applied across *D3* to trigger the multivibrator (*Q3* and *Q4*). The purpose of diode *D3* is to remove the negative portion of the pulses, so that only the positive spikes appear at *Q3*'s base.

In the absence of a trigger pulse, transistors *Q3* and *Q4* are in the saturated *on* state, and their output current biases *Q5* to *off*. When a trigger pulse arrives, however, *Q3* and *Q4* are turned off, the reverse bias on *Q5* is removed, and current flows from *Q5*'s collector through the meter. Once *off*, *Q3* and *Q4* remain off until the timing capacitor (*C8*, *C9*, *C10*, or *C11*) charges through its timing resistor (*R9*, *R10*, *R11* or *R12*) to turn on *Q4* again.

As *Q4* turns on, its collector current flows through the base of *Q3* and is amplified by this transistor. Amplification of *Q4*'s base current results in a further increase in collector current. Thus, a very fast regenerative switching action takes place as *Q3* and *Q4* turn on to discharge the timing capacitor and ready the circuit for the arrival of the next trigger pulse.

The current to the meter consists of a series of pulses at the collector of *Q5*. Pulse width will be constant on each range, but the higher the input frequency, the more pulses appear in a given time, and the average current is increased. The inertia of the meter move-

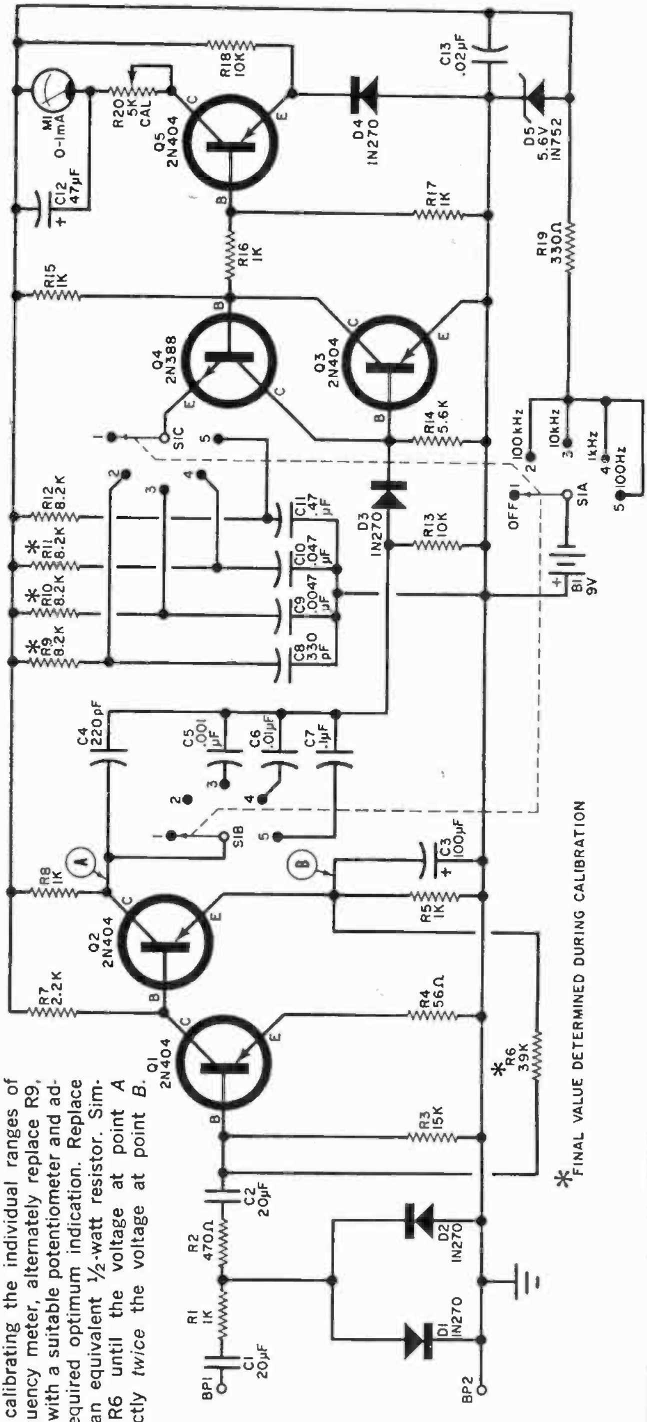



Fig. 1. When calibrating the individual ranges of the audio frequency meter, alternately replace R9, R10, and R11 with a suitable potentiometer and adjust for the required optimum indication. Replace the pot with an equivalent ½-watt resistor. Similarly, adjust R6 until the voltage at point *A* measures exactly *twice* the voltage at point *B*.

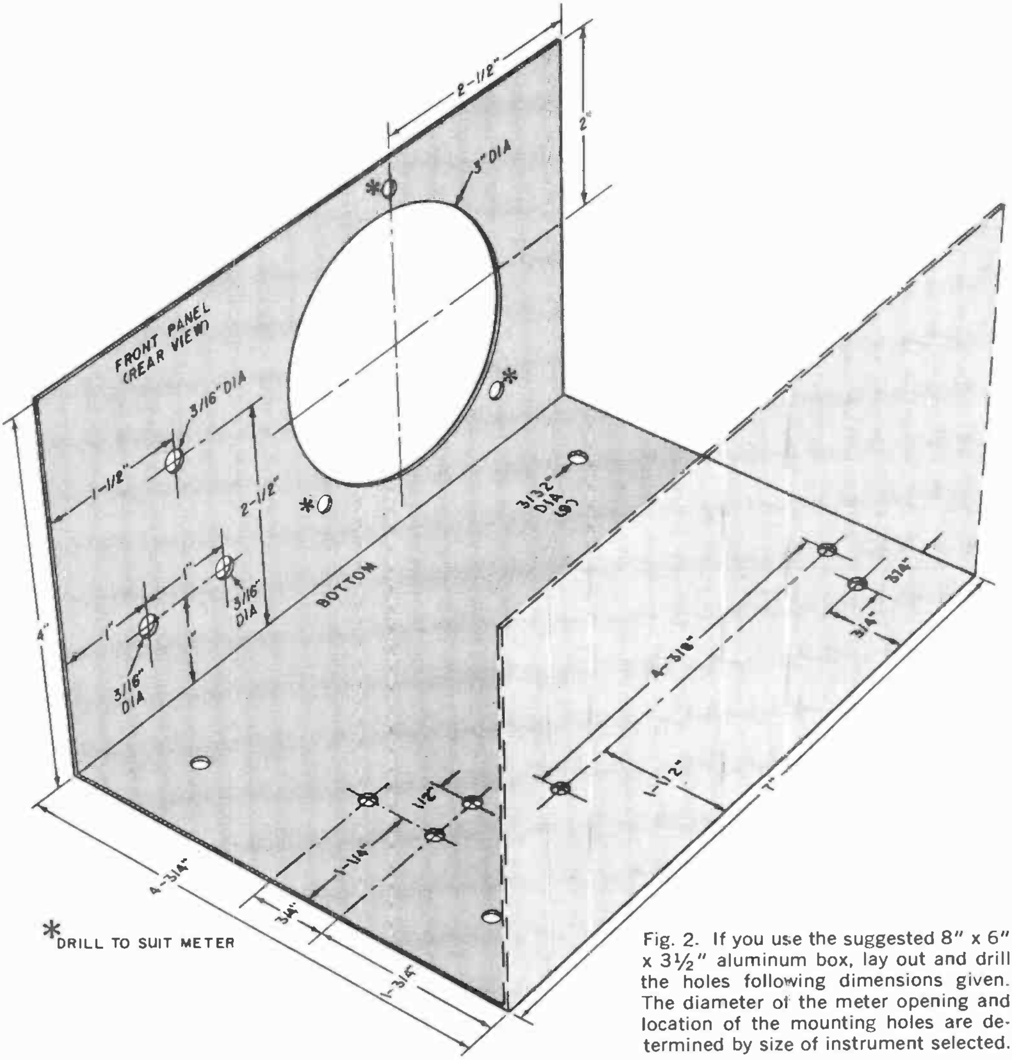



Fig. 2. If you use the suggested 8" x 6" x 3½" aluminum box, lay out and drill the holes following dimensions given. The diameter of the meter opening and location of the mounting holes are determined by size of instrument selected.

## PARTS LIST

*B1—9-volt battery*
*BP1, BP2—5-way binding post*
*C1, C2—20-μF, 30-volt non-polarized electrolytic capacitor (Cornell-Dublier BRNP 20-30, or similar)*
*C3—100-μF, 10-volt electrolytic capacitor*
*C4—220-pF mica capacitor*
*C5—0.001-μF, 100-volt disc ceramic capacitor*
*C6—0.01-μF, 100-volt disc ceramic capacitor*
*C7—0.1-μF, 100-volt disc ceramic capacitor*
*C8—330-pF, 100-volt mica capacitor*
*C9—0.0047-μF, 100-volt mica capacitor*
*C10—0.047-μF, 100-volt tubular capacitor*
*C11—0.47-μF, 100-volt tubular capacitor*
*C12—47-μF (or 50-μF), 10-volt electrolytic capacitor*
*C13—0.02-μF, 100-volt disc ceramic capacitor*
*D1, D2, D3, D4, D5—1N270 diode*
*M1—0-1 mA milliammeter*
*Q1, Q2, Q3, Q5—2N404 transistor*
*Q4—2N388 transistor*
*R1, R5, R8, R15, R16, R17—1000 ohms*
*R2—470 ohms*
*R3—15,000 ohms*
*R4—56 ohms*
*R6—39,000 ohms—see text*
*R7—2200 ohms*
*All resistors ½ watt, ± 10%*
*R9, R10, R11, R12—8200 ohms—see text*
*R13, R18—10,000 ohms*
*R14—5600 ohms*
*R19—330 ohms*
*R20—5000-ohm potentiometer (Bourns 3067-S, or similar)*
*S1—5-position, 3-pole rotary switch (Mallory 1325L, or similar)*
*1—8" x 6" x 3½" aluminum box*
*Misc.—4-pin terminal strips (3), 4¾" x 2¾" perforated phenolic board, flea clips, battery holder, wire, solder, etc.*

ment and the filtering action of *C12* cause the meter pointer to move smoothly rather than oscillate with the pulses. Potentiometer *R20* sets the basic calibration of the instrument.

Zener diode *D5* regulates the supply voltage so that an aging battery, for example, will not cause any abrupt change in the calibration of the instrument.

**Construction.** The ideal size enclosure for the radio frequency meter is an 8" x 6" x 3½" aluminum box. The meter, range switch, and input binding posts are mounted on the front panel, which can be laid out and drilled as shown in Fig. 2. The layout for the bottom plate shows mounting holes for four rubber feet, the battery holder, two terminal strips, and the phenolic circuit board which mounts the small parts.

A three-lug terminal strip, mounted on the range switch (see Fig. 3), serves as potentiometers to achieve greater flexibility of adjustment during calibration. If you do use potentiometers, mount them on the circuit board instead of on the switch. Incidentally, the switch has five positions, although only four of these are used for range selection. The first position is your power on-off control.

Capacitor *C12* is mounted directly across the meter terminals; be sure to observe polarity. Except for input capacitor *C1*, coupling capacitor *C2*, resistors *R1* and *R2*, and diodes *D1* and *D2*—which are mounted on terminal strips—all other parts are assembled on a 4-¾" x 2-¾" perforated phenolic circuit board. Do not solder *R6* permanently in place at this time, since its value may have to be changed during calibration. Note that sockets are not required for mounting the transistors, although they were used in the author's model of the unit. Also, other high-gain, fast-switching transis-

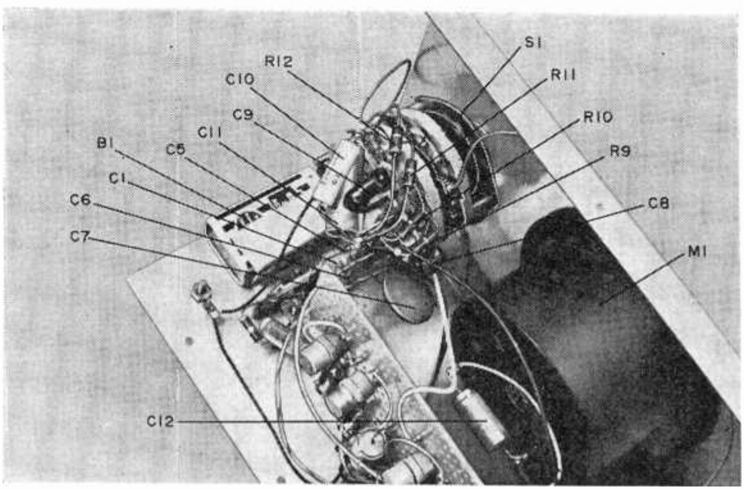



Fig. 3. The frequency-determining components can be assembled on the back of the switch, and the entire assembly mounted on the front panel.

connecting terminals for the timing resistors (*R9*, *R10*, *R11*, and *R12*) and capacitors (*C8*, *C9*, *C10*, and *C11*) as well as for the differentiator network capacitors (*C5*, *C6*, and *C7*), all of which are mounted on the back of the switch. However, the timing resistors should not be permanently connected to the switch until their final value has been determined during calibration.

A convenient, though more expensive, alternative is to replace the timing resistors with miniature-type 15,000-ohm tors can be substituted for the types indicated.

After assembly, the board is mounted vertically on the chassis as shown in Fig. 4. But be sure to keep it at least a half-inch away from the back panel or other metal surfaces in order to minimize stray capacitance.

While, in general, the circuit layout is not critical, it is important that you isolate the leads to the amplifier input from those going to the meter, to prevent cross-coupling. Also, run ground leads from the various points in the circuit to a single ground lug on the chassis. The lug can be secured under one of the screws.

**Checkout And Calibration.** After you have carefully checked all your wiring, insert the battery in its holder and turn the range switch to the 100-kHz position. The meter pointer should suddenly deflect up-scale and then settle down back to zero. With the positive lead of your voltmeter at ground (chassis), measure the voltages at the emitter and collector of transistor *Q2*. Ideally, the voltage at the collector should be twice the voltage at the emitter, although in practice this ratio is difficult to achieve.

If this voltage ratio cannot be achieved, within reasonable limits, alternately lower and raise the value of *R6* as necessary. Once the final resistance value has been determined, solder this resistor in place permanently.

Now set the range switch to the 100-Hz position and connect a 60-Hz signal across the input binding posts. An accurately calibrated audio signal generator can be used as the signal source, but the signal amplitude should be at least 1 volt peak-to-peak (0.4 volt r.m.s.). A 6- or 12-volt filament transformer connected to the a.c. power line can also be employed as a 60-Hz signal source.

The meter should give a reading when the test signal is applied to the binding posts. Adjust *R20* for a reading of exactly 0.6 on the dial. Thus, the range setting (100 Hz) times the meter reading (0.6) gives 60 Hz, the input frequency.

To calibrate the 1-kHz, 10-kHz, and 100-kHz ranges, you'll need an audio oscillator. However, to obtain an accurate calibration on each range, it will be necessary for you to adjust the value of the timing resistor for each range. Thus, *R9* is adjusted for the 100-kHz range calibration, *R10* for the 10-kHz range, and *R11* for the 1-kHz range. If potentiometers are used in place of resistors, calibration will be quite simple.

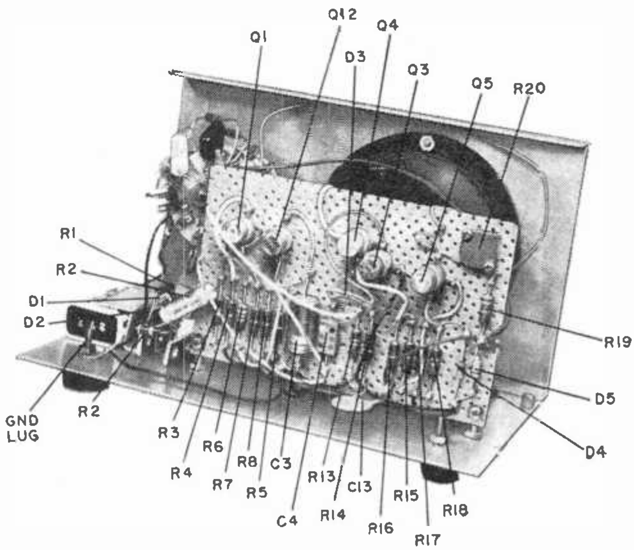



Fig. 4. When mounting the circuit board, position it at least ½" above bottom plate and away from back panel, to minimize stray capacitance.

**Operation.** To operate the audio frequency meter, simply connect the signal whose frequency is to be measured to the input binding posts. *Caution*: Since the input capacitor, *C1*, is rated at 30 volts, do not apply higher level signals to the instrument.

Turn the range switch clockwise from *off* until you get a meter reading between 0.1 and 1.0. The exact signal frequency is determined by multiplying the reading indicated by the setting of the range switch. After use, turn off the instrument to save the battery. –30–


"SHAME ON YOU FOR MAKING THE CB MESS!"

# FCC Proposes CB "Type Acceptance"
# Manufacturers Blamed for CB Malpractices

IN A sudden—but not unexpected—move, the Federal Communications Commission has proposed (Docket No. 17196) that at some not too-distant date all new CB transceivers be "Type Accepted." This announcement was made on February 17 at a meeting in Washington, D.C., called by the FCC to discuss the CB "mess" with CB equipment manufacturers.

Type acceptance is a formal FCC method of controlling the manufacture of transmitting equipment.* If the proposal becomes law, the FCC would check out the operating characteristics of sample CB transceivers submitted to the FCC by the manufacturers. Approval by the FCC would be required before a CB unit could be offered for sale to the general public.

With regard to CB equipment now in use, the FCC docket proposes that all transceivers have a five-year life, or amortization period. In addition, the new rule would allow a six-month period after finalization of the rule change wherein manufacturers of CB equipment could dispose of stock on hand that might not meet "type acceptance."

**What New Equipment Will Be Like.** One of the greatest surprises to the manufacturers attending the February meeting was the "specifications" for type acceptance. Practically all "frills" would be swept off the faces of the new CB transceivers.

The *ONLY* external controls accessible to the user would be: the a.c. or d.c. power plug, microphone connection, antenna connection, on-off switch and volume control, channel selector switch (with a maximum selection of 23 channels), transmit-receive switch, and a switch to enable the use of the modulator amplifier for public address.

Missing from CB transceivers under type acceptance would be the following typical controls: squelch (!), S-meter or any type of r.f. output meter/indicator, connections for selective calling, fine or "delta" tuning control, r.f. gain or tone controls, panel crystal socket, voice enhancement switch or control, earphone jack, etc.

Manufacturers were given until March 27 to file comments on the proposed docket. As this magazine went to press, no manufacturer had been able to formalize objections to some of the proposed changes.

**The Manufacturers Did It.** Attending the Washington meeting were representatives of practically all the major CB equipment trade papers. The FCC had called the meeting to discuss with equipment manufacturers improved compliance by CB users to the Part 95 CB Rules and Regulations.

As the 75 attendees of the meeting sat in

**Type acceptance is not something created just to bedevil CB'ers. Type acceptance of transmitters is presently required for all radio services except CB and ham radio.*

somewhat stunned silence, it was apparent that all of those present were being blamed for every ill to befall CB—including what the CB user says on the air and exactly how the CB'er uses his equipment! Although many of the attendees made various suggestions and offers of cooperation—if the FCC would provide guidelines—this part of the meeting accomplished little.

**The Walkie-Talkie Gossip.** Almost as an afterthought, the FCC announced at the Washington meeting that newspaper and magazine stories concerning an impending frequency change for the 100-milliwatt walkie-talkies were not true. Although the problem (if there really is one to begin with —Ed.) of interference between the 5-watt CB transceivers and walkie-talkies is being studied, no "imminent" change in the appropriate Part 15 Rules and Regulations was foreseen.

**Heath Asks for Kit Recognition.** In a separate action, but noted by the FCC in the proposed type acceptance docket, the Heath Company has filed a petition requesting a special exception for CB gear assembled by kit builders. As implied above, the type acceptance proposal would eliminate all CB transceivers not produced under the direct control of a specific manufacturer. No allowance is made in the present proposal for CB transceiver kits. —30—

## EDITORIAL COMMENT

In this latest "Proposal for Rules Making" to straighten out the "mess" on the CB channels, the FCC has backed itself into an unenviable position. CB is big business and the public has invested well over a half billion dollars in CB equipment. Industry figures show that twice as much money is spent on CB as on ham radio. CB—as we know it right at this moment—can never be disbanded by the FCC.

Isn't it time that the FCC took a long, hard, serious look at CB as it really is? Piecemeal legislation and rule changes cannot resolve the problems afflicting CB. The FCC has been victimized by its own poor planning and appalling disinterest in the wants or desires of hundreds of thousands of the very citizens it supposedly represents.

Continual "re-interpretations" of the CB rules will not solve the basic problem of how to "police" the CB'ers already on the air. Certainly the FCC doesn't seriously envision the day when CB will be legislated out of existence. What does the FCC think would happen to all that equipment? Wouldn't the "policing" problem become a national scandal if the CB rules were suddenly junked?

The CB equipment manufacturers did not "create" CB. In fact, for the most part, the equipment manufacturers have had little to do with or to say about the CB rules. It seems rather ironic that the FCC finds it apparently impossible to shoulder the burden of guilt for the so-called CB "mess."

Isn't it time the FCC recognized that there are only two feasible solutions to the CB problem? The FCC can either legislate the CB hobbyists to a new band of radio frequencies; or move the legitimate—but abused—CB user to a new, small business band.

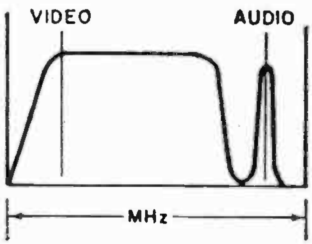
OLIVER P. FERRELL, KOD3631

# ELECTRONICS I.Q. QUIZ

By ROBERT P. BALIN

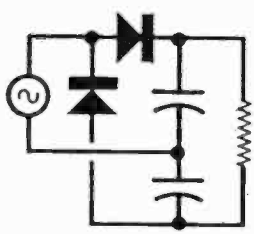
Each of the sketches (A-I) below can be directly associated with a single digit (1-9) that helps to describe its purpose, or interprets its function. For example, in the sample sketch (X), the silver band on the resistor indicates a tolerance of ±10%. If you answer 9 out of 9, you're a genius; 7 correct answers is about average.

(*Answers appear on page* 104)




? MHz

A

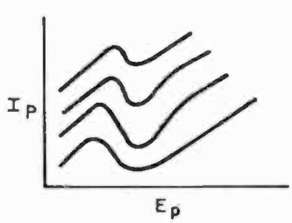


? × $E_{in}$ = $E_{out}$

B

Morse code digit?

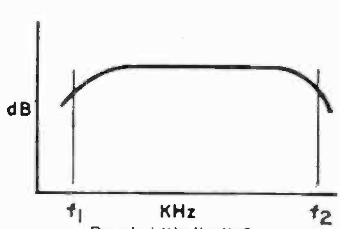
C




Tube type?

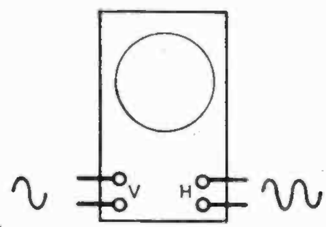
D

E



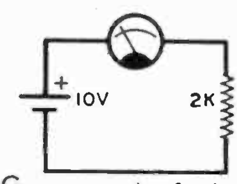

Bandwidth limits?


X



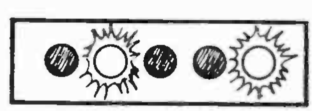

F

Lissajous figure?




G

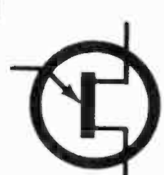
I = ? mA



H

Binary readout?

I



Number of junctions?

1 ____

2 ____

3 ____

4 ____

5 ____

6 ____

7 ____

8 ____

9 ____

10 X

# INFORMATION CENTRAL

By CHARLES J. SCHAUERS, W6QLV

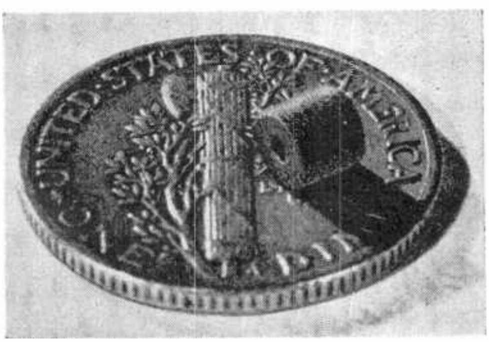
JUST AS there is no 100% typical reader of POPULAR ELECTRONICS, there is no typical question being asked your *Information Central.* Questions that have been arriving at my desk range from the very simple to some of the most complex—as a matter of fact, they are occasionally so involved that an electronics research and development laboratory would have difficulty solving the problems.

I continue to be pleased by the very favorable response to this new department. To date, the majority of questions that I have received have been thoughtfully presented and appear to be sincere queries about perplexing problems. Although I conducted a column similar to this one for many years in a ham radio magazine, I freely admit that the POPULAR ELECTRONICS reader offers a much greater challenge.

Keep sending your questions to *Information Central,* % POPULAR ELECTRONICS, One Park Avenue, New York, N.Y. 10016. I want the editor to think that this department is a success!

**Ferrite Beads.** *I understand that ferrite beads can be used for r.f. decoupling, r.f. shielding, and even parasitic suppression. Do you have any information on them?*

Ferrite beads have not been used in too many ham applications, but they are amazing little devices. Each bead acts like an r.f. choke, and when strung on a connecting lead—say in a power supply or an audio circuit—it imposes a high impedance along the r.f. path. When there is an undesirable r.f. signal traveling along a low-impedance path, the ferrite beads can do a remarkable job of "stripping" the hash. They can also be used in grid circuits of r.f. amplifiers to make neutralization easier or even to keep r.f. out of a high-gain audio circuit.



If you want to experiment with ferrite beads, write to Ami-tron Associates, 12033 Otsego Street, North Hollywood, Calif. A dozen or so beads will probably cost you about $2.00.

**TVI Elimination.** *I have tried just about everything to eliminate the TVI caused by my ham rig on neighboring TV receivers, but there is still a little cross-hatching that defies all my efforts. I have a 3-element, 3-band trap beam antenna fed with 52-ohm coax. Is there any last-resort TVI elimination measure I could take?*

Each situation requires a different type of treatment, but there is one thing that has helped me. Try a 1:1 balun right at your antenna. The balun should be a 52-to-52-ohm unit and must be encapsulated against the weather and large enough in power-handling capacity to suit your rig.

**Tape Recorder Hiss.** *My solid-state tape recorder has developed an excessive hiss. This becomes unbearable when the tone control is turned into the treble range, and even when the volume is increased above average room level. Is there any kind of a filter that I could place between the tape recorder output and my speaker system?*

Rather than try to insert a filter, I would look for three possible causes of your problem. In order of likelihood, first I would make sure that the playback head was demagnetized. Some tape recorders need head demagnetization every five or six weeks, depending on use. A second possibility concerns the tweeter level of your speaker system. Has the level been changed or accidentally set too high? Finally, you might have a very noisy transistor in the playback amplifier, but this is very unlikely.

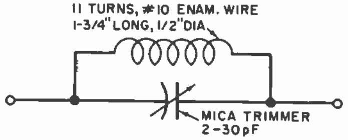
**Van de Graaff Spheres.** *I built a 300,000-volt Van de Graaff electrostatic generator for a Science Fair project, and I need a large aluminum sphere for the top of the column. I can't buy one and no one seems to advertise them. What do I do?*

You can buy spun aluminum spheres from Morris & Lee, 1685 Elmwood Ave., Buffalo, N.Y. 14207. This company specializes in Science Fair project materials and sells spheres (either copper or aluminum) at about $1 per inch of diameter.

**Generator Whine.** *My car uses a regular d.c. generator (not an alternator) and the "whining sound" coming over my CB rig is driving me crazy. I have tried bypassing the generator leads, but this has provided only a partial solution to my problem. Is there any 100% toolproof method of eliminating the whine?*

I think so, but your letter doesn't indicate whether you used a coaxial capacitor in series with the armature lead to the generator. You must use a coaxial capacitor since the usual automotive type of capacitor is not too effective in suppressing this whine around 27 MHz.

If bypassing is not the answer, buy or build a wave trap and place it in series with the armature lead. The trap should be tuned to the CB channels that you want to hear.




Allied Radio catalogs such a trap as 17A8512 ($2.35) and Lafayette Radio Electronics has one under catalog number 99C6018 ($2.49).

Some generators may require an additional 0.01-$\mu$F metal-cased tubular capacitor from the hot brush of the generator to ground.

**Hammarlund HX-500 VOX Hang-On.** *My HX-500 transmitter has been exhibiting VOX relay hang-on. This is something new to me, so where should I look first to locate the trouble?*

User reports on this transmitter indicate that the condition can almost always be cured by merely replacing the 6U8 tube (V-8 on the schematic) with a quality 6U8A tube.

**"Apache" Heating.** *I am stationed in Germany with the Armed Forces and have my "Apache" TX-1 Heathkit transmitter on the air. The power transformer is really heating up. I am surprised that the 50-cycle current would cause this much heating. Is there anything I can do about it?*

This is strange, for I once operated an "Apache" transmitter on 50 cycles without undue heating. The 10-cycles difference can cause overheating if the transformer is operated in excess of its ratings. Have you tried keeping your input down to a maximum of 110 volts? And how about the oscillator filament transformer. Does that heat up? If the filament transformer does not overheat, the problem could be in your power transformer, although I doubt it. There is also the possibility of getting a transformer wound for 50-cycle operation; there are many shops in Germany that can do this for you.

**The "Official" Ten Code.** *I know that CB'ers "lifted" the Ten Code from the police, but how much difference is there between the "Official" Ten Code and the code used by CB'ers?*

Actually, there is quite a bit of difference and if you're involved in emergency communications, be careful if you attempt to use the Ten Code. For example, 10-10 on CB means standing by, but the police signal means that a fight is in progress; 10-11 among CB'ers means speak slowly, but the police know that it means "dog case." In fact, a quick comparison between the CB Ten Code and the police "official" ten signals indicates that less than half of the police signals are applicable to CB and over two-thirds of the police signals are not the same as the CB Ten Code.

**Tape Recorder Connection.** *I have a medium-priced tape recorder with only a microphone input, and I would like to make tape recordings from my radio. What must I do?*

Locate the volume control in your radio and bring out a shielded lead (with appropriate microphone connector) with the center conductor in series with a 0.01-$\mu$F ceramic capacitor attached to the top terminal on the control. Connect the shield to the bottom of the control.

**SWL Receiver Improvements.** *I have a $60 short-wave receiver and I would like to improve the sensitivity so that I can hear some of the DX in the 16- and 19-meter bands.*

The SWL receiver that you have has no r.f. stage and would be vastly improved if you could add an outboard preselector or r.f. amplifier. Your best bet would be to build the nuvistor cascode preamplifier sold by AMECO as Model PCL-P. This unit includes a built-in power supply and sells for under $35. Holstrom and Lafayette sold SWL'ing preselectors some years ago, but I no longer find them cataloged.

**SB-33 Transistor Replacement.** *I own a second-hand SB-33 transceiver which is giv-*

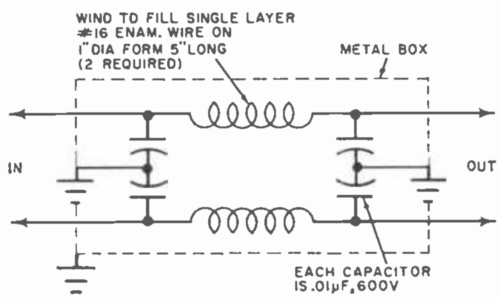
*ing me excellent service except that the T6417, 2N1727 and 2N1867 transistors are below par. Are there any recommended substitutions?*

All the transistors mentioned can be replaced by the Amperex 2N2672. Also, in your transceiver, the T6126 transistor can be replaced with a 2N1304 or 2N1700. A 2N1305 can be used to replace the T2515 transistor.

**Aquarium Neon Noise.** *I am positive that it is the neon bulbs in my aquarium heaters that are interfering with the radio reception. Is there anything I can do to eliminate this noise?*

Generally speaking, the elimination of neon fixture noise is difficult because of the lack of space in which to mount the necessary suppression components. However, try two 0.01-μF ceramic capacitors tied in series across the heater a.c. line input. The center connection of the two capacitors should be grounded to the metal fixture frame.

If this doesn't work well enough, try the filter shown in the accompanying diagram.




Mount the filter components in a small metal box and run an inconspicuous grounding lead between the aquarium heater metal fixture and the metal box. If this improves things, but does not completely eliminate all of the interference, try using some fine wire mesh copper screen to shield the neon bulbs in their metal enclosure. The screen will shield out the r.f., but allow the light to come through.

**Do-Everything FET.** *Is there any such thing as a universal field effect transistor? I am looking for a FET that will work in any frequency range from 1 Hz to maybe 400MHz. Any suggestions as to where I can obtain one.*

Yes, I would suggest that you try the 2N4416 FET made by Union Carbide. The manufacturer claims that it will replace 80% of all currently available FET's. For additional technical data, write to Untion, 365 Middlefield Rd., Mountain View, Calif. 94040.

**EICO 753 Modification.** *I have an early model of the 753 transceiver that I bought from a friend. I am experiencing the following difficulties: the set has a very low output and it is hard to adjust the final power amplifier bias, and there appears to be frequency instability with FM and chirping of my CW signal. Has any information been released on these problems?*

Yes. Your first problem will be solved if you replace the final amplifier 6DQ6B tubes with factory replacements. Your second problem can be resolved with the addition of a zener diode, a resistor, and a change in capacitor type and value if you have a vacuum-tube-operated VFO. A solid-state VFO with instructions for installation is available. However, I would suggest that you write to EICO, 131-01 39th Avenue, Flushing, N.Y. 11354 (Att.: Service Department) for exact modification information.

**CB FM'ing.** I have a couple of popular CB rigs. One is my base station and the other two are mobiles. Oddly enough, one of the mobiles works fine, but the other has distorted modulation and FM'ing. What do I look for?

*If both of your mobile rigs are solid-state and one works, but the other doesn't, I'd suspect "downward" modulation. Some of the older transistorized CB outfits were notorious for their inability to maintain sufficient drive to the final amplifier. When the drive is low, the modulation peaks go down rather than up. Read the article in the April issue of* POPULAR ELECTRONICS *(page 72) on CB tune-ups. There's one CB rig that has a 6-watt output (illegal), but the modulation is all downward.*

**SWL'ing and BCI.** I have a National NC-121 receiver and the local broadcast stations (each a half-mile away on opposite sides of my location) produce harmonics all over the dial. Can I trap these stations out?

*There's no doubt you're suffering from r.f saturation (probably in the a.c. power lines) and there's little you can do. Unfortunately, the NC-121 has no r.f. stage; unless you put in a selective (tunable) r.f. preselector and filter the a.c. lines, you're licked.*

**Tape Recorder Auto-Cueing.** How about some plans for automatically cueing my tape recorder?

*Sorry, Mister, but the first thing you need is a good tape recorder and your $60 unmentionable is not in that ball park. To make auto-cueing work, you've got to record a tone signal between 16,000-17,000 hertz—your recorder would be lucky if it got close to 11,000 hertz.* —30—

# FOREIGN-LANGUAGE BROADCASTS TO NORTH AMERICA

**Prepared by BILL LEGGE**

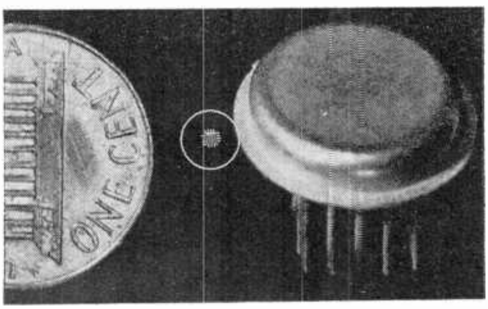
| LANGUAGE | STATION | Time—EST | Time—GMT | Frequencies (MHz) |
|---|---|---|---|---|
| ARABIC | Beirut, Lebanon | 9-9:30 p.m. | 0200-0230 | 11.76 |
| | Cairo, U.A.R. | 6:30-7:30 p.m. | 2330-0030 | 9.475 |
| BULGARIAN | Sofia, Bulgaria | 8-8:30 p.m. | 0100-0130 | 9.70 |
| CHINESE | Peking, China | 8-10 p.m. | 0100-0300 | 12.01, 15.095, 17.795 |
| | | 10-12 p.m. | 0300-0500 | 9.48, 12.01, 15.08 |
| CZECH/SLOVAK | Prague, Czechoslovakia | 8:30-9 a.m. (Sun.) | 1330-1400 | 15.285, 17.825 |
| | | 10-10:30 p.m. | 0300-0330 | 5.93, 7.345, 9.55, 11.99 |
| DANISH | Copenhagen, Denmark | 8-8:45 p.m. | 0100-0145 | 9.52 |
| DUTCH | Brussels, Belgium | 6:15-8 p.m. | 2315-0100 | 11.85 |
| | Hilversum, Holland | 9:30-10:50 p.m. | 0230-0350 | 9.59 |
| FINNISH | Helsinki, Finland | 7:15-10:10 a.m. | 1215-1510 | 15.185 |
| FRENCH | Brussels, Belgium | 6:15-8 p.m. | 2315-0100 | 11.85 |
| | Lisbon, Portugal | 9:15-10 p.m. | 0215-0300 | 5.985 |
| | Paris, France | 7-7:30 p.m. | 0000-0030 | 9.755, 11.845 |
| | Rome, Italy | 8:20-8:35 p.m. | 0120-0135 | 11.81, 15.385 |
| | Vatican | 8:10-8:25 p.m. | 0110-0125 | 7.27, 9.645, 11.76 |
| GERMAN | Berlin, Germany | 8:30-9:30 p.m. | 0130-0230 | 9.73, 11.92 |
| | Cologne, Germany | 7-10 p.m. | 0000-0300 | 6.10, 9.545, 11.795 |
| | | 10 p.m.-1 a.m. | 0300-0600 | 6.10, 9.64, 11.795 |
| | Vienna, Austria | 7-9 p.m. | 0000-0200 | 9.77 |
| HUNGARIAN | Budapest, Hungary | 7-7:30 p.m. | 0000-0030 | 9.833, 11.91 |
| | | 9-10 p.m. | 0200-0300 | 9.833, 11.91 |
| ITALIAN | Rome, Italy | 5:30-8 p.m. | 2230-0100 | 11.81, 15.385 |
| JAPANESE | Tokyo, Japan | 7:15-7:30 a.m. | 1215-1230 | 9.505, 11.815 |
| | | 8:30-9 p.m. | 0130-0200 | 15.135, 15.235, 17.825 |
| LITHUANIAN | Vilnius, U.S.S.R. | 5:30-6:30 p.m. | 2230-2330 | 9.745, 11.79 |
| NORWEGIAN | Oslo, Norway | 10-11:30 a.m. | 1500-1630 | 15.175 |
| | | 6-7:30 p.m. | 2300-0030 | 11.85 |
| PORTUGUESE | Lisbon, Portugal | 7-9 p.m. | 0000-0200 | 6.025, 6.185, 9.68 |
| | | 9:45-11 p.m. | 0245-0400 | 6.025, 6.185, 9.68 |
| RUMANIAN | Bucharest, Rumania | 6:15-7 p.m. | 2315-0000 | 9.57, 11.94, 15.38 |
| | | 10:30-11 p.m. | 0330-0400 | 9.57, 11.94, 15.38 |
| RUSSIAN | Moscow, U.S.S.R. | 7 a.m.-12:30 p.m. | 1200-1730 | 15.135 |
| | | 6:30-7 p.m. | 2330-0000 | 9.685, 11.955 |
| | | 8:30-9 p.m. | 0130-0200 | 9.685, 11.955 |
| SPANISH | Buenos Aires, Argentina | 8-9 p.m. | 0100-0200 | 9.69 |
| | | 11-12 p.m. | 0400-0500 | 9.69 |
| | Havana, Cuba | 6 a.m.-4 p.m. | 1100-2100 | 6.135, 15.30 |
| | | 5-11 p.m. | 2200-0400 | 6.135, 11.93 |
| | Quito, Ecuador | 6-9 a.m. | 1100-1400 | 9.745, 11.915, 15.115 |
| | | 7:30-9 p.m. | 0030-0200 | 9.745, 11.915, 15.115 |
| SWEDISH | Stockholm, Sweden | 8-8:30 p.m. | 0100-0130 | 11.805 |
| | | 11-11:30 p.m. | 0400-0430 | 11.805 |
| UKRAINIAN | Kiev, U.S.S.R. | 6:30-7 p.m. | 2330-0000 | 9.665, 9.685, 11.79 |
| | | 7:30-8 p.m. | 0030-0100 | 9.665, 11.79 |

# SOLID STATE

By LOU GARNER, Semiconductor Editor

SEMICONDUCTOR DEVICES must be sealed during production, against outside contamination, to insure consistent characteristics and long operating life. With present methods, these devices are first formed by vapor diffusion and alloying techniques on crystalline slices containing hundreds (or thousands) of individual units. Then the slices are cut up into separate devices, with each device (or IC) sealed individually by means of an epoxy plastic coating or a vacuum-tight metal container.

In contrast, a new production technique developed by Bell Telephone Laboratories (Murray Hill, N.J.) brings *batch* processing to the encapsulation (sealing) step, permitting thousands of devices to be sealed simultaneously. This not only reduces production costs, but can result in smaller, more reliable devices. The hermetic seal is formed by applying a layer of silicon nitride along with beam lead contacts to the silicon dioxide layer of the semiconductor device.



A new semiconductor encapsulation process developed by Bell Labs makes possible the fabrication of smaller IC devices (center) by eliminating the need for the hermetically sealed can at the right.

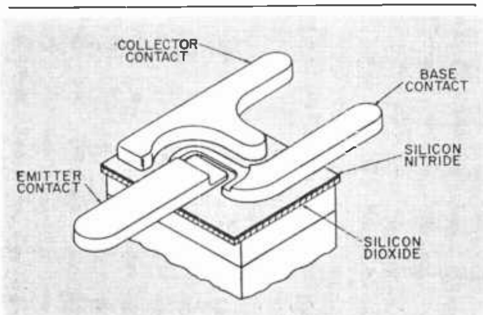



Fig. 1. A layer of silicon nitride is shown applied with beam lead contacts to a silicon dioxide layer during the sealing of a semiconductor device.

Several steps are required in the new process. First, the silicon slice containing the devices is heated to 875° C. in a closed chamber containing pure hydrogen gas. Second, a mixture of two gases, silicon hydride and ammonia, is introduced into the chamber. When this mixture makes contact with the heated slice, the heat causes the two gases to react chemically to form a silicon nitride layer which adheres to the slice, forming a protecting barrier against the penetration of contaminating elements.

In order for the beam lead contacts to make electrical contact with the interior regions of the semiconductor devices, "windows" are opened in the silicon nitride coating by etching with boiling phosphoric acid. In an alternate method, the silicon nitride in the window area is anodized or converted electrolytically into silicon oxide.

The precious metal beam contacts are applied to the devices through the etched window openings. The contacts form a strong chemical bond with the silicon nitride layer, further sealing the contact areas. Afterwards, the slice may be cut into individual devices similar to the one in Fig. 1.

In preliminary tests of the new technique, epitaxial silicon transistors with the new seal were deliberately contaminated with metallic ions and then subjected to accelerated power aging. That is, they were operated with normal bias voltage but at a power level considerably above their ratings. Such a test accelerates failure by raising the transistor junction temperature to about 300° C. Although these tests are continuing, devices with the new seal have already exhibited a longer median life than conventional hermetically-sealed transistors.

**Reader's Circuit.** Are you one of that growing number of hi-fi enthusiasts who are experimenting with headphone reproduction of stereo program material? If so, you should be interested in the amplifier circuit

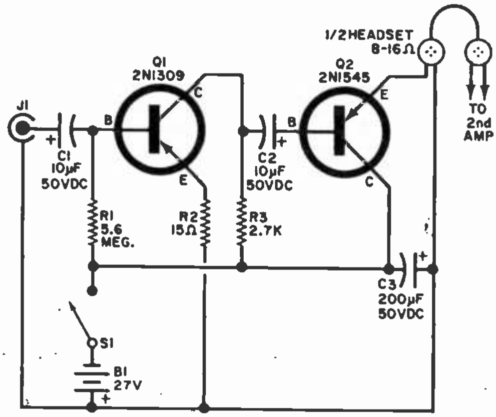



Fig. 2. This simple two-transistor amplifier circuit submitted by reader Christopher C. Hoffman provides ample power for low-impedance headphones.

shown in Fig. 2. Submitted by reader Christopher C. Hoffman (676 Yale Station, New Haven, Conn.), this simple circuit is designed to provide adequate drive for the popular low-impedance (8-16 ohms) dynamic headphones widely used for hi-fi listening.

The design features a pair of R-C coupled *pnp* transistors, with *Q1* used as a common-emitter amplifier to provide voltage gain, while *Q2* serves as an impedance-matching emitter-follower power amplifier. The input signal at *J1* is applied to *Q1*'s base circuit through coupling capacitor *C1*. Base bias is supplied through *R1*, with emitter resistor *R2* providing stabilization, and with *R3* serving as the collector load.

The amplified signal at *Q1*'s collector is applied to *Q2* through interstage capacitor *C2*. The second stage, *Q2*, is operated without external base bias. Operating power is furnished by *B1*, controlled by s.p.s.t switch *S1*, and bypassed by *C3*.

Inexpensive parts are used in the circuit. Transistor *Q1* is a 2N1309, and *Q2* a 2N1545. All resistors are half-watters and the three capacitors are 50-volt electrolytic units. Jack *J1* is a standard phono type. Any toggle, slide, or rotary switch can be used for *S1*. A 27-volt power source (*B1*) is required; this can be either a line-operated d.c. power supply or three 9-volt batteries connected in series.

The amplifier can be assembled on a small chassis, a phenolic circuit board, or a suitably designed etched circuit board. Remember that for stereo listening you'll need two identical amplifiers. Heat-sink the output transistor (*Q2*) on a 2" x 4" light-gauge aluminum plate.

For maximum output volume when using headphones of average sensitivity, the amplifier should be driven with a moderate-level signal, such as might be obtained from an FM tuner or standard preamplifier. However, Chris reports that he has obtained adequate volume (without RIAA compensation, of course) by connecting his amplifier directly to the output of a magnetic phono cartridge.

**Manufacturer's Circuit.** Our reader mail clearly indicates a growing interest in line-operated transistor circuits. For, although batteries are relatively inexpensive, line operation is not only feasible at times, but actually preferable to battery power. A general-purpose line-powered audio amplifier circuit is illustrated in Fig. 3. Appearing in a General Electric (Semiconductor Products Department, Syracuse, N.Y.) Application Note, this amplifier can be used in a phonograph or intercom, or in the audio section of a radio or TV receiver.

Employing *npn* transistors, the circuit makes use of a direct-coupled design and is capable of delivering approximately 1 watt of audio power to a speaker load when driven with a 3-millivolt input signal. It has relatively low distortion and adequate frequency response, but is not intended for high-fidelity applications.

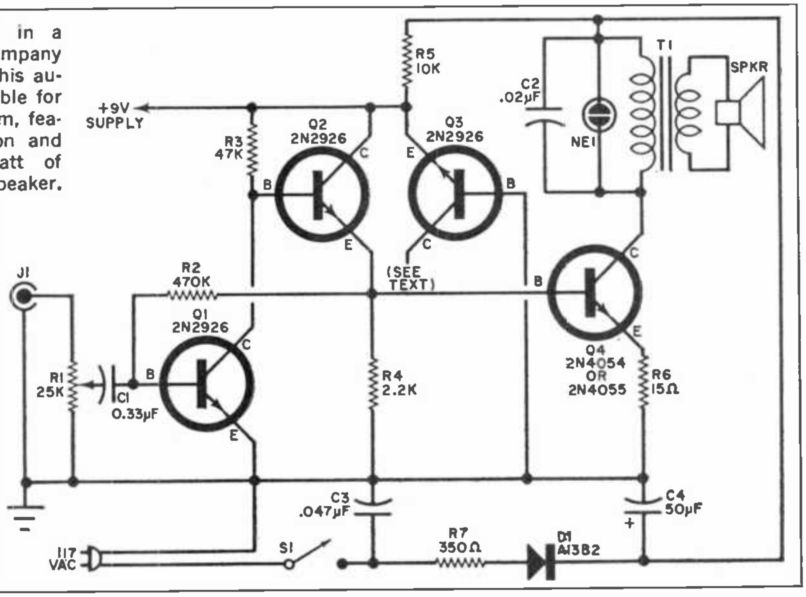
The input signal at *J1* is applied across gain control *R1* to the base of *Q1*, through capacitor *C1*. Transistor *Q1*, biased by *R2*, is hooked up as a common-emitter amplifier, with its amplified output signal developed across collector load *R3*, and direct-coupled to emitter follower *Q2*, serving as an impedance-matching device. Transistor *Q2*'s output, developed across emitter load *R4*, is direct-coupled to the base of power amplifier *Q4*. This stage is stabilized by unbypassed emitter resistor *R6*, while overall stabilization is provided by the feedback applied to *Q1*'s base through bias resistor *R2*.

Transformer *T1* matches *Q4*'s collector circuit to the low-impedance loudspeaker load. Capacitor *C2*, shunted by neon lamp *NE1* and the primary of *T1*, balances the overall frequency response by providing a high-frequency roll-off. Neon lamp *NE1* acts to short out inductive transient spikes which could damage *Q4*.

A conventional line-operated power supply, consisting of rectifier *D1*, limiting resistor *R7*, and filter capacitor *C4* is employed. Power is controlled by switch *S1*, while *C3* serves as a noise bypass across the line.

Transistor *Q3*'s role is an interesting one; observe that its collector is not connected at all. This device is hooked up to function as a zener diode rather than as a transistor. Together with series resistor *R5*, it main-

Fig. 3. Appearing in a General Electric Company Application Note, this audio amplifier, suitable for a phono or intercom, features line operation and can deliver 1 watt of audio power to a speaker.




tains a 9-volt d.c. potential at the collector of $Q2$, and supplies this voltage to other parts of the circuit.

If preferred, you can substitute a low-wattage 9-volt zener diode for *Q3*. Transistors *Q1*, *Q2*, and *Q3* are 2N2926's and *Q4* is a 2N4054 or 2N4055 power unit which, according to GE, will be at their distributors in June. Diode *D1* is a A13B2 unit, but any standard type, such as a 1N4003 or 1N4004, can be used instead. Gain control *R1* is a conventional potentiometer with an audio taper; all resistors are half-watters except *R5* which is a 2-watt unit, and R7, which is rated at 5 watts. Capacitor *C1* is a low-voltage ceramic unit, *C2* and *C3* are 200-volt tubular paper types, and *C4* is a 150-volt electrolytic capacitor.

Neon lamp *NE1* is a NE-2H, selected to trigger above 90 volts. If preferred, a Ferroxcube No. E299DD-P340 voltage-dependent resistor can be used in place of the neon lamp. The output transformer, *T1*, should have a 2000-ohm primary, with its secondary chosen to match the voice-coil impedance of the speaker used. Input jack *J1* is a standard phono type, while *S1* can be any toggle, slide, or rotary s.p.s.t. switch. With one side of the power line connected directly to the amplifier's ground, as in a a.c./d.c. tube-operated receiver, a polarized line plug should be employed to minimize shock hazards which are inherent in line-operated power supplies of this kind. The use of an isolation transformer in the line is more desirable.

The builder can follow his own inclinations as far as assembly is concerned, using either chassis or circuit board construction. Signal leads should be kept short and direct, of course, with the power supply circuit kept away from the input stage to minimize hum pickup. Although not specified in the GE Application Note, it would be a good idea to provide a small heat sink for *Q4*. And if substitute transistors are used for *Q1* and *Q2*, try adjusting *R2*'s value, experimentally, for optimum performance.

**The "Guesstimate" Game.** Without counting the usual run-of-the-mill applications of solid-state devices in home entertainment equipment, what would be your guess as to the number of consumer products—intercom, burglar alarm, light dimmer, sewing machine control, garage door opener, etc.—in which solid-state devices are used? Would you say 100? How about 10?

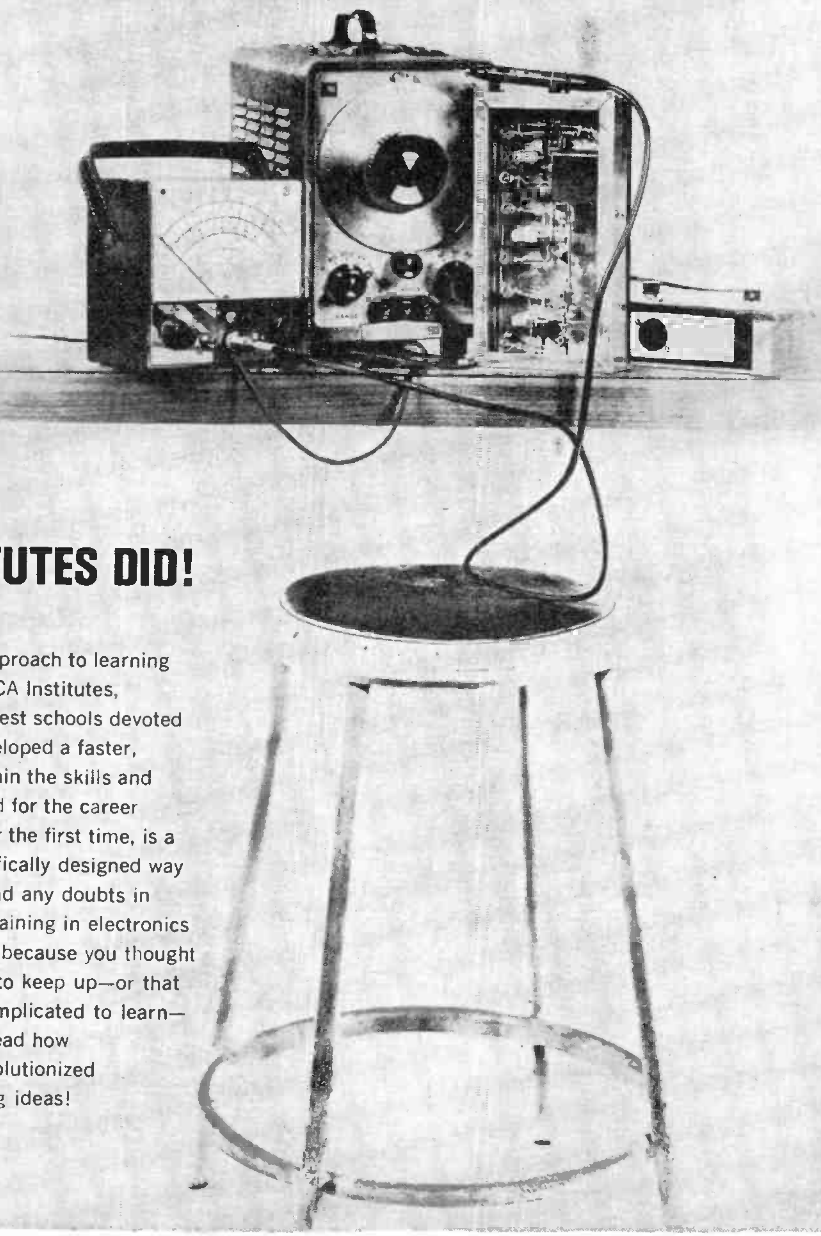
If you'd like to play this guessing game, write a short letter or send us a postcard listing the different circuits in which you think these devices could be used or are being used. You'll see your name in print if you come up with the longest list of practical applications.

But don't pick applications that can be handled more economically by other techniques. An expensive electronic thermometer, for example, is hardly a practical application in non-critical areas where an old-fashioned mercury or alcohol type will do as well.

**Product News.** Three new series of digital and linear integrated circuit (IC) designer/

(*Continued on page* 105)

# SOMEONE SHOULD DEVELOP AN EASY WAY TO LEARN ELECTRONICS AT HOME



## RCA INSTITUTES DID!

Here is a whole new approach to learning electronics at home! RCA Institutes, one of the nations' largest schools devoted to electronics, has developed a faster, easier way for you to gain the skills and the knowledge you need for the career of your choice. Here for the first time, is a student-proved, scientifically designed way to learn. If you have had any doubts in the past about home training in electronics —if you have hesitated because you thought you might not be able to keep up—or that electronics was too complicated to learn— here is your answer! Read how RCA Institutes has revolutionized its entire home training ideas!

# ENGLISH-LANGUAGE BROADCASTS TO NORTH AMERICA

## FOR THE MONTH OF MAY

**Prepared by ROBERT LEGGE**

### TO EASTERN AND CENTRAL NORTH AMERICA

| TIME—EST | TIME—GMT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|---|
| 7:15 a.m. | 1215 | Helsinki, Finland | 15.185 (Tues., Sat.) |
| | | Melbourne, Australia | 11.71 |
| 7:45 a.m. | 1245 | Copenhagen, Denmark | 15.165 |
| 6 p.m. | 2300 | London, England | 9.58, 11.78, 15.30 |
| | | Moscow, U.S.S.R. | 9.665, 11.715, 11.955 |
| 6:45 p.m. | 2345 | Tokyo, Japan | 15.135, 17.825 |
| 7 p.m. | 0000 | London, England | 9.58, 11.78, 15.30 |
| | | Moscow, U.S.S.R. | 9.665, 9.685, 11.715 |
| | | Peking, China | 15.06, 17.68 |
| | | Sofia, Bulgaria | 9.70 |
| | | Tirana, Albania | 7.263 |
| 7:30 p.m. | 0030 | Budapest, Hungary | 9.833, 11.91 |
| | | Johannesburg, South Africa | 9.675, 11.90 |
| | | Kiev, U.S.S.R. | 9.665, 11.79 (Mon., Thurs., Fri.) |
| | | Stockholm, Sweden | 11.805 |
| 7:50 p.m. | 0050 | Vatican | 7.27, 9.645, 11.76 |
| 8 p.m. | 0100 | Berlin, Germany | 9.73, 11.92 |
| | | Havana, Cuba | 6.17, 11.76 |
| | | London, England | 7.13, 9.58, 11.78 |
| | | Madrid, Spain | 6.13, 9.76 |
| | | Moscow, U.S.S.R. | 9.665, 9.685, 11.87 |
| | | Prague, Czechoslovakia | 5.93, 7.345, 9.55, 11.99 |
| | | Rome, Italy | 11.81, 15.385 |
| 8:15 p.m. | 0115 | Berne, Switzerland | 6.12, 9.535, 11.715 |
| 8:30 p.m. | 0130 | Bucharest, Rumania | 9.57, 11.94, 15.38 |
| | | Cairo, U.A.R. | 9.475 |
| | | Cologne, Germany | 9.64, 11.945 |
| | | Hilversum, Holland | 9.59 |
| 9 p.m. | 0200 | Lisbon, Portugal | 6.025, 6.185, 9.68 |
| | | London, England | 7.13, 9.58, 11.78 |
| | | Moscow, U.S.S.R. | 9.665, 9.685, 11.73, 11.87 |
| | | Stockholm, Sweden | 11.805 |
| 9:30 p.m. | 0230 | Beirut, Lebanon | 11.76 |
| 10 p.m. | 0300 | Bucharest, Rumania | 9.57, 11.94, 15.38 |
| | | Budapest, Hungary | 9.833, 11.91 |
| | | Havana, Cuba | 6.135, 6.17 |
| 10:30 p.m. | 0330 | Prague, Czechoslovakia | 6.095, 7.345, 9.55, 11.99 |

### TO WESTERN NORTH AMERICA

| TIME—PST | TIME—GMT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|---|
| 6 p.m. | 0200 | Melbourne, Australia | 15.22, 17.84 |
| | | Tokyo, Japan | 15.135, 15.235, 17.825 |
| 6:50 p.m. | 0250 | Taipei, China | 15.125, 15.345, 17.72 |
| 7 p.m. | 0300 | Moscow, U.S.S.R. | 15.14, 15.18, 17.76 |
| | | Peking, China | 9.457, 11.82, 15.095 |
| 7:30 p.m. | 0330 | Stockholm, Sweden | 11.805 |
| 7:45 p.m. | 0345 | Berlin, Germany | 9.65, 11.92 |
| 8 p.m. | 0400 | Sofia, Bulgaria | 9.70 |
| 8:30 p.m. | 0430 | Budapest, Hungary | 9.833, 11.91 |
| 8:45 p.m. | 0445 | Cologne, Germany | 9.735, 11.945 |
| 9 p.m. | 0500 | Berne, Switzerland | 9.695, 11.715 |
| | | Moscow, U.S.S.R. | 9.54, 11.755, 11.85 |

# AMATEUR RADIO

By **HERB S. BRIER,** W9EGQ
Amateur Radio Editor

## THE FASCINATION OF AMATEUR RADIO

WHAT IS THERE about amateur radio that attracts and holds the interest of such diverse personalities as Barry Goldwater, K7UGA; Andy Devine, WB6RER; the King of Bhutan; doctors; nuns; housewives; and people just like you and me? Well, for one thing, an amateur radio station presents an opportunity to make new friends in distant locations. For another, it attests to your ability as a communicator or as an electronics wizard of sorts, for each time you work another state or country it is renewed proof that you are a "master of the airways."

In addition, an amateur station in your home, car, boat, or aeroplane will let you rag-chew with other amateurs, participate in contests, experiment with antennas and exotic forms of electronic communication, and relay messages for people, including those in the armed forces. If you are interested in any of the above, you are a potential radio amateur (assuming that you don't already have a license), and you can learn a lot more about this fascinating hobby by reading POPULAR ELECTRONICS' *Communications Handbook,* now available at most newsstands.

Then comes the moment of truth. Do you want to become an amateur enough to learn the code? If not, forget the whole idea, because the code is a permanent part of all amateur license examinations. Although learning the code is not really hard, there is

AMATEUR STATION OF THE MONTH

Don C. Miller, W9NTP, Waldron, Ind., operates on all amateur bands from 1.8 through 1296 MHz, and uses CW, RTTY, SSB and TV modes! Under special FCC authorization, Don keeps "slow-scan" TV and voice schedules on 14 MHz with U.S. installations in the Antarctica, and transmits normal wideband TV pictures on 432 MHz. (The insert picture is of Don's wife, Sue, W9CNW, transmitted by W9NTP on 14 MHz and tape-recorded by WAØNLQ in Colorado.) Equipment not built by Don includes E. F. Johnson "Ranger" and "6N2" and Hallicrafters HT-32 transmitters, National NC-303 and Hammarlund HQ-129A receivers. Don will receive a one-year subscription for submitting the winner for May in our Amateur Station of the Month photo contest. To enter the contest, send a clear picture of your station with you at the controls and some details on the equipment you use and your ham career to Amateur Radio Photo Contest, c/o Herb S. Brier, Box 678, Gary, Ind. 46401.

no denying that it does take some intestinal fortitude to spend a half hour or so a day five to seven days for five weeks or so to bring your speed up to 5 wpm for a Novice or Technician license. (Don't worry about the 13-wpm General Class code test at this point; you will easily be able to increase your speed to that level while working the world with your Novice license.)

One good way to learn the code is to make friends with a ham or two and help them with their projects (like putting up an antenna, for example) in return for help with the code. Formal code classes sponsored by local radio clubs and recorded code courses available from amateur supply houses are also good.

Get a short-wave receiver capable of receiving amateurs as soon as you can. Eavesdropping on amateur phone conversations is lots of fun and will give you much useful information; and the receiver will give you almost unlimited opportunities for over-the-air code practice. While single-sideband (SSB) modulation, used by most amateur phone stations because of its superior "getting out" ability, is unintelligible gibberish on a conventional broadcast receiver, the chances are good that a receiver capable of receiving code signals will also receive SSB signals.*

**SSB modulation compares to conventional amplitude modulation (AM) used by broadcast stations and most CB transmitters about like a cup of regular coffee to a cup of instant coffee. Like the water that must be added to the instant coffee granules the receiver beat frequency oscillator (BFO) must be added to the SSB signal to make it intelligible.*

To receive an SSB signal, tune the receiver for the loudest gibberish from the loudspeaker. Then retard the r.f. gain (sensitivity) control and advance the a.f. gain (volume) control to keep the speaker signal at the desired level. Next, turn on the receiver BFO and adjust its pitch control until the sounds from the speaker become intelligible. (One setting of the pitch control is normally used to receive SSB signals on the 75-meter phone band, and a slightly different setting is used on the 40-, 20-, 15-, and 10-meter bands.)

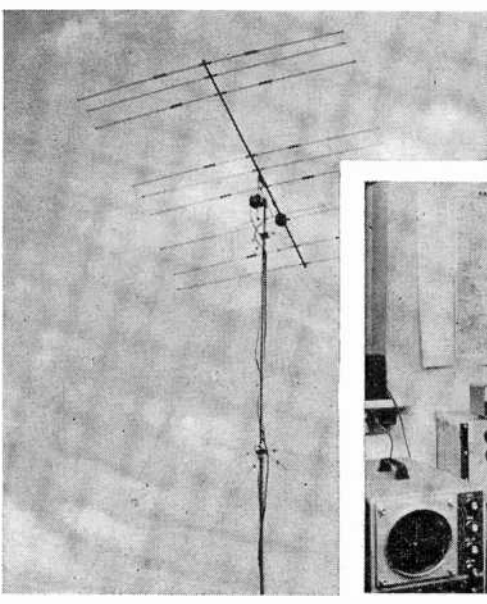
The main factor in receiving SSB signals is precise tuning. Once the knack is acquired, most short-wave receivers with BFO's will do at least a passable job of receiving them, although not as good a job as a receiver specifically designed for SSB reception, of course.

**"Short Skip" on Six.** Starting around the first of May and continuing past Labor Day, experienced 50-MHz operators will be watching, morning, noon, and night, for the 50-MHz band to break open with strong signals from distances of 600 to 1000 miles and more. Whether you call the phenomena "short skip" or "sporadic-E propagation," the theory is that radiation from the sun produces intense patches of ionization in the ionosphere that reflect 50-MHz and even higher frequency signals (which usually sail uselessly into outer space) back to the earth hundreds of miles from the transmitter.

No one can yet predict when "short skip"

(*Continued on page* 112)

Jack Elias, WA3EVG, Philadelphia, Pa., concentrates on six and two meters. Included in the picture below are a Heathkit oscilloscope, a homebrew 2-meter transmitter, "Poly-Comm 6" transceiver, and a Hammarlund HQ-100 receiver. On the roof of the WA3EVG shack is a Hy-Gain DB-62 six-and-two-meter beam (photo at left).



# ON THE CITIZENS BAND

By **MATT P. SPINELLO,** KHC2060, C3 Editor

CITIZENS BAND CLUBS are always searching for ways and means to stimulate membership. On the other hand, individuals interested in CB radio or already licensed to operate, never seem to know where the nearest club is located, or how to find out more about nearby emergency teams and the requirements for membership.

Many clubs that have been printing a news sheet or multi-page club paper for several years have found that their publications do more than just serve as a news vehicle for the immediate club membership. Groups currently plagued with membership problems, organizing a new club, or trying to keep an existing club from falling apart, would do well to follow the printed examples set by some of the more successful CB newspapers.

## CLUB PAPER SWAP SHOP

We realize that it is not possible for a thousand clubs and the 20,000 new CB licensees joining the band each month to communicate directly, but there are ways in which the interested bystander or new CB'er can be introduced to the local or area club, and there are ways in which a club can promote the worthwhile aspects of the organization and establish a more solid rapport with local authorities.

For one thing, CB clubs interested in gaining the attention of non-member CB'ers should make it a point to distribute a supply of extra copies of the club publication to electronic sales centers, distributors, and dealers. Placing these publications on their counters will serve to stimulate both the interest of the newcomers and CB equipment business for the firm.

Secondly, as we have mentioned before in this column (October, 1966), a copy of the club paper should be sent to the news director of each radio and television station in the area, as well as to local newspapers. Area news media should be informed about worthwhile club activities by means of a press release, accompanied by a glossy photo if possible. Following through on these counts is the fastest route to attracting the attention of area authorities.

Then, make sure your publication contains the club name and address, the month and year of publication, and the editor's and/or officers' names and addresses. Too often CB sheets are written on a local level, without proper identification for recognition by CB'ers in other areas.

Finally, your OTCB Editor will be happy to serve as a CB "club paper swap shop." Those clubs currently publishing a news sheet should supply us with a monthly copy of the paper and indicate whether they are willing to swap publications with other clubs across the country. When a sizable list of would-be publication swappers has been compiled, we will forward a copy of the list to all interested groups who supply us with a self-addressed, stamped envelope.

This procedure can serve two purposes:


The CB publications shown here are but a handful of the newsworthy bulletins received by your OTCB Editor each month, and they represent a small portion of a large group of clubs that strive to bring their memberships the complete CB picture on a monthly basis. Each of these clubs is well known for numerous emergency assists in its own area.

swapping, say, 50 monthly copies of your club paper will move as many different CB publications from coast to coast. You will have spread your word to 50 areas, and at the same time obtained a good idea of how clubs in other areas operate, what their problems of organization are, and, in some cases, the solution to your own hang-ups. Moreover, the receipt of 50 different CB club papers each month should give your publication's editor at least 25 new ideas on how to better the publication, as well as how to profit from the mistakes of others.

In addition, you may be able to reprint some of the better articles from other club papers to fill in your own membership on the national scene. The process could, under practice and control, add up to the start of a national CB link through the printed word.

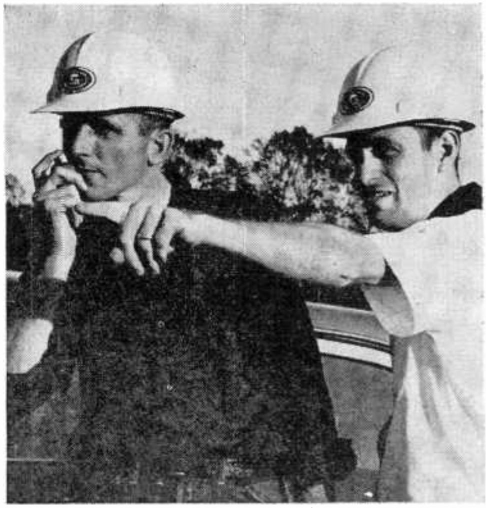
**Skip To The Rescue.** Ionospheric reflections tend to "skip" or bounce CB signals as far as 2000 miles at certain times of the year. The condition is normally highly undesirable since it can add air-traffic problems to an already CB-active area by almost doubling the number of stations that can be heard in the process of conversation.

But four hunters can be grateful for at least one bounce that paid off. Vernon Towne, of Plainwell, Mich., and three companions found themselves pretty well stranded on a muddy Mesa Mountain road near Durango, Colo., when their two-week hunting trip came to an abrupt halt via one broken front axle on Towne's pickup truck.

Towne's CB plea for help was received by a woman in Ohio. She called the Walbridge Post of the Ohio State Highway Patrol, the Walbridge Post called their Headquarters at Findlay, the Ohio Headquarters called the Colorado State Patrol at Denver, and Denver contacted the Durango Post. And before the four Michigan men had been towed to Durango for repairs, Towne's wife was receiving the news in Plainwell from another CB'er who had picked up Towne's CB call on her gear in Detroit.

**Near Disaster Averted.** One night a couple of months ago, David Johnson, Lemon Grove, Calif. (call-sign unknown), heard a weak call for help and immediately responded to it, asking for details while literally ringing up the Sheriff's Office with the other hand. The call came from a TV transmitter site high up on San Miguel Mountain. A TV technician had accidentally driven his jeep off the road and plunged 150 feet down a steep embankment.

The technician was injured, but managed to crawl back to the transmitter room only to find that the telephone service was dead. Repeated weak CB calls for help—between



Emergency teams are always on the lookout for new members who can be trained to supplement their mobile search and rescue operations. The men shown here are members of the ALERT team in Baton Rouge, La., an organization that works closely with Civil Defense, Red Cross, and law enforcement agencies.

lapses into comas—were laughed at by dozens of CB'ers who thought someone was "putting them on." Three hours passed before Dave heard the call, at 2 a.m., and responded to it. Fortunately, the TV technician is now okay.

The moral of this story is obvious. A clear channel for emergency calls is needed. Sometimes I wonder how many lives would not have been lost, and how much damage could have been prevented, if CB'ers only had a clear emergency channel.

**REACT Report.** REACT (Radio Emergency Associated Citizens Teams) is doing its part by monitoring channel 9 twenty-four hours a day. A CB-equipped motorist can call "REACT control" in over a thousand communities on channel 9, and the chances are good that his call will be received by a REACT mobile or base station and the assistance required dispatched quickly.

Since its inception, this four-year-old organization—sponsored by the Hallicrafters Company—has rendered assistance in over 1,200,000 situations requiring emergency aid or road information; 72% of these emergencies involved motor vehicles and nearly a third of these involved accidents.

A new pocket-size folder listing the locations and membership of the currently existing 1185 REACT teams throughout the Western Hemisphere is available from REACT National Headquarters, 5th and Kostner Aves., Chicago, Ill. 60624. The aver-

*(Continued on page 111)*

# NEW LITERATURE

*To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15.*

A total of 6600 cartridge listings are cross-referenced in *Sonotone Corporation*'s 1967 replacement manual—some 900 more than in the 1966 edition. Once again, the data has been printed from a solid-state computer, and is arranged in two sections: Sonotone cartridges are related to competitive cartridges in Section 1, to phonographs in Section 2. The 32-page (8½" x 11") three-hole-punched manual carries a price of 50 cents, but is being offered *free* for a limited period only.

Circle No. 87 on Reader Service Page 15

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*Delmar Publishers, Inc.*, has available a comprehensive 8-page catalog describing electricity and electronics texts and work-text-books which can be used either in the classroom or for home study. Some of the titles in the catalog include: Basic Electronics, Electricity I-IV, Alternating Current Fundamentals, Direct Current Fundamentals, and Basic Mathematics Simplified.

Circle No. 88 on Reader Service Page 15

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Nine new dynamic electric power drills with machine-gun grip auxiliary handle are described in a 4-page, 3-color folder put out by *Wen Products Inc.* Detailed mechanical and electrical features of the four ¼", four ⅜", and a single ½" drill are provided.

Circle No. 89 on Reader Service Page 15

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The 1967 full-line catalog released by the Distributor Division of *Clarostat Mfg. Co., Inc.*, features potentiometers, field-assembled controls, power rheostats, and resistors. Also covered in its 32 pages are sound system attenuators, precision decade boxes, shafts, bushings, etc. Complete technical specifications and dimensional information are included.

Circle No. 90 on Reader Service Page 15

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Over 450 items are listed in *Robins Industries* new 24-page shopping guide for tape recordists and phono enthusiasts. A complete selection of recording tapes is fully described, as are tape splicers and other tape accessories, and phono care accessories and kits.

Circle No. 91 on Reader Service Page 15

# TIPS & TECHNIQUES

PARTS · METHODS · IDEAS · GADGETS · DEVICES

### STRIPPED SCREW HOLES CAN BE BEEFED UP BY "STAKING"

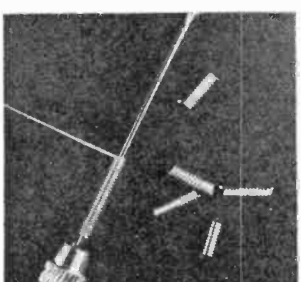
Because of the stripping action of overtightened self-tapping screws, getting them to hold firmly in soft aluminum after they have been removed and replaced a few times can become a problem. You can use a larger screw, but this would necessitate using an even larger screw subsequently. However, there is a simple solution to the problem—at least temporarily.

"Stake" the edges of the screw hole with a broad-bladed screwdriver or small dull chisel. All it takes is a few light taps with a hammer.

—*Henry R. Rosenblatt*

### MAKE YOUR OWN WIRE PIGTAILS TO SIMPLIFY COMPONENT REPLACEMENT

If you don't have a supply of the commercially available pigtails ("Kwikette") made by Sprague, you can whip up a few of your own, minus the solder (the commercial units are coated with solder). A pigtail serves as a small coupler between the lead of an original component being replaced and the replacement component lead. To make one, you simply wind a short length of 22-AWG bare wire around a sewing needle or another stiff piece of wire of appropriate diameter. Make it loose enough to fit over the component leads easily. When replacing a component on a printed circuit board, leave as much of the original component's leads as possible on the board. Solder the pigtail in place, but do not allow the old leads to

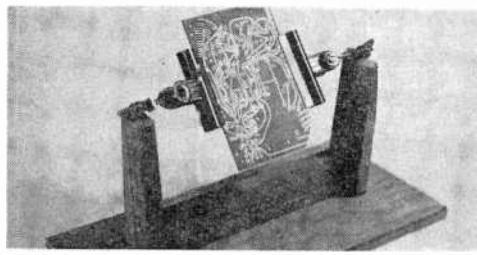


## TIPS *(Continued from page 99)*

shift their position if they become momentarily desoldered. If possible, heat-sink the old component leads with a pair of pliers when applying heat. *—Louis H. Phelps*

### PAPER-CLIP JIG HOLDS PRINTED CIRCUIT BOARD

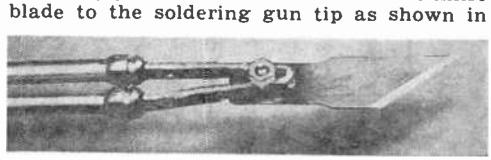
Two large paper clips mounted on a suitable bracket can be used to support a printed circuit board and small components. Both sides of the printed circuit board are accessible for work at the flip of the clips. There's less chance of damaging the components and you can place a work light behind the board to help you trace out a circuit. The jig shown in



the photo can be duplicated for about $2.00. The upright supports can be either wood or metal and, with a little ingenuity, can be made to adjust the height of the work. Slip wide rubber bands over the jaws of the clips to cushion the board. Here, each clip is bolted to an eye bolt which is held in place with a small compression spring. However, almost any other mechanically secure arrangement can be used. *—David A. Reid*

### HOT KNIFE MAKES "COOL" CUTTING TOOL

The plastic boxes popularly used for small electronic projects have a nasty habit of cracking and deforming if slots are cut into them without special tools. One way to avoid making a mess is to use a tool that does not require much physical pressure to cut the slots. An "X-Acto" hobby knife blade (it doesn't have to be a new one so long as it has a clean edge) and a 150- to 240-watt soldering gun will do the trick. Bolt the knife blade to the soldering gun tip as shown in



the photo; use lock washers to hold the blade firmly in place. Before using the tool, allow the blade to heat up sufficiently to cut through the plastic when it is applied with a slight but steady pressure. After cutting out the slot, sand the edges of the slot smooth. *—Bruce Pelkey*

# OPERATION ASSIST

*Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information, write him directly—he'll appreciate it. If you need help, send a postcard to Operation Assist,* POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name, model number, year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

**Eveready** Model 1 receiver, ser. W15574; tunes BC; has 8 tubes. **Atwater-Kent** Model 20 receiver. ser. 336149; tunes BC; has 5 tubes. Schematics and operating manuals needed. (Tim Krichbaum, 634 Highland Ave., Mansfield, Ohio 44903)

**Knight-Kit** transmitter; 50 watts; 8 to 10 meters; has 5U4, 6AG7, 807 tubes. Operating manual needed. (Douglas Stivison, Knights of Airwaves Amateur Radio Club, Uniondale High School, Uniondale, N.Y. 11543)

**Bell** Model T-300 tape recorder. Source for capstan motor and springs needed. (Paul Taylor, 525 N Middletown Rd., Media, Pa. 19063)

**Webster** Model 80-1 wire recorder, ser. 7846. Operating manual and source for recording wire needed. (Bob Mattingley, 618 Miller Ave., Sunnyside, Wash. 98944)

**Philco** Model 46-480 receiver; tunes BC, FM and s.w.; has 7 tubes. Schematic needed. (Jack Saint, 4415 Kiger St., Huntsville, Ala. 35805)

**Zenith** Model A600 "Trans-Oceanic" receiver; tunes 550 kHz to 18 MHz on 7 bands. Schematic and operating manual needed. (Rick Campbell, 564 Lincoln Ave., Lansing, Mich. 48910)

**Globe** Model HG303 transmitter; covers 80, 40, 20, 15, and 10 meters; has 2 tubes. Schematic needed. (David Gross, 31 Eaton Rd., Syosset, N.Y. 11791)

**Hickok** Model 540 dynamic mutual conductance tube tester, circa 1942. Schematic, operating manual, and information on updating equipment needed. (Dwight L. Roberts, 6826 Rosefield Dr., San Diego, Calif. 92115)

**Ecco-Fonic** Model 109B. Schematic needed. (C. R. Rader, 9608 Mellor, Wichita, Kan.)

**Philco** Model 50-3001 "Philco-Tropic" receiver, circa 1939; tunes AM and s.w. on 2 bands; has 5 tubes. Schematic and source for cabinet and power cord needed. (Richard Mote, 13703 River Forest, Corpus Christi, Tex. 78410)

**Stromberg-Carlson** Model 38-A receiver, circa 1928; tunes BC; has 9 tubes. Schematic and source for tubes needed. (Tom Harris, 99 Calif. Ave., Mill Valley, Calif. 94943)

**RCA** Model AR 88 receiver, circa 1944; tunes 550 kHz to 30 MHz. Schematic and operating manual needed. (Paul Jacobi, Oasis Oil Co. of Libya. Inc., Box 395, Tripoli, Libya, N. Africa)

**RCA** Model C11-1 receiver; tunes BC and s.w. on 3 bands. Source for power transformer needed. (Lannie L. Brown, Rt. 1, Valley View, Tex. 76272)

(*Continued on page* 102)



## ASSIST (*Continued from page* 101)

**Packard-Bell** Model 2602 receiver/phono/TV combo. Schematic needed. (David B. Holzinger, 4401 Bell Ave., Houston 23, Tex.)

**Crosley** Model 817 receiver, ser. 1402970; has 8 tubes. (Jack Mesaros, 132 South St., Jim Thorpe, Pa. 18229)

**Potter Instrument** Model 830 frequency counter. Schematic, operating and alignment instructions needed. (Sgt. Cecil R. Browning, RA 17298056, Co A 1st Bn, 48 Inf., APO, New York, N.Y. 09039)

**Zenith** Model G724 receiver, chassis 7G02, circa 1951; has 7 tubes. Schematic and other data needed. **Knight-Kit** Model KG-400 stereo amplifier. Schematic needed. (Robert Peterson, 9315 Latrobe, Skokie, Ill. 60076)

**Sentinel** Model 816C color TV receiver, ser. 50821. Source for 7-megohm, 2-watt ceramic wire-wound resistor or substitute for same needed. (C. W. Gordon, 305 Bettencourt St., Sonoma, Calif. 95476)

**Hallicrafters** Model S40 receiver; tunes 550 kHz to 44 MHz. Operating manual and schematic needed. (Paul Lee, Box 456, Morrisburg, Ont., Canada)

**Heathkit** Model 0-9 oscilloscope, circa 1954. Construction and operating manuals needed. (Peter Z. Simpson, 18 University Dr., Natick, Mass. 01760)

**E. H. Scott** Model CZC-46139 receiver, ser. 1088, circa 1942; tunes 0.53 to 15.6 MHz on 3 bands; has 11 tubes. Operating manual and alignment data needed. (Paul T. Judkins, 1200 Stuart Rd., Herndon, Va. 22070)

**Precision** Model 912P tube tester, ser. 9262. Operating manual, latest roll charts, tube listings, test data, and source for 9-pin tube adapter needed. (Wayne Weaver, Jr., Box 223, Haleyville, Ala. 35565)

**GE** Model CR05S oscilloscope. Schematic and operating manual needed. (John Neighbors, 5544 Fillmore Ave., Alexandria, Va. 22311)

**Sonora** Model NL-0101 organ. Schematic, service and instruction manual needed. (M. Strong, 114 Scott St., Massapequa, N.Y.)

**Crosley** Model 7H4 receiver, ser. K948739; tunes s.w. on 3 bands. Schematic, parts list, and source for parts needed. (Cliff Briere, Rt. 4, Box 283, Mechanicsville, Va. 23111)

**Superior** Model 670-A VTVM. Schematic and operating manual needed. (S. B. Stovall, 3054C McQueen St., Montgomery, Ala. 36107)

**Radio City Products** Model 446 multitester, series 8-2-40. Schematic needed. (Max Klinger, 855 E. 231 St., Bronx, N.Y. 10466)

**McMurdo Silver** "Masterpiece VI," circa 1938; has 20 tubes. Schematic needed. (George B. Publow, Box 590, Picton, Ontario, Canada)

**Zenith** Model 6S254 receiver, ser. R323058, circa 1933; tunes on 3 bands. Service manual needed. (Thomas K. McNally, Fine Rd., High Bridge, N.J. 08829)

**Zenith** Model 49CZ668 "Trans-Oceanic," receiver, circa 1949; tunes on 6 bands; has 5 tubes. Complete chassis needed. (Mac's Radio Service, 2769-J-Rodman Rd., Aberdeen Proving Ground, Md. 21005)

**Weston** Model 983 oscilloscope. Schematic and operating manual needed. **RCA** Model T64 receiver. Schematic needed. (Wilfrid N. LaChance, 286 N. Spring Garden St., Ambler, Pa. 19002)

**Capehart** Model 21M2 "Panamuse" receiver, ser. 75551, circa 1947; has 15 tubes. Schematic and alignment data needed. (G. R. Butler, 5388 Highland Rd., Cleveland 24, Ohio)

**Superior** Model TD-55 tube tester. Schematic and operating manual needed. (Dan Wischhoe, 814 13 St., Estherville, Iowa 51334)

**Precision** Model T60 tube tester. Roll chart and tube testing data needed. (Matthew J. Socha, Rt. 1, Box 420, Summerfield, Fla. 32691)

**Continental** Model TP-410 tape recorder, made in Japan; has 4 transistors. Schematic and operating manual needed. (Tarcizo Alves Batista, Centro Alte Morais Rego (SN-20), Ministerio Marinha—Divisao Postal, Rio De Janeiro, Brasil)

**GE** Model E72 receiver, ser. 2243237; tunes 550 to 1600 kHz and 1.5 to 20 MHz; has 7 tubes. **Philco** Model 90 superhet receiver ser. 104529; tunes BC; has 9 tubes. Schematic, parts list, and alignment data needed. (Frank Brown, 51 Farnham St., Portland, Me. 04103)

**Mosley** Model CM-1 receiver, ser. 1430-3-62; covers 80 to 10 meters; has 5 tubes. Schematic and operating manual needed. (Gary McCorkle, Rt. 1, Box 75, Gatesville, Tex. 76528)

**Emerson** Model 109 receiver; tunes BC; has 4 tubes. Schematic and parts list needed. (Ed Kalin, 75 Tumblebrook Ln., W. Hartford, Conn.)

**Atwater Kent** Model 188; has 8 tubes. Schematic and source for parts needed. (Don C. Cox, Box 127, Welch, W. Va. 24801)

**Stromberg-Carlson** receiver, chassis 30317; tunes 550 to 1600 kHz and 6 to 18 MHz; has 9 tubes. Schematic, parts list, alignment data, and operating manual needed. (Bill Lockwood, 429 E. Grandview Blvd., Erie, Pa. 16504)

**Hammarlund** Model SP200 SX "Super Pro"; tunes 1250 kHz to 40 MHz. Schematic and operating manual needed. (Paul Dolengewicz, White Oak St., Middle Island, N.Y. 11953)

**Majestic** Model 7YR752 phono-receiver combo with wire recorder, circa 1946. Schematic and source for parts needed. (R.F. Hill, 386 Roosevelt Ave., Lyndhurst, N.J. 07071)

**Somerset** Model 5A receiver, circa 1924; tunes BC. Schematic and coil wiring information needed. (Pastor L.M. Schaeffer, Mortons Corners Rd., Springville, N.Y. 14141)

**Hallicrafters** Model CA2 "Skytone" receiver. Schematic and tube layout needed. (W. Gladman, General Delivery, Crofton, V.I., B.C., Canada)

**Philco** Model 41-280 receiver, circa 1941; tunes 540 kHz to 12 MHz on 3 bands; has 8 tubes. Operating manual and source for parts needed. (Dave Zawodny, 2330 Nebraska Ave., Toledo, Ohio 43607)

**Rocket** Model 8-HL TV receiver, circa 1962. Source for high-voltage transformer and other parts needed. (E.J. Bunker, 1804 Thornbury Rd., Baltimore, Md. 21209)

**GE** Model FE-51 receiver, circa 1946; tunes 540 to 1800 kHz and 5.6 to 19 MHz; has 5 tubes. Schematic and source for parts needed. (Lou Kurdziel, 28 Crosman Ave., Buffalo, N.Y. 14211)

**Precise** Model 300B oscilloscope, circa 1955; has 10 tubes and 7JP1 cathode-ray tube. Schematic and operating manual needed. (John Albion, 3631 Cedar Hill Rd., Victoria, B.C., Canada)

**Hallicrafters** Model S-40 receiver, circa 1940; tunes 540 kHz to 44 MHz on 4 bands; has 8 tubes. Schematic and alignment data needed. (Jack Yeager, 7529 Baily Rd., Montreal, Quebec, Canada)

**Sentinel** Model 1U-816C color TV receiver, circa 1957. Source for horizontal output transformer #20E1208 needed. (Fred Cerne, 2809 S. Austin Blvd., Cicero, Ill. 60650)

**Superior Instrument** Model 85 "Dynamic" tube tester. Schematic and tube chart needed. (Frank Sheldon, 9303 107 St., Richmond Hill 18, N.Y.)

**Motorola** Model 65T21 receiver; tunes BC and s.w. on 2 bands; has 6 tubes. Schematic and operating manual needed. (Thomas Markos, 130 Marietta Dr., McKeesport, Pa. 15131)

**Collins** Model 310B exciter, circa 1948. Operating manual and parts list needed. (Curt Britton, 78 Laurel Ave., Bradford, Mass. 01830)

**Zenith** Model G500 "Trans-Oceanic" receiver, circa 1950; tunes BC and s.w.; has 5 tubes. Schematic and operating manual needed. (Don Hoefer, 1402 Mimosa Ln., Silver Spring, Md. 20904)

**RCA** Model 6BX672 receiver; tunes s.w. on 7 bands; has 5 tubes. Schematic, operating manual, and source for headphone and parts needed. (Allen Curtis, 1337 Brookline Rd., Cleveland Hts., Ohio 44121)

**National** receiver, type RCP, ser. 40; tunes 200 to 400 kHz and 1.3 to 30 MHz. Schematic and operating manual needed. (Alan S. Jenson, 721 Santa Rita, Sunnyvale, Calif. 94086)

**Pilot** Model T-500 receiver, circa 1946; tunes BC and s.w. Source for 4" speaker needed. (Arnold A. Pfeiffer, 66 Ridgeway Ave., Setauket, N.Y. 11785)

**Pfanstiehl** Model 34 receiver; has 7 tubes. Schematic of power pack needed. (Homer Madden, U.S. Lock #14, Box 58, Heidelberg, Ky. 41333)

(*Continued on page* 104)

## ASSIST (*Continued from page* 103)

**Sonograph** Model C4 receiver, ser. 605648; has 5 tubes. Schematic of amplifier section and source for parts needed. (Robert Stainer, Box 348, Oliver, B.C., Canada)

**Hickok** Model 530 tube tester. Operating manual needed. (R.L. Trott, 1690 Sharkey St., Tallahassee, Fla.)

**Lysco** Model 381 converter; covers 80 to 40 meters; has 3 tubes. Schematic needed. (Stan Putta, 1429 Lawndale, Racine, Wis. 53403)

**Majestic** receiver, ser. A 134128; tunes AM and FM, and 9.5 to 15.5 MHz; has 12 tubes. Schematic, alignment data, and photo of unit wanted. (Robert Blacka, 533 Levick St., Philadelphia, Pa. 19111)

**Solar** Model CF "Capacitor Exam-eter," ser. F-92206. Schematic and source for power transformer needed. (S.W. Wilkinson, 4124 E. Hastings St., Burnaby 2, B.C., Canada)

**Simpson** Model 300 tube tester. Schematic, operating manual, and tube chart needed. (Robert F. Eager, 1225 Saunders Settlement Rd., Niagara Falls, N.Y. 14305)

**Kolster** Model K-34 receiver, ser. 27101, circa 1925; has 7 tubes. Schematic and source for parts needed. (Jack Alexander, Jr., 10246 Woodbury, Apt. C, Garden Grove, Calif. 92640)

**Bremer Tully** Model 7DB-21 "Counterphase" receiver; tunes BC. Schematic and year of manufacture wanted. (Roy Flippo, 4712 Holladay Rd., Virginia Beach, Va.)

**Packard Bell** Model 651 "Stationized" receiver; tunes BC and 6 to 18 MHz; has 6 tubes. Schematic and alignment data needed. (Tom Carson, 7934 Amestoy Ave., Van Nuys, Calif. 91406)

**RCA** Model AVR-20A aircraft receiver, ser. 1849; tunes 2.3 to 6.5 MHz on one band; has 4 tubes. Schematic, operating manual, and parts list needed. (Michael G. Farrell, 1710 E. 4 St. #B, Long Beach, Calif.) —30—

## QUIZ ANSWERS

(*Quiz appears on page* 80)

1 — I The unijunction transistor has but ONE p-n junction.

2 — B The voltage doubler output is approximately equal to TWO times its r.m.s. input.

3 — E Audio equipment frequency response is measured within the half-power point on the curve—read as THREE db down.

4 — D These curves, representing the characteristics of a tetrode (FOUR-element vacuum tube) plate, display a negative resistance region.

5 — G By Ohm's law, the current flowing in the circuit is FIVE mA.

6 — A Television channels are SIX-MHz wide.

7 — C This is the Morse code symbol for numeral SEVEN.

8 — F A figure-EIGHT (Lissajous) pattern on a scope indicates that the scope's horizontal input is being fed a sine wave having twice the frequency of the vertical input signal.

9 — H The "on" lamps are reading NINE in the binary number system.

## SOLID STATE

(*Continued from page* 87)

experimenter breadboard kits are now available from Texas Instruments' distributors. Priced at $49.50 apiece, each kit includes from four to eight IC's, breadboarding sockets, specification sheets, sample diagrams, application information, and service data, all designed to provide the engineer, student or experimenter with the essential components needed to check out and test basic IC applications.

A new silicon *npn* transistor for UHF applications has been introduced by the International Rectifier Corp. (233 Kansas St., El Segundo, Calif. 90245). Designated as Type TR-24, the transistor is specifically designed for general replacement use in TV receiver UHF oscillators, FM converters, and other circuit applicatons in the 100-MHz range.

The Tor Manufacturing Co. (16329 E. Arrow Hwy., Irwindale, Calif. 91707) has introduced a series of four power transistor mounting kits. These kits, according to the manufacturer, will cover the hardware needs of over 80% of all standard transistor types. Each kit is individually packaged, and includes Teflon or mica insulating washers, bushings, screws, nuts, and solder lugs.

**Transitips.** It's no trick to convert a.c. line voltage to d.c. All that is needed is a diode rectifier. But the d.c. you get in this manner is not "pure." Rather, it is a pulsating unidirectional wave containing both a.c. and d.c. components. The a.c. component, commonly called *ripple,* will introduce intolerable hum into the equipment (amplifier, receiver, etc.) powered by the pulsating d.c., unless it is removed by a suitable filter.

A variety of techniques can be used to reduce the amount of ripple, some of which are shown on p. 110. In Fig. 4(a), a large value capacitor, *C1*, is used as a ripple filter. The a.c. input is rectified by diode *D1*, in series with limiting resistor *R1*, acting to control surge currents while *C1* is charging, and thus prevent *D1* from burning out. Typically, the value of *R1* is between 22 and 100 ohms, while *C1* may range from 50 $\mu$F to as high as 5000 $\mu$F, depending on the d.c. load.

A simple filter of this type is inexpensive and may even be mandatory where high currents are involved. However, it has poor d.c. regulation and is relatively inefficient. While satisfactory for moderate-gain or low-gain circuits, it is usually not suitable for high-gain amplifiers.

(*Continued on page* 110)

Where additional filtering is required, a resistor (*R2*) or a choke can be connected in such a way as to form an a.c. voltage divider with the filter capacitor. Such an arrangement becomes a basic *L-type* filter, and is illustrated in Fig. 4(b). As before, d.c. is obtained from *D1*, in series with *R1*. The value of *R2* can range from as little as 50 ohms to as high as 10,000 ohms, depending on the load current and voltage requirements. In practice, however, both resistors are not used in an L-type filter, since a single resistor, either *R1* or *R2*, will suffice if its value is fixed at from 100 to, say, 2500 ohms.

An L-type filter is effective, but introduces a definite power and voltage loss, due to the IR drop across the series resistor. For a given applied a.c. input, the d.c. output can be raised appreciably by the addition of an input filter capacitor (*C2*) shown by the dashed lines. This converts the arrangement to a pi-type ($\pi$) filter.

The voltage drop across *R2* can be considerably reduced if this resistor is replaced with an iron-core choke coil, *L1*, shown in Fig. 4(c). This type of filter is very effective and has been used extensively in vacuum tube power supplies. However, where low voltages and high currents are involved—as

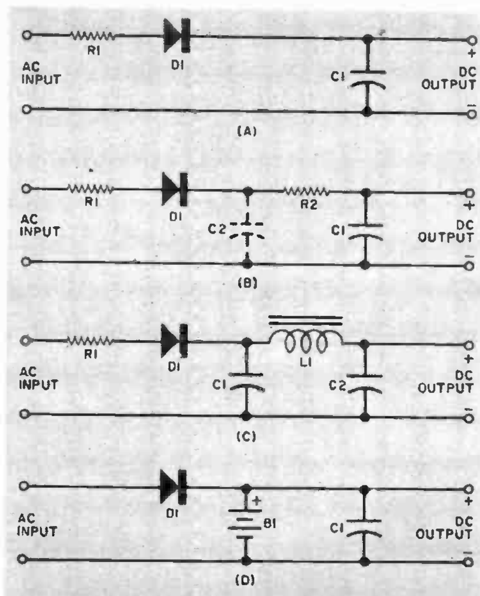



Fig. 4. Power supply ripple filters include (A) a large value capacitor, C1, in the output circuit. For additional filtering, a basic L-filter (B) can be formed by adding a resistor, R2, in the output circuit. To achieve greater d.c. output, resistor R2 can be replaced with a choke, L1, having a capacitor on each side as shown in (C). Floating a battery, B1, across the line as in (D) obviates the need for either a coil or additional resistor.

is the case with many transistor circuits—the arrangement becomes impractical due to the physical size, and cost, of the choke needed for effective filtering.

A less popular, less expensive, yet extremely effective ripple filter is shown in Fig. 4(d). Here, a battery (*B1*) is floated across the d.c. line and a relatively small filter capacitor (*C1*) is used. With this arrangement, *R2* is no longer needed, since the fixed battery voltage prevents sudden current surges. In practice, *B1*'s voltage is slightly under the d.c. voltage supplied by *D1*. Thus, *B1* supplies relatively little current and, instead, acts very much as if it were a large filter capacitor. The life of the battery in this application approximates its normal shelf life.

Although half-wave rectifiers are featured in each of the circuits shown, full-wave rectifiers can be used in similar filter arrangements. Filtering action is much more efficient in full-wave rectifier circuits due to the higher ripple frequency involved.

That closes out this month's column. See you in June.

*—Lou*

## ON THE CITIZENS BAND

(*Continued from page* 95)

age team has 31 members, the combined total membership being in excess of 37,000.

**A REACT Assist.** As a monitor for Kanmo REACT Headquarters, Kansas City, Mo., Jan Orth, KNI0377, has handled the usual landline relays required at the scene of several accidents, aided in searches for lost persons, and even helped arrange transportation from a private airport into town to a chartered airline. But Jan admits that the most unusual call came from a physician who was mobile, en route from Cameron, Mo., to Kansas City.

Learning of the illness of one of his patients, the doctor ordered her admitted to Cameron County Hospital. In order to save time, he issued the following orders to Jan's monitoring station through his mobile CB radio while proceeding to the hospital:

. . . *Symptoms—pneumonia and possible heart failure. Orders—oxygen, 4 liters; head of bed elevated 40 degrees; 600,000 units penicillin . . . immediate EKG (electrocardiograph), CBC (complete blood count) tonight; chest X ray on admission; for temperature above 101 degrees, 1 cc Diperone . . .*

Jan relayed the information to Kanmo REACT Headquarters, and it was relayed to the hospital from there.

**Aid to Brazil?** Artur Chamis, 2BX442, Brazilian CB operator, would like to correspond with U.S. CB'ers. He is specifically interested in learning more about how CB works in the U.S., as well as setting up club and network operations. A few well-printed CB club papers might prove quite helpful to Artur. Those interested in his cause should contact him at A. Eduardo Prado 383 C/8, S. Paulo, Brazil.

I'll CB'ing you,

*—Matt, KHC2060*

## AMATEUR RADIO

(*Continued from page* 94)

will occur or for how long an opening will last, but in the United States the spring and summer months and the late forenoon hours (local time) are the most likely times. Just keep listening to the band as much as you can; and, even if you are using only a 5-watt transceiver and a simple antenna, you will end up with a lot of new states in your logbook before fall rolls around.

**"Veishea" Contest.** Out at Iowa State University, the Campus Radio Club, WØYI, and the Men's Residence Association Radio Club, WAØKHF, will jointly operate at least three rigs during "Veishea"—the nation's largest student-managed festival at which educational displays and entertainment are provided for thousands of people. WØYI and WAØKHF are offering a certificate to any amateur radio operator who works either or both stations on any amateur frequency.

Operation will be from 0000, May 5, through 0600, May 7, and it is suggested that you monitor the following frequencies: 3.780, 3.975, 7.055, 14.270, 21.410, 28.600, and 50.400 MHz. To obtain the certificate, send your QSL to WØYI (WAØKHF), Campus Radio Club, Electrical Engineering Bldg., Iowa State University, Ames, Iowa 50010. The QSL must include the date and time (in GMT) the contact was made and a full return address, and it should be sent within a week after the contest takes place so that the certificates can be processed and mailed before the end of the school year.

**Coast Guard Cutter On the Air.** Amateur mobile radio station WA5KSJ on the Coast Guard Cutter *Campbell* officially went on the air on February 2. Operating out of the ship's home port, Staten Island, N.Y., at that time, the station was expected to be used extensively on the *Campbell*'s scheduled cruise to Ocean Station Echo, located some 800 miles east northeast of Bermuda.

Due to the absence of mail for as long as 30 days while the cutter is out "on station," WA5KSJ plans to keep crew members in touch with relatives and friends at home through broadcasts to other ham stations in the U.S. and overseas. In one of the first "on-the-air" sessions, WA5KSJ made a loud-and-clear contact with a West German ham.

The station will also be used to receive and transmit distress broadcasts intercepted by other ham operators, and so assist the cutter in its mission of Search and Rescue.

### NEWS AND VIEWS

During the big snow storm in Northern Indiana and Illinois in late January, hundreds of radio amateurs were busy handling vital communications. For example, Chicago TV station WFLD televised "live" reports on snow, road, and other emergency conditions from amateurs all over the Chicagoland area as the reports were received over the WFLD amateur radio club station, WA9RTP, located in the TV studios . . . Complicating conditions just south of the main snow belt, ice and freezing rain knocked out many miles of power and telephone lines, leaving amateur radio as the sole means of communications with many areas. **"Ray" Lane, W9KXN,** Clinton, Ill., for example, dispatched all railroad trains in and out of Clinton via amateur radio for several days; **Pauline Course, WA9CNV,** acted as his Chicago outlet.

To keep the record straight, although K3SIO reported from Asia in the December "News and Views" that WA8OBB/XV5 was active from Cam Ranh Bay, Vietnam, **S/Sgt. George J. Wade, WA8PPQ,** who operates MARS Station AB8AB in Quinhon, Vietnam, reports that K1YPE/XV5 is still the only officially authorized amateur station in the country. K1YPE, by the way, is William Porter, the U.S. Deputy Ambassador to Vietnam . . . **Arthur Malatzky, WN2WFJ,** 83-19 141 St., Jamaica, N.Y., worked 27 states and Canada in 10 months as a Novice—not bad for a 40-meter dipole antenna strung along the baseboard in his apartment. A Heathkit DX-20 transmitter and a Lafayette HA-225 receiver took turns huffing and puffing on the antenna. Art has a Rag Chewers' Certificate and a 20-wpm code certificate on the shack wall, and when his General ticket (which is on the way) arrives, he plans to buy a WRL "Galaxy-V" transceiver . . . **Dr. Carl W. Boyer, WA3EAW,** 8304 20th Ave., Adelphi, Md., is another ham who has had excellent results with an indoor antenna. His was a 20-meter dipole tacked to the attic rafters while he was stationed in Hawaii and signing KH6FDG. This antenna, fed by a National NCX-3 transceiver, worked all over the Pacific and the United States on 20-meter SSB. Carl admits, however, that his present, home-brew, 2-element beam radiates better than an indoor dipole.

**John W. MacMillan, VP1JM,** P.O. Box 441, Belize City, British Honduras, is the answer to many amateurs' prayers. John, who works in a bank, QSL's 100% by airmail! And he claims that his returns are just about 100%, too; having a DX call does help. John uses an EICO 753 transceiver; it drives a WRL vertical antenna and has worked many U.S. stations and Canadians, and quite a bit of DX on 20-meter SSB—usually between 14.2 and 14.25 MHz. And he is going back to CW, part time at least, after neglecting it for several years . . . **Scott J. MacGregor,** WA7ECY, 495 NE Beech St., Gresham, Oreg., started his Novice career with a second-hand "Globe Scout" transmitter and a Hallicrafters S-118 receiver. Twenty states later, he had a Heathkit DX-60A transmitter and HR-10

Lew Christie, WB6QQP, of Fontana, Calif., is another of the increasing number of hams who prefer CW to phone. Lew's record: WAS; WAC; 52 countries with less than 100 watts; and Idaho with 25 mW.

receiver; these carried him to 37 states, Japan, and New Zealand. Next came his General ticket and a Drake TR-4 transceiver; a Heathkit "Twoer," used both at home and as a mobile for mountaintop operation; and a Heathkit HW-12A for 75-meter mobile work. Oh, yes, the states-worked total now is up to 47, and a tri-band beam is scheduled to take its place among the dipoles and verticals on his 80-acre antenna farm shortly . . . **Buzz Jehle, WN8TFJ,** 7275 Tangle Ridge, Cincinnati, Ohio, has worked one state for every watt of transmitter power—50 watts to a Johnson "Adventurer." His receiver is a Heathkit HR-10, and his antenna is a "ground plane" vertical. The band is 15 meters. Still to come are Buzz's General Class ticket and a QSL card from Asia for his Worked All Continents certificate.

**Bill Pearl, WN6UYW,** 8704 Rosewood Ave., Los Angeles, Calif., figures his amateur station cost him \$100—the best \$100 he ever spent. Half of it went for a used Hallicrafters SX-43 receiver, \$25 for a home-brew 50-watt transmitter, and \$25 for a Hy-Gain 18-V vertical antenna, wire, etc. Operating the 80-, 40-, and 15-meter Novice bands, Bill has worked 26 states and Japan in a month . . . **Chuck Starling, W9FTK/8,** says if you want some real high-speed code practice, listen to W1EIA and W1NJM on 3637 and 7120 kHz, Sundays at 8:30 p.m. EST (0130 GMT, Mondays). Transmission speeds are 35 to 65 wpm! . . . **Wiley G. Clarkson, WA5OTR,** 1417 Hillcrest, Fort Worth, Texas, works all amateur bands from 80 meters through 2 meters. A Gonset GSB-100 AM/CW/SSB transmitter, a National NC-303 receiver, a Hy-Gain 14-AVQ vertical antenna, and an 80/40 meter "trap" doublet handle things up to 10 meters. A Hallicrafters SR-46 transceiver with matching VFO and a 5-element Cush Craft beam cover 6 meters, and a 75-watt home-brew transmitter and another 5-element beam cover 2 meters. Wiley is a member of Air Force MARS and of several amateur emergency nets . . . **Dave Gross, WN2ZQE,** 31 Eaton Rd., Syosset, N.Y., raised the very first station he called as a Novice. And in two weeks he has worked 15 states and three countries, all on 15 meters, with a "Globe Scout" transmitter, Lafayette HA-225 receiver, and a dipole antenna.

If there is some facet of amateur radio that you would like to have us discuss in this column, let us know what it is. And let us have your "News and Views," pictures, club newspapers, and information on any club code courses. Address your letters to: Herb S. Brier, W9EGQ, Amateur Radio Editor, Popular Electronics, P.O. Box 678, Gary, Ind. 46401.

*73, Herb, W9EGQ*

# SHORT-WAVE LISTENING

(*Continued from page* 61)

news item claiming that the clandestine *R. Peyk-e Iran* (widely heard on 11,695 kHz) belongs to the Kurds in northern Iran. The station was attacked by Iraqi bombers and is reportedly located near the Iranian border. *R. Peyk-e Iran* is often jammed by a station which used to be known as the "Kiss Me Honey" station; some months ago the "Kiss Me Honey" recording was dropped for a Beatles recording of "Can't Buy Me Love," and lately they have been using a variety of pop records. The jamming station is also being reported on 9555 and 11,410 kHz, around 1400.

In the December, 1966, column, "466 Weaver St., Webster, N.Y." was listed as being an address to which reception reports for 4VEH (Cap Haitien, Haiti) might be sent. This is actually the address of the DX Stamp Service from whom mint (unused) stamps of many foreign countries can be purchased for return postage use.

### CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports are as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to SHORT-WAVE LISTENING, P.O. Box 333, Cherry Hill, N.J., 08034, in time to reach your Short-Wave Editor by the fifth of each month; be sure to include your WPE identification, and the make and model number of your receiver.

**Ascension Island**—The government of this island recently issued a set of stamps of the 1d, 3d, 6d, and 1/6d denominations to mark the setting up of a BBC relay station here.

**Brazil**—*Emissora Rural, A Voz do San Francisco,* Petrolina, 5025 kHz, is the station being heard here from 2230 to 0203 s/off with native music and commercials. This 500-watt station evidently is the only one active on this channel; two other listed Brazilians are not being heard.

**Ceylon**—The Commercial Service of *R. Ceylon,* Colombo, 9667 kHz, has a BBC news relay at 1300 with musical programs before and after the news.

**Colombia**—Station HJGR, *La Voz del Pueblo,* Pereira, is on 5997 kHz, where it suffers QRM from the *VOA* on 5995 kHz. It has the usual Latin American features and is audible around 0100 and later.

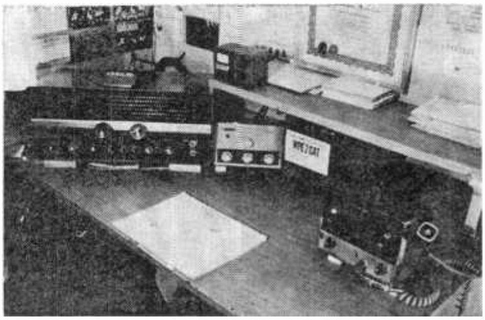
**Congo (Democratic Republic)**—*La Voix de la Fraternite Africaine,* Lumumbasi, has returned to 11,866 kHz, where it has been noted at 1820 with an ID. This station has Eng. news on Sundays at 1745-1755 followed by pop music and an Eng. period until 1827. Reports indicate that the Eng. period may vary as to time.

**Costa Rica**—*Esta Es Radio Popular,* San Jose, has been noted with many ID's around 0302 on 4780 kHz. Tune carefully; this station may drift in frequency.

**Denmark**—Copenhagen's current Eng. schedule reads: to N.A. at 0145-0215 on 9520 kHz, to the Far East at 0745-0815, to N.A. at 1245-1315, to S. Asia at 1445-1515, and to Africa at 1915-1945, all on 15,165 kHz. In addition, there is an Eng. test xmsn at 1015-1100, Saturdays only, on 9520 kHz. There are no Eng. xmsns on Sundays.

**Ecuador**—*HCOS4, La Voz del Rio Carrizal,* is a new station noted on 3569 kHz, with listener's request periods mostly, and with closing around 0330.

**Ethiopia**—Station ETLF, Addis Ababa, has Eng. for W. Africa at 1900-1945 on 15,115 kHz. It was also noted at the same time on 15,385 kHz, a new channel.



The listening post of Mel Granick, WPE2GAT, Laurelton, Queens, N.Y., contains a Hallicrafters S-108 receiver plus a Heath HD-11 Q-multiplier for SWL'ing, and a Johnson "Messenger II" transceiver for CB operation. His SWL record is 31 countries verified out of 36 heard (plus 4 out of 5 on the medium waves), and 24 states verified out of 25 logged.

**Formosa**—*Voice of Free China,* Taipei, noted on 15,125 kHz with Eng. news at 0257, an ID at 0301, Chinese music at 0309, a news review at 0322, and is heard well to close at 0348 now that Seoul has vacated the channel. This xmsn is dual to 7130, 15,345, 17,720, 17,780 and 17,890 kHz.

**Germany (East)**—*R. Berlin International* is noted on 21,560 kHz at 1325 with Eng. news, and from 1330 to 1355/close with dance music in the Africa service. The 6120-kHz outlet has also been logged at 0230-0300 to N.A. with news, music, discussion-type shows, and current event reports.

**Guatemala**—Station TGBA, *R. Maya Barillas,* Huehuetenango, 2360 kHz, may run past normal s/off time to as far as 0500 on special occasions. Their QSL indicates that the languages used for programming include Aguateca, Ixil, Quiche, Chuj, Mam, K'anjobal, and some Spanish.

**Haiti**—*R. 4VEH, Inc.,* Cap Haitien, has been heard with a good signal at 2300-0305 (to 0335, Wednesdays and Fridays) in Eng. on 11,835 kHz (4VEJ); 9770 kHz (4VEH); and 890 kHz (4VE—a new station). Frequencies in use after 0130 include 6120 kHz (4VE), 2450 kHz (4VSO), and 1035 kHz (4VEF).

**India**—*All India Radio, Delhi,* has been operating in Eng. on 15,375 kHz from 1330 to 1500; news is aired at 1445. Two other channels have been reported for the first time: 7195 and 11,850 kHz, both with Eng. news around 0230-0240.

**Italy**—Rome is heard well on 9630 kHz in Eng. to N.A. from 0100 and in Spanish to Latin America at 0245-0330.

**Kenya**—*Voice of Kenya,* Nairobi, is definitely on 4934 kHz, and verified as such. They have Eng. news, closing at 0615, followed by a commercial-type program with some ads in Eng. but primarily in Swahili. Listen to 0400 for seven gongs at 7 a.m. their local time. Many listeners are confusing this station with Lagos, Nigeria, newly located on 4932 kHz, which opens at 0600 with a commercial service.

**Korea (North)**—*R. Pyongyang* continues to be heard well on 14,510 kHz from 2300 to 2350 s/off in Spanish to Latin America, dual to poorer 11,765 kHz. They announce another xmsn at 0100-0150 on the same frequencies. Also being logged is 6285 kHz, around 2330.

**Korea (South)**—A new frequency for *Voice of Free Korea,* Seoul, is 15,430 kHz, heard from 2245 to 2300 in Korean, at 0215-0230 in Spanish, to 0300 in native language (possibly Oriental), and at 0300-0400 in Eng. with news, commentary, pop Korean music, and "Korean Impressions."

**Libya**—Libyan Broadcasting & TV Service, Tripoli, was heard on 7165 kHz from 2146 to 2215 s/off with instrumental music, singing, news, and anmts in an all-Arabic xmsn.

**Mongolian People's Republic**—A registered letter from *R. Ulan Bator* gives this adjusted and corrected schedule for Eng.: at 2200-2300 on Mondays, Tuesdays, Thursdays and Fridays; and 1300-1450 on Tuesdays, Wednesdays, Fridays and Saturdays.

**Mozambique**—*R. Clube de Mocambique,* Lourenco Marques, has been found on a new frequency of 4860 kHz at various times between 2130 and 0400 with Eng. and Afrikaans commercial service; they may ID as "This is LM Radio." The dual channel on 11,780 kHz has also been noted from 0335 to 0445. *R. Pax,* Beira, 7205 kHz, has a Portuguese music program at 0415-0425; s/on is at 0400 with a chimes IS and singing by a choir.

**SHORT-WAVE ABBREVIATIONS**

| | |
|---|---|
| anmt—Announcement | QRM—Station interference |
| BBC—British Broadcasting Corporation | QSL—Verification |
| Eng.—English | R.—Radio |
| ID—Identification | s/off—Sign-off |
| IS—Interval signal | s/on—Sign-on |
| kHz—Kilohertz | VOA—Voice of America |
| kW—Kilowatts | xmsn—Transmission |
| N.A.—North America | xmtr—Transmitter |

## RADIO BUCHAREST LETTERS CONTEST

Would you like to have a souvenir from Romania? An art album, collections of records, slides of picture postcards presenting the beauty spots of Romania? All you have to do is listen to **Radio Bucharest** at least 12 times before June 1, 1967, and send the station 12 reception reports of about 150 words each. Include in the reports—in addition to the usual data on reception conditions—comments on the programming, and suggestions for possible changes or improvements in the program material.

**Netherlands**—*R. Nederland,* Hilversum, has Dutch to the West Indies at 0000-0100 on 6200 kHz in parallel to 9630 kHz.

**New Hebrides**—*R. Port Vila* has been heard in Eng. and later in French on 3905 kHz until 0709/close. The signal is weak; QRM from ham operators is heavy.

**Nicaragua**—*R. Zelaya,* Bluefields, is now on 5950 kHz with Eng. at 1140-1204. Pop music is noted around 2355.

**Pakistan**—*R. Pakistan,* Karachi, is heard on 15,090 kHz at 1335-1350, and on 15,210 kHz at 1440 with music, at 1500-1515 with Eng. news, and to past 1530 with native-language programs.

**Portuguese Guinea**—*Emissora da Guine Portuguesa,* Bissau, is weak on 5041 kHz to 2300 s/off. Some monitors claim that membership in *R. Portugal's* DX Club seems to speed up a QSL considerably.

**Somali Republic**—Add 6107 kHz as being in use by *R. Mogadiscio* from 0330 s/on after the normal "A" running signal. They have native-language news at 0345-0355 followed by music. The QRM is very heavy and very selective tuning is required for this one.

**South Africa**—*R. South Africa,* Paradys, has Eng. from 0430 s/on on a new frequency of 7260 kHz.

**Thailand**—Bangkok is currently audible as early as 2350 with native music and Thai on 11,910 kHz. By 0030 they are generally "over S9," indicating that the new 100-kW xmtr is doing a good job. This would be a good time period for them to have Eng. to N.A.; undoubtedly they would draw a large response since their beam is on target and propagation conditions are good.

**Tunisia**—*R. TV Tunisienne,* Tunis, has been found on 6285 kHz at 2215 with the end of news in Arabic, followed by a talk in the same language. The signal is generally good.

**Uganda**—Being reported for the first time is the Blue Network of *R. Uganda,* Kampala, 7110 kHz, which was noted with a weak signal at 0650-0715, carrying instrumental music and talks in vernacular.

**United Arab Republic**—Cairo has been logged on two seldom-heard channels: 15,360 kHz from 2230 s/on in Arabic, and 9305 kHz from 0240 with Eng. talks and Arabic music until a 0300 clock strike.

**Upper Volta**—*Radiodiffusion de Haute-Volta,* Ouagadougou, is currently on 7230 kHz from 0600 s/on, with French music from 0630 to 0645.

**Vatican City**—*R. Vaticano* has Eng. at 1800-1812 on 11,700 kHz with church news.

**Venezuela**—*R. Barquisimeto* has reactivated the 9510-kHz channel: all-Spanish programming was noted at 0235, 0600, and 0800-1055, with talks and pop music. *R. Monagas,* Maturin, has opened operations on 11,770 kHz and is heard at 0005-0215 with sporting events; not known, as yet, is whether this is a change from or an addition to the normal 3325-kHz frequency. *La Voz de la Patria,* Caracas, has moved from 3305 to 4839 kHz, and is loggable from 0745 to 0809 s/off with Latin American music. However, they are still announcing, at press time, as being on 3305 kHz.

**Zambia**—Rarely heard on the West Coast is Lusaka on 4965 kHz with native-language programs overriding *R. Santa Fe* (Colombia) at 0500. According to some DX'ers, this phenomenon occurs only once or twice a year.

**Clandestine**—Many reporters are hearing a station in the 49-meter band (frequencies vary from 6100 to about 6140 kHz) with an ID of *Phoenix, Voice of International Waters on Radio Phoenix Six, The Call of the High Seas.* Most reports list it as being heard at 1700-2200 on Sundays only with pop records and frequent ID's. Two disc jockeys are on board, one named Don Stack. The station refers to "our Miami listeners." But other reports claim that the announcer stated that they were just off Atlantic City, N. J. Still other reports quote the announcer as saying they are anchored just outside the three-mile limit and can be seen from the beach (but the exact beach was not given—Ed).

**Utility**—If you hear CW beacon station RAB, Rabinal, Guatemala, on 1613 kHz, send your report to Pan-American Communications Department, Miami, Fla. 33159. —30—

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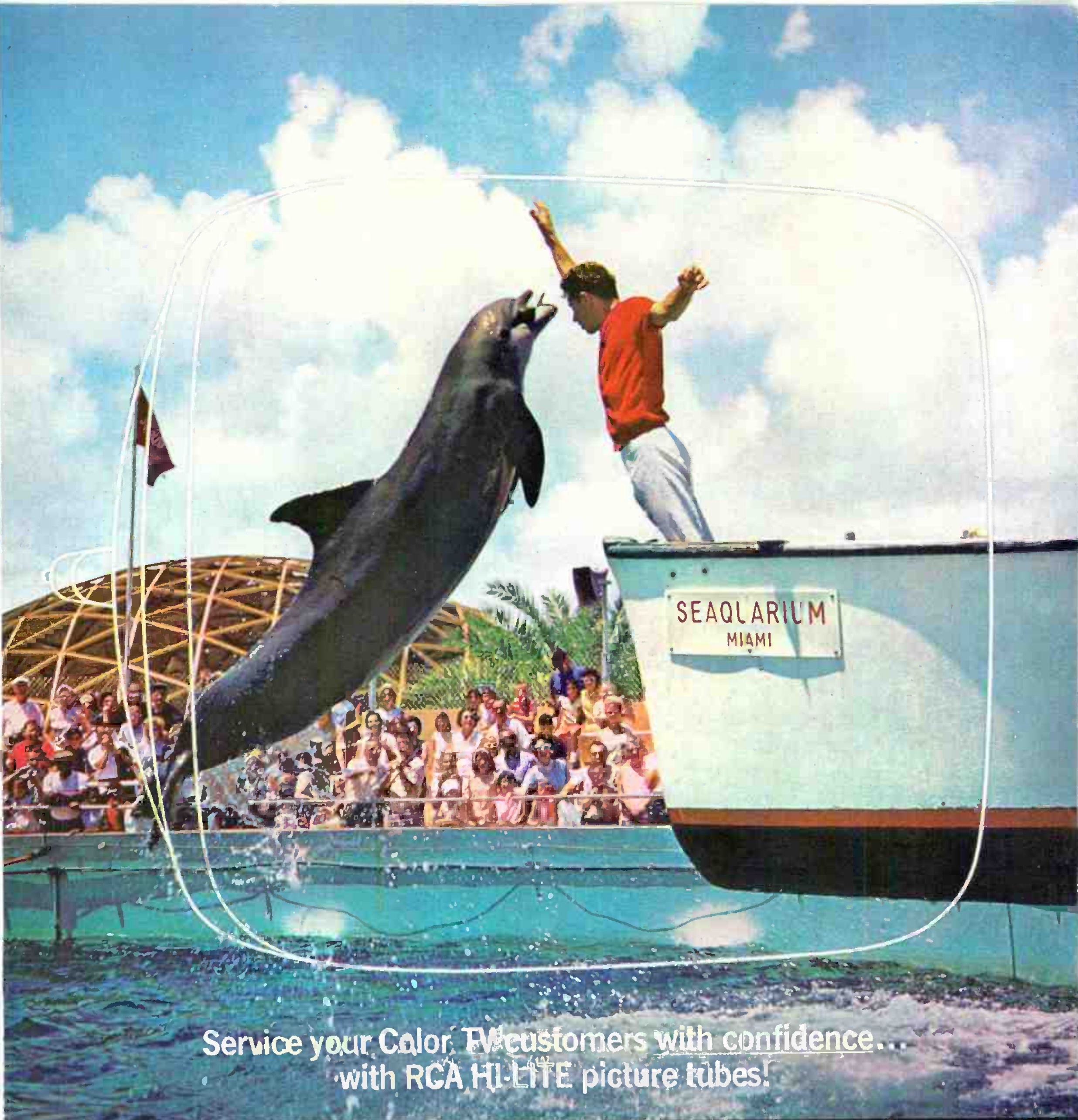


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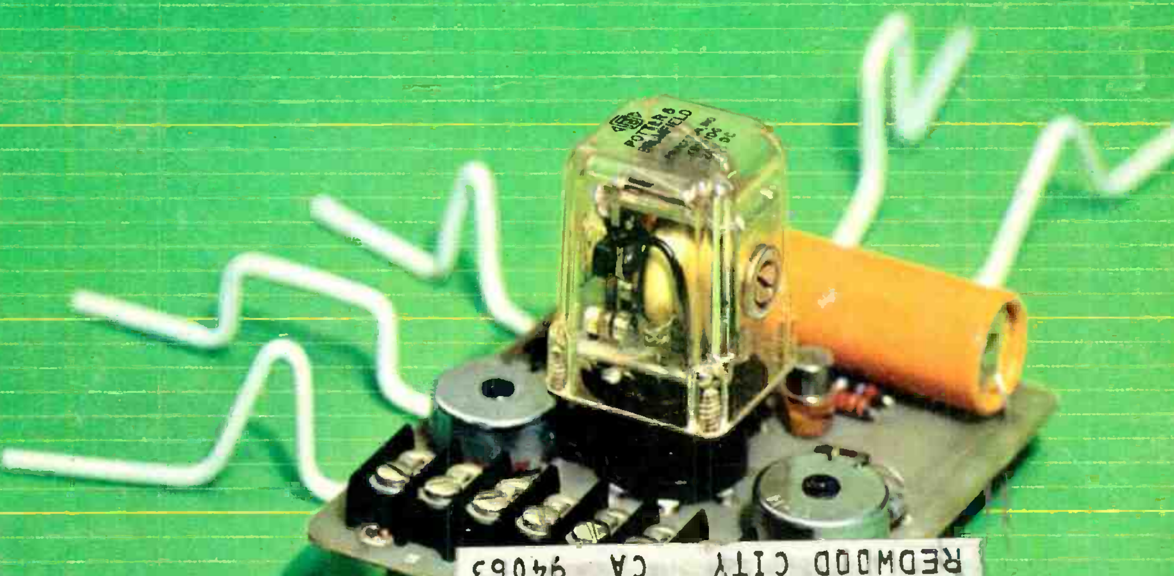


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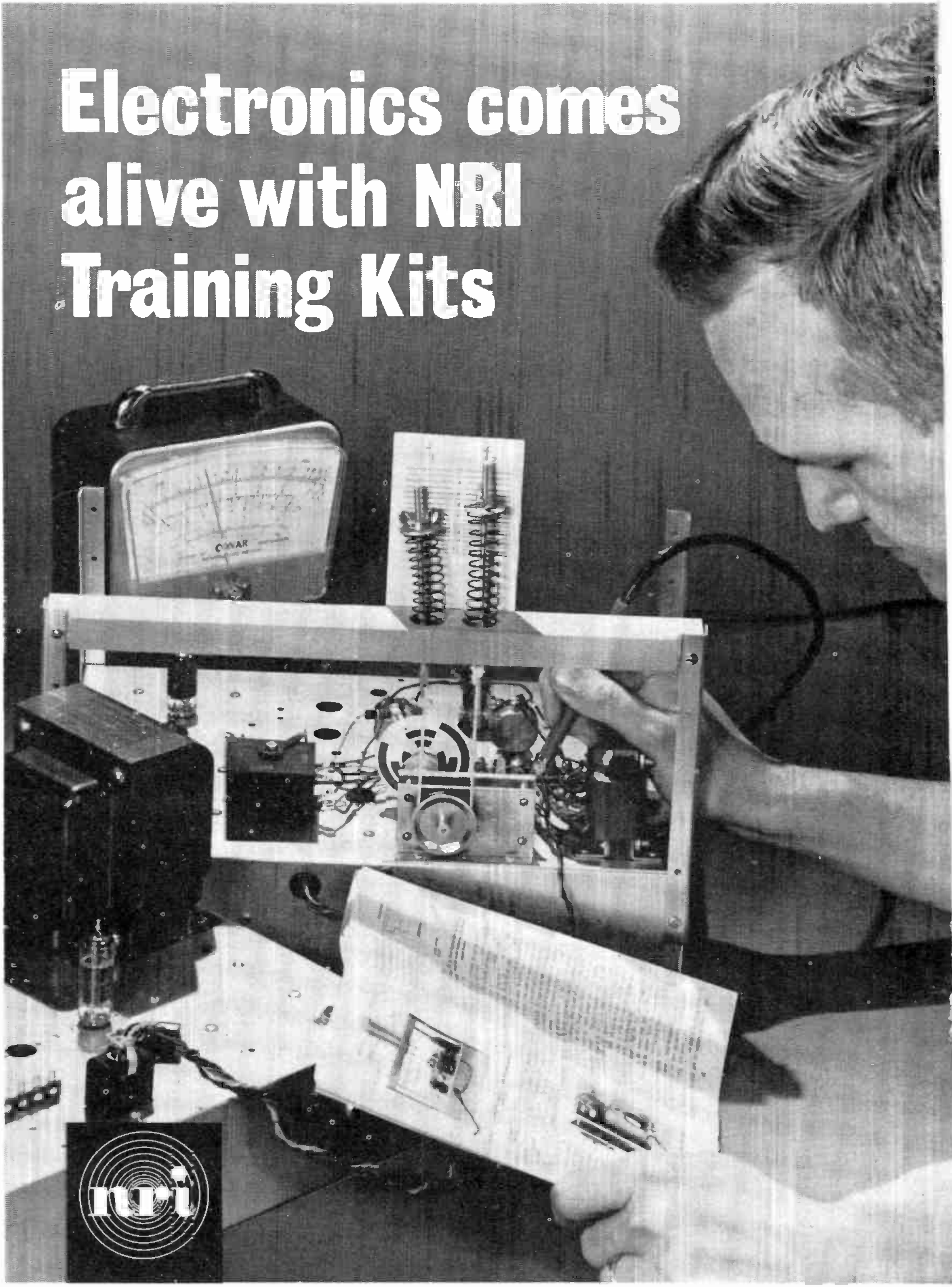

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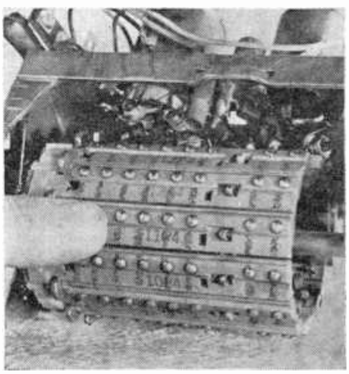


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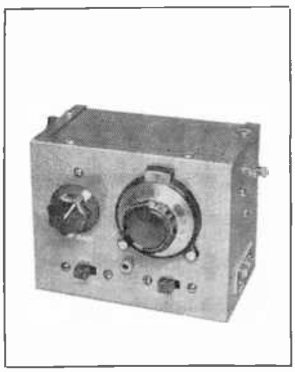

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# LETTERS
## FROM OUR READERS

*Address correspondence for this department to:*
*Letters Editor,* POPULAR ELECTRONICS
*One Park Avenue, New York, N. Y. 10016*

### FISH "TALK"

Horror of horrors! Re July, 1966, and the article on fish "talk" ("Is Plasmonics for the Birds?"), the simple fact is that every aquarist spends time and effort in order to avoid the slightest contamination of the water through contact with metals that might poison his fish. Copper being one of the principal offenders—I repeat, horror of horrors!

DALE KOBY
New York, N.Y.

*You're right about the possibility of contamination, Dale. But, don't despair; reports we have received indicate that better results are obtained with this equipment in lakes and other large bodies of water. So let the fish in your tank be, and stick the copper probes in the ocean.*

### PERSONAL P.E. INDEX

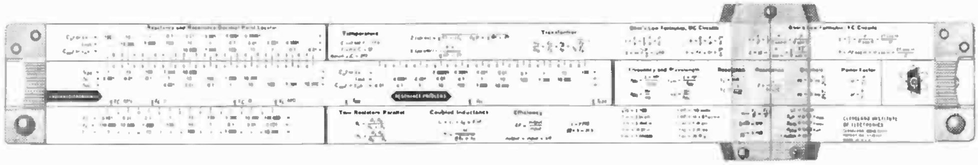
With regard to Al Diamond's letter (December, 1966), I too have all issues of P.E. (from October, 1954, to date), and have found them to be very good reference material on many subjects. To get around the index problem, I started a card file years ago. I take every issue and go through it for construction items and articles that contain information of interest—even though I think I may never need the information—and type up a 3" by 5" file card for each one. On the card, which starts out with a general classification like "Amplifiers," I put the title, the issue and page numbers, and give a short description of the article. For construction articles, I may even include estimated cost in building, whether a project is simple or difficult, whether it uses tubes or transistors, etc. You might think this would be quite time-consuming, but it isn't. I usually let about six issues pile up and then go through them—I can easily handle six issues in about 45 minutes.

DUTCH MEYER
Missoula, Mont.

### "FUZZBOX" ECHOES

Being a "Rock-and-Roll" music lover, I decided to make Mr. Anderton's "Fuzzbox For Under $3" (January, 1967). I made it exactly according to his plan and was quite satisfied. There was one thing though which I thought was lacking and that was a fuzz control. So I proceeded to devise such an item. At total resistance there is no differ-

# IN ELECTRONICS AND ELECTRICITY THIS AMAZING NEW SLIDE RULE SEPARATES THE MEN FROM THE BOYS!



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The Head of the Electrical Technology Dept., New York City Community College, Mr. Joseph J. DeFrance says:
"I was very intrigued by the 'quickie' electronics problem solutions. Your slide rule is a natural."

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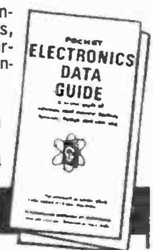


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CIRCLE NO. 7 ON READER SERVICE PAGE

## LETTERS *(Continued from page 8)*

ence between the fuzz with the pot in or out of the circuit, but as you lessen the resistance, the amount of fuzz is lessened accordingly, until zero resistance is reached, at which point no more fuzz exists.

BYRON NATE
Calgary, Alberta,
Canada

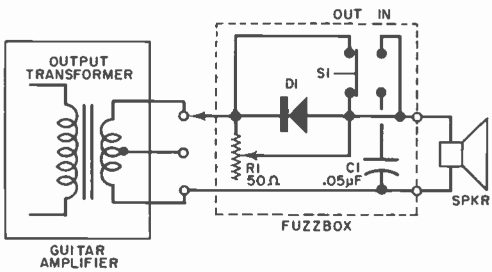
I constructed this simple unit for the lad who lives in the house next door. Although his guitar sounds just as bad as it always has, he is convinced that the POPULAR ELECTRONICS "Fuzzbox" is almost as good as the commercial units which his friends have. The big difference is that the factory units have variable fuzz.

L. E. GRUBGELD, JR.
Palo Alto, Calif.

I built the "Fuzzbox" as per the schematic diagram, using the exact parts specified, and it worked okay. The only fault I found was that the low notes were somewhat distorted with *S1* in the "off" position. I changed the location of the capacitor to get it out of the circuit when the switch is in the "off" position.

JACK WILLHELM
Fort Smith, Ark.

*Looks like Byron anticipated your letter, L.E. Your suggestion, Jack, to get the capacitor out of the circuit when it isn't needed is a good one, and Byron, your variable control will be appreciated by many. The Fuzzbox item looks like a real quick-and-dirty*




*project, but judging by the volume of favorable mail, it works well. We have combined both Byron's and Jack's suggestions into the one diagram shown above.*

### VU BALLISTICS

May I bring to your attention the fact that the reference level for the vu unit is plus 4 dBm, not 0 dBm as stated in "What Are These Things Called Decibels?" (October, 1966). Also inherent in the use of the vu is the fact that the vu meter has very specific ballistic characteristics which must agree with ASA specifications. There are a number of imported "so-called" vu meters available today, but few, if any, of them have the correct ballistic action in the movement. These meters are mere volume indicators as they


Imperial
MIC
VOLUME
ON
FINAL
22
23

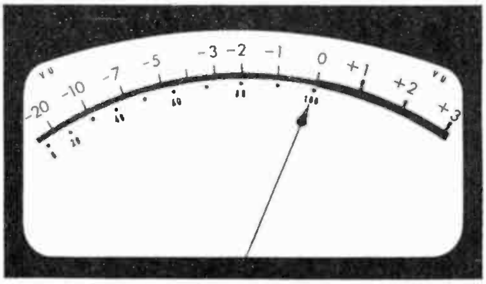
## LETTERS *(Continued from page 10)*

do not give the proper averaging of speech or musical waveforms.

ROBIN H. SPURGIN
Vancouver Recording Services
Vancouver, B.C., Canada

*Yes, Robin, it's true that 0 vu is equal to 4 dBm, but it's also true that the vu is based on the same 1mW in 600 ohms as the dBm. Reference volume is defined as that strength of electrical speech which gives a reading of 0 vu on a volume indicator which is calibrated to read 0 vu on a steady 1000-Hz wave whose power is 1 mW in 600 ohms. However, the total impedance of the volume indicator is usually about 7500 ohms; and to avoid loading down a 600-ohm line, an additional 3600 ohms of resistance is connected in series with the meter. The loss across this resistance is 4 dB, and in order to bring the vu meter up to the 100% mark (0 vu), a signal strength of 4 dBm is needed.*

*In the article, an attempt was made to give our readers an understanding of dB's without becoming involved with formulas, and to explain how to use a VOM or a VTVM in conjunction with a chart; it also points out*




*the difference between the vu and the dBm and states that the two should not be used interchangeably. It's true, too, that a vu meter must have a certain specified ballistic characteristic to read out average levels in a waveform, and to keep it from responding to signal peaks. Your letterhead logo seemed so apropos to this discussion that we have reproduced it here.*

### ANTENNA PATTERNS

You might want to acquaint your readers with the fact that the polar patterns published in your November 1966 issue in conjunction with my article ("Antenna Placement Does Make a Difference") were plotted in dB with reference to field strength—not power. This does not invalidate the patterns, however, since we are only interested in the order of magnitude between the different antenna mountings.

ROBERT L. RUYLE, WØFCH, KGI-13471
Lincoln, Nebr.

*Fine, Bob; we have had some nice comments on your article, and look forward to your upcoming feature on "grounds" for the ham, SWL and CB'er.* —30—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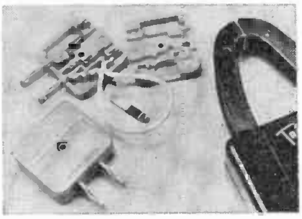
**CIRCLE NO. 15 ON READER SERVICE PAGE**

PARTS
METHODS
IDEAS
GADGETS
DEVICES

# TIPS & TECHNIQUES

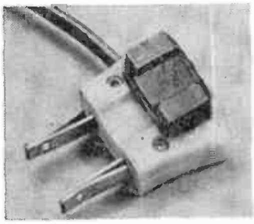
## PLUG-IN LOOP ADAPTER FOR CLAMP-ON AMMETERS

Here's an easy way to wrap a clamp-on ammeter around one side of the a.c. power line without breaking into the line, and without disconnecting the unit under test. Secure a plastic light flasher (such as the "Snapit" by Cable Electric Products, Inc.) and carefully drill out the center retaining rivet. Break away the wire-wound flasher element, and connect a 1½"-diameter loop of 14 AWG stranded wire in place of it. Cut a notch in one of the walls of the case to clear the loop of wire. Use a 4-40 nut and bolt in place of the rivet. —*Vincent F. Allen*



## MAGNET CURES "LINE CORDITIS"

Like most electronics enthusiasts, you probably have your fair share of power cords that consistently and obstinately unwrap themselves from around your electronic equipment when you are moving it from one place to another, and try to trip you up. You can cure this "line corditis" with a small but powerful magnet. Glue the magnet to the cord plug as shown in the photo. If your equipment cabinet is made of aluminum or other nonmagnetic material, bolt or glue a small sheet of steel to it. Wrap the line cord securely around the unit and place the magnet against the steel plate. —*D. E. Hausman*



## WEATHER STRIPPING PROVIDES FEET FOR PROJECTS BY THE YARD

Foam rubber weather stripping, the type used around doors and windows to prevent drafts, can be transformed into excellent and

# POPULAR ELECTRONICS
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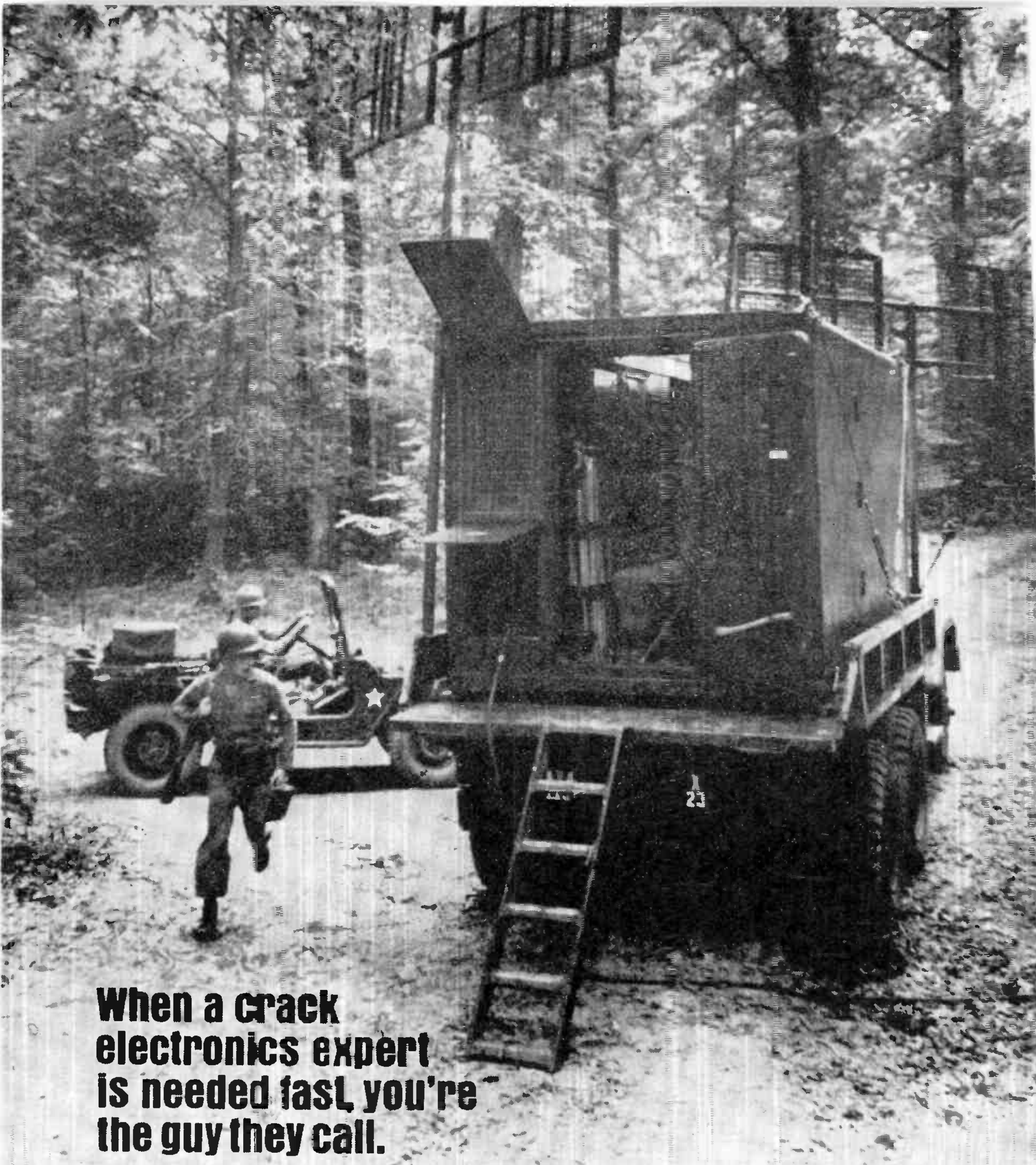
3



# When a crack electronics expert is needed fast, you're the guy they call.

Sometimes you feel like a country doctor with sixteen cases of measles in town.

But working on emergencies is nothing new to you.

You're the expert and emergencies are your job.

You're the one guy in the company that can practically field strip a computer and put it back together again. Circuits are so pressed into your brain you can almost hear a short one. They make the TV's you repaired back in high school look like crystal sets.

If it wasn't for the electronic training you got in the Army, you'd still be a tube tester. But the Army opportunity came along and you took it.

A full-dress, eight-hours-a-day, five-days-a-week school that taught you a skill you'll build a career on.

A solid career that can mean sound security all your life.

There's nothing like being an expert. That's what you can be in today's action **Army**

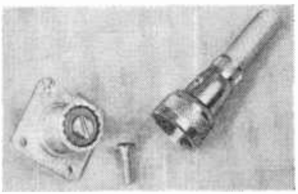
 (Continued from page 14)

inexpensive rubber feet for your projects. The strips are usually backed with an adhesive that will stick to just about any clean surface, so there's no need to drill holes in the cabinet. Use a sharp knife or a pair of scissors to cut the strips into small rectangular or square pieces as required. Strip away the protective backing, and stick the pieces to the bottom of the cabinet. (With some types of weather stripping, it is necessary to use a reducing solution to make the pieces stick.)

—*Jean Heroux*

## MICROPHONE CONNECTOR CAN BE COAXED IN EMERGENCY

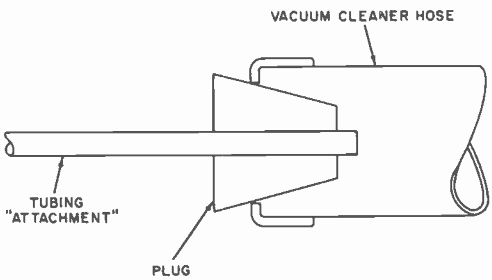
You can use a microphone connector (such as an Amphenol 75-MCIF) and a 6-32 x ½" machine screw to make an emergency PL-259 type connector. Push the machine screw into the center of the coaxial receptacle to extend the center contact. If the connectors seem to bind when you try to screw them together, don't force the fit. Use a longer machine screw for the center contact and try again. A slight difference in number of threads per inch is responsible for the binding. In a great many instances, you will be able to screw the connectors together in spite of a difference in thread, because of normal wear and tear on the parts.



—*David N. Bertollo*

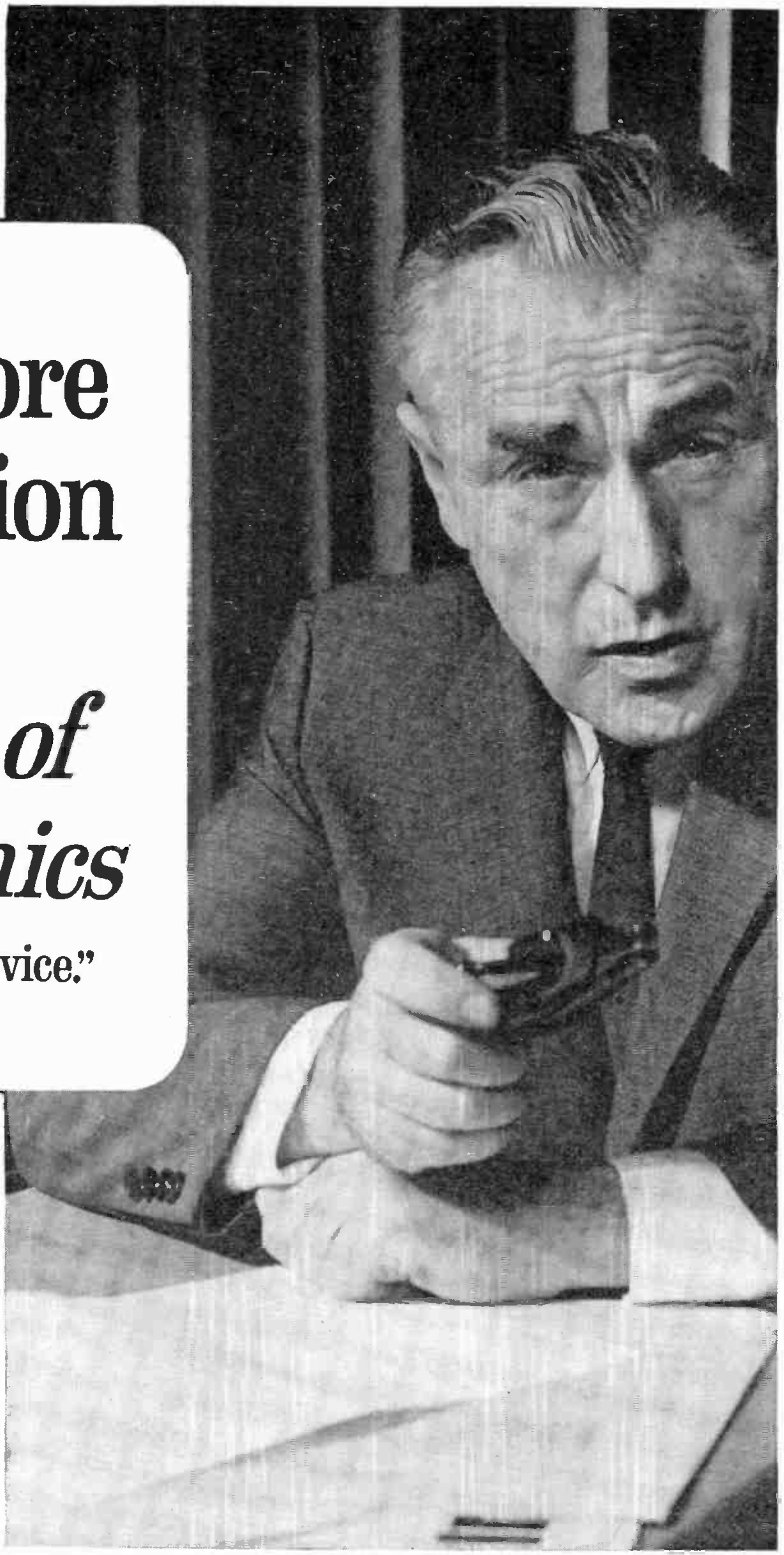
## VACUUM CLEANER HOSE ADAPTER CUTS CHASSIS CLEANING CHORES

Vacuum cleaner attachments are too large and bulky to get into a radio, TV, or hi-fi chassis satisfactorily. However, a short length of small-diameter flexible plastic tubing and a large cork or other suitable plug can be used to make an adapter that will let you get into every nook and cranny. Drill a hole




through the center of the plug just large enough to allow the tubing to fit snugly. Push the tubing into the hole, and apply a daub of cement to hold it in place. Then push the plug into the end of the vacuum cleaner hose. You can use the adapter either to blow or draw air.

—*William B. Rasmussen*



# NEW PRODUCTS

*Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15.*

### MOTOR-SPEED/LIGHT CONTROL

There are a great many uses for the Knight-Kit Model KG-201 motor-speed/light control offered by *Allied Radio Corporation.* It permits control of the speed of electric drills, food mixers, sewing machines, and other electrically operated devices; when used with power tools, there is virtually no loss of torque, even at low speeds. It also controls the brightness of incandescent lamps, photofloods, and units with heating elements up to 900 watts. You can even use it with a soldering iron to limit heat for protection of delicate components. Detailed step-by-step instructions are supplied for easy assembly in just a few hours.


Circle No. 75 on Reader Service Page 15

### LOW-COST SPEAKER SYSTEM

Tight budget? Limited living quarters? You'll be interested in the SP5A deluxe speaker system offered by *Tang Incorporated.* Designed with small rooms in mind, the SP5A has a low-distortion, high-efficiency output from 60 to 18,000 Hz (full range is 45-18,500 Hz). It can be used with any amplifier rated at up to 25 watts music power per speaker per channel (or with higher power amplifiers through the addition of a 10-ohm resistor or 8-ohm L-pad). Features include a special 5" speaker, tuned solid walnut enclosure, and a special "money back" guarantee. Two for stereo.

Circle No. 76 on Reader Service Page 15

### POLAR DIVERSITY ANTENNAS

A line of polar diversity antennas, designated "AVANTI PDL," is being developed by *Avanti Research & Development, Inc.* At the present time, two models are available—the PDL-27A and the PDL-27B—both intended for the 27-MHz band. The PDL arrays provide for switching between horizontally and vertically polarized signals using a common loop radiator and special crossed feed elements. Their purpose: to permit communications via the horizontal mode when channels are crowded, and also to maximize long-distance reception. All necessary parts, including boom, mount for attachment to a vertical pipe, and switch box are included with each array.

Circle No. 77 on Reader Service Page 15

### TRANSCEIVER/COMMUNICATIONS RECEIVER

Citizens Band operators who would like to tune in the ham bands can now do so—with *Hammarlund's* new HQ-205, a 6-channel, 5-watt CB transceiver plus a 540-30,000 kHz communications receiver. The rugged crystal-controlled transceiver is easily retunable to the 10-meter ham band without instruments. Electrical bandspread tuning is provided for 80 through 10 meters and there is a variable BFO for CW or SSB reception, a Q-multiplier, a calibrated S-meter, and a "self-adjusting" noise limiter. An optional accessory matching speaker, communications-type microphone, and a 100-kHz crystal calibrator complete the two-tone beige-and-brown desk-top ensemble.

Circle No. 78 on Reader Service Page 15

### MUTUAL-CONDUCTANCE TUBE CHECKER

Said to be the only Gm tester that uses a 5-kHz square wave, *Sencore*'s MU140 "Continental" is designed for fast, accurate, true mutual conductance tests. The compact portable unit measures mutual conductance in actual micro-ohms, and features an automatic biasing system. All TV and radio tubes can be checked—including novars, compactrons, nuvistors, magnovals, and foreign tubes—and space is provided for additional sockets to accommodate future tubes with different base arrangements. The MU140 comes in a smartly styled "attache" case, with an up-to-the-minute tube chart.

Circle No. 79 on Reader Service Page 15

### 2-METER PORTABLE/MOBILE TRANSCEIVER

The HA-144 2-meter transceiver announced by *Lafayette Radio Electronics* is suitable for portable, mobile, or fixed station use. Incorporating 18 transistors and 7 diodes, the HA-144 features a selective 144-148 MHz tunable dual-conversion superhet receiver with 1-$\mu$V sensitivity for a 10-dB signal-to-noise ratio. A

## PRODUCTS *(Continued from page 22)*

10.7-MHz mechanical filter effectively reduces adjacent station QRM (selectivity is 40 dB down at 30 kHz), and a series gate limiter automatically suppresses noise. The push-pull high-level modulated transmitter delivers over 1 watt of r.f. output power for 2.5 watts input. Supplied with leather carrying case, shoulder strap, whip antenna, mobile power cable, mobile mounting bracket, and ten "D" size batteries.

Circle No. 80 on Reader Service Page 15

### SOLID-STATE CB RIG

Four engineering exclusives are claimed for the "NOVA-23" (Model 7923) 23-channel, 5-watt CB rig announced by *EICO Electronic Instrument Co., Inc.* Small enough to hold in your hand, the unit is "function-engineered" so that you can operate it without difficulty. A dual-crystal lattice filter provides unusual selectivity, while an up-converter frequency synthesizer provides extra stability and trouble-free performance. The unique use of

precision series-mode fundamental crystals results in superior transmit and receive stability (crystals are supplied for 23 channels). Sensitivity is less than 0.5 $\mu$V for 10 dB S/N ratio, squelch adjustable to 1 $\mu$V. The unit operates from a 12-volt d.c. negative-or-positive-ground supply, or from 117 volts a.c. with an optional power supply. Special feature: a flick of a switch converts the NOVA-23 to a 3.5-watt p.a. system.

Circle No. 81 on Reader Service Page 15

### FET COMMUNICATIONS RECEIVER

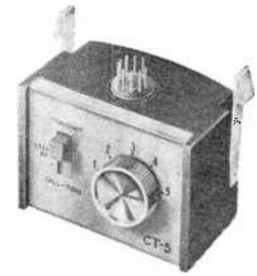
All of the circuitry in the solid-state DR-30 communications receiver available from *Davco Electronics* is contained on nine plug-in glass-epoxy modules. The use of FET's in the r.f. stages of this compact, dual-conversion superhet makes for greater sensitivity, better image rejection and freedom from cross-modulation or overloading on strong signals.

Designed for heavy-duty service, the DR-30 covers 80 through 10 meters (plus a portion of 6 meters), 9.5 to 10.5 MHz for WWV and the 31-meter SWL band, and has provision for two optional crystals for additional frequency coverage.

Circle No. 82 on Reader Service Page 15

### CB "CALL-TONE SELECTOR"

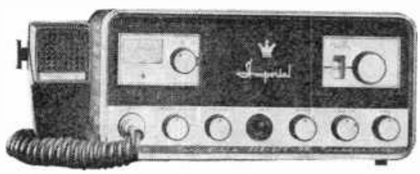
Background "hash" and unwanted calls can be completely eliminated through the use of a CB "Call-Tone Selector" now available from *Fanon Electronic Industries, Inc.* Designated as Model CT-5, it is a compatible unit that plugs into built-in sockets on the bases of Fanon transceivers. With it, any operator can pinpoint a call to any one other CT-5 equipped unit. Transceivers within this "Call-Tone" system cannot be broken into by any transceiver not equipped with a CT-5. Up to five transceiver operators can selectively signal each other on each transceiver with frequency-controlled tone.




Circle No. 83 on Reader Service Page 15

### 23-CHANNEL DSB/AM TRANSCEIVER

Lots of unusual "goodies" seem to have been made available for the CB'er recently—including the *Regency* "Imperial," a 23-channel transceiver compatible to both sidebands and conventional AM transmit and receive facilities. The Imperial can receive on



three different modes in each of the 23 CB channels, and it can transmit on two modes within each channel. A simple front panel control enables you to select the upper sideband, lower sideband, or AM function on the receiver. For transmitting, you can use the double sideband with reduced carrier facility for conventional AM signals, or transmit on both sidebands simultaneously without carrier. The Imperial operates on 117 volts a.c., or 12 volts d.c.

Circle No. 84 on Reader Service Page 15

### ACOUSTIC INSULATOR KIT

*Olson Electronics* has announced a kit of four acoustic insulators (called the Model HF-97) which fit under the mounting feet of record changers, tape recorders, tuners, amplifiers, etc., and absorb vibrations to prevent acoustic feedback. Each insulator is 2" in diameter and 1⅛" high. Felt pads prevent furniture scratches.

Circle No. 85 on Reader Service Page 15


CIRCLE NO. 2 ON READER SERVICE PAGE

# ELECTRONICS LIBRARY

### ELECTRONICS FOR PHOTOGRAPHERS

*By Marshall Lincoln*

Marshall Lincoln, a frequent contributor to POPULAR ELECTRONICS, has turned his talents toward unraveling the mystery of electronics as it concerns the photographer. Exposure meters, strobes, timers, and enlarging meters are discussed in detail (fairly basic material) and some general information is given on automatic cameras and exposure settings.

*Published by Amphoto Books, 915 Broadway, New York, N.Y. 10010. 160 pages. Hard cover. $5.95.*

### ELECTRONIC CABLE HANDBOOK

Anyone who uses or specifies cable has—for the first time—a practical one-source reference in the *Electronic Cable Handbook*. Written by the Engineering Staff of the Belden Manufacturing Company, the book explains the design, construction, and handling of virtually every type of electronic cable—including the exotic cables used in space satellites. It covers specific applications in detail, devoting whole sections to the types of cable used in intercoms and entertainment systems, two-way radio, etc., and includes military and non-military specifications. Couched in easily understood terms, it contains many useful tables and a glossary.

*Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206. Soft cover. 224 pages. $3.95.*

### PRINCIPLES OF RF POWER AMPLIFIERS

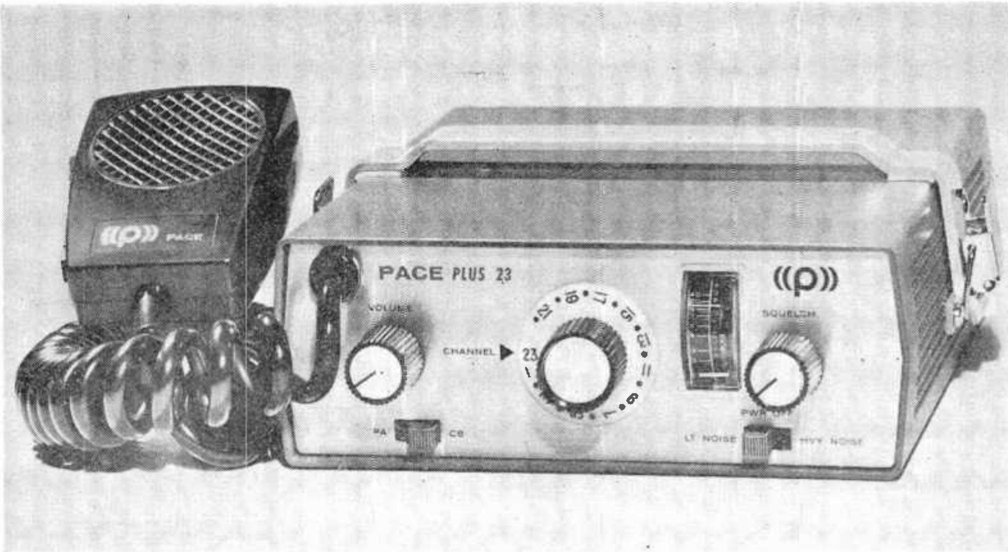
A "basic" book on the intermediate and final power amplifiers used in radio transmitters, this volume opens up with an explanation of the classes of operation and biasing methods, then goes on to discuss amplifier loads, frequency multiplication, neutralization, and the use of r.f. power amplifiers. Final sections cover transmitter troubleshooting and keying methods. Simple diagrams are scattered throughout.

*Published by Techpress, Inc., Brownsburg, Ind. 46112. 118 pages. Soft cover. $1.95.*

### HAVING FUN IN ELECTRONICS

*by Leo G. Sands*

Your reviewer must assume—after reading this book—that the electronics publishing industry is running out of titles. This is not a "fun" book; it's a concise, well-organized paperback loaded with circuit diagrams. The first two dozen pages concern basic elec-




# SOME STRAIGHT-FORWARD TALK ABOUT THE PACE PLUS-23 CB TRANSCEIVER

The PLUS-23 is an all silicon transistor, all solid state Citizen Band 2-way radio, manufactured by Pace Communications Corp., priced at $199.00 with all channels supplied. Ask any proud PACE owner, or ask your dealer for an in-field comparison test. You will find the PLUS-23 even outperforms its own specs. This is because we guarantee our sets will perform to specifications under the worst possible conditions—not under ideal or laboratory conditions.

PACE is a pioneer in all solid state CB design, specializing in all silicon transistor 2-way radios. The advantages are many: You don't risk a rundown car battery because the current drain is so low; you get a compact unit that fits conveniently under the dash—not the large, knee-knocking chassis of a tube set; you get reliability that means top performance on a below-zero winter morning or when it's 100 degrees in the desert sun; you get rugged dependability that keeps on operating after a day-long trip over bumpy mountain roads.

Reliability is the name of the game at PACE. That's why we clip and bend every component lead by hand. And test every PLUS-23 on a vibration stand. We also check every set for all of the published performance specifications—even operation on a weak battery or high voltage conditions. A signed process report goes with every radio—like a pedigree. Take a look at one and see for yourself how we take the guesswork out—and build performance in to every PLUS-23. We build in dependability too. You get full diode protection plus complete AGC at every stage, with heavy duty silicon transistors and lifetime guaranteed circuit boards and computer-verified synthesizer.

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We are proud of our equipment, and stand behind it with a no-gimmick warranty. Don't be fooled by misleading claims. Compare and ask questions before you buy. Have a qualified technician look at a PACE chassis. He will confirm the quality construction and components we use. For more information, and the name of your nearest authorized PACE dealer, write:

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CIRCLE NO. 27 ON READER SERVICE PAGE

## LIBRARY (Continued from page 26)

tronics theory, but after that the diagrams come thick and fast—we counted 135 and there were more to go. This could be called an "idea" book—which it is; but is it fun to look at circuit diagrams? Forget the title—the book is worth looking at.

*Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206. Soft cover. 160 pages. $3.25.*

### THIN-FILM AND SEMICONDUCTOR INTEGRATED CIRCUITRY

*by John Doyle*

This is not a book of circuits involving the use of IC's. It is a book that deals with the problems of fabricating IC's, from the development of the mask pattern through to the tests for reliability. The author, long associated with National Radio Institute, exhibits an unusual grasp of his subject and provides the reader with liberal reference material.

*Published by McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036. Hard cover. 314 pages. $6.95.*

### BASIC DATA PROCESSING

*by Peter Abrams and Walter Corvine*

In the introduction, the authors acknowledge that there are numerous textbooks on computers and programming. But, as they so rightly state, most texts deal with hardware or systems and few books containing a "overview" of the data processing field have been published. This low-cost paperback is well worth the attention of any reader who has any contact with computer data processing. Although the contents are arranged like a classroom text, the treatment of the subject matter is not dry or superficial. For an up-to-the-minute look at data processing at the senior high school level, this book can be highly recommended.

*Published by Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York, N.Y. 10017. Soft cover. 464 pages. $5.95.*

### ABC's OF ELECTRONIC TEST PROBES, Second Edition

*by Rudolph F. Graf*

Probes are a vital link between test equipment and circuits under test; yet many people think they are just handy terminations for cables. To achieve accurate measurements, test probes must be selected with the right electronic properties for each type of circuit. This book gives complete information on the construction, basic principles, and applications of most of the common types of probes used in up-to-date electronic testing. It is written in down-to-earth language with many supporting illustrations.

*Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206. Soft cover. 128 pages. $2.25.* —30—

# HAM HOBBY CLEARINGHOUSE

*If you have a hobby or interest in addition to amateur radio and would like to talk about it on the air, you can contact other hams with the same hobby through this column. To be listed here, just send a legibly printed postcard to Ham Hobby Clearinghouse,* POPULAR ELECTRONICS, *One Park Ave., New York, N.Y. 10016, including on it your call letters, other hobbies, the frequencies you use, mode of operation, when you operate, and your name and address.*

**WA1FKQ**—Stamp collecting, clarinet, saxophone, all sports, traffic handling, sometimes NCS of N.E. Teenage Net: 3880 kHz, Tuesdays, Wednesdays, and Thursdays at 2100 GMT; 80 and 10 meters, CW, AM and some SSB weekends and evenings to 0200 GMT. (Douglas A. Fisher, 6 Washington St., Norwood, Mass. 02062)

**WA1FRV**—Chess, chemistry, cornet, radio and electronics theory, mathematics, general science; 80 and 10 meters, AM and CW; evenings, weekends, and school holidays. (Gerald R. Larocque, 729 Bernardston Rd., Greenfield, Mass. 01301)

**WN1HFE**—Astronomy, rocketry, science fiction, space exploration; 3719 kHz, CW; Fridays and weekends. (David Rose, Long Crossing Rd., East Hampton, Conn. 06424)

**W2FCJ**—Motorcycles, flying, guitar, hi-fi, solid-state experimenting, electronics design; 10 and 6 meters, phone; hours vary. (Myron Gottesman, 118 W. 57 St., New York, N.Y. 10019)

**WB2SXY**—Chess, science fiction, fishing, SWL'ing, hydroponics, astronomy, pen pals, building electronics equipment; low end of 6 meters, CW; after 1500 EST. (W. D. Kasperkoski, 72 Hennessey Rd., Ontario, N.Y. 14519)

**WB2UUH**—Current events, races, ARRL Intruder Watch, Spanish; 28 and 50 MHz, AM, and 14 MHz, SSB and CW. (Lee Stewart, R.D. 2, Canisteo, N.Y.)

**WN2WZK**—Photography, chess, physics, biology; 146 MHz, phone; 0000 GMT daily. (Hilary Miller, 98 Highview Place, White Plains, N.Y. 10604)

**WN3ELB**—Hockey, ham SWL'ing, current events, professional broadcasting, space and UFO's; 40 meters, CW; afternoons and weekends. (D. J. Zagrodnick, 604 Iolite Ave., Johnstown, Pa. 15902)

**WN4CFU**—Photography, carpentry, antenna farming; 80 and 40 meters, CW; after school, weekends, and school holidays. (John Craver, 4001 Third St., Chesapeake, Va. 23506)

**WNØOOM/6**—Swimming, SWL'ing, trombone; 3720-3738 kHz, 21.15 MHz, 80 meters, CW; 2 meters, MARS. (Dennis Merritt, 222 Travis Ct., Suisun City, Calif.) —30—

# OPERATION ASSIST

*Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information, write him directly—he'll appreciate it. If you need help, send a postcard to Operation Assist,* POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name, model number, year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

**Globe Transformer Corp.** "Pee Wee" Novice transmitter; has a 6L6G oscillator tube and an "8" rectifier tube. Schematic and operating manual needed. (Jack Pejsa, 218 N. Owasso Blvd., St. Paul, Minn. 55112)

**Airline** Model 62-188 receiver; tunes BC, 6 to 18 MHz, and police calls; has 7 tubes. Schematic and operating manual needed. (Wesley M. Ridgway, Jr., Rt. 1, South Shore, St Charles, Mo. 63301)

**RCA Victor** Model K80 receiver, ser. 10045, circa 1931; tunes 540 to 4000 kHz and 5800 to 18,000 kHz; has 7 tubes, and magic eye. Schematic and source for parts needed. (Richard Richer, 180 S. Middle Neck Rd., Great Neck, N.Y. 11021)

**RCA** "Radiola 66" AR-598 receiver; tunes BC. Schematic and parts list needed. (Kenneth J. Pfitzer, 2700 Countryside Dr., Florissant, Mo. 63033)

**GE** Model E-76 receiver; tunes 540 kHz to 18 MHz on 3 bands; has 7 tubes. Schematic and alignment data needed. (R. W. Gontrum, 10 Wallace St., Lexington, Va. 24450)

**Zenith** Model 6-S-362 receiver; tunes on 3 bands. Source for electrodynamic speaker needed. **Olson** Model TE-184 VOM. Value of shunt resistor needed. (William P. Korbe, 2437 Waterman Ave., Pittsburgh, Pa. 15227)

**DuMont** Model 214 oscilloscope. Schematic, operating and servicing manual needed. (William McConnell, III, 4216 Lanark Ave., Ft. Worth, Tex. 76109)

**Paco Electronics** Model C20 resistance-capacity ratio bridge tester. Schematic and operating manual needed. (Andres Banuchi, 106 Grattan St., Brooklyn 37, N.Y.)

**Zenith** Model 5-S-319 receiver, ser. S35073; tunes 570 to 1600 kHz and 5 to 18 MHz. Source for compensating coil #20-183 needed. **Truetone** Model D-1143 receiver, ser. 0119706; tunes 570 kHz to 14.9 MHz on 4 bands; has 8 tubes. Schematic, parts list and source for band switch and band coils needed. (Charles Woolf, 16 Hilltop Rd., Freehold, N.J. 07728)

**Doolittle** Model PUY 12 mobile receiver, ser. 531. Schematic, operating manual and frequency coverage needed. (R. Arthur, 945 S. Mt. Prospect Rd., Des Plaines, Ill. 60018)

**Arkay** Model A-12 amplifier; has 5 tubes. Schematic needed. (Mark Handley, 31 Mohawk Dr., Clarendon Hills, Ill. 60514)

**Solar** Model CE capacitor analyzer. Schematic and operating manual needed. (Herbert H. Cross, 59 Flagler Ave., Cheshire, Conn. 06410)

**Korting** Model MT 156 tape recorder. Operating manual needed. (Luis Rodriquez, 67-59 224 St., Flushing, N. Y.)

(*Continued on page 34*)

## ASSIST

*(Continued from page 32)*

**RCA** Model 262 receiver, circa 1934; tunes 140 kHz to 36 MHz on 5 bands; has 10 tubes. Source for first a.f. transformer and output transformer 68728 needed. (John W. Weiler, 220 Wood St., Crown Point, Ind.)

**Meissner** Model EX signal shifter, circa 1943. Schematic needed. (Charles D. Pierce III, 8527 Golden Ridge Rd., Lakeside, Calif.)

**Oak Ridge Products** Model 106 "Cathette" CRT tester. Schematic, parts list, and instruction manual needed. (William C. Parker, Box 38, Hannibal, N.Y. 13074)

**Hickok** Model RFO 5 oscilloscope. Source for low-frequency coil assembly OS2206 and high-frequency coil assembly OS2207 needed. (Lawrence Merat, Frenchville. Pa. 16836)

**Radio City Products** Model 802N tube tester. Tube testing charts or roll charts needed. (Charles F. Maugle, 156 Pickford Ave., Kenmore, N.Y. 14223)

**Motorola** Model 53LC2 receiver, chassis HS-347; tunes BC; has wind-up clock. Schematic and source for 1V6, 1AJ5 and 1AH4 tubes needed. (Jim Hiebeler, 2308 W. 110 St., Minneapolis, Minn. 55431)

**Triplett** Model 1183-SC tube tester, ser. 0693, made for Signal Corps, circa 1943. Schematic needed. (Clifford Fountain, Code 5012, USNOTS, China Lake, Calif. 93555)

**Heraldyne** receiver, ser. 14535, circa 1927; tunes 100 to 500 meters on 2 bands; has 5 UX-301A tubes. Schematic and parts list needed. **Philco** Model 37-60 receiver, circa 1931; tunes 540 to 1700 kHz and 2.4 to 7.4 MHz; has 5 tubes. Schematic and source for tuning dial assembly and pilot lamp shadow assembly needed. (Robert T. Millard, 1420 Hollywood Dr., Lancaster, Pa. 17601)

**Westinghouse** scope transformer Model L-406784 needed. (George Kapsokavadis, Kolokotroni 13, Corfu, Greece)

**Lavoie** Model LA-239A oscilloscope, ser. GNV, made for U.S. Navy, I. D. 91809-100153. Schematic, operating and calibration manuals needed. (Brian G. Petix, 11021 Woodbury Rd., Garden Grove, Calif.)

**Philco** Model 050 tube tester. Schematic and operating manual needed. (Reuben J. Blatt, 416 Centre St., Hyde Park, Reading, Pa. 19605)

**Triumph** Model 841 oscillograph. Schematic needed. (Bill Hliwa, 4212 Harvey Ave., Western Springs, Ill. 60558)

**Interocean** "Skyrover" receiver, circa 1931; tunes 200 to 400 kHz and BC. Schematic needed. (Jay Budzowski, 755 Arlington Ave., New Castle, Pa. 16101)

**AN/GPG-1** radar tracker set T9, surplus. Schematic needed. (Eugene Fleming, 328 Gunnison Ave., Grand Junction, Colo. 81501)

**Zenith** Model S-17784 receiver; tunes AM and FM. Schematic and operating manual needed. (D.M. Diegert, 6234 Big Tree Rd., Livonia, N.Y. 14487)

**RCA** "Radiola 62" Model AR-892; tunes BC. Schematic needed. (Mike Campbell, 206 Goff Dr., Leitchfield, Ky. 42754)

**Delco** Model R1128 receiver, circa 1938; tunes on 4 bands; has 7 tubes. (Edmond McKenzie, 8 Vicky Ct., Trenton, N.J. 08610)

**Hammarlund** Model HQ-129-X receiver; tunes 0.54 to 31 MHz on 6 bands. Operating and instruction manual needed. (Ronald S. Lettieri, 433 E. Drinker St., Dunmore, Pa. 18512)

**Stewart-Warner** Model 11-9B7 receiver; has 9 tubes. Source for speaker, knobs, and push button needed. (Clyde E. Propst, Rt. 2, Sellersville, Pa. 18960)

**Silvertone** Model 2761 receiver, ser. 549264, circa 1949; tunes s.w. from 1.7 to 18 MHz; has 6 tubes. Schematic and source for 1N5, 1A5, 1A7, 1H5 tubes needed. (David Rose, Long Crossing Rd., East Hampton, Conn. 06424)

**Supreme** Model 546 oscilloscope. Schematic and parts list needed. (Julius Finkel, 9428 Woodley Ave., Sepulveda, Calif. 91343)

**Rider** Vol. I of radio receiver diagrams, circa 1925, needed. (Donald Ryan, Star Route, Box 301A, S. Plymouth, N.Y. 13844)

**United States** Model CFM 12823-1 TV set; tunes FM and TV. Schematic needed. (C.B. Mueller, 3801 N. Oakley, Chicago, Ill. 60618) —30—

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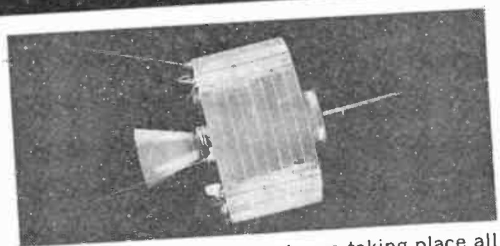

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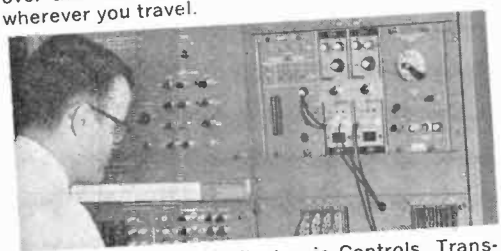

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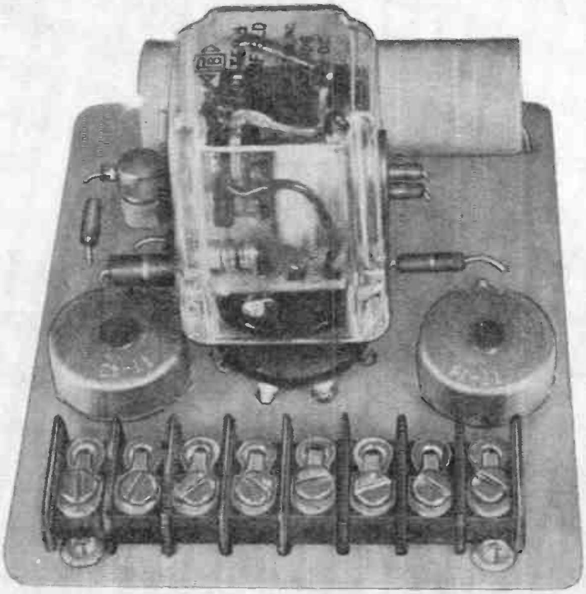


COVER STORY

# BUILD THE SUPERTROL

For . . .

- Automatic start switching
- Interval timing
- Voltage Sensing
- Delayed Stop Action
- Etc., etc., etc.

By DON LANCASTER

ASK NOT what the Supertrol can do, but rather, what it cannot do. For here is a circuit with an abundance of useful applications. The Supertrol is primarily a free-running master sequence generator, suitable for an exhibit or display, which provides a completely adjustable on/off ratio of from 50 milliseconds to 10 seconds. Husky 10-ampere relay contacts provide dual complementary—off/on, on/off—outputs.

Change around a connection or two and the Supertrol becomes a sensitive voltage level detector which opens or closes a relay with a positive snap action as the input voltage exceeds 2 volts, or drops below 1 volt.

Add a d.p.d.t. switch and once again change some connections around and you have a time-delay relay or an interval timer—depending upon your choice of output contacts. With this arrangement you can turn on a load once for a predetermined time interval, or get a continuous output at the end of an adjustable 0- to 20-second time interval.

**How It Works.** The Supertrol's actual circuit (Fig. 1) is nothing more than a jazzed-up version of a basic Schmitt trigger as described on page 44. Transistors *Q2* and *Q3* comprise the Schmitt trigger while *Q1* is an emitter follower used to keep charging capacitor *C1* from loading down the circuit. The capacitor charges through potentiometer *R11*, so that this control determines the relay's *on* time. Similarly, *R12*, which provides a discharge path for the capacitor, determines the relay's *off* time.

Most of the resistors added to the basic circuit are for stabilizing purposes, and to help eliminate current surges from the power supply and the unit's control circuitry. Capacitor *C2* helps to speed up the turn-off operation, while *D1* protects *Q3* from voltage spikes due to the inductance of the relay coil.

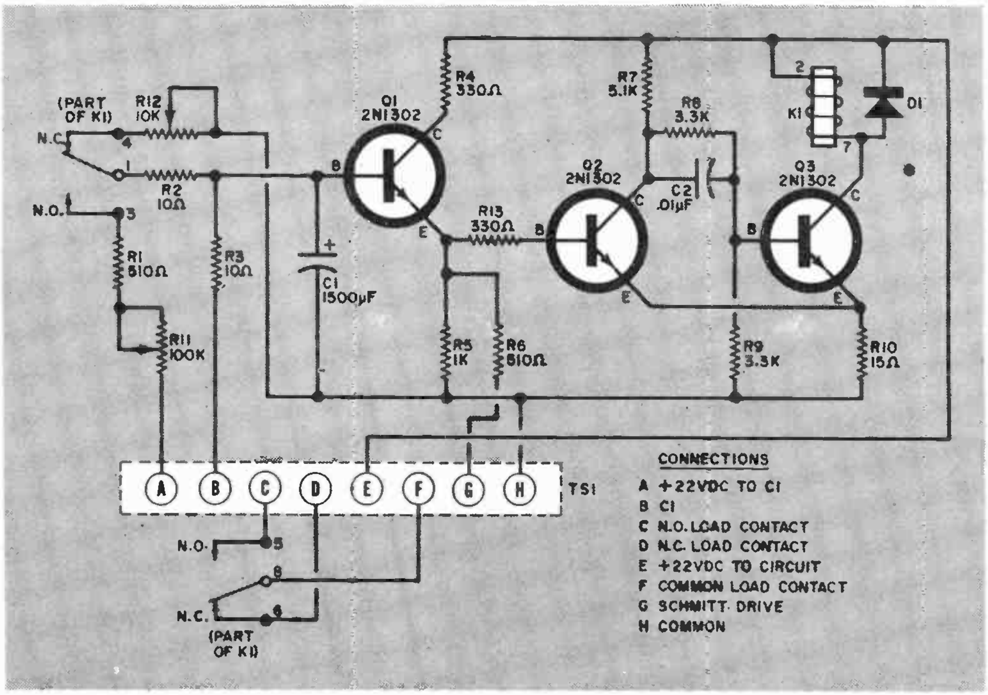



Fig. 1. The Supertrol is a practical application of the well-known Schmitt trigger circuit. A technical explanation of the triggering operation appears on page 44. Relay K1 is the workhorse of the Supertrol and the second set of contacts (octal pins 5,6, and 8) are used to operate other circuits up to a drain of 10 amps. The author brought all control wiring functions out to a terminal strip, but this may be eliminated if the Supertrol is to be used for only one job.

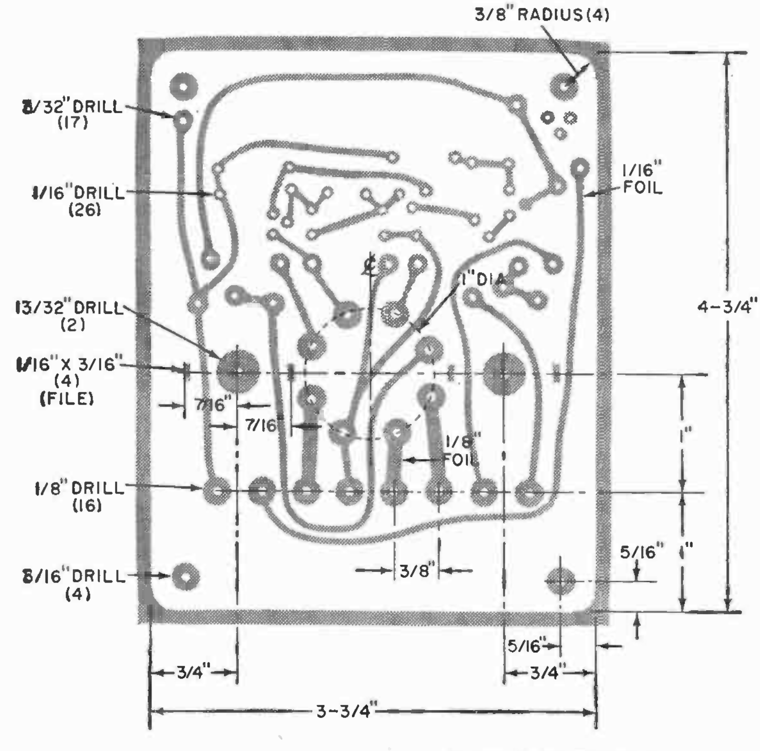



Fig. 2. A printed circuit board can be etched following the outlines shown in this drawing. Use of this outline should be predicated on the physical size of capacitor C1, location of the terminals for the octal socket to hold K1, and whether or not the builder uses twist-tab potentiometers for R11 and R12. Point-to-point wiring can be used in place of a printed circuit without encountering any problems.

## PARTS LIST

*C1—1500-μF, 6-volt d.c. electrolytic capacitor*
*C2—0.01-μF disc capacitor*
*D1—750-mA, 200-PIV silicon diode*
*K1—24-volt d.p.d.t relay, 400-ohm coil, with 10-ampere contacts (similar to Potter & Brumfield KRP11DG)*
*Q1, Q2, Q3—2N1302 transistor or similar unit*
*R1, R6—510-ohm, 1-watt resistor*
*R2, R3—10-ohm, ½-watt resistor*
*R4—330-ohm, ½-watt resistor*
*R5—1000-ohm, ½-watt resistor*
*R7—5100-ohm, ½-watt resistor*
*R8, R9—3300-ohm, ½-watt resistor*
*R10—15-ohm, ½-watt resistor*
*R11—100,000-ohm twist-tab potentiometer (similar to Centralab TT-40)*
*R12—10,000-ohm twist-tab potentiometer (similar to Centralab TT-14)*
*1—3" x 4" x 5" box, or printed circuit board*, or both*
*1—8-terminal barrier strip (similar to Cinch Jones 140-Y)*
*Misc.—Octal PC tube socket, knobs (2), threaded rivet-type standoffs (4), solder, 22½ volt battery or a.c.-operated d.c. supply—see below.*

*An etched and drilled circuit board, complete with all mounting hardware, is available for $2.50 postpaid in the U.S.A. from DEMCO, Box 16297, San Antonio, Texas 78216

**Construction.** The Supertrol can be built on a printed circuit board or on a punched phenolic circuit board, and can be housed in a small plastic container or in a metal box. If a printed circuit board is preferred, one can be purchased from the source indicated in the Parts List. If you want to etch your own board, you can do so following the layout given in Fig. 2, and the parts can be mounted as shown in Fig. 3.

For printed circuit construction, be sure to use the specified twist-tab potentiometers since the PC board has been laid out with holes drilled for these units.

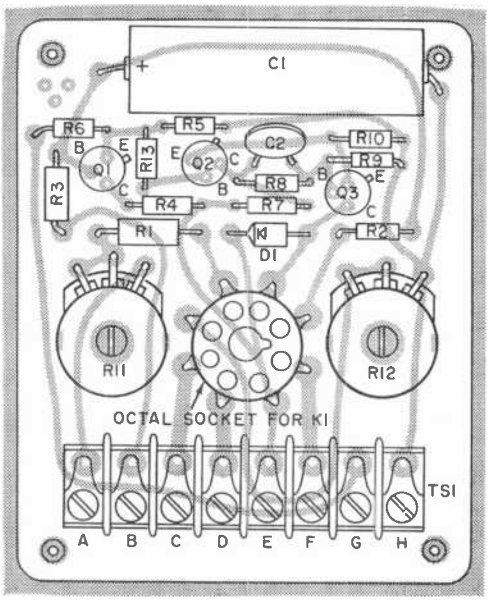



Fig. 3. If you make or buy a printed circuit board the components should be positioned as shown. The 3 spare holes in the corner mount a socket to hold Q1 when this transistor is not in the circuit.

## POWER SUPPLY PARTS LIST

*C1—500-μF, 25-volt electrolytic capacitor*
*D1—750-mA, 100-P.I.V. silicon power diode (similar to Motorola 1N4002)*
*R1—4700-ohm, ½-watt resistor*
*T1—Power transformer: primary, 117 volts; secondary, 18 volts, 100mA, or higher (similar to Stancor TP-1 or Knight (Allied Radio) 54 A 3987*

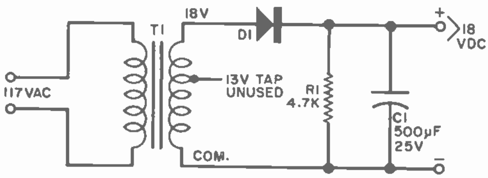



Fig. 4. For continuous duty operation, this power supply can be substituted for the 22½-volt battery. The circuit will work on 17 to 24 volts d.c.

Suitable standoffs can be used to mount the circuit board in its enclosure, if one is used, or else support it on a table or other surface.

While transistors *Q2* and *Q3* can be wired directly to the circuit board, *Q1* should be installed in a socket since it has to be removed from the circuit during certain applications. After completion, the circuit can be tested by hooking it up as shown in Fig. 5. With power applied, it should start oscillating at about 1 hertz. If it does not, adjust *R11* and *R12* as necessary.

If the Supertrol is to be used only on occasion, and if you do not want to go through the expense of building an a.c.-operated power supply, you can operate the unit with a 22½-volt battery which can be housed with the circuit board in the same enclosure. If, on the other hand,

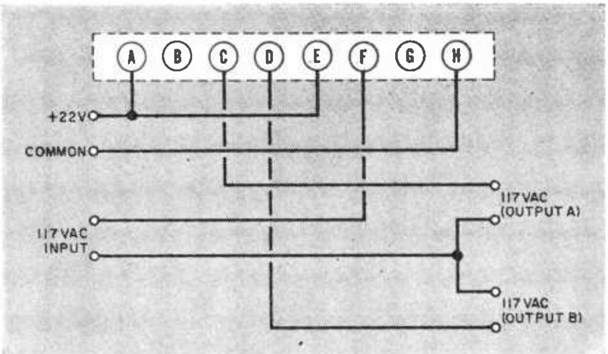



Fig. 5. To test the Supertrol, connect a 22½-volt battery with the plus side going to terminal strip points A and E, and the negative side of the battery to point H. The circuit should start oscillating at about 1 hertz. If the relay does not start clicking, juggle R11 and R12 until the relay has a rhythmic beat. As explained below this circuit is also used to make the Supertrol a display sequence generator.

you plan to use the Supertrol on a fairly continuous basis, you may want to build the power supply shown in Fig. 4 using the parts shown on the accompanying Parts List. The output voltage from this supply will be up to 24 volts depending on the load.

**Applications.** To have the Supertrol function as a display sequence generator, make the connections shown in Fig. 5, enabling one set of relay contacts to alternately switch the "hot" side of the 117-volt a.c. line between Outputs *A* and *B*. The *common* side of the line goes directly to the load, and there is no connection between this set of contacts and the rest of the Supertrol circuit. The switching time required to go from *A* to *B* is determined by the adjustment of *R11* and *R12*. This circuit is ideally suited for running exhibits and displays.

The connections required for a voltage level detector function are shown in Fig. 6. Here, emitter follower *Q1* must be removed from its socket. This enables the circuit to turn on whenever the input signal exceeds 2 volts or turn off when the signal drops below 1 volt. Input impedance is approximately 1000 ohms. Relay contacts *C* and *D* are used as required to provide power for an alarm bell, signal light, etc.

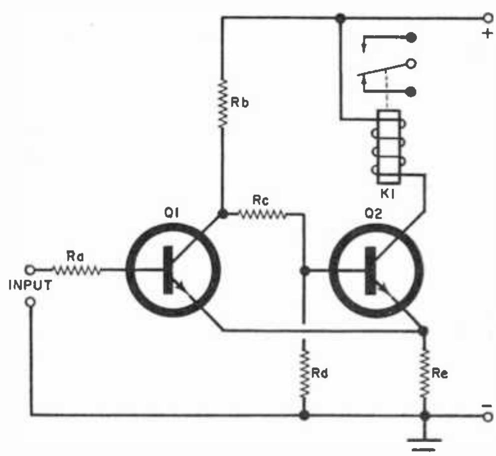
(*Continued on page* 94)

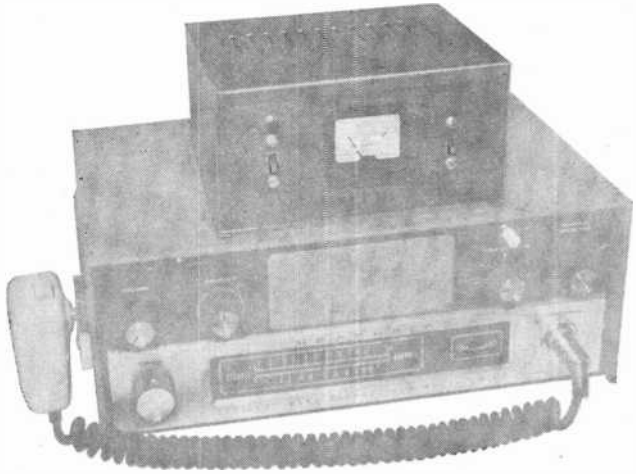
## CIRCUIT THEORY

To understand the secret behind the Supertrol's success, consider the Schmitt trigger circuit shown at right. The circuit and biasing arrangement is such that Q1 is normally OFF while Q2, which controls relay K1's current, is normally on.

If a positive voltage—say about 2 volts—is applied to base resistor Ra, Q1 turns on, causing Q2 to turn off due to reverse biasing applied across Rc and the increase in the voltage across emitter resistor Re. This causes the relay, which acts as Q2's collector load, to drop out as the current falls to zero or to any value below its pickup point. The circuit will revert to its original quiescent state whenever the voltage at the input falls below the tripping level, and the relay will pull in again.

By placing a relatively large capacitor in Q1's base circuit (see Fig. 1), and a charging path from a battery through the relay contacts and a couple of current-limiting resistors, the circuit can be made to free-run by the charge and discharge of the capacitor, enabling Q1 and Q2 to change state at a predetermined interval. The rate at which the transistors change state is established by the charge and discharge rate of the capacitor; and this, in turn, is a function of the resistor values chosen. It can be seen that if a potentiometer is substituted for at least one of the resistors, the charging time can be varied at will.





BUILD

# The "Mule Box"

By **DANIEL MEYER**, KMT 2967

## OUTBOARD CONVERTER OFFERS "LEGAL" INCREASE OF CB TALK POWER

IN RESPONSE to hundreds of inquiries as to how the serious CB user can make his communications network more effective—and remain "legal"—the author developed the "Mule Box," an outboard converter that changes the CB signal before it goes on the air from amplitude modulation (regular AM) to double-sideband with reduced carrier (DSBRC). For all means and purposes, any receiver intercepting a DSBRC signal reacts as though the signal were regular AM—with two notable exceptions. The S-meter reading will be much lower, and the apparent "talk power" will be vastly increased.

Due to the circuit design of the Mule Box, it is practically impossible to operate this converter illegally. The power supply will put out only so much voltage, the single tube will take only a moderate "beating," and if you try to overdrive the Mule Box, your signal will be distorted. But if the instructions published in this article are followed, the converter will operate within the FCC interpretation of "average" power input of 5 watts and "average" power output of 4 watts.

EDITOR'S NOTE: The construction, installation, servicing, and maintenance of the project described in this article MUST be made by or under the immediate supervision of a person holding a first- or second-class commercial radio operator FCC license—a CB license is not enough to build or install this amplifier.

**How It Works.** The circuit (Fig. 1) combines two separate functions: it is an r.f. amplifier that generates the reduced carrier signal; and a switching circuit that operates the T-R change-over relay. When the transceiver is in the receive position, relay *K1* simply connects the antenna directly to the receiver, bypassing the amplifier circuit. When the transmitter is keyed, however, the r.f. voltage present at *J1* is sufficient to force diodes *D1* and *D2* into conduction, applying a positive voltage to the SCR gate. This, in turn, switches on SCR1 to operate the relay.

The output of the transmitter is then switched to the grid circuit of *V1* while the antenna is switched to the plate circuit (point *E*). Because the amount of power required to drive *V1* is considerably less than the 4 watts at the transmitter output, a limiting resistor (*Rx*) is put in series with the grid circuit to cut down the power level and also to present, as nearly as possible, a 52-ohm resistive load to the transmitter output. This is important because some transmitters will not operate properly if the load is highly reactive.

The input voltage of *V1* is stepped up by matching coil *L1* to a level sufficient to drive *V1*. Tube *V1* is biased to almost complete cutoff by battery *B1*. The idea is to drive *V1* so it produces an output of 1 to 2 watts carrier power. This is done by adjusting the matching coil (*L1*) and the drive trimmer (*C1*). When the transmitter is modulated, the additional grid voltage caused by forward modulation drives *V1* to a higher output. However, amplification is nonlinear, and

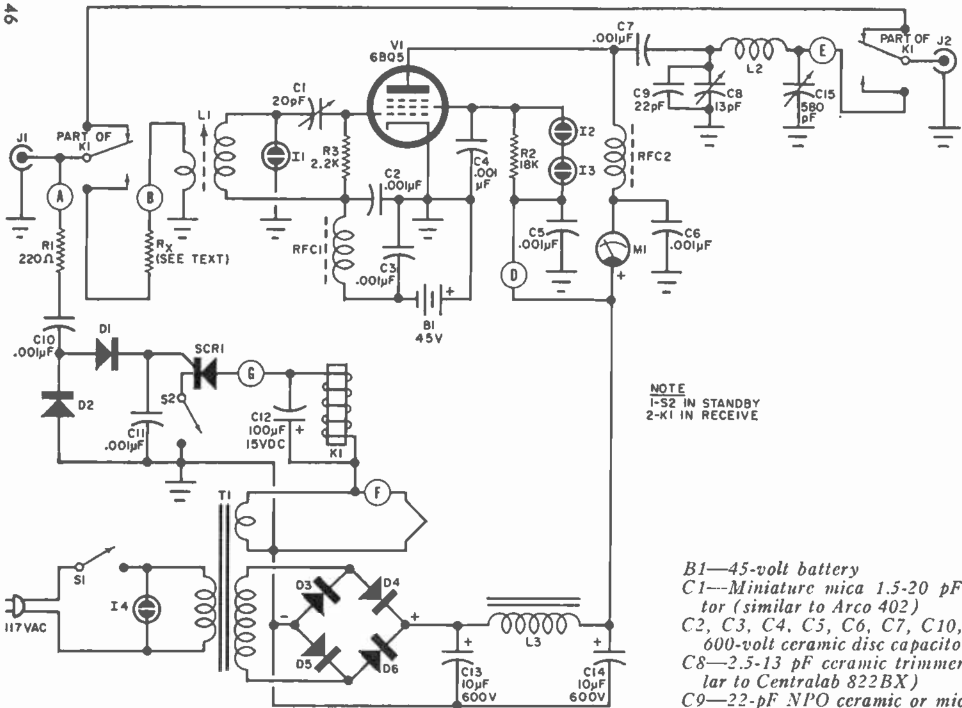



Fig. 1. Schematic diagram of the complete "Mule Box" showing T-R change-over relay K1 in receive position, and OPERATE-STANDBY switch S2 in STANDBY. With S2 set to OPERATE, the transmitter's output appearing at J1 is switched to the grid of V1 while the plate is switched to the CB antenna.

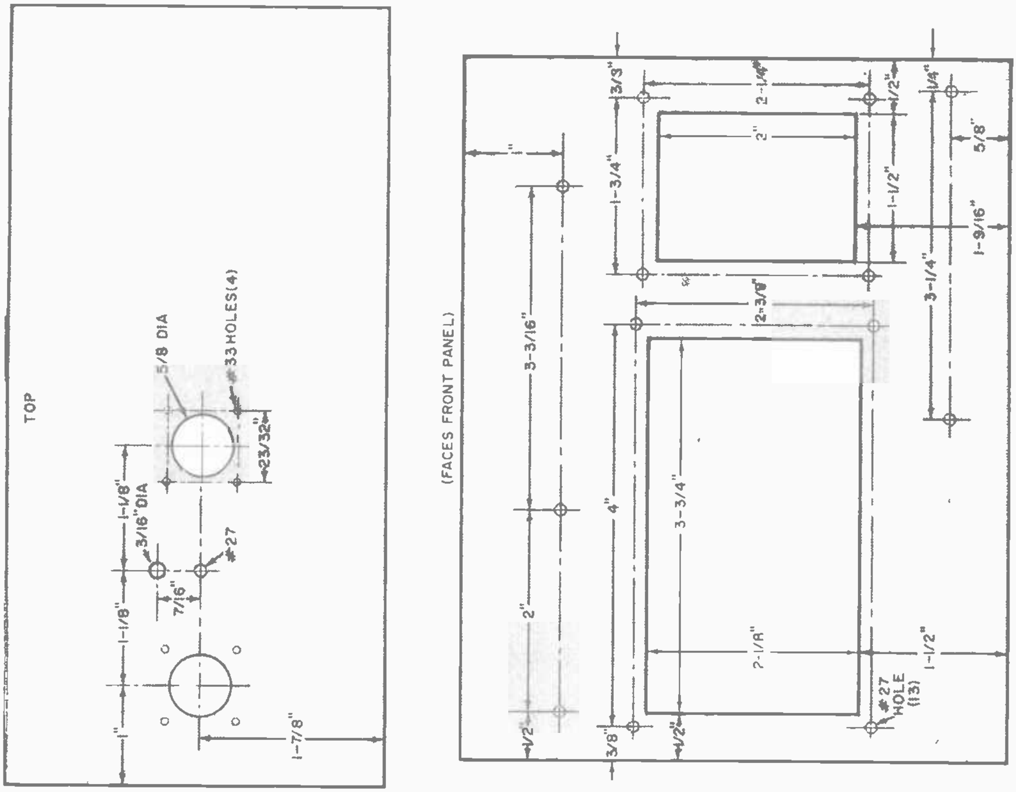
Fig. 2. If you buy the LMB CB-2 aluminum box specified at right, you can build the "Mule Box" using the dimensions below for the front panel.

Fig. 3. The back panel, which mounts the input and output connectors as well as the T-R change-over relay, is drilled following dimensions below, right.

## PARTS LIST

*B1—45-volt battery*
*C1—Miniature mica 1.5-20 pF trimmer capacitor (similar to Arco 402)*
*C2, C3, C4, C5, C6, C7, C10, C11—0.001-μF, 600-volt ceramic disc capacitor*
*C8—2.5-13 pF ceramic trimmer capacitor (similar to Centralab 822BX)*
*C9—22-pF NPO ceramic or mica capacitor*
*C12—100-μF, 15-volt electrolytic capacitor*
*C13, C14—10-μF, 600-volt electrolytic capacitor*
*C15—110-580 pF mica trimmer capacitor (similar to Arco 467)*
*D1, D2—1N34, or 1N294, or other similar germanium diode*
*D3, D4, D5, D6—0.75-ampere, 600-volt PIV silicon rectifier*
*I1, I2, I3—NE-2 neon lamp*
*I4—Neon pilot lamp, with current limiting resistor (similar to Lafayette 34 R 5208)*
*J1, J2—Coaxial connector (similar to Amphenol 83-1R)*
*K1—D.p.d.t. relay, 6-volt d.c. coil (similar to Potter and Brumfield KT11D)*
*L1—Input coil: primary, 3 turns of #24 enameled wire; secondary, 18 turns of #24 enameled wire on ¼"-dia. coil form with ferrite slug**
*L2—Output coil: 9 turns of #16 enameled wire on ¾"-dia. coil form*
*L3—8-H, 40-mA filter choke (similar to Thordarson 20C52)*
*M1—0-30 mA, 2¼" d.c. meter (similar to Emico RF-2C)*
*R1—220-ohm, ½-watt, 10% resistor*
*R2—18,000-ohm, 1-watt, 10% resistor*
*R3—2200-ohm, ½-watt, 10% resistor*
*RFC1, RFC2—22-μH r.f. choke (similar to Wilco W220)*
*Rx—33-ohm, 1-watt, 10% resistor (see text—value may be reduced for low-power transmitters)*
*S1, S2—S.p.s.t. slide switch*
*SCR1—25-volt PIV silicon-controlled rectifier (similar to Motorola MCR 2304L)*
*T1—Power transformer: primary, 115 volts; secondaries, 360 volts @ 42 mA and 6.3 volts @ 2.8 A (similar to Thordarson 22R38)*
*V1—6BQ5 vacuum tube*
*1—6" x 8" x 4½" cabinet (similar to LMB CB-2, gray finish)*
*1—Circuit board (DEMCO 135)**
*1—9-pin printed circuit miniature tube socket*

*Circuit board and coil L1 are available from DEMCO, Box 16297, San Antonio, Texas 78216, for $3 postpaid in U.S.A.; complete kit of parts with punched chassis, $35 postpaid in U.S.A.



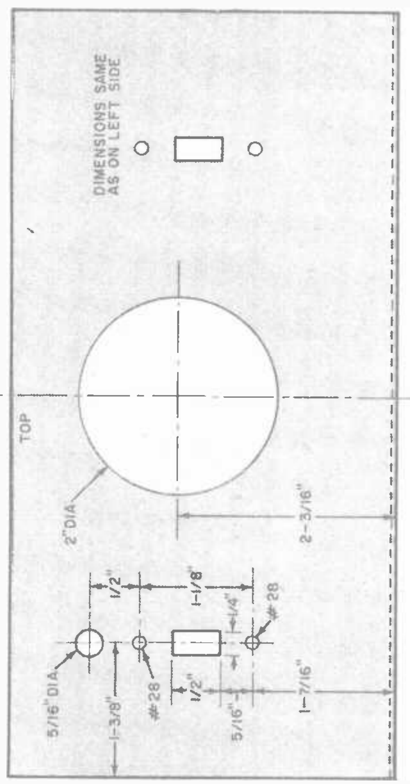
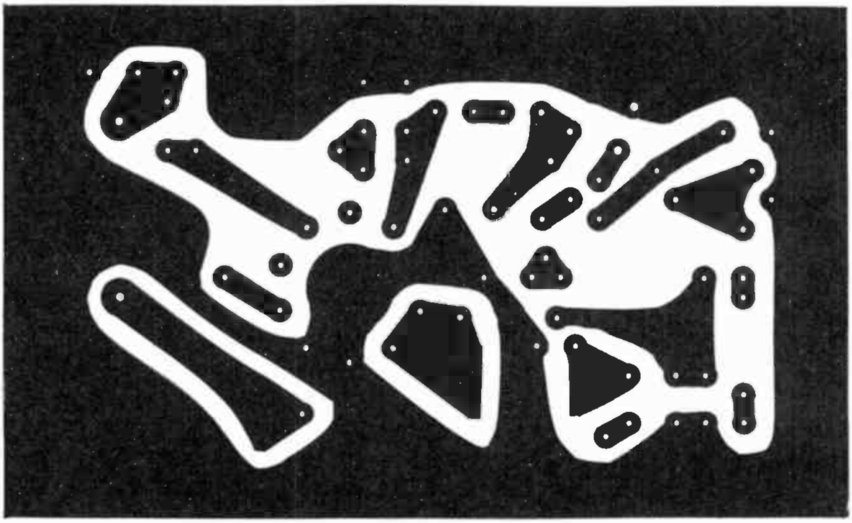




Fig. 4. These are the chassis dimensions. The cutout at the left mounts the circuit board while the one at right provides seating for the power transformer.

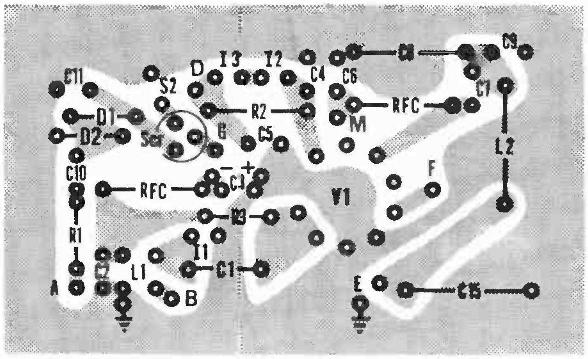
only the forward modulation sideband energy is amplified. The negative half cycle of the modulation envelope is attenuated, resulting in a distortion of the audio waveform—although not enough to cause any great loss of intelligence.

The amplifier output feeds into a *pi* matching network of the type found in most transmitter finals. It matches the Mule Box into an antenna load of approximately 40 to 70 ohms. The power supply, which uses a full-wave bridge rectifier and a capacitor-choke filter, provides good voltage regulation for the amplifier.

**Construction.** As with all high-frequency r.f. circuits, parts layout and lead dress are critical. Too much coupling between output and input circuits can easily turn the amplifier into an oscillator. Therefore, closely follow the layout given unless you are pretty much a pro and have sufficient experience in building similar equipment. The chassis recommended comes in three separate parts,



Actual-size photo shows foil side of printed circuit board (top); component side of board is at right. Observe polarity markings when installing diodes and electrolytic capacitors.



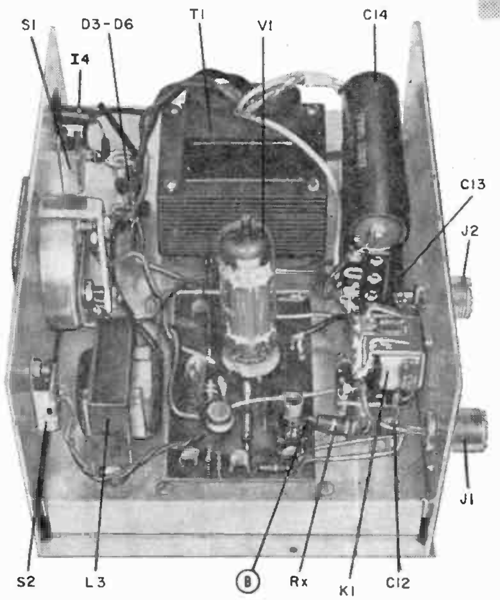




Fig. 5. With cabinet wrap-around cover removed from unit, the completely assembled "Mule Box" should look like this. Note positions of major components.

making the unit relatively easy to assemble.

Begin construction by drilling and punching the necessary holes in the chassis (see Figs. 2, 3 and 4). The meter, pilot light, and switches are mounted on the front panel (Fig. 2) while the connectors (*J1* and *J2*) and relay are mounted on the back panel (see Fig. 3). Mount *C12* under the relay (Fig. 5) and wire the leads directly to the coil lugs of the relay, observing orientation of the capacitor polarity.

Mount the transformer on the main chassis by first removing the four mounting screws holding the transformer together, and reinserting them from the opposite ends of the holes. Then secure the transformer upside-down in its place with wires visible from the top. The four rectifiers go on a terminal strip situated between the transformer and front panel. Follow the schematic (Fig. 1) for proper

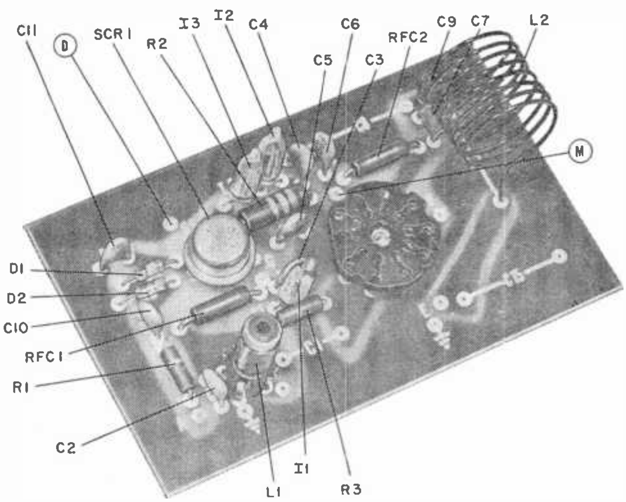



Fig. 6. Except for the necessary inter-unit wiring, the printed circuit board must be fully assembled as shown here before it is installed on the chassis.

polarity orientation of the rectifiers. Filter capacitors *C13* and *C14* are mounted on two terminal strips positioned vertically on the chassis between the transformer and back panel. The filter choke (*L3*) is bolted on the chassis behind *S2*, as shown in Fig. 5.

The circuit board can now be assembled with the parts in the positions indicated by the markings on the printed circuit board (Fig. 6). Trimmers *C1*, *C8*, and *C15* are mounted on the foil side of the board (Fig. 7) so that they will be accessible for adjustments from the bottom of the unit.

Trim off the connecting lugs on *C1* and *C15* where they protrude on the reverse surface of the circuit board to prevent their touching other components. Also, don't let an adjusting screw touch the board, as this would short out the bias battery. Mount *C8* flat against the circuit board as shown, and be sure that the lug on *C8* and *C15* which goes to the adjusting screw is soldered to the circuit board ground.

Screw the main chassis to the back panel and begin final wiring of the circuit. The transformer filament leads go first to the relay coil, and then to point *F* on the board. Mount resistor *Rx* between the relay and point *B* on the board. The connection from *J1* to the relay should be made with bare heavy stranded wire (Fig. 8); the connection from *J1* to point *A* on the board and ground is made with solid bare wire. The connections from the output circuit (point *E*) to the relay and *J2* are made with short pieces of shielded coax cable. Solder the ends of the cable shields at a common point and ground them to the front panel and to the ground near terminal *E* on the circuit board.

Connect one choke (*L3*) lead to a terminal on the rectifier terminal strip, together with a wire run from the positive side of *C13* to this point. Then cut and strip the ends from two 3½" pieces and one 5" piece of hookup wire. Connect one 3½" wire from point *D* (Fig. 6) to the positive (+) meter terminal, and the 5" length of wire from this terminal to the positive side of *C14*. Connect the other 3½" hookup wire from point *M* to the negative side of the meter.

Now mount the front panel on the main chassis. Connect the line cord to one side of the power switch, *S1*, and to the unused lug on the rectifier terminal strip. Connect the transformer primary leads to the rectifier terminal strip and to the unused lug on *S1*. Connect the two leads to *S2* (see Fig. 5). And, finally, connect the battery clip to the points marked + (plus) and – (minus) adjacent to *C3* on the circuit board. (See Fig. 6.)

WARNING: All tests and adjustments must be made by an appropriately licensed technician—your CB license is *not* a commercial operator's license.

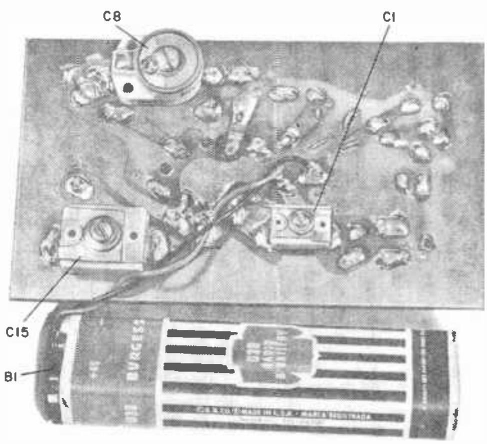



Fig. 7. The trimmer capacitors are mounted on the foil side of the printed circuit board, and are accessible for adjustments from bottom of unit only.

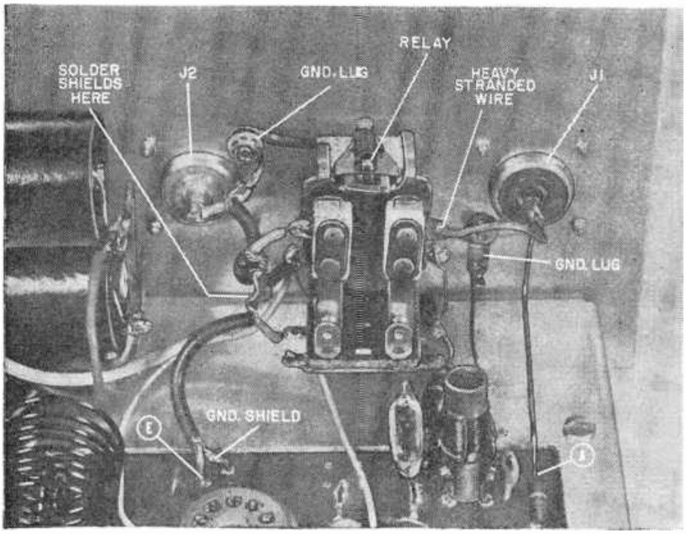



Fig. 8. Be sure to use heavy stranded wire from J1 to indicated relay terminal, and solder the cable shields together to insure common ground throughout.

**Adjustment.** Install the bias battery in place, turn the power switch on, and check for the presence of approximately 500 volts d.c. from the (+) side of the meter lugs to ground. Watch the Mule Box panel meter as the tube filament warms up. It should read 0 mA. If it indicates a current of more than 1 or 2 milliamperes, the bias circuit is not working properly and the circuit should be checked.

If all seems normal, connect the input of the Mule Box (*J1*) to your transmitter antenna connector, and the output (*J2*) to a 52-ohm dummy load.

Back off a couple of turns on the adjustment of *C1*, and adjust the slug in *L1* until it is even with the top of the coil form. With both your Mule Box and transmitter fired up, key the transmitter as you listen for a click from the changeover relay. The meter on the panel may, or may not, give a plate current reading. If it gives a reading beyond the mid-scale point, back off a bit on the adjustment of *C1* to reduce the reading.

In the following procedure, *C8* and *C15* must be adjusted to resonate on a channel in the center of the band. Adjust *C1* for a reading of 10 mA, and then adjust *C8* and *C15* for maximum meter deflection. These trimmers will interact to some extent, so the adjustments must be gone over at least a couple of times. If you get a reading in excess of 15 mA at any time, reduce the drive (*C1*).

After completing the adjustment of *C8* and *C15*, your next step is to adjust *C1* and *L1* to their final settings. To do this, back off on drive trimmer *C1* and adjust the slug in *L1* by screwing it into the coil form. Observe the meter while making this adjustment, and be sure to keep the current from going above 15 milliamperes. As the slug is advanced into *L1*, neon lamp *I1* in the grid circuit should fire. At the point at which it fires, back off on the slug just enough to extinguish the lamp.

Now recheck your final tank settings and set *C1* for a reading of 10 to 12 mA.

**Operation.** To check the operation of the unit, whistle into the microphone. If your transmitter has proper forward modulation, the reading on the Mule Box meter should increase to about 20 milliamperes and lamp *I1* should light each time the transmitter is modulated. The screen grid lamps (*I2* and *I3*) should also flash on modulation peaks.

A good operational check is to connect a #47 lamp to the antenna connector. On normal operation, with the Mule Box on *standby*, the lamp should light when the transmitter is keyed and then flicker slightly with modulation. When the Mule Box is on *transmit*, the lamp should be dim with just the carrier applied, power output being between 1½ and 2 watts. When the transmitter is modulated, the lamp should flash brightly on modulation peaks.

(*Continued on page* 95)

# Taming Your TV Tuner

By CHARLES L. SMITH

CONTACT CLEANING IS EASY IF YOU FOLLOW THESE IMPORTANT INSTRUCTIONS

IF YOU HAVE TO jiggle the channel-selector knob on your TV set to bring in a program, or if the picture and sound conk out again just as the good guys are shooting it out with the bad guys, it's a good bet that your tuner needs a cleaning. When the many dozens of silver contacts in a tuner become tarnished and dirty from exposure to the atmosphere, they make intermittent and poor electrical connections. Connections can become so bad that the slightest vibration will cause the picture to flash on and off.

Tuner contacts, whether on black-and-white or color TV sets, require frequent cleaning. How often a cleaning is needed depends upon the environment and to some degree upon the way the TV set is used. Tuner design and type of contacts also affect the length of time between cleanings.

Cleaning tuner contacts can be costly. Service shop charges of $5 are not unusual if the set is brought into the shop. Charges run higher if a serviceman is sent to the home. Of course, rates vary. Don't put off cleaning the contacts if you have to "shake well" before using your set, for chances are you are going to jiggle something loose and do damage.

**Types Of Tuners.** Disregarding the electrical characteristics, but considering the mechanical aspects, there are basically two types of tuners in general use that have a large number of contacts. The turret-type tuner (Fig. 1) takes the prize for the largest number of contacts. The wafer-switch type (Fig. 2) has more hidden nooks than you can shake a cleaning cloth at.

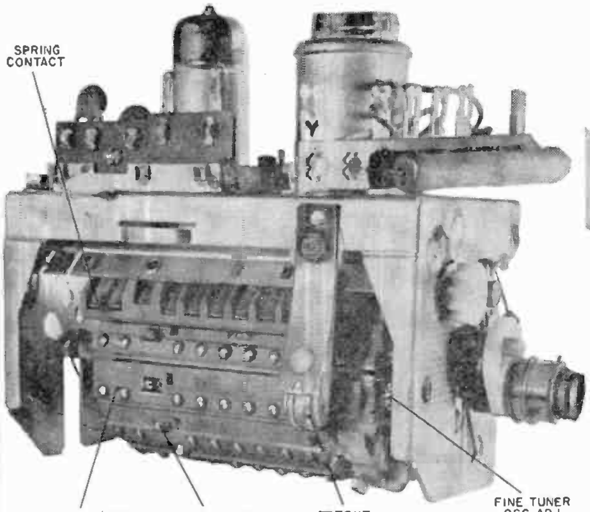


Fig. 1. Exposed turret tuner contacts are easy to clean. The detent should work easily and in a positive manner.

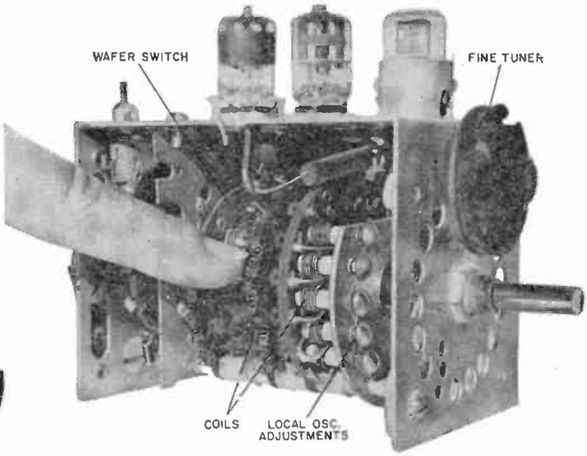
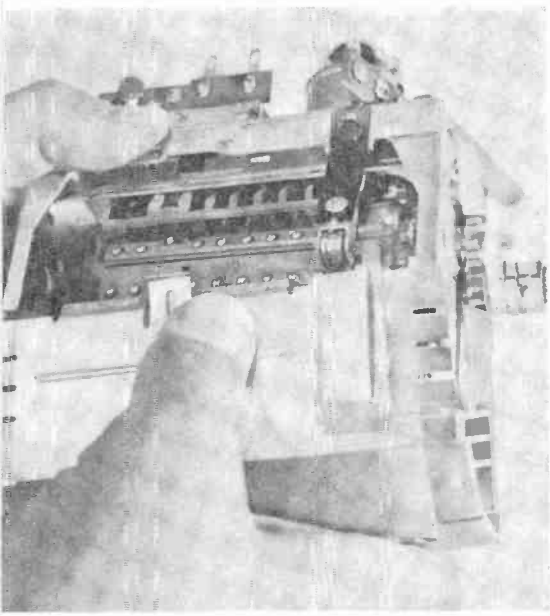


Fig. 2. Touch these coils only at the risk of detuning the channels. Cleaning the wafer-switch contacts presents a challenge, but it can be done.



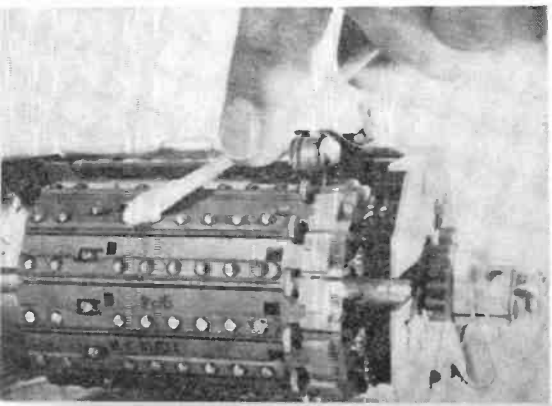
The turret tuner has a separate plastic strip for each channel. Each strip has a separate set of coils which is connected to a set of fixed half-round contacts. The strips are arranged in a turret-like manner. The turret can be rotated to bring one strip at a time into position, in line with a set of spring contacts.

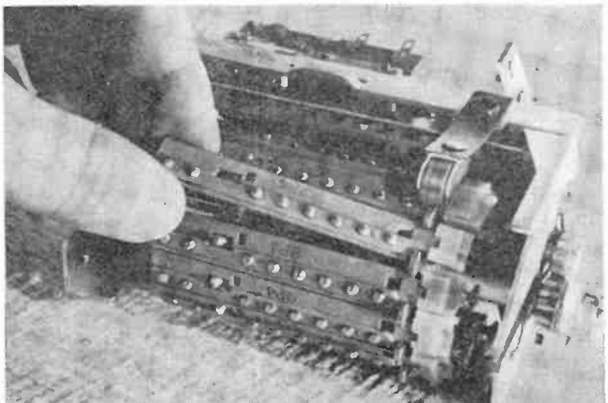
Unlike the turret tuner, the wafer-switch tuner has a set of coils connected in series on each wafer and, depending

Fig. 4. To remove the shield, depress the lip with your thumb. It is possible to get to the tuner on many sets without removing it from the TV chassis.

Fig. 5. Use a cotton swab or a piece of cloth dipped in tuner cleaner to make the tuner contacts shine. Rotate the drum to expose the hidden channel strips.

Fig. 6. Depress the channel-strip retainer to release the strip. Remove about five or six sections to get at the spring contacts. Each one is numbered in sequence and should be replaced in proper order.





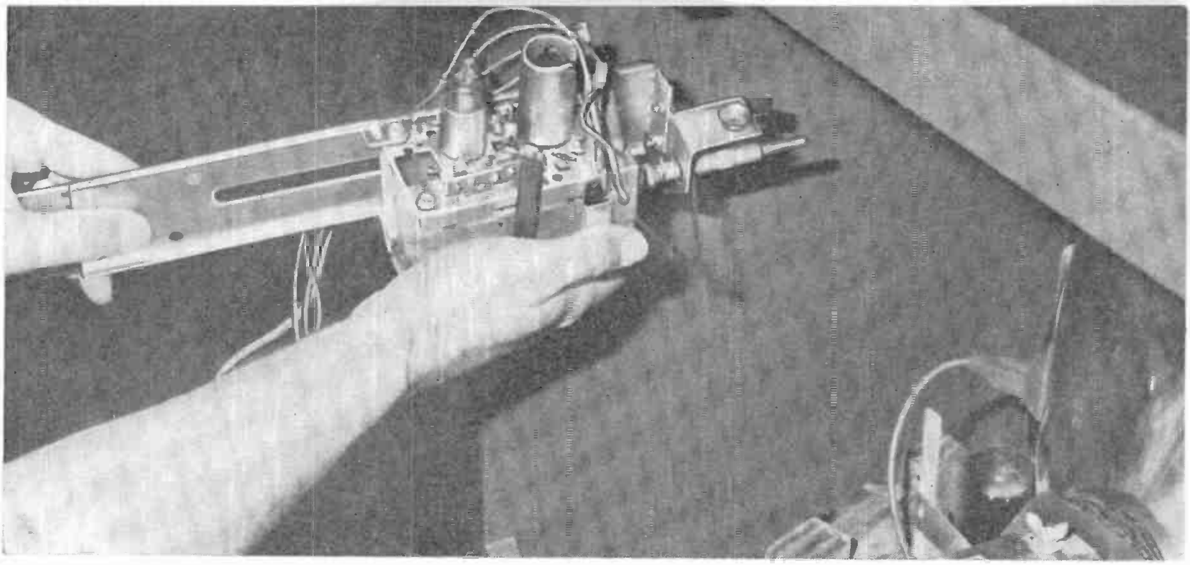


Fig. 3. Modular-type construction on some sets permits easy access to the tuner without the need to pull the chassis. In this case, you don't even have to disconnect any of the leads going to the tuner.

upon the channel selected, more or fewer coils are switched into each tuner circuit. The rotary switches "pick up" the correct number of coils for each channel. For instance, Channel 13 requires only one coil on each wafer, whereas all the coils are "alive" for Channel 2.

Warning: when you clean the tuner contacts, do NOT bend, twist, straighten or adjust any of the coils on the tuner; do NOT loosen, tighten or adjust any of the screws on the tuner; do NOT change the position of any components or leads inside the tuner; DO handle the tuner gently.

**Exposing The Tuner.** Always a formidable task for a neophyte (and even for a pro so far as some sets are concerned) is the job of pulling the chassis out of the cabinet to get at the tuner. If you never pulled a chassis, and if you have any doubts about your ability to do so, the best advice you can follow is to keep your hands off the set. You can do a lot of damage. But some sets have tuners that are easy to get to; unitized construction permits tuner removal for servicing in a matter of minutes. See Fig. 3.

Study the tuner mounting scheme in your particular set to find and remove the retaining screws. On some sets, only two screws at the back of the set need be taken out to remove the tuner. Carefully remove the tuner without disturbing the attached wiring. You may be able to get at the contacts without disconnecting any of the wires which connect the tuner to the set. If you do re-

Fig. 7. Be careful not to distort the setting of the spring contacts. These contacts can be reset, however, if necessary, by applying a little extra amount of pressure in the appropriate direction.

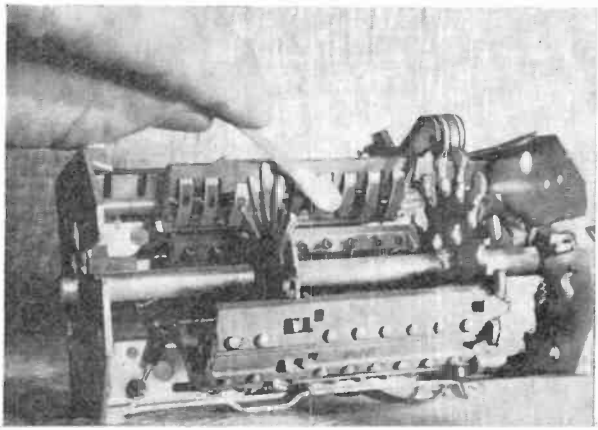
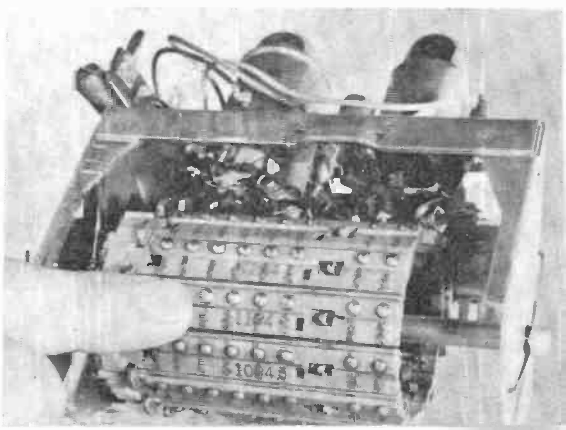


Fig. 8. Smudged channel strips are a sure indication that the spring contacts are riding on the plastic strips. Raise the contacts to clear the plastic, but not enough to miss the contacts on the strip.



move any of the wires, mark the wires and the terminals to prevent cross-wiring when reassembling—don't trust your memory. (Do not remove the tuner if it is mounted on the TV chassis unless you have to. Most chassis-mounted tuners can be cleaned without removal.)

Remove the U-shaped metal cover by depressing the lock until the projecting lip clears the tuner chassis as shown in Fig. 4. Dull, discolored contact surfaces showing thin black streaks reveal a definite need for cleaning.

**Cleaning Turret-Type Tuners.** Clean away the tarnish by wiping each contact with a cotton-tipped swab, or other suitable piece of cloth, lightly moistened with a cleaning solution, as shown in Fig. 5. Rotate the turret to expose all of the strips. Polish the contacts thoroughly, until all evidence of the cleaner disappears.

When all the rotary contacts are clean, carefully remove about five or six strips as shown in Fig. 6, and rotate the turret until the spring contacts are accessible, as shown in Fig. 7. Clean these contacts carefully. Do not exert enough pressure on the spring contacts to cause them to come to rest at a new angle. These contacts must be properly positioned. If they are too deeply recessed in their slots, they won't make contact with the contacts on the channel strips. If the spring contacts project too far out of their slots, they will ride on the plastic strips and smudge up the strips as well as the contacts so badly that you'll wonder where the yellow went. (Some plastic strips are yellow.) See Fig. 8.

You can check the position of these spring contacts by observing their action as you rotate the turret. The springs should rise and fall as the contacts on the strips pass the springs. If any of the springs do not rise, gently and judiciously pull them down just enough to reset them in a lower position. Recheck the action after an adjustment is made.

It's a good idea to check out the action for all channel strips just in case there is an out-of-round condition which requires a touch-up adjustment. Of course, you should also check to see that the springs are not set low enough to touch the plastic strips.

Don't overlook the detent—it centers and holds the turret on the selected channel. The detent should be free-acting, clean and lubricated. Lubriplate or other similar lubricant can be used. Do not disassemble the detent if it is in working order.

After you have cleaned the tuner and are satisfied with the mechanical action, you can "button it up."

**Cleaning Wafer-Switch Tuners.** Because of their concealed type of construction, wafer-switch type tuners are more difficult to get into. In a great many cases you can rely on the wiping action of the contacts to do the elbow work on a cleaning job. Try wiping the rotary contacts with a pipe-stem cleaner, soaked in a cleaning solution, as you rotate the tuner shaft. In many cases you have to rely on the rotating contacts to carry the cleaner around to the inaccessible stationary contacts.

Spray cleaners are handy to get at the "buried" sides of the switches, but you should avoid spraying anything except the contacts. Some of the sprays can detune your tuner, especially while they are still wet. If you find a few misplaced channels after an indiscriminate spraying job, you will have to "dry" out the tuner. Most sprays, particularly the aerosols, dry out by themselves.

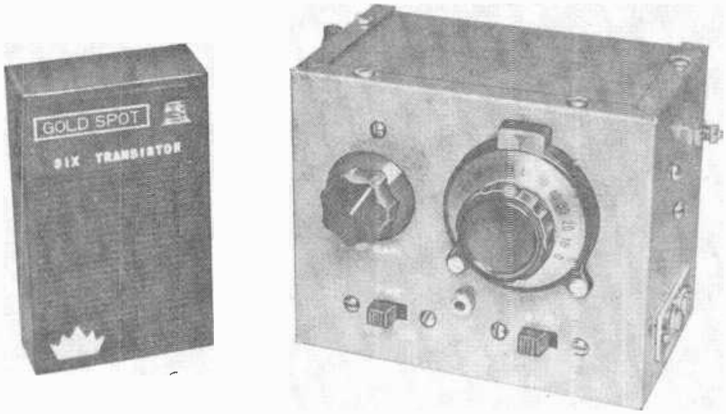
**Choosing A Cleaner.** Most electronic supply houses stock general-purpose contact cleaners in 2-oz. bottles that sell for about 50 or 60 cents. If you elect to use such a general-purpose cleaner, follow up the contact-cleaning operation with a light, filmy application of silicone lubricant.

There are special-purpose tuner and contact cleaners in various types of packaging, ranging from eye-dropper bottles to aerosol spray cans; prices range from less than a dollar to more than three dollars. The aerosol spray cleaner, consisting of carbon tetrachloride, trichloroethane, or other chlorinated hydrocarbon solvent, washes away foreign matter under the pressure of freon propellant. Freon, containing no active properties, evaporates thoroughly.

Most tuner cleaners deposit an extremely thin film of silicone lubricant that guards against future contamination. -30-

BUILD

# The "Camper's Cuzzin"




SMALL CONVERTER SETS UP ORDINARY AM RADIO FOR 75- AND 80-METER HAM BANDS

**By HARTLAND B. SMITH,** W8VVD

THE "CAMPER'S CUZZIN" can convert just about any AM broadcast radio into a 75- and 80-meter ham band receiver to pick up CW, SSB, and AM phone signals. It will even work on your small transistor radio. No modifications or connections to the radio are needed. The converter and the radio need only be placed near each other.

While primarily designed as a companion to the "Camper's Special" 80-meter CW transmitter (POPULAR ELECTRONICS, August, 1965), this unit will do an excellent job for the prospective ham who wants to tune in W1AW code practice transmissions, as well as for the SWL who would like to "dequack" single-sideband signals. It's the BFO in the converter that let's you hear CW and SSB as it should be heard.

Some of the features that make the "Camper's Cuzzin" suitable for camping, fishing and hunting trips are its small size, light weight, and small current battery operation. The low cost involved in building it, about $14, is also appealing.

**How It Works.** The signal from an antenna connected to *TS1* (see Fig. 1) is coupled to the base of *Q1*. Transistor *Q1* serves both as an amplifier and as a mixer. The slug in *L1* broadly tunes the input circuit for resonance at any frequency between 3.5 and 4.0 MHz; it protrudes through the front of the cabinet and is labeled *RF Gain.*

The r.f. signal is mixed with another signal coupled into *Q1*'s emitter from *Q2* by way of *C5*. The *Q2* circuit is a series-fed Hartley oscillator which can be tuned through a frequency range of 5.1 to 5.6 MHz simply by varying the setting of *C9*. A vernier dial drives *C9* and makes it possible to obtain the very wide bandspread needed for non-critical tuning of SSB signals.

When the oscillator signal mixes with the incoming signal, sum and difference frequencies are produced. The difference frequency, which is on the order of 1.6 MHz, is the one that is needed to feed into the broadcast-band radio. Tank circuit *L2/C2* is slug-tuned to resonate and radiate at this frequency.

If the converter is used in a transmitter and receiver setup, the jumper wire across *TS2* can be removed and a switch or the normally-closed contacts on a transmit/receive relay can be connected in its place. When the transmitter is on, the relay is energized and removes the forward bias voltage needed to operate *Q1*, and "silences" the converter. Notice that battery power to the other circuits in the converter is not affected. This eliminates the oscillator drift which would otherwise occur every time the power was turned on and off.

Transistor *Q3*, like *Q2*, is a local os-

## PARTS LIST

*B1—9-volt battery*
*C1, C7, C13—75-pF NPO disc capacitor**
*C2, C5, C10—100-pF NPO disc capacitor**
*C3, C6, C8, C11, C12, C14, C15—0.0047-µF disc capacitor*
*C4—0.001-µF disc capacitor*
*C9—15-409 pF variable capacitor (Allied Radio 43 A 3524, or similar)*
*L1—1.7-5.5 MHz antenna coil (J. W. Miller B-5495-A, or similar)*
*L2—540-1650 kHz loop antenna (J. W. Miller 2002, or similar)*
*L3—Slug-tuned oscillator coil wound on J. W. Miller No. 21A000RBI coil form as described in text*
*L4—455-kHz oscillator coil (J. W. Miller 2020, or similar)*
*Q1, Q2, Q3—2N1526 transistor*
*R1, R9—3900 ohms*
*R2—10,000 ohms*
*R3, R6, R8—1000 ohms*
*R4—100,000 ohms*
*R5—8200 ohms*
*R7—18,000 ohms*
*R10—22,000 ohms*
(All resistors ½ watt)
*S1, S2—S.p.s.t. switch*
*TS1, TS2—Two-screw terminal strip*
*1—5" x 4" x 3" metal box*
*Misc.—Transistor sockets (3); 2-lug terminal strip (1); 3-lug terminal strip with ground lug (1); ¾" spacers (2); vernier dial; short length of ¼" round insulated rod; knob; 6-32 hardware; solder; wire, etc.*

*NPO disc capacitors: Sprague 10TCC, or similar

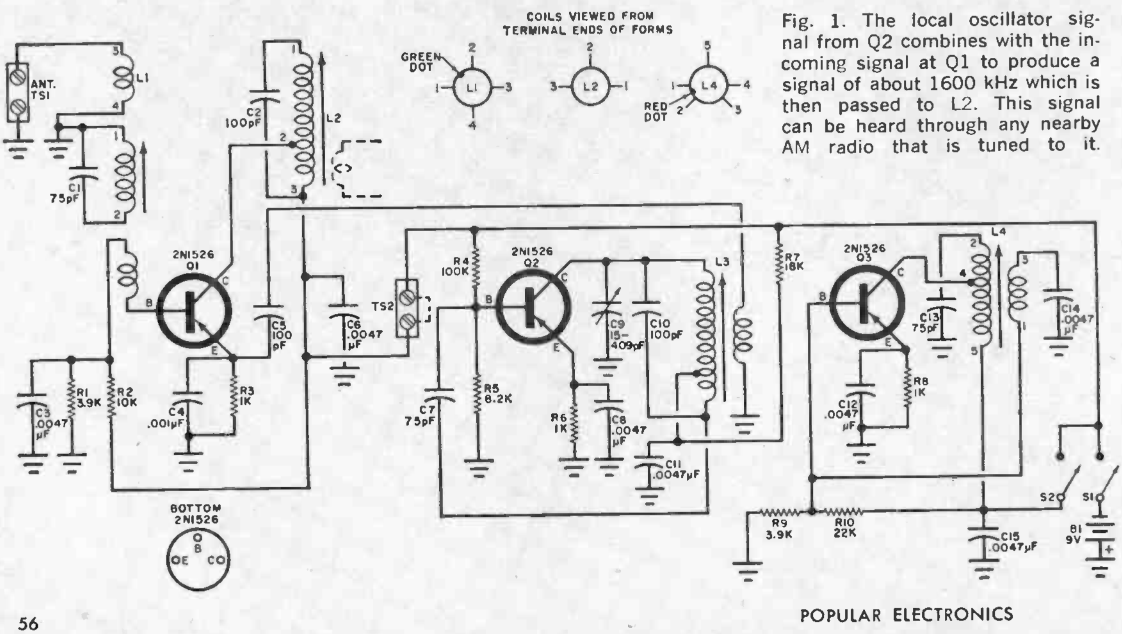
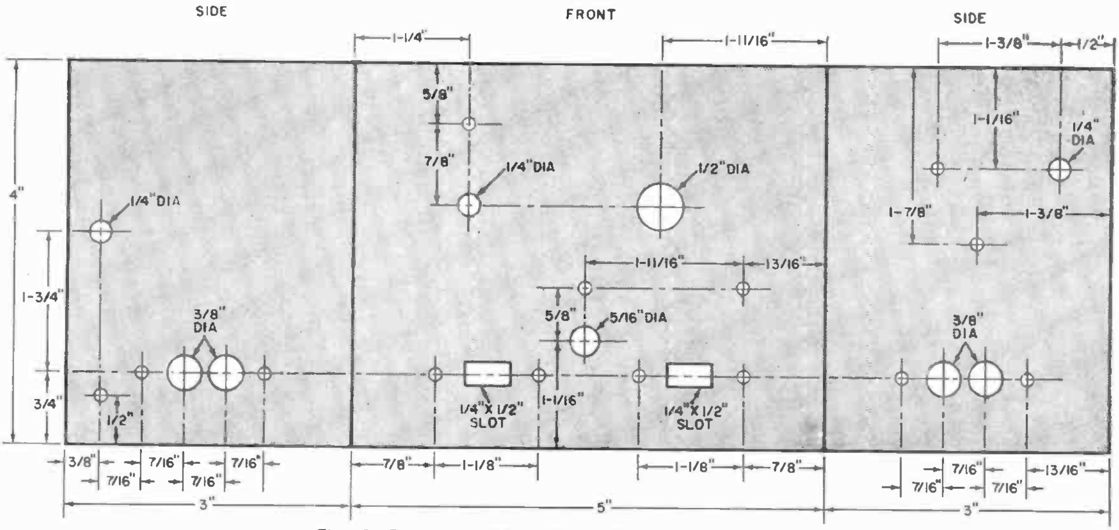



Fig. 1. The local oscillator signal from Q2 combines with the incoming signal at Q1 to produce a signal of about 1600 kHz which is then passed to L2. This signal can be heard through any nearby AM radio that is tuned to it.




ALL HOLES NO. 28 DRILL UNLESS OTHERWISE NOTED

Fig. 2. Prepare a 5" x 4" x 3" metal utility box exactly as shown. Pay particular attention to the mounting holes for C9 in the upper portion of the front and side.

cillator, but is tuned to approximately 1600 kHz, and serves as a BFO. When *S2* is switched on, the BFO reinserts a carrier to make SSB signals intelligible, or it beats with an incoming CW signal to make it readable. The BFO signal is strong enough to get into the *Q1* circuit without direct coupling. For AM phone reception, *S2* is left in the *off* position.

Power for the converter can be obtained from a 9-volt transistor battery, or from six 1.5-volt penlight cells connected in series.

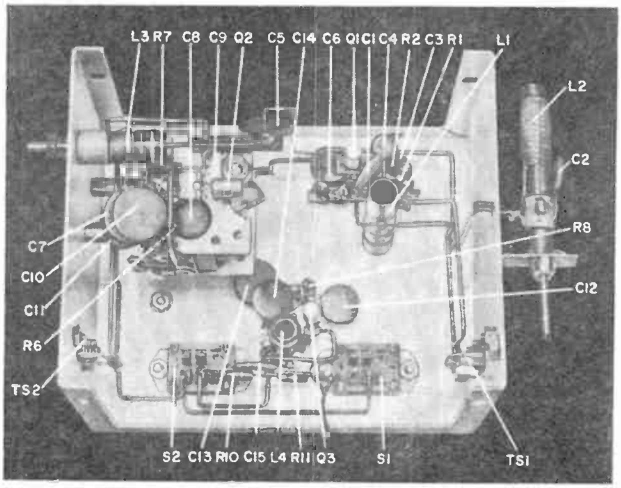



Fig. 3. All components associated with C9 and Q2 should be solidly mounted. For best results, keep leads as short as possible and dress wires neatly.

**Construction.** Prepare a 5" x 4" x 3" metal box as shown in Fig. 2. Follow the layout shown in Fig. 3. Pay particular attention to the mounting of variable capacitor *C9* and the vernier dial. Use ¾"-long metal spacers to position *C9* securely in place.

Only two plates on the rotor of *C9* are needed. If your capacitor has a fiber spacer strip attached to one end of the rotor plates, carefully cut through this strip, between the second and third plates from the front. Use a pair of long-nose pliers to work the rotor plates free, one at a time. Remove all but the two plates at the front end. Do not do anything to the stator plates, and be careful not to bend or shift the position of the remaining plates.

Good SSB reception will only be possible if the tunable oscillator is mechanically rugged. All components associated with *Q2* and *C9* should be solidly mounted. When mounting *C9* on the chassis, keep your eyes on the ends of the mounting screws and avoid digging into and shorting out the capacitor's plates. If necessary, grind the ends of the screws down, or place washers under the screw heads. Mount *L3*, *C9*, and *Q2* as close to each other as possible in order to keep their leads short. (See Parts List for type of coil form needed for *L3*.)

The tapped primary winding for *L3* requires 23 turns of #28 enamel-covered wire, tapped 3 turns from the *C7* end.

Remove the enamel coating from the ends of the wire and solder the wires to the solder rings supplied with the coil form. Wrap one layer of electrical tape around the untapped 20 turns. The secondary winding consists of 4 turns of #28 enameled wire wound over the tape. Use coil dope to cement each winding in place. If you don't have any suitable cement, you can pour melted wax over the windings.

Modify coil *L1* by adding a 5-turn winding of #28 enamel-covered wire to the top end of the coil, over the secondary winding—this is the end away from the terminals. Use cement or wax to hold the windings in place.

Solder the ground leads of *C8, C11, R5,* and *R6* to a ground lug on the frame of *C9*. The ground leads of *C12, C13, C14* and *R8* go to a ground lug held in place by one of the nuts used to mount the vernier dial.

To mount the control knob for *L1*'s slug, drill a hole the same size as the diameter of the adjusting screw on the slug in the center of one end of a ⅜"-long by ¼"-diameter piece of plastic rod. Cement this end onto the adjusting screw and, when dry, secure the knob in place. Use a knob equipped with a setscrew.

Cut the transistor leads to about ⅜" in length and bend them to conform with the holes in the transistor sockets. Observe polarity when connecting the battery—it can be mounted inside the case. Close the cover before using the unit.

**Adjustment.** Tune your AM broadcast radio to a "dead" spot near 1600 kHz on the dial. Set the converter near the radio so that *L2* is close to the radio's loop antenna. (If the radio doesn't have a loop antenna, wind about five turns of #28 insulated wire around *L2* and connect one end to the receiver's antenna, and the other end to ground. Turn on the radio and crank up the volume control.

Switch on the "Camper's Cuzzin." Slowly screw the slug into *L2*. If the mixer is working properly, you'll begin to hear a hissing sound in the speaker. Adjust the slug for maximum hiss.

Connect a suitable 75- to 80-meter antenna, preferably fed by a coaxial cable or other 75-ohm lead, to *TS1*. Set the vernier control (*C9*) to its approximate midposition, and adjust *L3* to tune an AM phone amateur station. Move the radio away from the converter until the signal is very faint. (If you had to connect a 5-turn winding on *L2* to your radio, temporarily reduce the number of turns, to reduce the coupling.) Peak the *RF Gain* control for maximum signal.

Tune in an SSB station for maximum by adjusting the vernier control, with the BFO off. Switch the BFO on, and tune *L4* for clearest voice reception. Now jockey the slug in *L3* back and forth until you can hit the low-frequency edge of the band when *C9* is at or near maximum capacity. The high end of the band should come in where *C9* is at or near minimum capacity.

Then tighten the lock-nut on *L3*, and bring the radio back in close to the converter for normal operation.

**Operating Hints.** When searching for a weak station, adjust the *RF Gain* control for a maximum amount of background noise. For strong CW or SSB signals, you may find it advantageous to cut down the gain to prevent the incoming signal from overriding the BFO.

Putting a converter into operation for the first time is a relatively simple job if you understand what each part of the circuit is supposed to do. In case you encounter any problems, remember that *C1* and *L1* tune between 3.5 and 4 MHz. Coil *L2* should be peaked at 1.6 MHz, and *L3* should resonate at 5.4 MHz with *C9* at half capacity. If you have a general-coverage receiver, listen at 5.4 MHz for the signal generated by *Q2*. Transistor *Q3* oscillates at 1.6 MHz—you can hear its steady carrier on the broadcast set.

Transistor *Q1* is not supposed to oscillate. In the unlikely event that you hear birdies as *L1* is tuned through its range, reverse the leads on the winding you added to *L1*. If this doesn't help, remove a turn or two from the winding.

The "Camper's Cuzzin" is very sensitive. When hooked up to a good antenna, it will pull in any 75- or 80-meter station that can be heard on a top-quality communications receiver. Its ability to separate signals during periods of heavy QRM is dependent, of course, on the selectivity of the broadcast-band receiver with which it is used. Obviously, the sharper the receiver, the better will be the overall performance. —30—


# STAMP OUT AUTO THEFT

THE ONLY WAY YOUR CAR CAN BE STOLEN WHEN IT IS PROTECTED WITH THE "AUTO SENTINEL" ALARM IS FOR THE THIEF TO PICK IT UP BODILY AND CARRY IT AWAY

By R. L. WINKLEPLECK

AUTO THEFT is a big business for organized crime and an actively pursued hobby for thousands of teen-agers looking for "kicks." In an effort to stave off these thefts, many laws have been put into effect through which stiff fines and summonses can be handed out to owners who leave keys in ignitions when they get out of their cars, who fail to lock their car doors when their cars are left unattended for a long time, and who conspicuously display valuable goods in their cars—and who commit other such offenses that are open invitations to a thief to ply his trade. Although these

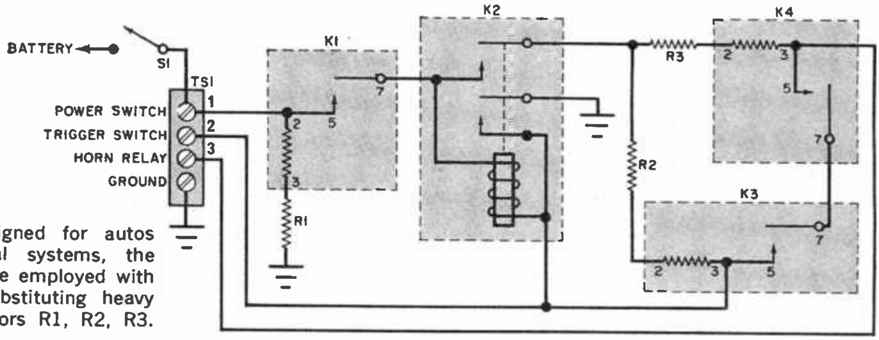



Fig. 1. Although designed for autos with 12-volt electrical systems, the "Auto Sentinel" can be employed with 6-volt systems by substituting heavy jumper wire for resistors R1, R2, R3.

laws are fine as far as they go, they will not effectively thwart a determined car thief. It is for this reason that auto alarms are constantly being designed to help stamp out auto theft.

The "Auto Sentinel" alarm system has a unique quality which places it at the top of the list so far as alarms are concerned; it can be put on the alert without anyone knowing about it, even if the driver is being "cased." There are no external locks or switches mounted on the car to set or deactivate the system. Cost is less than $15.00.

**How It Works.** The circuit of the Auto Sentinel, shown in Fig. 1, is simple and virtually foolproof. Once it is connected to your car's electrical system and power switch *S1* is thrown on, the battery voltage is applied to thermal relay *K1*. After about 15 seconds, *K1*'s contacts close, and place the alarm system on standby.

If a door is opened while the system is on standby, magnetic relay *K2* energizes and latches in this mode through its lower contacts. Even if the door is opened momentarily and then immediately closed, the alarm circuit is activated.

Once the circuit is activated by a thief, his time begins running out. At the end of about 15 seconds *K3* energizes, grounding the car's horn relay through *K4*, *K3* and *K2*. As the horn relay closes, *K4*'s heater circuit is completed, and after one piercing blast from the horn (at which the surprised thief will, hopefully, drop everything and run for the hills), the horn will continue to sound at a rate of 30 times a minute until *S1* is shut off.

You have 15 seconds (the time needed for *K1* to energize) to get out of your car after the switch is thrown and to close the door. This time margin is more than adequate for you to activate the alarm without alerting anyone to what you are doing, but not adequate enough for a thief to achieve his purpose. Upon re-entering the car, you have another 15 seconds—before *K3* energizes—to switch the alarm system off.

**Construction.** First, decide where you want *S1* mounted. You can mount it on the same box in which the rest of the circuit is assembled, or you can hide the switch behind the dashboard in any convenient place.

Almost any type of chassis construction is suitable, but since the unit is likely to be subjected to a lot of mechanical stresses, all connections should be mechanically sound—use enough solder

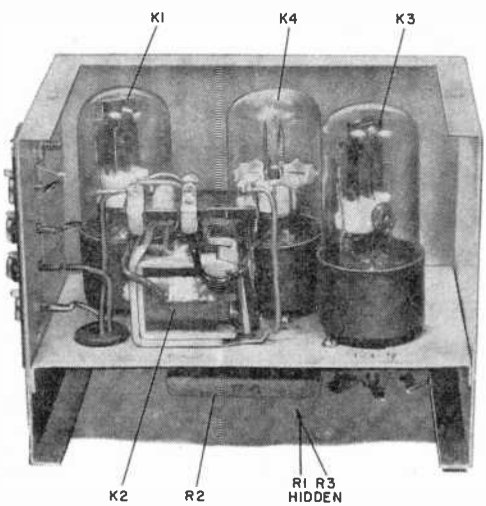



Fig. 2. Typical layout shows all relays mounted on chassis surface while the resistors are underneath it. Note that K1, K3, and K4 are socket-mounted.

to keep them that way. Also, use lockwashers with all screws.

Parts layout is not critical, and can be as shown in Fig. 2. The completed unit is shown in Fig. 3. Construction is the same for both 6- and 12-volt electrical systems except that *R1, R2* and *R3* are not used for a 6-volt system.

If you decide to mount the box in the engine compartment, keep it away from heat, oil, water, and other debris.

**Hookup.** Connecting the Auto Sentinel to your car's electrical system is a snap. The door switches that operate the dome light, or other courtesy lights, plus a switch on the car's trunk lid, and another on the engine hood all serve as "triggers" for the alarm system. If all your doors, hood, and trunk are not already equipped with switches, you will have the additional task of installing suitable switches in order to protect all entry areas. Mercury switches are the easiest types to install on the hood and trunk lid.

**PARTS LIST**

*K1, K3—S.p.s.t., normally open thermal relay with 15-second delay (Amperite 6N015 or similar)*
*K2—D.p.s.t., 6-volt relay*
*K4—S.p.s.t., normally closed thermal flasher with 30 flashes per minute (Amperite 6F30 or similar)*
*R1—20-ohm, 5-watt resistor**
*R2, R3—15-ohm, 5-watt resistor**
*S1—S.p.s.t. switch*
*TS1—4-post terminal strip*
*Misc.—Small utility box, hookup wire, octal sockets (3), solder, etc.*

**Omit these parts with 6-volt systems*

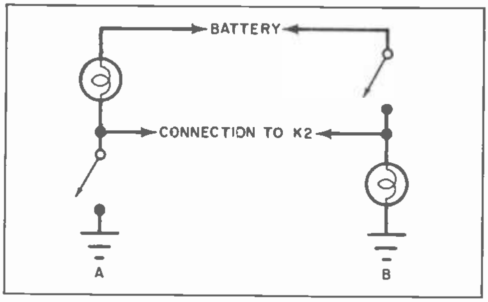



Fig. 4. If a mercury switch is used for the trunk light and it is wired as shown in B, rewire it to conform to the configuration shown in A at left.

Generally, door switches are wired like the circuit shown in Fig. 4(a). Connect a wire from terminal *2* on *TS1* to any door switch on the dome light side as shown. If a mercury switch is used for the trunk light and it is wired as shown in Fig. 4(b), rewire it to conform with 4(a).

Connect the horn relay to terminal *3* on *TS1*. (There's nothing to prevent you from installing a siren and let it do the screeching for you, instead of your horn, if you are so inclined.) Finally, connect *S1* between the ungrounded side of the car's battery and terminal *1*. If the alarm box is well grounded, there is no need to make a connection between terminal *G* on *TS1* and the car's ground.

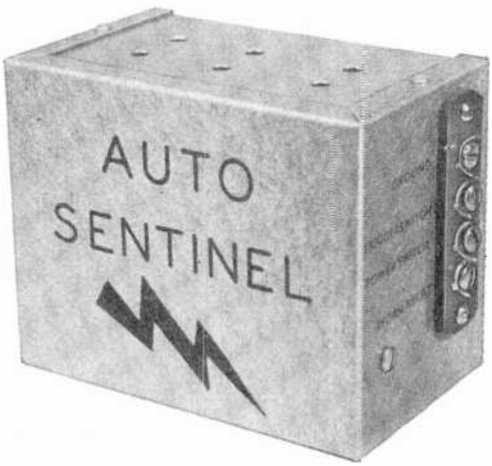


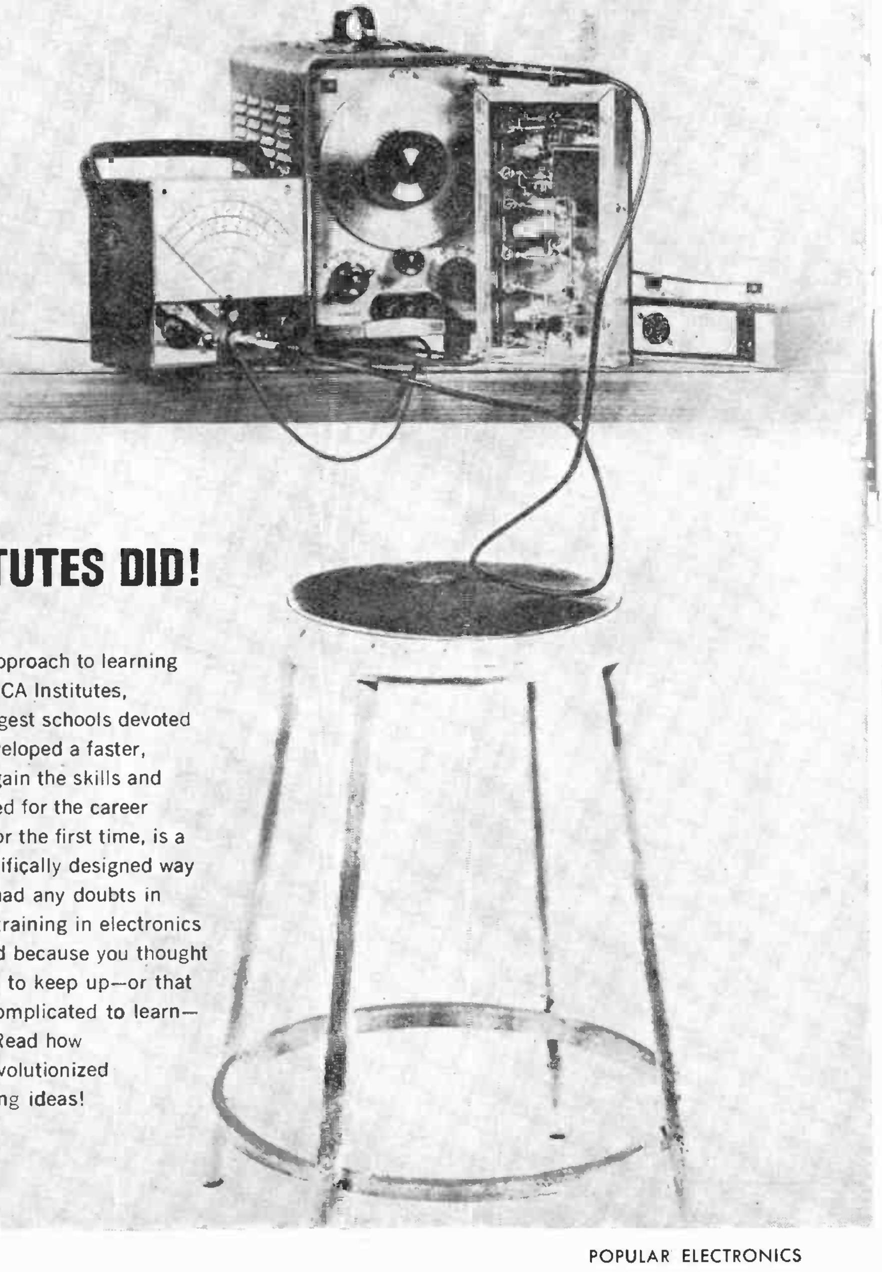

Fig. 3. If desired, the "Auto Sentinel" can be mounted in the glove compartment, or behind the dash where connecting wires can be run out of sight.

**Finishing Touches.** All that's left now is for you to test the alarm system. If it works as described here, and it should, you're in business, and a thief will just have to look somewhere else to make his illegal livelihood.

Put the system on standby, lock all of the car doors, and relax. Don't worry about the drain on your battery while the alarm is on standby; it's only about 15 milliamperes.

One final word: if you have a tendency to leave your keys in the ignition lock when you get out of your car, forget this whole idea—you'll never remember to turn the Auto Sentinel on—or off! —30—

# SOMEONE SHOULD DEVELOP AN EASY WAY TO LEARN ELECTRONICS AT HOME



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# INFORMATION CENTRAL

By CHARLES J. SCHAUERS, W6QLV

AS DETAILED on page 68 of the February issue, this new department, *Information Central,* will be devoted to answering questions submitted by readers. This month I have chosen another batch of letters from the huge volume of mail received at the POPULAR ELECTRONICS editorial offices. The subject matter of many of them may pertain to your own hobbyist/experimenter activities.

Included in this month's selection are questions on the repair and maintenance of electronic equipment, ham radio, CB, solid-state experimenting, SWL'ing, etc. If you have a problem or question that has been plaguing you for some time, don't hesitate to send it to *Information Central.*

**Preselectors for CB.** *I have seen some advertisements for 27-MHz preselectors that can be connected between my antenna and transceiver. Are they worthwhile?*

Unless your CB transceiver is an old clunker, it is very doubtful that a preselector will be of much value for *normal* CB operations. At least nine out of every ten CB transceivers have more than sufficient receiver sensitivity; and with the channel congestion problem, you need selectivity—not sensitivity. However, in some instances where "fringe" receiving conditions prevail, you might find a r.f. preselector of value. But you'll have to develop a switching arrangement to keep the r.f. of the transmitter out of your preselector.

**Degaussing Coil.** *I just assembled a color TV kit and was wondering if I could make my own degaussing coil?*

Although there is some question as to the amount of money you might save, you can make your own degaussing coil if you happen to have a couple of thousand feet of No. 20 cotton-covered wire on your workshop shelf. Simply select a convenient 12"-diameter form and wind about 450-500 turns on it into a coiled-rope shape, about 1" in diameter. Bring the two ends of the coil out and solder them to a zip cord with an a.c. plug to fit into your household 117-volt line. Be sure to insulate the connections between the zip cord and the coil and to tape the coil "bundle" in at least eight or ten different places so that it won't lose its shape. Don't leave the coil plugged in to the house wiring too long as there will be some heating.

**Simple Treble Cut.** *I own a popular ham band transceiver and would like to add some additional bass. The audio is of good communications quality; but for my voice, it sounds lousy.*

Probably the easiest solution to your problem would be to add the treble cut circuit shown in the accompanying wiring

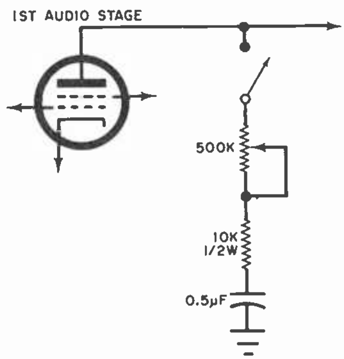



diagram. I would recommend inclusion of a s.p.s.t. switch just in case a visitor doesn't have your particular voice quality.

**Large Screen Oscilloscope.** *For a high school science project, I would like to convert an old 17" TV receiver into a large screen oscilloscope. Can this be done?*

Yes—at least from a theoretical aspect—you should be able to make this conversion, although the job is not exactly an easy one. You have to know quite a bit about TV circuitry and be a fairly good analyst of wiring diagrams. Generally, the conversion is made by using the existing high voltage circuits and converting the vertical and horizontal drive circuits while adding the proper sawtooth (sweep) oscillator. I understand that plans are available from Relco, A33, Box 10563, Houston 18, Texas, for about $2 which might assist you in this endeavor.

Unfortunately, I have never seen a set of these plans and cannot judge their value.

**Intermittent Ohmmeter.** *I have a low-cost VOM and it is now "intermittent." Sometimes the meter will read perfectly, but every once in a while I get all sorts of screwy readings.*

The solution to this problem probably lies in the pressure contacts that hold the batteries in place. These contacts—on the cheaper meters—tend to corrode rapidly; and as you jiggle the meter, the batteries shift position and upset your readings. Disassemble your VOM and clean the battery contacts with a good "TV tuner" cleaner spray. Simultaneously, you might find it advantageous to shoot some of the spray into the rotary switch contacts—although, generally speaking, these contacts on good meters are "self-cleaning."

**Dial Cord Slippage.** *My modestly priced short-wave receiver has a dial cord operated dial mechanism. The cord is slipping and I don't look forward to the mechanics of installing a new one. Is there any other cure?*

Yes; check to be sure that the tension spring is still slightly expanded, thus indicating that the dial cord is working under tension. If the spring has collapsed or if there is any slack, untie one end of the cord and shorten it enough to put the spring to work. You can also coat the dial cord with one of the commercially available non-slip compounds such as Injectorall's "Grip-Well," or GC Electronics' "Liquid Non-Slip."

**Antennas for TV DX'ing.** *I was told that the best bet for someone living in a deep fringe area, or for a fellow interested in DX'ing, was to stack two identical TV antennas. Is this so?*

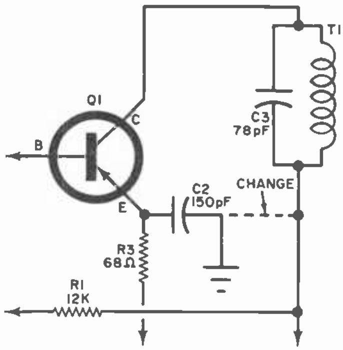
Yes, indeed. All sorts of communications facilities have stacked antennas to increase signal pickup. One of the better articles available on stacking TV antennas appeared in POPULAR ELECTRONICS, November, 1965, page 63.

**Is Hertz Really Number 1?** *I have the opportunity to read numerous technical electronics magazines and am sick and tired of reading about the changeover from cycles-per-second to hertz. Give me the straight dope—was this thing necessary and is it official throughout the world?*

Oddly enough, the answer is no! Although the U.S. Government has been urging that all publications make the changeover from cps to hertz, most of the government agencies continue to use cycles, kilocycles, megacycles, etc. In fact, the regulations of the International Telecommunications Union are still very much in effect and these regulations—as they pertain to broadcasting and worldwide communications—stipulate that cps should be used in preference to hertz!

**Curing CB-12 Feedback.** *My faithful Hallicrafters CB-12 transceiver has developed the irritating habit of occasionally squealing when I have the volume control turned up. What's going on?*

You can easily solve this problem by following the service notes published by Hallicrafters. The manufacturer recommends that the transceiver models CB-10 and CB-12 be modified as detailed below. First, remove capacitor *C4* and discard it; this is a 0.01-$\mu$F ceramic-disc capacitor in the collector circuit of transistor *Q1*. Unsolder the end of capacitor *C2* (150 pF) which is connected to the junction of *C3, T1* and *R1*, solder it directly to chassis ground. The



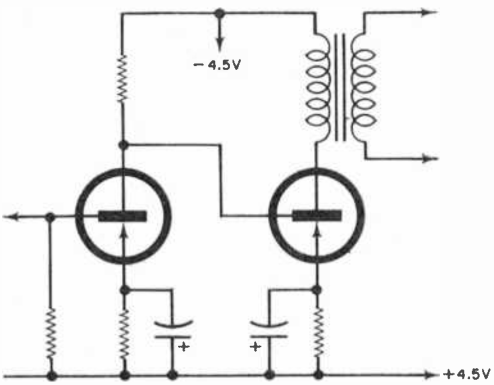

best way to do this is to use the hole in the chassis formerly used to ground *C4*. It may be necessary to add a short extension lead to *C2*. When you make this modest circuit change, your squeal should vanish.

**Commercial Kit Diagrams.** *I don't understand how kit manufacturers operate. Do they keep instruction books on hand for all of their kits, regardless of when they were manufactured?*

No, most of the kit manufacturers don't have enough storage space for all of the kit manuals that they would be required to store. In the case of the Heath Company, I am informed that they carry complete manuals until the existing surplus stock is depleted. At that time, a condensed version of each manual (eliminating the wiring steps) is prepared, which can be obtained direct from Benton Harbor at prices ranging from 50 cents to $2.00. Beyond this, Heath will also Xerox specification sheets and schematic diagrams at 5 cents a page. The Knight-Kit people tell me that they stock kit manuals until the supply is depleted, but make no provisions to publish a condensed manual. However, anyone can obtain a copy of the schematic diagram of any old Knight-Kit by writing to the Technical Service, Knight Electronics Corporation, 2100 Maywood Drive, Maywood, Illinois 60154.

**American Vs. European Transistor Symbols.** *Why don't Americans use sensible symbols for transistors? I just saw some British wiring diagrams and their use of transistor symbols really makes sense.*

We'll agree with this reader that the British (literally speaking, European) transistor symbols do make sense and that their circuit diagrams look like tube-style layouts. For those readers not familiar with the European style symbols, the accompanying diagram illustrates the similarity




between solid-state and vacuum-tube amplifier circuits. How it all started, I don't know, but presumably the Europeans improved on our symbol techniques.

**Rise Time—What Is It?** *My electronics school teacher and I had an argument over the exact definition of "rise time." How do you explain it?*

Very simply. Rise time is the amount of time (measured in very small fractions of a second) it takes for a waveform to go from 10% to 90% of its peak value.

**A New Advertising Term?** *In looking through an electronics catalog, I saw some capacitors advertised as "GMV"—what does it mean?*

This is an abbreviation for "guaranteed minimum value." The actual value of the capacitor is not less than the value printed on it. You generally see the term "GMV" used with ceramics and electrolytics.

**Time-Signal Receiver.** *I home-built the "Time-Signal" receiver featured in the October, 1966, issue. I want it to operate on 15.0 MHz, but the oscillator doesn't seem to work right. I didn't see any corrections to this story in "Out of Tune"—what do you think can be wrong?*

Although the receiver will work (on the printed circuit board) with the components shown, some home-built units may operate better if the capacity of *C14* and *C15* is reduced from 0.001 μF to 270 pF. Make these substitutions and your receiver should operate like a charm.

**Cutting Down Ignition QRM.** *My CD ignition system is raising hob with my mobile CB rig. Neither resistor spark plugs nor shielded ignition leads seem to make a difference. Isn't there somthing I can do?*

The most effective suggestion for reducing ignition noise comes from Sydmur—ground the metal case of the ignition coil; Murray Gellman of Sydmur says that the case "floats" and is a good radiator of r.f. energy. Solder a wire braid to the metal case and ground the other end to the engine block. Don't depend on the supporting bracket holding the coil being grounded—it's insulated from the coil case by layers of paint. If your ignition coil is a new one with a plastic housing, the noise radiation will be particularly bad. However, these coils can be damped by enclosing them in aluminum foil and then grounding the foil to the engine block.

**Antique Radios.** *I have a Garod V receiver that was manufactured in 1923. Is this worth anything as an antique?*

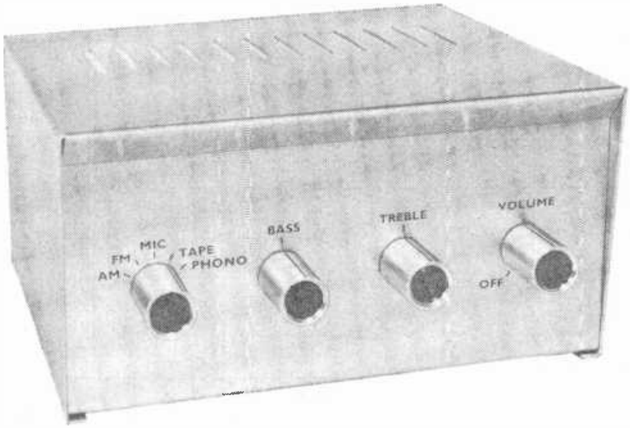
If in good condition, it is worth \$25-\$35, although the number of antique radio collectors is pretty small. By the way, the Antique Wireless Association says that old broadcast receivers fall into three categories: A-V-C. The "A" receivers are "antiques" and were made during 1920-23; you can identify these sets by the "peep" holes in the front panel, separate rheostats on each tube filament, tapped inductances, etc. The "V" receivers are "vintage" and consist of those made during 1924-27; this was the great Neutrodyne era, with Crosley, Radiola, Leutz, etc., receivers being very popular. The "C" receivers are "classics" (Silver-Marshall, National, Scott, etc.), and can be anything made after 1927 and before World War II.

**Key Click Eliminator.** *I would like to incorporate some sort of transistorized switching in a little CW ham band rig I am building. I understand that solid-state circuits eliminate key clicks.*

*(Continued on page 101)*

BUILD THE

# "TWO-BY-TWO" STEREO PREAMPLIFIER




SOLID-STATE HI-FI CONTROL CENTER CAN BE USED WITH ANY STEREO POWER AMPLIFIER. CONSTRUCTION IS SIMPLIFIED THROUGH USE OF PRINTED CIRCUIT BOARDS

**By DANIEL MEYER**

MODERN DESIGN TECHNIQUES make it possible for you to build this modular "Two-By-Two" stereo preamplifier all at once or one circuit at a time. The completed unit can "tailor" phono, tape, microphone, and AM and FM tuner signals to fit almost any hi-fi amplifier, including the "Brute-70" which was described in the February issue of POPULAR ELECTRONICS.

Generally speaking, a preamplifier—be it a mono or a stereo affair—is the control center of a component hi-fi system. It serves as a "matchmaker" between the program source and the basic amplifier. Regardless of the number and type of program sources, they are all fed into the front end of the preamp, and at the flip of a switch are individually and effortlessly patched into a power amplifier. The preamp also has the ability to raise or lower volume, to boost or cut

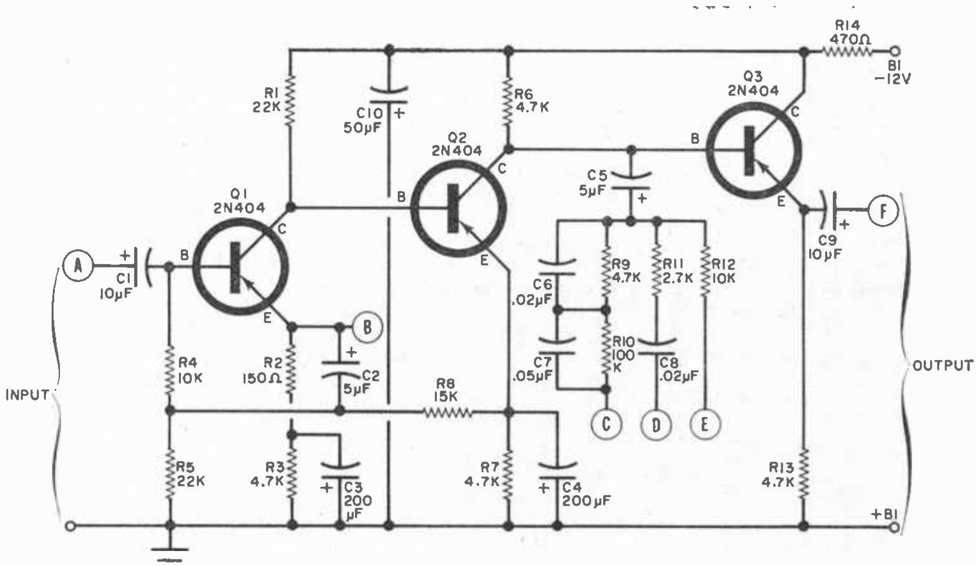



Fig. 1. This is the circuit diagram of one of the fixed gain preamplifiers. The two preamplifiers are identical. Points labeled A,B,C,D,E, and F are printed circuit connection points to input jacks, switches, and other printed circuit boards.

bass and treble, and to compensate for dips and peaks in programs, in room acoustics, and in hi-fi equipment.

In the "Two-By-Two" preamp, there are two sections in each of two identical channels employing 2¼"-square printed circuit boards. One of the sections is a 3-transistor preamplifier equipped with three compensating networks to accommodate the different input devices. The other section is a 2-transistor base and treble tone control circuit capable of a 15-dB boost or cut on both ends of the audio spectrum.

A minuscule amount of power is required by the "Two-By-Two," and almost any 12- or 24-volt d.c. supply will do. In many instances you can steal

## PARTS LIST

*C1, C9, C13—10-μF, 15-volt electrolytic capacitor*
*C2, C5—5-μF, 15-volt electrolytic capacitor*
*C3, C4, C14—200-μF, 6-volt electrolytic capacitor*
*C6, C8—0.02-μF ceramic disc capacitor*
*C7, C12—0.05-μF ceramic disc capacitor*
*C10—50-μF, 25-volt electrolytic capacitor*
*C11—0.001-μF ceramic disc capacitor*
*C15—470-pF ceramic disc capacitor*
*C16, C17—30-μF, 15-volt electrolytic capacitor*
*C18—50-μF, 25-volt electrolytic capacitor*
*C19—500-μF, 50-volt electrolytic capacitor*
*C20—100-μF, 25-volt electrolytic capacitor*
*D1, D2—500-mA, 100-PIV silicon diode or better*
*D3—24-volt zener diode*
*Q1-Q5—2N404 pnp transistor or similar*

*R1, R5, R19—22,000 ohms*
*R2—150 ohms*
*R3, R6, R7, R9, R13, R15, R16, R17, R21, R28, R30—4700-ohms*
*R4, R12, R18—10,000 ohms*
*R8—15,000 ohms*
*R10—100,000 ohms*
*R11—2700 ohms*
*(All resistors ½-watt unless otherwise specified)*

*R14, R22, R23—470 ohms*
*R20—2200 ohms*
*R24, R25—Dual 50,000-ohm, ½-watt, linear-taper potentiometer*
*R26—Dual 5000-ohm audio taper potentiometer (with switch S2)*
*R27, R29—220,000 ohms*
*R31—1000 ohms, 1 watt*
*S1—Two section, two-pole, five-position ceramic or other low-loss rotary switch*
*S2—S.p.s.t. switch (mounted on R26)*
*T1—Transformer: primary, 117 volts a.c.; secondary, 40 volts center-tapped (similar to Knight 54 A 4731)*
*1—6" x 8" x 4½" cabinet (similar to LMB CB-2)*
*Misc.—Printed circuit boards, knobs, wire, solder, spacers, 6-32 machine screws and nuts, input and output jacks, etc.*

Etched and drilled printed circuit boards at $1.50 each; all parts (less board and potentiometers) for the 3-transistor amplifier section at $4.50 each; and all parts (less board and potentiometers) for the 2-transistor tone control at $3.25 each are available from DEMCO, Box 16297, San Antonio, Texas 78216.

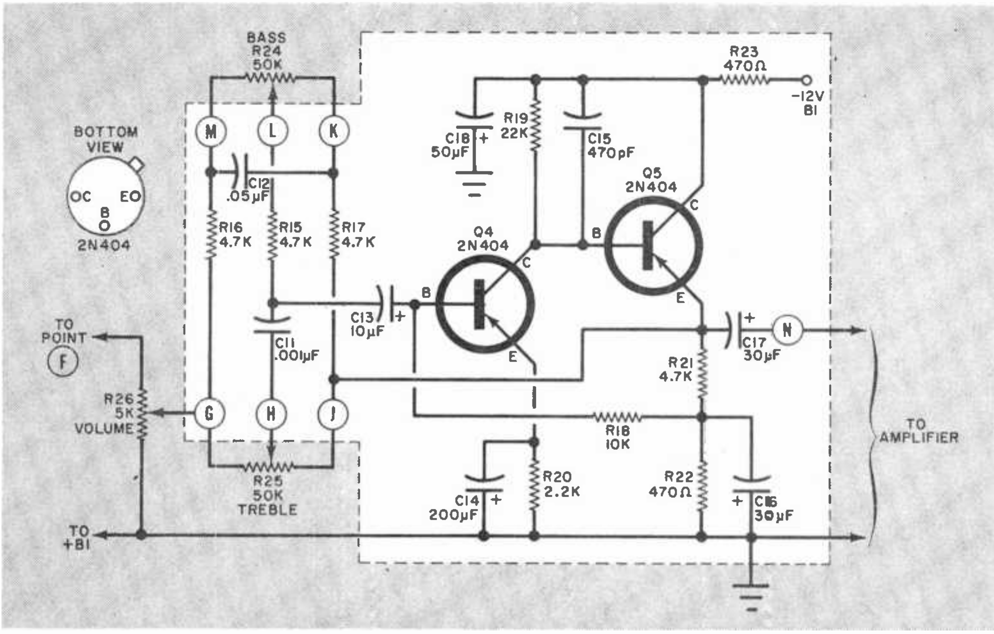



Fig. 2. Circuitry important to the tone controls of the stereo preamp is etched in two printed circuit boards. As in the diagram on the facing page, points G,H,J,K,L,M, and N are connections to jacks, switches, and front panel controls.

this power from your amplifier. Just in case you can't, details for building a simple power supply are presented on page 72.

**How It Works.** The preamp consists of two high-gain amplifier stages (*Q1* and *Q2*), and an emitter follower stage (*Q3*), as shown in Fig. 1. The three feedback networks (*C, D,* and *E*) from the collector of *Q2* are connected one at a time to the emitter of *Q1* (point *B*) to provide a flat output signal for a magnetic phono cartridge (*C*), a tape head (*D*), and an AM/FM tuner or microphone (*E*). The latter network provides an essentially flat amplifier response characteristic, whereas the first two networks compensate for the disc and tape recording industry's standards and practices.

Input impedance of *Q1* is made high by the bootstrap action of *C2*. This action is achieved in a very interesting manner. An increase in value of any of the bias resistors effectively increases the input impedance. However, there are practical limits which restrict the size of these resistors, and prevent an appreciable increase in impedance. The desired effect of increased input impedance is the reduction of input signal current flow. In this case, it can be achieved by making *R4* "look" like a much larger resistor than it actually is. Fortunately, you can do this with a feedback signal to the bottom of *R4*, which is in phase with the input signal voltage. If the voltage applied to both ends of *R4* is equal and of the same polarity, no current will flow. (The stronger the applied signal, the greater the feedback.) The resulting input impedance is high enough to handle ceramic and other high-impedance microphones without loading problems.

Capacitor *C9* couples the signal to the top of the volume control (*R26*) shown in Fig. 2. The tone controls are low-distortion feedback types with a variable turnover characteristic, which simply means that the point at which boost or cut begins changes as the control is rotated. This is much more desirable than the simpler constant-turnover type tone control, which affects all frequencies up to the designed turnover point even when a small amount of boost or cut is used.

The tone control network, Fig. 2, has a one-stage amplifier (*Q4*), and an emitter follower (*Q5*). Output impedance of this circuit is low, which permits proper operation with almost any type of hi-fi power amplifier made. For a dynamic microphone or other low-impedance pickups not requiring a compensating amplifier response curve, you can omit the compensating networks and wind up with higher gain, but with a lower input impedance—on the order of 10,000 ohms.

A two-pole, five-position rotary switch, as shown in Fig. 3, is used to select any one of the five inputs on one channel of the "Two-By-Two." A double-ganged affair is needed to handle both channels. Use a ceramic or other low-loss switch to minimize crosstalk.

The inherent stability of the circuit permits proper operation over a wide supply voltage range, without modification of bias, and without materially affecting gain. However, the lower the supply voltage used, the lower the clipping point for input signals and the lower the peaks of the output signals, as shown in the specs on p. 98. For best results, use 24 volts. Figure 4 shows a circuit for a zener-regulated, full-wave power supply that you can easily put together, if you need one. It's a good idea to keep a.c. and power supply components on a separate chassis, away from the preamp.

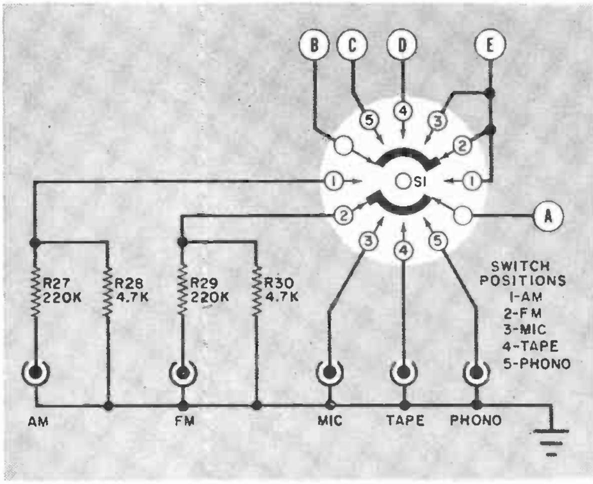



Fig. 3. Input selecting switch feeds compensating network output (C, D, and E) to emitter of transistor Q1 to alter frequency response of preamplifier.

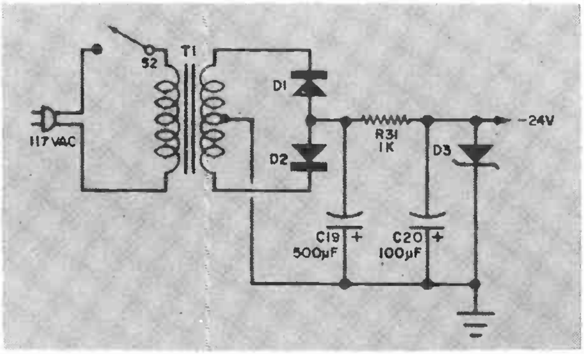



Fig. 4. If you find it difficult to "steal" 12 or 24 volts of pure d.c. from your power amplifier, a zener-regulated, full-wave supply may be substituted.

**Construction.** The "Two-By-Two" can be built and used as a "One-By-One," as a "Two," or just a "One." If you are not interested in stereo and only want a mono preamp, you can assemble a "One-By-One," which is one amplifier section, and one tone-control section. If you just need an amplifier and are not interested in the tone controls, you can build a "One," a "Two," or for that matter a "Three," or even a "Four," leaving off the tone-control section each time.

If you are building the amplifier section only, just connect a jumper wire from point *B* (see Fig. 1) to the proper compensation network, if one is to be used. However, you will find a rotary switching arrangement to be most convenient, if more than one type of input device is to be used.

The simplest way to put this project together is to use printed circuit boards, as shown in Fig. 5. Other construction techniques can be used, but be alert to the need for proper lead dress and for proper component layout to minimize

(*Continued on page* 98)

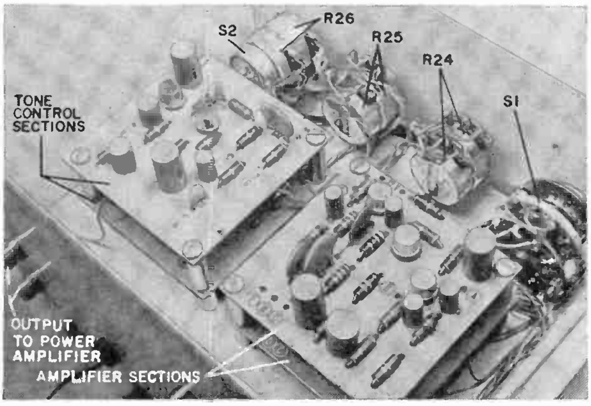



Fig. 7. The amplifier and tone control sections of the "Two-By-Two" can be neatly stacked. Note dual section controls used for a stereo installation.

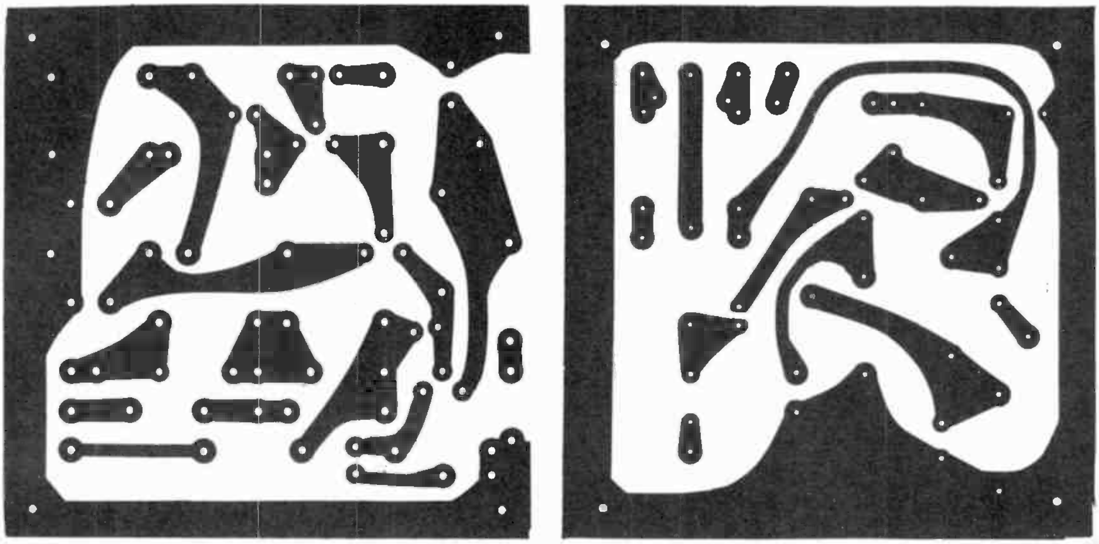


Fig. 5. Same-size layouts of the foil side of the two printed circuit boards are shown above. The fixed-gain preamplifier is to the left and the tone control board to the right. For stereo operation the builder requires 4 boards, two of each circuit.

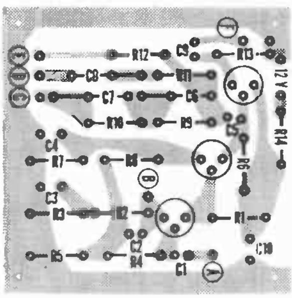
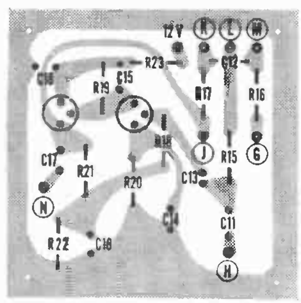


Fig. 6. Position components on plain side of the circuit boards as shown—amplifier to the left and tone control to the right.



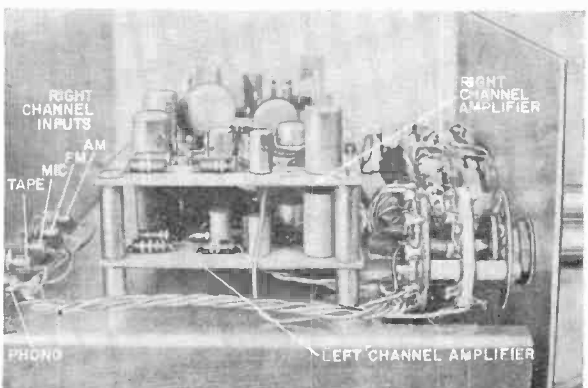



Fig. 8. Side view shows use of metal spacers. Unshielded leads run between switch and input jacks. In case of hum pickup substitute shielded leads.

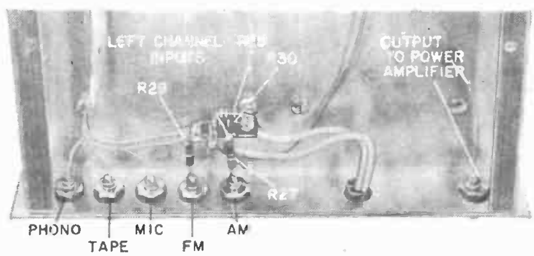



Fig. 9. Underside of chassis is bare except for input loading resistors for the main AM and FM left channel inputs. All input jacks for the right channel are isolated above the chassis. This improves channel-to-channel separation. If hum pickup is a problem use shielded leads here also.

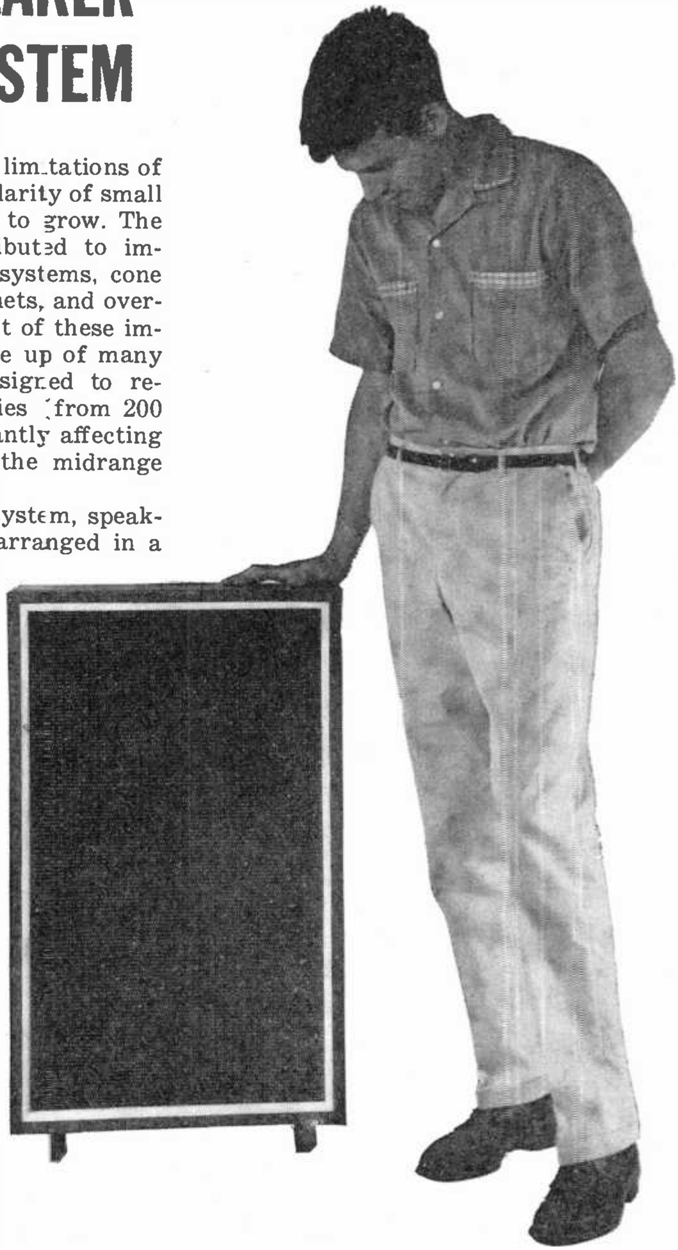
# BUILD THE "MIXED TWELVE" SPEAKER SYSTEM

STAGGERED RESONANCE ARRANGEMENT PROVIDES EXCELLENT RESPONSE AT LOW COST

IN SPITE OF the obvious limitations of small speakers, the popularity of small speaker systems continues to grow. The reasons why can be attributed to improvements in suspension systems, cone materials, voice coils, magnets, and overall construction. As a result of these improvements, a system made up of many small speakers can be designed to reproduce the bass frequencies (from 200 Hz down) without significantly affecting their normal response to the midrange and the high frequencies.

In the "Mixed Twelve" system, speakers of different sizes are arranged in a

By DAVID B. WEEMS



somewhat irregular and unusual manner in order to set up a "staggered resonance" condition. For the money (about $35), performance is excellent, and the ability of the system to reproduce "big" source sounds and handle orchestral transients without "going to pieces" is remarkable.

Some multiple-speaker systems reproduce sounds that bounce from one speaker to another, resulting in what can best be classified as a "ping-pong" effect. (Yes, it is possible to create this effect in a mono system.) In the "Mixed Twelve," the audio spectrum is not split up—every speaker in the system works simultaneously. The sounds are more smoothly reproduced and appear to have a more natural character.

Besides the system's low cost, a big advantage of the "Mixed Twelve" is the fact that it can be driven by a low power amplifier.

**The Speakers.** While a major reason for using small speakers instead of large ones is economy, keep in mind when selecting speakers that there are some which are too poor in quality to be considered. The three most important things to look for in a speaker, besides the way it actually sounds, are magnet strength, cone material, and overall construction. If any of these appear to be below standard, chances are that the speaker will compromise the quality of the sound.

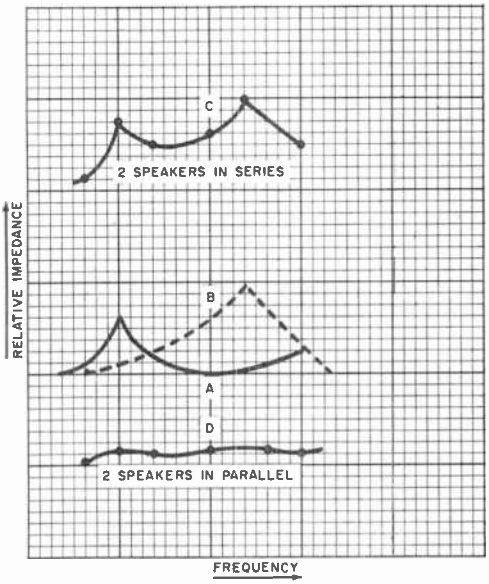



Fig. 1. By connecting two speakers with different resonances in a parallel arrangement, sharp peaks found in a series arrangement can be flattened.

If the magnet strength is insufficient, damping will be inadequate to prevent the speaker cone from continuing to vibrate after the signal is removed. If the speaker cone material is too light in weight, it will "break up" when loud passages are reproduced and add its own voice. The speaker's own voice and continued vibrations are nothing more—or less—than distortion.

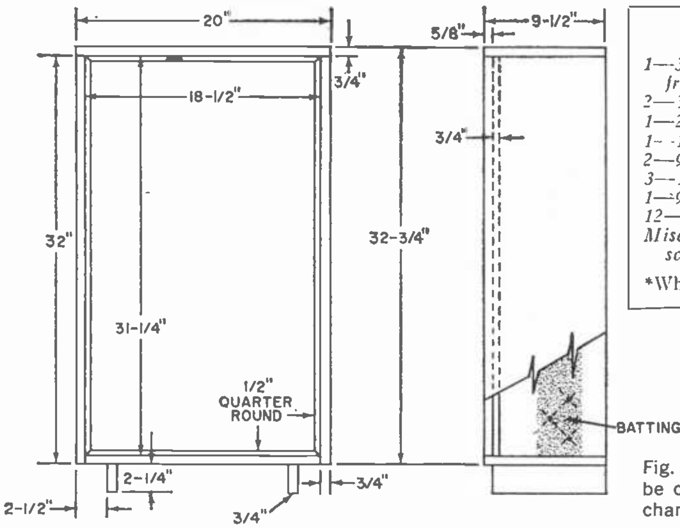
You should also give some thought to the size and shape of the speakers you intend to use. As a rule, a speaker with a large-cone area usually has a better low-frequency response than a speaker with a small-cone area. Conversely, a smaller speaker usually has better high-frequency characteristics. In most speaker systems, the overall audio spectrum is covered by the use of several different-size speakers in one enclosure.

Speaker shape has a direct bearing on the performance of a staggered-resonance system. Round speakers can be used, but oval types offer certain advantages. The oval speaker usually has a better high-frequency response than a round speaker that has the same cone area. And better horizontal sound dispersion is obtained from an oval speaker that has its long axis vertically oriented.

In addition, do not mix speakers having different impedance ratings. If the speakers in a system do not have the same impedance, they will "see" different amounts of power, and the system will not operate as predicted here.

Four of each of the following size speakers are used in the "Mixed Twelve": 3" x 5" (RCA), 4" x 6" (Zenith), and 5" x 7" (imported); the two smaller sizes of speakers have 1.47-oz. magnets, and the largest has a 2.14-oz. magnet. All of them are rated at 3.2 ohms impedance. But you can choose a different assortment of speaker sizes, if you wish, and still come up with a good system.

**Speaker Arrangement.** Low frequency response (mainly attributed to the stiffness of the cone) in small speakers is limited. When several of them are connected together, however, they help each other boost the low frequency response.




**BILL OF MATERIALS**

*1—31¼" x 18½" sheet of ¾" fir plywood for front panel*
*2—32" x 9½" x ¾" sides**
*1—20" x 9½" x ¾" top**
*1—18½" x 9½" x ¾" bottom**
*2—9¾" x 2¼" x 1" bottom rails*
*3—18½" x 2" x 1" braces*
(*Soft pine lumber*: sides, top, bottom, bottom rails and braces)
*1—96"-long piece of ½"-quarter-round molding*
*12—Speakers of your choice—see text*
*Misc.—Grille cloth, speaker wire, sheet metal screws, finishing nails, etc.*

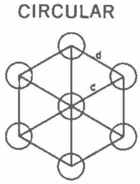
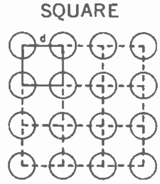
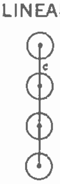
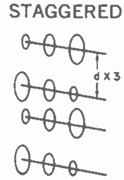
*When ordering, specify 1" x 10" pine shelving.

Fig. 2. Top, bottom and side walls can be cut shallower than shown, but do not change the dimensions of the front board.

If all the speakers had the same resonance characteristic, there would be some unwanted side effects in the mid-range. Fortunately, speakers of different sizes and shapes do have different resonant frequencies, and they do bypass many of these side effects when properly hooked up.

Consider two speakers, each having different resonant frequencies with relative curves (*A*) and (*B*) respectively, as shown in Fig. 1. When they are connected in series, a sharply spiked curve (*C*) will be obtained. Total impedance for the two speakers will be approximately double that of either speaker. The curve for the same two speakers connected in parallel (*D*) is more uni-

**SPEAKER ARRANGEMENT CHARACTERISTICS**

| PATTERN | CIRCULAR | SQUARE | LINEAR | STAGGERED |
|---|---|---|---|---|
| |  |  |  |  |
| NUMBER OF SPEAKER SIZES | 1 | 1 | 1 | 3 |
| D/n RATIO* | 1.7/1 (D=12, n=7) | 1/1 (D=4, n=4)<br>1.33/1 (D=12, n=9)<br>1.5/1 (D=24, n=16) | n−1/n | 0.5/1 (D=3, n=6)<br>0.75/1 (D=9, n=12)<br>0.8/1 (D=12, n=15) |
| EFFECT OF PATTERN ON MUTUAL COUPLING | Excellent | Good | Fair | Good when speakers are of various sizes |
| FREEDOM FROM PEAKS IN THE MID-RANGE | Poor | Progressively poorer as n increases | Good | Good |
| HORIZONTAL DISPERSION CHARACTERISTICS | Poor | Poor | Excellent | Fairly Good |

**D=the number of identical distances between adjacent speakers in the speaker pattern, and n=the number of speakers; this is the ratio of the number of identical distances between speakers adjacent to each other and the total number of speakers that gives a good estimate of the tendency of the system to peak. A low ratio is desired because the higher the ratio, the greater the tendency to peak. Terms like good, fair and poor are only relative.*

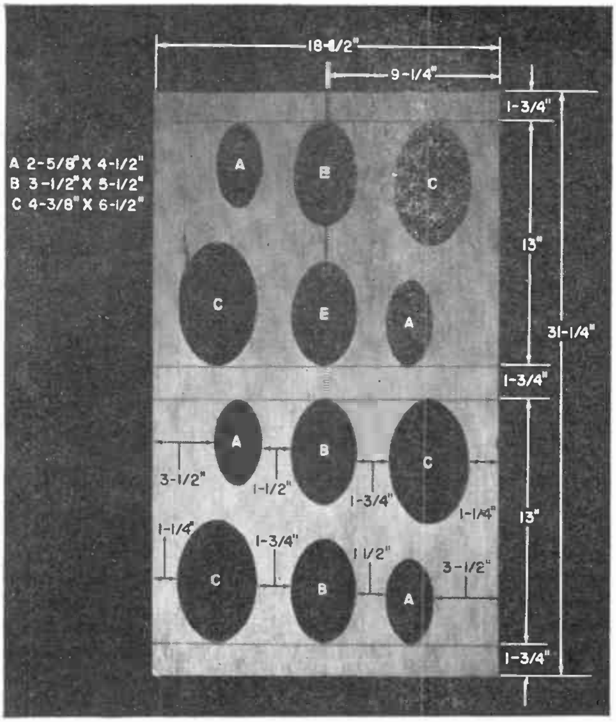



Fig. 3. Using the lines drawn on the front board to obtain proper placement, start drawing speaker cutout lines along the vertical line with medium-size template. Then draw in the other cutout lines.

**Construction.** The back of the "Mixed Twelve" cabinet has been deliberately left off to minimize the effects of cabinet resonance. As a result of the backless feature, overall dimensions are not critical. The width of the top, bottom, and sides can be slightly larger or smaller than shown in Fig. 2, but do not change the size of the front panel. (Finished width of 10" shelving is 9⅝" and there's no need to strip the lumber down to 9½".)

To lay out the openings on the front panel, draw a line across the top and bottom, spaced 1¾" in from the top and bottom edges, as shown in Fig. 3. Draw two more lines 13" from the top and bottom lines. Then draw a vertical line down the center.

Cut up a piece of heavy cardboard to serve as a template for the cutouts. You will need a separate template for each different size speaker. The dimensions of *A*, *B*, and *C* in Fig. 3 are typical. If your speakers require a different set of contours, modify the cutouts accordingly. (Avoid using speakers larger than 5" x 7", if you don't want to redesign the entire cabinet.)

(*Continued on page* 96)

form and virtually flat over a wide range of frequencies. Also, their combined impedance is reduced drastically.

When several small speakers are used in a single cabinet, a certain amount of desirable mutual coupling at low frequencies is obtained, and a certain amount of undesirable interactions at other frequencies is also present. These interactions can cause dips and peaks in the system's overall response curve. Peaks and dips occur when the distances between speakers are certain fractions of a wavelength of the sound.

To design a multiple speaker system completely free of peaks and dips is almost impossible, but fortunately it is possible to minimize these effects by following a simple rule-of-thumb—stagger the positions of the speakers in the cabinet so that center-to-center distances are not the same for immediately adjacent speakers. The characteristics obtained with different speaker arrangements (at left) can be used for comparison.

Fig. 4. Templates that are cut from heavy paper or cardboard greatly facilitate the laying out of speaker cutout lines on the front board. A different template is needed for each size of speaker used.

# SOLID STATE

By LOU GARNER, Semiconductor Editor

WE'VE received a number of letters from readers expressing an interest in the "bargain" transistor assortments offered by major outlets from time to time. Most of these bargains consist of plastic bags containing from 50 to 100 unidentified transistors selling at prices representing a net cost of less than 10 cents apiece. But these assortments may not be true "bargains," as a great deal depends on the needs and interests of the individual purchaser.

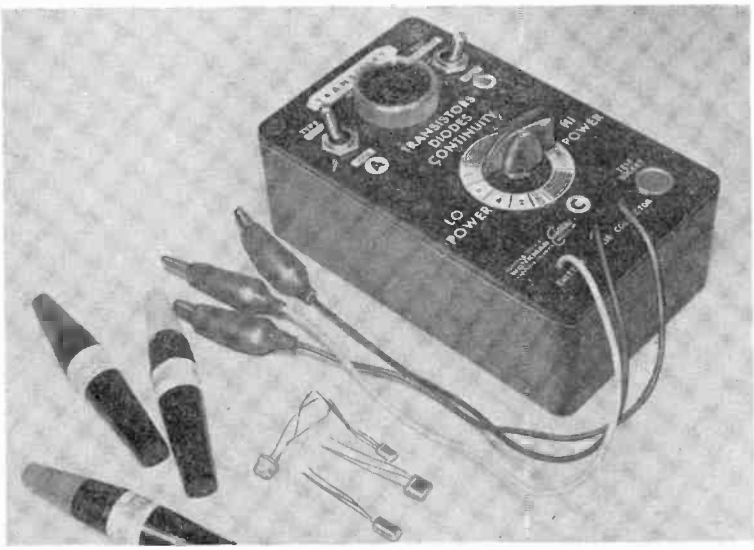
If you have specific projects in mind, your best bet is to use transistor types specified by the original designer (or author). On the other hand, if you like to experiment with different circuits, trying various breadboard arrangements as you go along, and want to keep costs to a minimum, the "bargain" assortments may be just your cup of tea. And they are excellent for school and student use.

One reader, Leonard E. Laabs (220 North College, College Place, Wash.), is planning a serious statistical study of typical assortments as part of a college research project. If you've had any experience with these bargain packages, write to Leonard and pass on your findings.

Remember that any given assortment may contain transistors coming from a variety of sources: manufacturers' surplus, distributors' excess inventory, discontinued types, off-tolerance units, factory overruns, low-voltage types, and units with external defects including incorrect markings, dented cases, or short leads. Some units may be of extremely high quality, while others may be of marginal quality. Often, only a small percentage will be defective.

For example, two seemingly "identical" assortments purchased at the same time from the same dealer may have entirely different contents. One might include up to 70 to 80 percent good-quality units, with the balance of little or no value. Another may contain only four or five top quality devices, but the entire assortment may be useful, even if it's of mediocre quality.

Regardless of original source, or purchase price, maximum dollar value can be obtained by first assorting the units according to type (*npn* or *pnp*), relative gain, and leakage. This can be done using a transistor checker capable of identifying type and which can also check for opens, shorts, leakage and relative gain. Suitable checkers include the Workman Model BZ8 (shown here) and the Seco Model 100 Dynamic




Inexpensive transistor and diode testers like this Workman Model BZ8 can be used for checking transistor type, relative gain, leakage, opens and shorts.

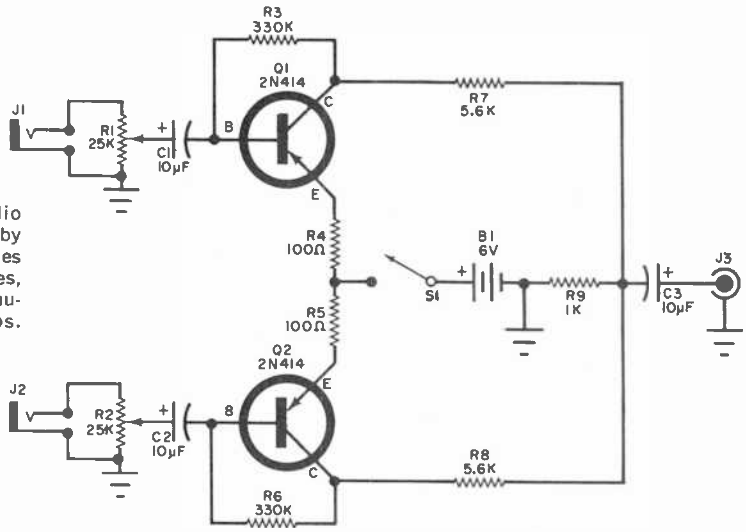



Fig. 1. Two-channel audio mixer circuit submitted by Aron J. Davidson matches low-impedance microphones, phono cartridges, and musical instrument pickups.

Checker. Adopt a suitable color code and use felt-tipped marking pens to identify the transistors as they are checked and sorted.

A red line on the side of the case might be used to identify *pnp* units, while an absence of this line could denote *npn*. Approximate gain (*beta*) can be identified by colored dots, with various colors selected for low-, medium- and high-gain types. Similarly, other colors (or symbols) may be used to identify low- and high-leakage types. If two identical units are found, these could be taped together as a *matched pair* for future push-pull circuit application.

Units found to be excessively leaky, shorted, or open, can be discarded . . . or, if preferred, saved for use as dummies when you're developing and checking circuit layouts. Units that are only slightly leaky can be saved for use in non-critical a.c. amplifier and oscillator circuits. Finally, devices with a single open element (as, for example, an open collector electrode) can be used as general-purpose diodes—you simply clip off the lead to the open electrode.

If adequate test equipment is available, additional tests can be performed to determine noise, temperature, and high-frequency characteristics. As a general rule, however, such extensive tests are not justified unless special jigs are assembled and relatively large quantities of transistors are involved.

Unfortunately, there is no simple way to separate silicon and germanium types, nor can maximum ratings be determined easily using commonly available test equipment without some danger of destroying the device being tested. A good rule-of-thumb is to restrict the use of "bargain package" types to low-voltage, low- to medium-power applications. In other words, don't try to push for maximum outputs.

**Reader's Circuit.** Submitted by reader Aron J. Davidson (1004 Stratford Ave., Philadelphia, Pa. 19126), an inexpensive and easily assembled two-channel audio mixer circuit is illustrated in Fig. 1. Suitable for use with low- to moderate-impedance microphones, phono cartridges, and musical instrument pickups, it can be assembled as a self-contained "outboard" accessory or, if preferred, incorporated as a built-in feature in an existing guitar or p.a. amplifier.

Aron has used *pnp* transistors (*Q1* and *Q2*) as common-emitter amplifiers. Jacks *J1* and *J2* provide individual channel inputs, *R1* and *R2* are the respective gain controls, *C1* and *C2* are channel input coupling capacitors, and *R3* and *R6* are base bias resistors. Resistors *R7* and *R8* serve partially as collector loads, but are intended primarily to isolate the stages. The combined output signal is developed across common collector load *R9*.

Unbypassed emitter resistors *R4* and *R5* introduce negative feedback which not only stabilizes each stage but also acts to raise the transistors' effective input impedances. The combined signal is applied to output jack *J3* through coupling capacitor *C3*. Operating power is furnished by *B1*, controlled by s.p.s.t. switch *S1*.

Inexpensive components are used throughout. Transistors *Q1* and *Q2* are 2N414's. Jacks *J1* and *J2* are open-circuit phone types, while *J3* is a standard phono jack. Potentiometers *R1* and *R2* are audio tapers and the resistors are all half-watters. Capacitors *C1*, *C2* and *C3* are 25-volt electrolytics, and switch *S1* can be either a toggle, slide, or rotary type. The power pack, *B1*, is a 6-volt battery.

Although neither parts placement nor wir-

(*Continued on page* 102)


# ON THE CITIZENS BAND

By **MATT P. SPINELLO,** KHC2060, CB Editor

SOME seventy Canadian GRS licensees recently attended the third General Radio Service Convention held in London, Ontario. The delegates appointed a resolutions committee and a group from their ranks to meet with Department of Transport (D.O.T.) officials in Ottawa.

The resolutions committee will ask the D.O.T. for use of CB channels 1, 2, 3, and 23. (Canadians have been restricted to the use of CB channels 4 through 22 to date.) This request was prompted by the D.O.T.'s recent type-acceptance of 23-channel transceivers for use in Canada.

## GRS DELEGATES CONVENE

Another of the 19 resolutions voted on at the Convention consists of a request that the D.O.T. continue its efforts to obtain a reciprocal licensing agreement with the United States Government giving Canadians in the U.S. the same privileges extended to American tourists in Canada. Canadians traveling in the U.S. are unable to use their transceivers to seek assistance from our CB'ers.

With the hope of increasing the effective use of the frequencies allocated to the General Radio Service, the Convention also voted to ask the D.O.T. to approve, without further delay, the use of single-sideband equipment.

And, according to still another resolution, the D.O.T. will be asked to make available to all licensees a handbook dealing exclusively with General Radio Service Rules and Regulations governing transceivers, antennas, legal accessories, and operating procedure. In the event the D.O.T. should decide not to act upon this request, an amendment to the proposal would ask the Central General Radio Service Association to publish the handbook.

In an address presented by Mr. Lorne Greenwood, Regional Superintendent, Radio Regulations, D.O.T., Toronto, Ontario, the Convention was congratulated for having made great progress. Mr. Greenwood also recalled that past Conventions had assisted in obtaining exemption from the radio log-keeping requirements which were once a part of the GRS rules.

As to the present situation, Mr. Greenwood remarked that "At the end of last March (1966) there were 41,534 GRS stations in Canada [and] the number of new licenses issued each year has been averaging between 11,000 and 12,000, but because a large number of licensees do not renew . . . the annual increase . . . of licensed stations has been averaging between 5000 and 6000."

"On the whole," he continued, "the General Radio Service seems to be working out satisfactorily and fulfilling the communications requirements of those for whom it was intended. There are abuses, as we all know, and in a few cases we have had to suspend the operation of stations to keep matters in hand. . .

"Because of the increasing demand for radio frequencies, I believe the same holds true for the GRS as for the other services —it is a matter of either *use* or *lose* your assigned channels. Therefore, the best advice I can give you is to not only use your portion of the radio frequency spectrum, but use it efficiently and legitimately so that you will always be in a position to justify its need.

"Most users of the radio frequency spectrum want to know what the prospects are for obtaining additional channels, and in this I can offer no encouragement. I like to take the positive approach in all matters and would hope that the future holds promise, but as far as radio frequency communications is concerned there would seem to be little hope for additional channels in the General Radio Service.

"Certainly, present usage and justifiable demand for usage will determine future frequency allocations, both nationally and internationally. But in view of the scarcity of this fixed natural resource, I cannot foresee the day when the demand for radio frequencies will even come close to being satisfied.

"One area where much can be done in improving efficiency in frequency utilization," Mr. Greenwood stated, in conclusion, "is in self-regulation. Your association has done much to encourage this in the General Radio Service and the Department appreciates your efforts in this respect. However, as you know, this is a never-ending task and we continue to solicit your cooperation in this matter. If we fail, the alternative could be more rigid regulations which none of us wants. The more flexible the regulations, the more freedom we have to adjust to changing conditions."

**National GRS Club Representative.** Gearald Inch, XM-44-969, has been appointed club representative for *SCOPE*, Canada's General Radio Service journal. The appointment was made shortly after the third GRS/CB camp-out held in Tillsonburg, Ontario, of which Gearald was chairman.


Gearald Inch, XM-44-969, new GRS club representative for SCOPE, is shown at his base station.

Under his leadership the event became the largest GRS/CB gathering in the history of the General Radio Service.

Gearald is also past-president of the South Western General Radio Association. His appointment to the unpaid, voluntary staff of *SCOPE* will put him in contact with GRS clubs across Canada and will enable *SCOPE* to give equal coverage to GRS organizational activities in all areas.

**"Me-te-a Trail Activities.** The 11-Meter Communications Squad, Inc., Fort Wayne, Ind., provided radio communications for the Boy Scouts of America's annual "Me-te-a Trail Activities." Communications were handled for nearly 48 hours, according to Jack Forbing, KHC2683, commanding officer of the "Squad," as 750 scouts tromped through a 14-mile hike. They established ten radio check points along the way, with FCC authorization for the operation under special license KUY3259.

The "Squad" was organized in January, 1960, and today (according to Forbing) sports a most impressive communications network of highly trained, hand-picked operators. Membership is limited to 40. Current officers: Jack Forbing, KHC2683, commanding officer; John Schmitt, KHE1033,


Commanding officer Jack Forbing, KHC2683, and executive officer John Schmitt, KHE1033, of the 11-Meter Communications Squad, Inc., Fort Wayne, Ind., hold blow-up of the official Squad insignia.

executive officer; Wayne Salge, KPJ5297, treasurer; Larry Soughan, KLK7277, technical staff; plus awards, public information, and special events officers.

**Special Edition.** Richard Steimel, well-known Midwest CB'er and Editor of the Lakeland Citizens Radio Net *Newsletter* (Madison, Wisconsin), recently published a special edition of the club's paper in honor of their fifth anniversary. CB club editors across the country who are on the LCRN's exchange list admitted that Rick's 26-page bulletin is one of the finest, most informative CB club papers ever published.

When the average club paper is larger than 10 pages, it's usually because it has been supplemented with recipes, reprints from other sources, advertising, and sometimes too many off-color jokes. Rick Steimel laid out the "club publication of the year" by eliminating all subjects unrelated to CB and electronics. In his special issue of historic information and statistics, the following full-length articles appear: "What Is Lakeland Citizens Radio Net?"; "Attendance Records Analyzed"; "Five Years At a Glance"; "How Does a Citizens Band Club Get Started?"; "Who Can Belong to a CB Club?"; "Club Activities—They Move the Club"; "State Association News"; "History Highlights"; "Where Does the Money Come From?"; "An Open Letter On Civil Defense"; plus much more information of the same high caliber.

Kudos from POPULAR ELECTRONICS to editor Richard Steimel, and to the members of the Lakeland Citizens Radio Net for five years of growth, development, and public service.

(*Continued on page* 118)

# FOREIGN-LANGUAGE BROADCASTS TO NORTH AMERICA

**Prepared by BILL LEGGE**

| LANGUAGE | STATION | Time—EST | Time—GMT | Frequencies (MHz) |
|---|---|---|---|---|
| ARABIC | Cairo, U.A.R. | 6:30-7:30 p.m. | 2330-0030 | 9.475 |
| | Damascus, Syria | 8-9 p.m. | 0100-0200 | 9.605 |
| BULGARIAN | Sofia, Bulgaria | 8-8:30 p.m. | 0100-0130 | 9.70 |
| CHINESE | Peking, China | 8-10 p.m. | 0100-0300 | 9.92, 12.01, 15.095 |
| | | 10-12 p.m. | 0300-0500 | 9.48, 12.01, 15.08 |
| CZECH/SLOVAK | Prague, Czechoslovakia | 8:30-9 a.m. (Sun.) | 1330-1400 | 15.285, 17.825 |
| | | 10-10:30 p.m. | 0300-0330 | 5.93, 7.115, 7.345 |
| DANISH | Copenhagen, Denmark | 7-8:15 a.m. | 1200-1315 | 15.165 |
| | | 8-9:30 p.m. | 0100-0230 | 9.52 |
| DUTCH | Brussels, Belgium | 6:15-8 p.m. | 2315-0100 | 9.615 |
| | Hilversum, Holland | 9:30-10:50 p.m. | 0230-0350 | 9.59 |
| FINNISH | Helsinki, Finland | 7:15-10:10 a.m. | 1215-1510 | 15.185 |
| FRENCH | Brussels, Belgium | 6:15-8 p.m. | 2315-0100 | 9.615 |
| | Lisbon, Portugal | 9:15-10 p.m. | 0215-0300 | 5.985 |
| | Paris, France | 4-5 p.m. | 2100-2200 | 11.885, 15.13 |
| | Rome, Italy | 8:20-8:35 p.m. | 0120-0135 | 9.63, 11.905 |
| | Vatican City | 8:10-8:35 p.m. | 0110-0135 | 6.145, 7.25, 9.645 |
| GERMAN | Berlin, Germany | 8:30-9:30 p.m. | 0130-0230 | 5.955, 9.73 |
| | Cologne, Germany | 7-10 p.m. | 0000-0300 | 6.10, 9.545 |
| | | 10 p.m.-1 a.m. | 0300-0600 | 6.10, 9.64 |
| | Vienna, Austria | 7-9 p.m. | 0000-0200 | 9.77 |
| HUNGARIAN | Budapest, Hungary | 7-7:30 p.m. | 0000-0030 | 6.235, 9.833 |
| | | 9-10:30 p.m. | 0200-0330 | 6.235, 9.833 |
| ITALIAN | Rome, Italy | 5:30-8 p.m. | 2230-0100 | 9.63, 11.905 |
| JAPANESE | Tokyo, Japan | 7:15-7:30 a.m. | 1215-1230 | 9.505, 9.605 |
| | | 8:30-9 p.m. | 0130-0200 | 15.135, 17.825 |
| NORWEGIAN | Oslo, Norway | 10-11:30 a.m. | 1500-1630 | 15.175 |
| | | 4-5:30 p.m. | 2100-2230 | 11.85 |
| PORTUGUESE | Lisbon, Portugal | 7-9 p.m. | 0000-0200 | 6.025, 6.185, 9.68 |
| | | 9:45-11 p.m. | 0245-0400 | 6.025, 6.185, 9.68 |
| RUMANIAN | Bucharest, Rumania | 6:15-7 p.m. | 2315-0000 | 6.16, 9.57 |
| | | 10:30-11 p.m. | 0330-0400 | 6.16, 9.57 |
| RUSSIAN | Moscow, U.S.S.R. | 7 a.m.-12:30 p.m. | 1200-1730 | 15.135 |
| | | 6:30-7 p.m. | 2330-0000 | 7.15, 9.685 |
| | | 8:30-9 p.m. | 0130-0200 | 7.15, 9.685 |
| SPANISH | Buenos Aires, Argentina | 8-9 p.m. | 0100-0200 | 9.69 |
| | | 11-12 p.m. | 0400-0500 | 9.69 |
| | Havana, Cuba | 6 a.m.-4 p.m. | 1100-2100 | 6.135, 15.30 |
| | | 5-11 p.m. | 2200-0400 | 6.135, 11.93 |
| | Quito, Ecuador | 6-9 a.m. | 1100-1400 | 9.745, 11.915, 15.115 |
| | | 7:30-9 p.m. | 0030-0200 | 6.05, 9.745, 11.915 |
| SWEDISH | Stockholm, Sweden | 8-8:30 p.m. | 0100-0130 | 9.705 |
| | | 11-11:30 p.m. | 0400-0430 | 9.705 |
| UKRAINIAN | Kiev, U.S.S.R. | 7:30-8 p.m. | 0030-0100 | 7.12, 9.665 |

# SHORT-WAVE LISTENING

By **HANK BENNETT**, W2PNA/WPE2FT
Short-Wave Editor

## BBC VERIFICATION POLICIES

A NUMBER of the readers of this column have asked if there has been a change in the announced verification policies of the British Broadcasting Corporation. Like the *Voice of America,* the BBC has a number of relay stations which rebroadcast programs originating in the London studios. They are located in Malta, Cyprus, Liberia, Aden, Malaysia, and Ascension Island.

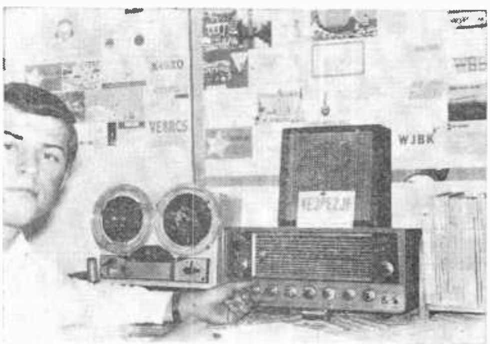
As far as we can determine, all reception reports should be sent to the London headquarters, % Chief Engineer, External Service, BBC, Bush House, Strand, London, W.C. 2, England. Unless your report contains exceptionally valuable information (a transmitter fault, identity of new interfering stations, or a sudden or unexpected change in propagation conditions), you will probably receive one of the well-known "Big Ben" acknowledgment cards indicating the location of the specific relay station (presuming that the frequency reported was correct), and a letter which will simply state that the report is in accordance with their published schedule.

Very few true verifications of the BBC London (or old Daventry) stations are in existence. Your Short-Wave Editor was fortunate in receiving one from the BBC TV outlet operating on 41,500 kHz from the Crystal Palace in London.

**1967 Red Cross Tests.** In 1967 the Radiocommunications Service of the International Committee of the Red Cross, Geneva, Switzerland, will make test broadcasts on 7210 kHz on the following dates: March 13, 15, and 17; May 22, 24, and 26; July 17, 19, and 21; September 18, 20, and 22; November 20, 22, and 24. Transmissions on all dates will be at 0600-0700, 1130-1230, 1500-1600, and 2300-0000. The 150-kW transmitter will be at Schwarzenburg working into a nondirectional antenna. Languages are to include French, English, and Spanish. You can obtain report forms upon request from the ICRC, 7 Avenue de la Paix, 1211 Geneva 1, Switzerland.

Unfortunately, news of the Red Cross tests was received too late for notice of the broadcasts which took place on January 23, 25, and 27 to be published here in time to be of any use. However, the ICRC offers all listeners able to send in reports on reception of broadcasts for all six months an attestation of "Listener of ICRC Test Broadcasts."

(*Continued on page* 113)



Thomas Treszow, VE3PE2JF, of Toronto, Ontario, Canada, uses a Lafayette HA-225 but keeps an old Philco 825-WAL (not shown) in reserve. He has 23 countries verified out of 55 heard; 24 states verified out of 47 heard. Thomas is also an amateur photographer—he took this photo himself.

John Shoptaw, WPEØEPO, Morehouse, Mo. (at right), receives with a Knight-Kit "Star Roamer" assisted by a 75' "L"-type antenna, 35' high. His record: 67 verified out of a total of 136 countries heard.

# ENGLISH-LANGUAGE BROADCASTS TO NORTH AMERICA

## FOR THE MONTH OF MARCH

**Prepared by ROBERT LEGGE**

### TO EASTERN AND CENTRAL NORTH AMERICA

| TIME—EST | TIME—GMT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|---|
| 7 a.m. | 1200 | Copenhagen, Denmark | 15.165 |
| 7:15 a.m. | 1215 | Helsinki, Finland | 15.185 (Tues., Sat.) |
| | | Melbourne, Australia | 9.585 or 11.71 |
| 6 p.m. | 2300 | London, England | 6.195, 7.13, 9.51 |
| | | Moscow, U.S.S.R. | 7.15, 7.205, 9.665, 9.685 |
| 6:45 p.m. | 2345 | Tokyo, Japan | 15.135, 17.825 |
| 7 p.m. | 0000 | London, England | 6.195, 7.13, 9.51 |
| | | Moscow, U.S.S.R. | 7.15, 7.205, 9.665, 9.685 |
| | | Peking, China | 15.06, 17.68 |
| | | Sofia, Bulgaria | 9.70 |
| | | Tirana, Albania | 7.263 |
| 7:30 p.m. | 0030 | Budapest, Hungary | 6.235, 9.833 |
| | | Johannesburg, South Africa | 9.675, 11.88 |
| | | Kiev, U.S.S.R. | 7.12, 9.665 (Mon., Thurs., Fri.) |
| | | Stockholm, Sweden | 9.705 |
| 7:50 p.m. | 0050 | Vatican | 6.145, 7.25, 9.645 |
| 8 p.m. | 0100 | Berlin, Germany | 5.955, 9.73 |
| | | Havana, Cuba | 6.17, 11.76 |
| | | London, England | 6.195, 7.13, 9.51 |
| | | Madrid, Spain | 6.13, 9.76 |
| | | Moscow, U.S.S.R. | 7.15, 7.205, 9.665 |
| | | Prague, Czechoslovakia | 5.93, 7.115, 7.345, 9.55 |
| | | Rome, Italy | 9.63, 11.905 |
| 8:15 p.m. | 0115 | Berne, Switzerland | 6.12, 9.535, 11.715 |
| 8:30 p.m. | 0130 | Bucharest, Rumania | 5.975, 7.195 |
| | | Cairo, U.A.R. | 9.475 |
| | | Cologne, Germany | 6.075, 9.735 |
| | | Hilversum, Holland | 9.59 |
| 9 p.m. | 0200 | Lisbon, Portugal | 6.025, 6.185, 9.68 |
| | | London, England | 6.195, 7.13, 9.51 |
| | | Moscow, U.S.S.R. | 7.15, 7.205, 9.665 |
| | | Stockholm, Sweden | 9.705 |
| 10 p.m. | 0300 | Bucharest, Rumania | 5.975, 7.195 |
| | | Budapest, Hungary | 6.235, 9.833 |
| | | Buenos Aires, Argentina | 9.69 (Mon.-Fri.) |
| | | Havana, Cuba | 6.135, 6.17 |
| 10:30 p.m. | 0330 | Accra, Ghana | 6.11 |
| | | Prague, Czechoslovakia | 6.095, 7.115, 7.345, 9.55 |

### TO WESTERN NORTH AMERICA

| TIME—PST | TIME—GMT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|---|
| 6 p.m. | 0200 | Melbourne, Australia | 15.22, 17.84 |
| | | Tokyo, Japan | 15.135, 15.235, 17.825 |
| 6:50 p.m. | 0250 | Taipei, China | 15.125, 15.345, 17.72 |
| 7 p.m. | 0300 | Moscow, U.S.S.R. | 15.14, 15.18, 17.76 |
| | | Peking, China | 9.457, 11.82, 15.095 |
| 7:30 p.m. | 0330 | Stockholm, Sweden | 9.705 |
| 8 p.m. | 0400 | Sofia, Bulgaria | 9.70 |
| 8:30 p.m. | 0430 | Budapest, Hungary | 6.235, 9.833 |
| 8:45 p.m. | 0445 | Cologne, Germany | 6.145, 9.735 |
| 9 p.m. | 0500 | Berne, Switzerland | 5.965, 9.535 |
| | | Moscow, U.S.S.R. | 9.64, 11.755, 11.85 |

# AMATEUR RADIO

By **HERB S. BRIER**, W9EGQ
*Amateur Radio Editor*

## THUMBNAIL REVIEW OF TR-108 TWO-METER TRANSCEIVER

LOOKING for a neat little 2-meter station for your shack or car? The Knight-Kit TR-108 transceiver may end your search. It features a 15-watt, crystal-controlled AM transmitter, a better-than-average dual-conversion receiver, and a combination 12-volt (transistorized) d.c. and 117-volt a.c. power supply. All this is accomplished with 12 tubes and 2 transistors. The TR-108 is distributed by Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680. A matching accessory VFO is also available.

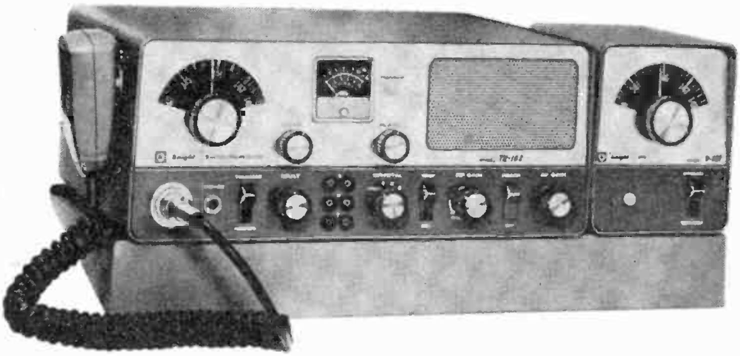
The TR-108 assembly instructions are crystal-clear, and should be easy to follow by anyone who can solder and use simple hand tools. Although we kept no precise time figures and did not try to rush the job, assembly took an estimated 40 hours. (Assembling the matching V-107 VFO required another evening.) A major contribution to the ease of construction is the pre-assembled and pre-aligned, crystal-controlled receiver "front end," which can be installed in minutes using two nuts and soldering four leads.

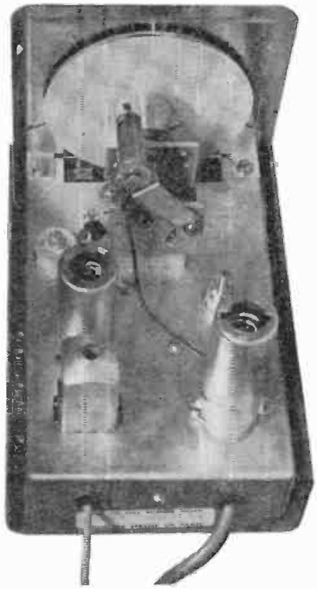
The completed unit worked after a fashion even before it was aligned; but it worked much better after alignment, of course. Although the manual recommends using a 1650-kHz modulated signal generator and two VTVM's to align the receiver i.f. transformers, a single VTVM can be employed if you switch it between the two test points. At any rate, the procedure is completely straightforward.

Peaking the transmitter requires a dum-

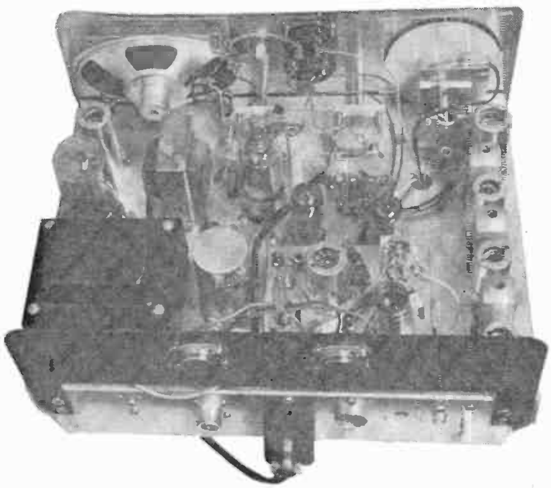
### AMATEUR STATION OF THE MONTH

Paul Dumais, W1LJO, Newton Centre, Mass., works all amateur frequencies from 3.5 to 148 MHz. With a 93' tower supporting a 10-, 15-, and 20-meter tri-band beam and a 6- and 2-meter beam antenna to supplement a Hallicrafters HT-32 SSB and Johnson 500 and "6-N-2" transmitters, Paul has little trouble making contacts. (His WAS, WAC, and DXCC certificates prove it.) The receiving is handled by a Collins 75A-4 and a Hammarlund HQ-170 with converters for 50 and 144 MHz. Paul will receive a one-year subscription to POPULAR ELECTRONICS for submitting the winner for March in our Amateur Station of the Month photo contest. To enter the contest, send a clear picture of your station with you at the controls and some details on the equipment you use and your amateur career to: Amateur Photo Contest, c/o Herb S. Brier, W9EGQ, Box 678, Gary, Ind. 46401.





The Knight-Kit TR-108 2-meter transceiver (shown above with its companion V-107 VFO) features 15-watts input to a 2E26 on "transmit," and a dual-conversion superhet with a crystal-controlled converter on "receive." The built-in power supply works both on 117 volts a.c., and 12-15 volts d.c. Interior views are shown below. Except for the common power supply and audio system, the transmitter and receiver sections of the TR-108 are essentially independent of each other. The switching transistors for 12-volt operation are centered on their common heat sink (below, right). Directly at right is an interior view of the transceiver's matching V-107 VFO.



my antenna, which may consist of four #47 pilot bulbs and crystals near each end and the center of the 2-meter band, in addition to the VTVM. The crystals, which oscillate in the 8-MHz range, are later used in normal transmitter operation.

The TR-108 delivers approximately five watts to the antenna and puts out an excellent signal over the normal 2-meter working range; this was verified by your reviewer by the ease of making contacts with a simple, non-directional antenna. Using the microphone supplied, all quality and modulation reports have been flattering. While a VFO is not quite as desirable on the VHF's as on the crowded lower frequencies, having one is undoubtedly an operating convenience; and the companion Knight-Kit V-107 VFO works well in conjunction with the TR-108. After a 15-minute warm-up, its stability is good for equipment of this kind; it is not entirely drift-free, however.

Contrary to the performance of some VHF tranceivers, the rated 1-$\mu$V sensitivity and 8-MHz selectivity of the TR-108 on "receive" are more than adequate for a unit of this type. Furthermore, its automatic noise limiter chops ignition noise from passing cars and similar impulse noises down to size. Plugging in the d.c. power plug automatically converts the power supply from power-line operation to 12-volt d.c. mobile operation.

In your reviewer's opinion, the Knight-

(*Continued on page* 110)

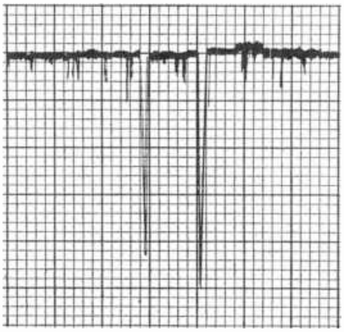
Some plain talk from Kodak about tape:

# Uniform magnetic sensitivity

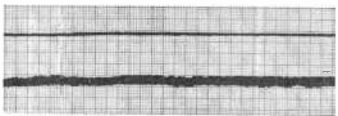
**(or the lack thereof)**

Uniformity for a tape is like kissing babies for a politician. Without it, you're hardly in the running. We take uniformity in all of tape's characteristics very seriously at Kodak. Maybe it's all those years of putting silver emulsions on film that's made us so dedicated to the idea. Uniformity in terms of magnetic sensitivity is one of the most important measures of a tape's performance. Non-uniformity can result in all sorts of bad things like level shifts, instantaneous dropouts, periodic non-uniformity, output variations, distortion, and variations from strip to strip.

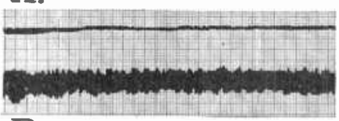
Testing for all these possible flaws on a tape is a simple procedure in the lab. Standard industry practice is to record a long wavelength signal (37.5 mil) at a constant input level. The signal from the playback amplifier is then filtered and the output at particular critical wavelengths is permanently charted by a high-speed pen recorder which registers variations on a chart. Instantaneous dropouts caused by foreign matter on the tape surface, for example, would look like this:



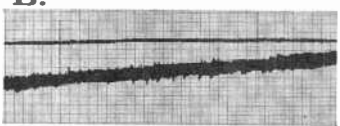
**The long and the short of it.** The low-frequency procedure gives a good picture of variations in oxide thickness. We take it one step further . . . also test for short wavelength—1.0 mil. This helps evaluate surface smoothness and tape-to-head contact. Taken together, they aid in evaluating the level of lubrication, slitting, and oxide binder characteristics. The smoother the lines, the more uniform the magnetic sensitivity. Guess which graph below is KODAK Sound Recording Tape (the other two graphs represent quite reputable brands of other manufacture):



**A.**



**B.**



**C.**

**What looks good sounds good.** Congratulations if you picked brand A, Kodak tape. It is notably more uniform . . . doesn't vary more than ¼ db within the reel . . . no more than ½ db from reel to reel.

You benefit as follows:

1. *Within-reel uniformity.*

(a) Less instantaneous and short-term amplitude modulation of the signal, which results in a cleaner signal on playback.

(b) Reduced drift gives less variation in frequency response.

(c) Better uniformity across the strip width (no lengthwise coating lines) results in a more nearly balanced output for stereo recordings.

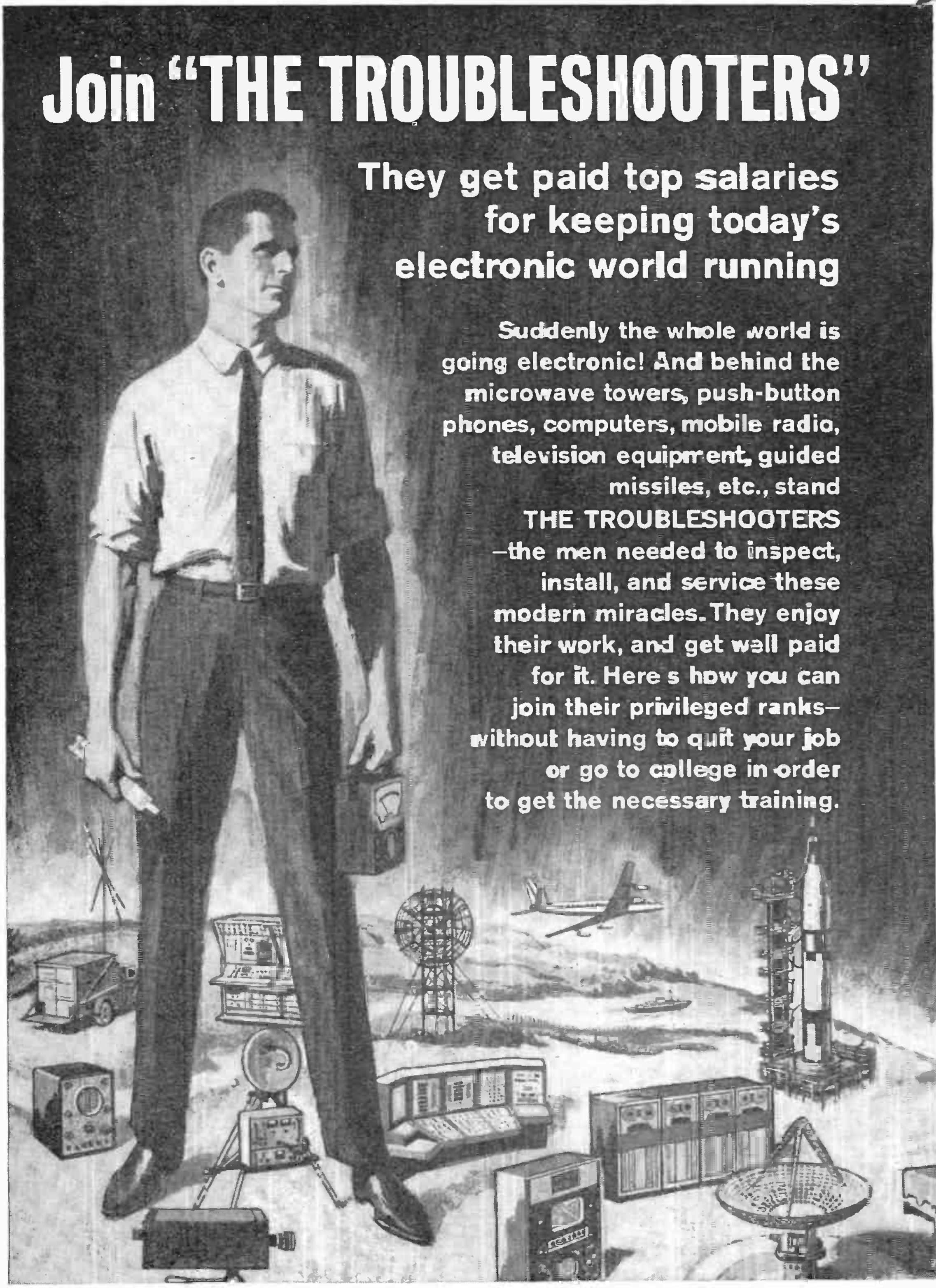
2. *Reel-to-reel uniformity*

(a) Better coating uniformity gives a more uniform low-frequency sensitivity. This allows splicing of sections of tape from one reel with tape from other reels without obvious signal level changes.

(b) Better coating uniformity also results in a minimum change in optimum bias which allows the professional to establish an operating bias nearer the optimum bias.

KODAK Sound Recording Tapes are available at most camera, department, and electronic stores. New 24-page comprehensive "Plain Talk" booklet covers all the important aspects of tape performance, and is free on request. Write: Department 940, Eastman Kodak Company, Rochester, N.Y. 14650.


CIRCLE NO. 11 ON READER SERVICE PAGE


Join "THE TROUBLESHOOTERS"
They get paid top salaries for keeping today's electronic world running
Suddenly the whole world is going electronic! And behind the microwave towers, push-button phones, computers, mobile radio, television equipment, guided missiles, etc., stand THE TROUBLESHOOTERS —the men needed to inspect, install, and service these modern miracles. They enjoy their work, and get well paid for it. Here's how you can join their privileged ranks—without having to quit your job or go to college in order to get the necessary training.

JUST THINK HOW MUCH in demand you would be if you could prevent a TV station from going off the air by repairing a transmitter...keep a whole assembly line moving by fixing automated production controls...prevent a bank, an airline, or your government from making serious mistakes by repairing a computer.

Today, whole industries depend on electronics. When breakdowns or emergencies occur, someone has got to move in, take over, and keep things running. That calls for one of a new breed of technicians—The Troubleshooters.

Because they prevent expensive mistakes or delays, they get top pay—and a title to match. At Xerox and Philco, they're called Technical Representatives. At IBM they're Customer Engineers. In radio or TV, they're the Broadcast Engineers.

What do you need to break into the ranks of The Troubleshooters? You might think you need a college diploma, but you don't. What you need is know-how—the kind a good TV service technician has—only lots more.

### Think With Your Head, Not Your Hands

The service technician, you see, "thinks with his hands." He learns his trade by taking apart and putting together, and often can only fix things he's already familiar with.

But as one of The Troubleshooters, you may be called upon to service complicated equipment that you've never seen before or *can't* take apart. This means you have to be able to take things apart "in your head." You have to know enough electronics to understand the engineering specs, read the wiring diagrams, and calculate how a circuit should test at any given point.

Now learning all this can be much simpler than you think. In fact, you can master it without setting foot in a classroom and without giving up your job!

### AUTO-PROGRAMMED™ Lessons Show You How

For over 30 years, the Cleveland Institute of Electronics has specialized in teaching electronics at home. We've developed special techniques that make learning easy, even if you've had trouble studying before.

For one thing, our AUTO-PROGRAMMED™ lessons build your knowledge as you'd build a brick wall—one brick at a time. Each piece rests securely on the one that came before it.

**ENROLL UNDER NEW G.I. BILL**

All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now, check box on reply card for G.I. Bill information.

In addition, our instruction is personal. When your teacher goes over your assignment, no one else competes for his attention. You are the only person in his class. He not only grades your work, he analyzes it to make sure you are thinking correctly. And he returns it the day it's received so that you can read his comments and corrections while everything is fresh in your mind.

### Always Up-To-Date

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In addition, there is complete material on the latest troubleshooting techniques including Tandem System, Localizing through Bracketing, Equal Likelihood and Half-Split Division, and In-circuit Transistor Checking. There are special lessons on servicing two-way mobile equipment, a lucrative field in which many of our students have set up their own businesses.

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Two-way mobile work and many other types of troubleshooting call for a Government FCC License, and our training is designed to get it for you. But even if your work doesn't require a license, it's a good idea to get one. Your FCC License will be accepted anywhere as proof of good electronics training.

And no wonder. The licensing exam is so tough that two out of three non-CIE men who take it fail. But CIE training is so effective that 9 out of 10 of our graduates pass. That's why we can offer this warranty with confidence: *If you complete one of our license preparation courses, you'll get your license—or your money back.*

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Want to know more? Mail the postage-paid reply card bound here. We'll send our 40-page catalog describing our courses and the latest opportunities in Electronics. We'll also send a special book on how to get a Commercial FCC License. Both are free. If the card is missing, just send us your name and address.

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A Leader in Electronics Training... Since 1934

# JUST WHEN I FORGOT MY (SOLDERING) GUN!

Sequel 4

THE UNABATED FLOOD of entries in our contest on nonsensical remarks about electronics continues on its merry way. Although the "type" of submission seems to have changed—there is a steady incoming flow of puns—we are pleased to see that this contest still has an enormous following.

If you have heard a wild, implausible, or inane remark about electronics, why not tell us about it? Send it in and you may win a soldering gun, a prize that will help you "snuff out" some of those people who talk without thinking.

Typical remarks have appeared in the July, September, November, and December issues.

**All About Wives.** For some inexplicable reason, "wife" remarks are always good for a laugh and five of the better stories received in the past few weeks concern equipment repair as seen through the eyes of the female side of the household. One hi-fi service call involved what was obviously a frozen motor shaft in a record player. When this fact was announced, the offended housewife exclaimed, *"That isn't true; it's never been that cold in this room!"*

The electronic engineer's wife who is always phoning her husband in the office decided to take things into her own hands when the TV receiver went bad, so she phoned a radio-TV service shop. After she explained the trouble, and the shop diagnosed the symptoms, the wife hung up and then telephoned her husband to bring home an *"intermittent tube."*

When another wife had the TV repairman come over to the house, it didn't take him long to spot the source of trouble, for there was the 300-ohm lead-in hanging a good 1" away from the TV receiver antenna terminal. When this fact was pointed out, the wife indignantly stated that she couldn't see "how come" *the TV signal had traveled 25 miles through the air to get to the antenna and then couldn't jump this last remaining little gap.*

Then, there was the woman who had the repairman come in to fix the vacuum cleaner. Claiming that it needed new brushes, he removed a worn brush, placed it on the table, and said, "Look at this." The housewife exclaimed, *"Well, I'll be! There's not a hair left on it."*

Finally, there was the housewife who had received a solid-state stereo receiver as a Christmas present; when the repairman arrived, he found that the a.c. cord hadn't been plugged in. Why not? Obviously, *anything*—according to the housewife—*that uses transistors uses batteries.*

**Puns, Puns, and More Puns.** The 1967 Lafayette Electronics catalog has a "Tube Gadget" listed on p. 277. It is described as a "combination 7 and 9 pin miniature tube straightener and tube puller." *It must be specially made for bent tubes.* . . . A group of Californians that reconditions old cathode-ray tubes supported Ronald *Re'gun* for Governor. . . . Mad Magazine's Alfred E. Neumann exclaimed on seeing his new ham ticket, *"What me WØRRY?"*. . . . RCA Victor has a recording crew in Haiti taping some voodoo music —it seems *they bought the rites.*

A woman in my neighborhood with a new color TV receiver had the repairman come over to *delouse the picture tube*. . . . Now that I'm interested in electronic espionage, my wife *wants my bug detector to get the moths out of her closet.* . . . A customer in a hi-fi salon rejected stereo discs, claimed she wanted some new *multiplex recordings*. . . . How come that raven in my room keeps saying *"Neper More"?*

My soldering iron developed a short and my wife *can't understand why I don't lengthen it.* . . . Did you know that if you *keep a roll of solder in the refrigerator you can make better cold solder joints?* . . . You've got to watch those store clerks; the last one didn't know anything at all about *collapsible cable.* . . . My wife's brother is so stupid he believes that if I hooked together all the batteries on earth I'd have *a world series.* . . . Did you hear about the fellow who thinks that *heptode tubes are cool frogs?*

**Winners.** This month soldering guns go to Michael Breuning, Dennis Courtney, Bruce Feezel, Robert Fleischer, Leroy Ireland, J. V. Luczynski, Don Norwood, Bruce Potterton, Charles Saleeby, Larry Simko, Earl Switzer, and Byron G. Wels. -30-

# THE "SUPERTROL"

(*Continued from page* 44)

In this application, the connection from the battery to terminal *A* is broken to prevent *C1*, which is rated at 6 volts, from charging up and shorting out. If you want to replace *C1* with a capacitor of higher voltage rating, say 25 volts, then the connection at point *A* need not be broken. It is important that you put *Q1* back in its socket before applying power to the circuit.

The connections for an interval timer or a time delay relay are the same as required for the voltage level detector (Fig. 6), except that the relay contact selection must be as shown in Fig. 7. This circuit also includes a d.p.d.t. switch, used to control the load power while charging capacitor *C1* is being shorted out. In position 2, power is applied to one set of contacts to enable the capacitor to charge sufficiently to trigger the Schmitt trigger circuit. The charging time is, of course, determined by the setting of *R11*. When *C1* charges to its upper trip point, *Q1* conducts and the relay switches power from the interval output to the delay output. When the switch is flipped to position 1, the capacitor is shorted through a resistor, and the circuit is reset.

The hookup shown in Fig. 7 can be used for a darkroom photo timer, as a delay relay to allow the filaments of a transmitter to warm up before plate voltage is applied, or as a starting relay for a generator or a fluorescent lighting system. You can also use it in a driveway or hallway lighting circuit to extinguish the lighting by delay action. By varying *R11*, the circuit can be made to introduce a time delay varying from 50 milliseconds to 10 seconds.

To keep the load from oscillating, an additional relay can be added to the output connections to lock up on its own contacts and thereby provide a continuous stable output. Another approach to this problem is to reset the switch to position 1 approximately 8 seconds or so before the oscillation starts. —30—

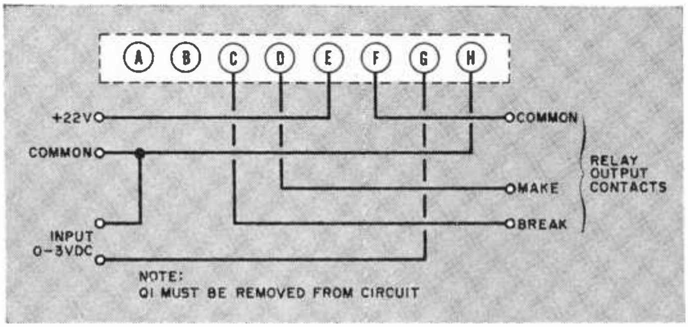



Fig. 6. Remove transistor Q1 and make the external connections in this diagram and your Supertrol becomes a low voltage sensor. An input of 2 volts turns the circuit on and a drop below 1 volt turns the circuit off. This circuit could be used as an alarm.

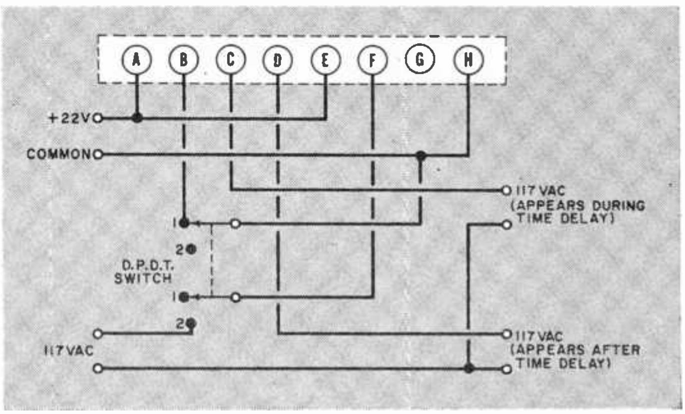



Fig. 7. The most practical application of the Supertrol is as an interval timer. However, this requires an external d.p.d.t. toggle switch wired into the circuit as shown here. Timing begins with the switch in position 2. Circuit reset is position 1.

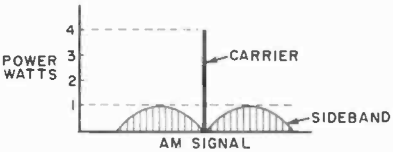
## THE "MULE BOX"

(*Continued from page* 50)

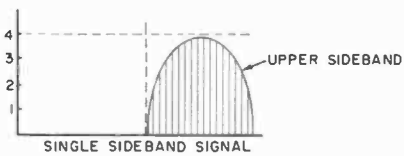
A few words of warning concerning the adjustments described above are in order at this time. First, running the carrier output at a higher level than indicated will only result in illegal operation and short tube life. Output power will not be increased, since the tube cannot produce any more power with the power supply specified. -30-

### Why DSBRC?

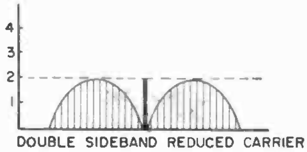
According to FCC Regulations (Part 95.43), the ideal unmodulated CB transmitter would have an average power input of 5 watts and an average power output of 4 watts. When the carrier wave is 100% amplitude-modulated, two sidebands appear, also containing r.f. power, but particularly carrying all of the useful voice intelligence, as in (A) below. To increase the "talk power" of a CB rig, a possible method would be to eliminate the useless carrier and concentrate all of the available r.f. energy in one or both sidebands, as in (B). Although advanced forms of voice communications (SSB) do just this, the absence of a carrier introduces a new set of complex receiving problems. The "Mule Box" effects a compromise by reducing the r.f. power in the carrier and simultaneously increasing the power in the intelligence-carrying sidebands, as in (C). Thus, the DSBRC signal sounds "louder." This idea has been used commercially for several years in the Regency "Range Gain" CB transceiver.




(A)




(B)




(C)

## "MIXED TWELVE"

(*Continued from page 77*)

Draw the cutout shapes on the front panel as shown in Fig. 4. Carefully cut out the openings and then paint the front of the panel and the sides of the openings. Use flat black paint to obtain a uniform front panel appearance and to keep the openings from being noticeable through the grille cloth.

Glue and nail all joints. Be sure to sand and stain the cabinet before tacking the grille cloth in place. Frame the front panel with ½" quarter-round molding.

Now center and mount the speakers over their respective holes, using 8 x ¾" pan-head sheet-metal screws to secure them. Glue 1" x 2" pieces of wood between the rows of speakers as shown in Fig. 5.

Wire the speakers all in phase as shown in Fig. 6. You can check speaker

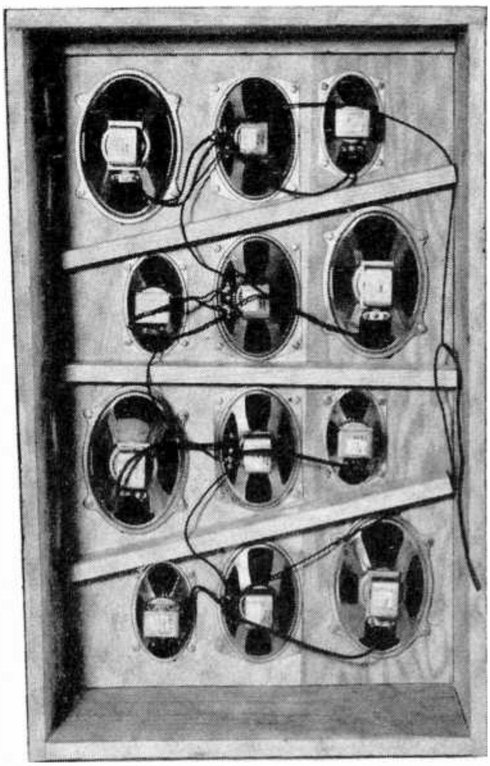


Fig. 5. Glue cleats between rows of speakers. Sturdier cabinet construction can be obtained if cleats are also used for mounting front board in place.

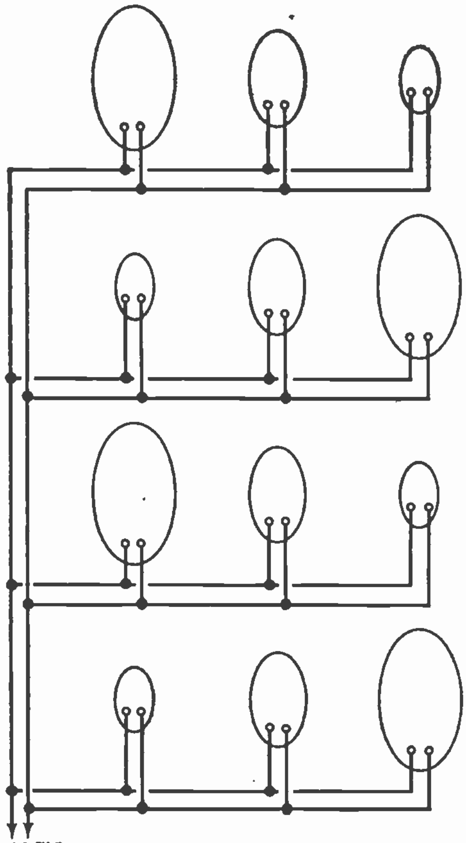



Fig. 6. Double-check wiring to make sure that all speakers are connected in phase. Simple battery test described in text can be used for this purpose.

phase by observing the direction of cone movement as you momentarily connect a 1½"-volt flashlight battery across the speaker terminals. When the speakers are all wired in place, double-check the phase by once again momentarily connecting the battery across the entire system; all cones should move in the same direction at the same time. If any of the cones do not move in the same direction as the majority, reverse the connections on the nonconformers.

To dampen the system, tack a 2"-thick sheet of cotton batting, or other suitable material, to the top of the cabinet and let it drape down to the bottom of the cabinet to form a thick "curtain" over the backs of the speakers.

Connect the "Mixed Twelve" to the 4-ohm output terminals on your hi-fi amplifier . . . and relax. -30-

## STEREO PREAMPLIFIER

*(Continued from page 72)*

unwanted feedback, crosstalk, and stray leakage paths. Component layout on the printed circuit boards is shown in Fig. 6.

The photographs (Figs. 7, 8, and 9) show the preamp mounted in a metal cabinet, but you can house the circuits in any type of enclosure. The input and output jacks are mounted on the back panel. Wire them in and leave enough length to reach the selector switch (*S1*) on the front panel.

Connect the voltage divider resistors (*R27* and *R29*) directly to the AM and FM inputs respectively. One end of resistors *R28* and *R30* can be tied to a

### SPECIFICATIONS

| | | | |
|---|---|---|---|
| Frequency Response | 10 to 100,000 Hz ± 1 dB (tone controls set for flat response) | | |
| Sensitivity (input needed for 1.0 volt rms output) | Phono: | 20 millivolts | |
| | Tape: | 12 millivolts | |
| | Mic: | 15 millivolts | |
| | AM-FM: | 0.95 volt | |
| Maximum Input (before clipping occurs, measured at 1 kHz) | | 12-Volt Supply | 24-Volt Supply |
| | Phono: | 30 mV | 60 mV |
| | Tape: | 25 mV | 50 mV |
| | Mic: | 25 mV | 50 mV |
| | AM-FM: | 1.25 V | 2.5 V |
| Maximum Output | 12-Volt Supply: 1.5 V rms | | |
| | 24-Volt Supply: 3.0 V rms | | |
| Distortion (measured at 1 volt rms output) | Less than 0.06%, any frequency from 20 to 20,000 Hz | | |
| Noise | Phono, Tape, Mic Inputs: | −65 dB | |
| | AM, FM Inputs: | −70 dB | |
| Input Impedance | At least 200,000 ohms, any input | | |
| Output Impedance | Less than 10 ohms | | |
| Without Compensation Networks | Frequency Response: | 50 to 10,000 Hz ±3 dB | |
| | Gain: | 60 dB | |
| | Input Impedance: | 10,000 ohms | |
| | Output Impedance: | 100 ohms | |
| Power | 12 to 24 volts, d.c., 4 to 8 milliamperes | | |

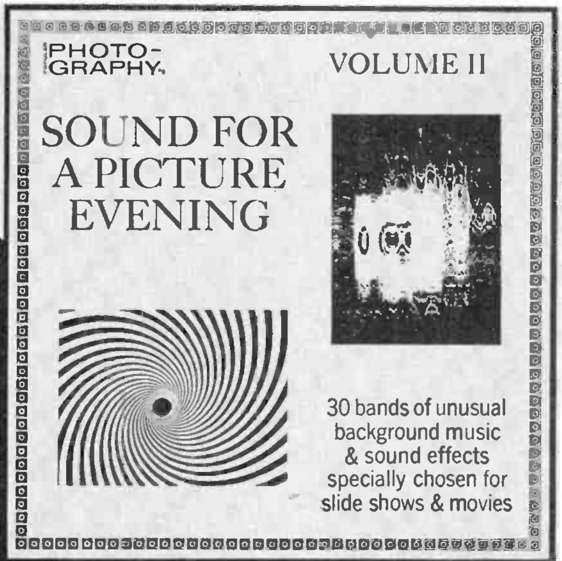
*Bring your slides and movies to Life...*

**( and your audience, too! )**

WITH VOLUME II

# SOUND FOR A PICTURE EVENING

**This superb 12-inch, 33⅓ rpm record brings you 30 selections of sparkling, mood-setting off-beat music and hard-to-find, sound effects. For use "as is" by playing the appropriate tracks as your slide or movie show proceeds or for editing your selections and recording them on tape, "Sound For A Picture Evening" adds another dimension to your photography—high fidelity sound.**




*19 Bands of mood and special-situation music... 11 Bands of unusual, hard-to-find sound effects...*

## MADE WITH PHOTOGRAPHERS IN MIND

Photographers are travelers . . . are parents . . . are sportsmen . . . are restless experimenters with the unusual. And so the editors of POPULAR PHOTOGRAPHY have produced this second volume of unusual music and sound effects expressly to match the activities and moods in the most popular types of pictures shown in slide and home movie shows. These are melodies and sounds selected from the vast resources of the Capitol Record Hollywood Library to fit the special needs of photographers. The 30 bands of "Sound For A Picture Evening, Vol. II" supplement but do not duplicate any of those in the first edition of this popular record.

## A POPULAR PHOTOGRAPHY EXCLUSIVE

The "Sound For A Picture Evening, Vol. II" album has been produced by the editors of POPULAR PHOTOGRAPHY exclusively for our readers and is prepared by the Custom Services Division of Capitol Records. This outstanding album, which cannot be purchased in any store, is available by mail only to the readers of Popular Photography and other Ziff-Davis magazines.

## YOU GET 30 SPECIAL MUSIC AND SOUND TRACKS

There are 19 bands of mood and special-situation music . . . 11 bands of unusual, hard-to-find sound effects.

MOODS: Majestic, Backyard Nature, Experimental, Mysterious, Music of the Spheres • NATIONAL PORTRAITS: Vive la France, German Village Band, Soul of Spain, American West, English Countryside, Buon Giorno, Italia •

SOUND EFFECTS: Bass Drum, Bassoonery, Cathedral Bells, Galloping Horses, Zoo Noises, Children at Play, Cocktail Party, Birds on a Spring Morning, Outboard Motor, Oars in Water, Skis on Snow, Trumpet Fanfare, Solo Violin • SPECIAL PURPOSE MUSIC: Music From Silent Movies, Music for Slow-Motion Movies, Music for Speeded-Up Motion, Music for Stop-Motion Movies, Underwater Music, Music for Old-Time Footage.

For photographers with wanderlust, you'll find the "National Portraits" to be authentic melodies to go with your vacation pictures of England, France, Germany, Italy, Spain and the American West.

There are also those special bands to accompany the kind of pictures sportsmen take: The sound of galloping horses, of boat motors, of skis on snow, of oars in the water. You'll even find other-wordly mood-music chosen especially to go with underwater pictures.

Experimental photographers will find the electronic music ideal accompaniment for abstract pictures. The music for stop-motion, slow-motion and speeded-up-motion pictures is fanciful and imaginative in helping to present the unusual scenes being portrayed on your screen. And there is even mood music to convey the visual grandeur of ancient museum relics and photographs of the stars and planets.

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Please send ________ "Sound For A Picture Evening, Volume II" albums at $3.98 each, postpaid. My check (or money order) for $________ is enclosed. (Outside U.S.A. please send $5.00 per record ordered.)

N.Y. State residents please add local sales tax.

Name ____________________

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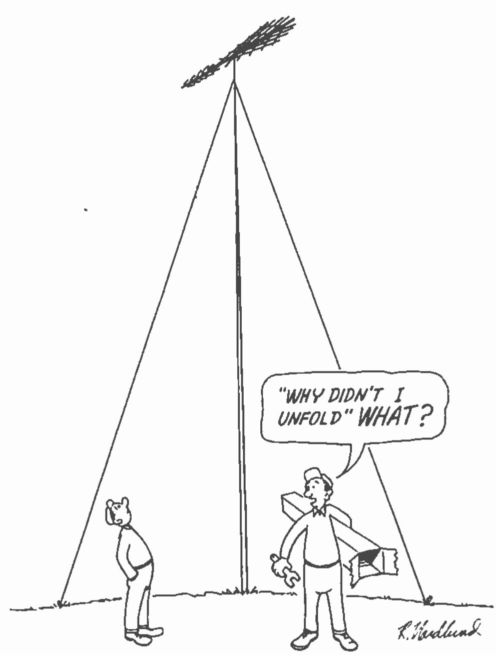
**"SOUND FOR A PICTURE EVENING, VOLUME I" still available.** I missed this first release containing 17 specific mood music backgrounds and 8 tracks for special sound effects. Please send ________ "Sound For A Picture Evening, Volume I" albums at $3.98 each, postpaid. (Outside U.S.A. send $5.00 per record ordered.)

single ground terminal mounted on the chassis next to the input jacks. It's a good idea to use shielded leads between the input jacks and the switch. If you do use shielded wires, connect only one end of the shields to ground, near the input jacks. Do not connect the shields to ground at the switch end of the wire.

Drill holes in the chassis to mount the circuit boards, using the boards as templates. Cut a notch in the chassis to clear the selector switch and wire the input leads to the switch before assembling the chassis to the front panel. The boards are mounted on ½-inch threaded spacers. Wire the controls and upper section of the rotary switch and the job is done.

**Finishing Touches.** A balance control could be included in the "Two-By-Two" to optimize adjustments for stereo programs. However, adjustment for balance is easily obtained by the use of concentrically-stacked volume controls which can be individually adjusted.

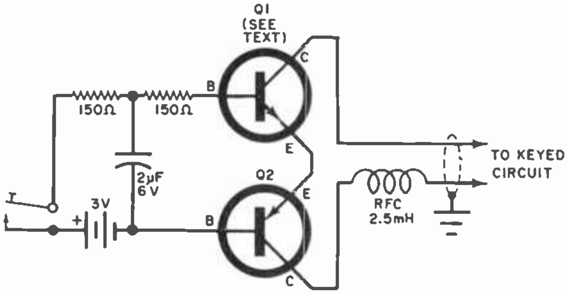
And, of course, you can dress up the front panel of the cabinet with self-sticking vinyl plastic such as the material used for shelf covering. Decals can be applied and sealed with a clear plastic spray. -30-



## INFORMATION CENTRAL

(*Continued from page* 68)

Eliminating key clicks is not all that simple, but you might try the circuit shown in the accompanying diagram. I have used this method to key a CW transmitter and it sure helps to cut down on key clicks—depending on the keying circuit. Transistor *Q1* can be a 2N438, 2N579 or 2N316; for




*Q2* I recommend trying a 2N595, 2N446, 2N377, or 2N585. You may also find it advantageous to vary the capacitor value for best results.

**Quickie Electronics Course.** *Is there a cheap refresher electronics study course I can buy?*

There are many courses that would fit the bill, but your best bet might be the brand-new 3-part self-study course offered by Westinghouse. There are three separate instructional handbooks and all of the fundamentals are covered—including molecular electronics. The complete course is $3 and should be ordered by requesting handbooks SA-9498, SA-9498 Pt.A, and SA-9498 Pt.B. Write to: Basic Electronics Course, Westinghouse Electric Corp., Printing Division, Box 398, Trafford, Pa. 15085. —30—

## SOLID STATE

*(Continued from page 79)*

ing is critical, good wiring practice should be observed during assembly, with signal leads kept short and direct and adequate separation provided between the two channels to minimize cross-coupling. The circuit can be assembled on a suitable etched circuit board, on a perforated phenolic board, or on a small metal chassis, as preferred.

**Manufacturer's Circuit.** Ever since the "great blackout," there has been an increasing interest in emergency lighting equipment. A unique, maintenance-free emergency light circuit is shown in Fig. 2. One of several circuits described in GE's Specification Note 150.9 (General Electric, Semiconductor Products Dept., Electronics Park, Syracuse, N.Y.), the unit keeps battery *B1* constantly charged, and operates automatically with an SCR in place of the more common electromagnetic relay to switch on the lamp when primary power fails. It can be used in elevator cars, corridors, basements, or any other area where a loss of light—even temporarily—is undesirable.

With the unit operating, the 12 volts a.c. across the transformer secondary is half-wave-rectified by *D2*, and provides a changing voltage for the battery through *R2*, which regulates the charging current. The battery, of course, serves as the emergency power source to light the lamp, in series with *SCR1*, only when there is a power failure. To keep the lamp from being turned on at other times, capacitor *C1*—in series with *R1* and *D1*—acts as a trigger. The charge on *C1* puts a negative voltage on the SCR gate to counterbalance and thus neutralize the positive battery voltage applied to the gate across *R3*. This keeps the SCR from switching on.

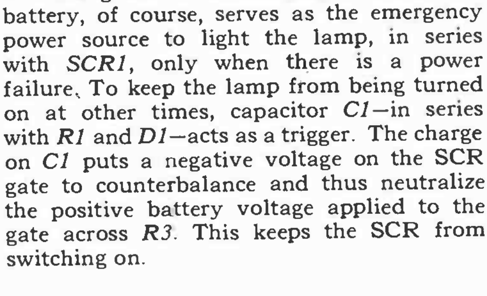



Fig. 2. This emergency light circuit, described in General Electric's Specification Note 150.9, keeps reserve battery (B1) fully charged and turns on an emergency lamp in case of primary power failure.

If line power fails, *C1* discharges gradually, and *SCR1* is triggered by the positive voltage which now remains on its gate. The SCR then switches on and conducts fully, applying power to the lamp. Reset operation is automatic once line power is restored, since *C1* recharges to again neutralize the SCR gate voltage.

Standard parts are used in the design. Transformer *T1* is a 12.6-volt, 1-ampere unit, *C1* is a 100-$\mu$F, 18-volt electrolytic capacitor, and all resistors are rated at 1 watt. The SCR is a GE C106Y, *D1* an A14F diode, and *D2* an A40F rectifier. A GE 1073 lamp serves as the emergency light. Any standard 12-volt storage battery can be employed for *B1*. Since *R2* serves to limit *B1*'s charging current, its value must be determined by the requirements of the battery used.

The individual builder can follow his own inclinations as far as construction and wiring are concerned but a heat sink should be provided for the SCR.

**Product News.** A 14-transistor receiver for \$6.95 or a 6-transistor set for \$8.95 . . . which is the better buy? Off-hand, the 14-transistor set seems like the better buy. But there's a good chance that the 6-transistor set might be a superior product, for, according to the National Better Business Bureau, a number of foreign manufacturers are producing sets with "dummy" (non-functioning) transistors to raise the "count," and thus gain a competitive edge. This practice is reminiscent of that used by several radio manufacturers during the mid-30's who offered 20- and 30-tube receivers in which only 4 or 5 tubes actually performed useful functions.

A probe-like general-purpose transistor tester is now being offered by Jensen Tools & Alloys (3630 E. Indian School Rd., Phoenix, Ariz. 85018). Battery-operated, the instrument is designed for in-circuit as well as out-of-circuit tests and, with pin-like probes, is quite suitable for use on etched circuit boards. Transistor (or diode) condition is indicated by a pilot lamp. Identified as Model SC-4, the tester sells for \$89.00.

Aul Instruments, Inc. (24-13 Bridge Plaza North, Long Island City, N.Y. 11101) has introduced the Model RS-30 low-voltage-regulated power supply suitable for transistor circuit tests and experiments. The instrument can supply from 1.4 to 30 volts d.c. at currents of up to 500 mA, and features short-circuit protection and a metered output. It sells for \$5.00.

**Problems! Problems!** Not too long ago, reader Emil E. Knospe of Depew, New York, sent us the following letter:

"Wow! I was really surprised to see the

flasher circuit I sent you printed in the June 1966 issue. Actually, I've intended for months to write to you but just now got around to it. I've been running the flasher in my '63 Ford for almost a year now and it works just fine . . .

"Last September, a POP'tronics reader in Florida called me, said he built the flasher from the magazine article but it wouldn't work. I told him to send it to me and I found that:

"(1) Transistor *Q1* was inoperative, probably wrecked from the heat of soldering;

"(2) He had switched *Q3* and *Q4*, and also had incorrectly mounted them to the heat sink;

"(3) Transistor *Q3* had low *beta* and wouldn't cut off power switch *Q4*;

"(4) Resistors *R1* and *R2* were 1.0 megohm instead of 1000 ohms.

"In other words, it didn't have a chance of working. I repaired it, sent it back, and got a nice letter from him saying that it works fine now. Just thought I'd pass the story along . . ."

And so, dear readers, let that letter be a lesson to you.

**Transitips.** As we all know, the letter "Q" is used to identify a transistor. It is also used to designate the selectivity or figure of merit of a coil or tuned circuit. Quite often, the two Q's do not go together. A high-Q (tuned) circuit may become a low-Q circuit when coupled to a Q (transistor).

In a coil, Q is equal to the inductive reactance ($X_L$) of the coil, at a given frequency, divided by the resistance acting in series with the inductance. Since the resistive component represents a circuit power loss, anything which increases power loss acts to reduce the coil's Q, and hence the Q (and selectivity) of the tuned circuit in which the coil is used. Similarly, any external series or shunt resistance loads the tuned circuit and reduces the Q.

A junction transistor has a low input impedance which is essentially resistive. When a tuned circuit is coupled to the input of the transistor, as in Fig. 3(a), severe loss of Q usually results. Tuned circuit *L1-C1*, coupled to *Q1* through *C2*, is loaded by *Q1*'s base-emitter resistance shunted by bias resistor *R1*. This accounts for the relatively poor selectivity of many home-built receivers.

If tuned circuit loading is reduced, then the effective circuit Q will go up. A technique to reduce loading is shown in Fig. 3(b). Here, the transistor is coupled to a tap on *L1*. Thus, the coil serves as an impedance-matching autotransformer. Circuit loading is reduced and overall selectivity (Q) is improved, even though the circuit may seem

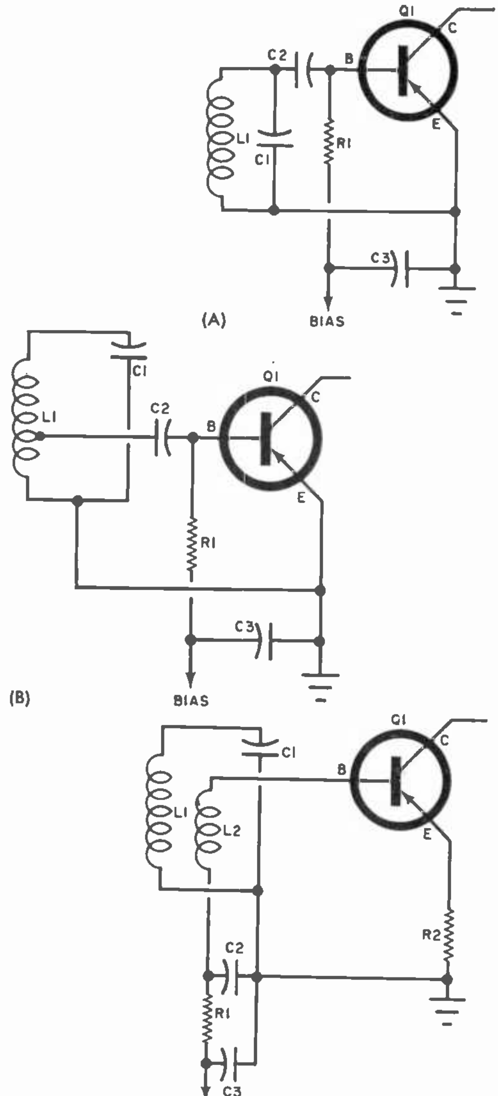



Fig. 3. Poor selectivity of some home-built receivers is sometimes due to loading of a tuned circuit —see C1-L1 in (A) above—by a transistor's base-emitter resistance. Loading can be reduced by coupling the circuit to Q1 through a tap on L1 (B). In (C), a step-down transformer serves the purpose.

less sensitive due to the reduction in the signal voltage applied to *Q1*.

Another technique is given in Fig. 3 (c). Step-down transformer secondary winding *L2* serves to reduce tuned circuit (*L1-C1*) loading. At the same time, a series-fed —rather than shunt-fed—bias arrangement is used, with *L1* loaded only by *Q1*'s base-emitter resistance. In addition, an unbypassed emitter resistor, *R2*, acts to raise *Q1*'s effective input impedance, with a cor-

(*Continued on page* 110)





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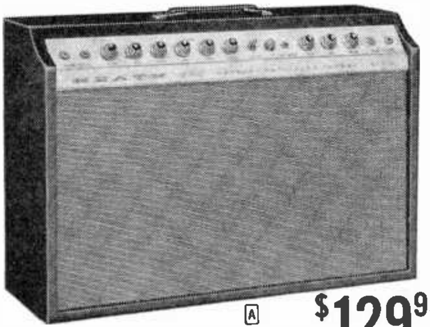

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[B] Kit TG-46 $219^{95} (save $111.55)

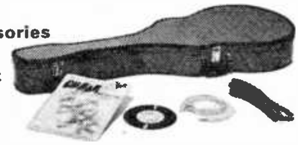
[C] Kit TG-26 $99^{95} (save $47)

[D] Kit TG-36 $119^{95} (save $40.55)

**[A] NEW Heathkit Transistor Guitar Amplifier**
60 watts peak power; two channels — one for accompaniment, accordian, organ, or mike, — the other for special effects.... with both variable reverb and tremolo; 2 inputs each channel; two foot switches for reverb & tremolo; two 12" heavy-duty speakers; line bypass reversing switch for hum reduction; one easy-to-build circuit board with 13 transistors, 6 diodes; 28" W. x 9" D. x 19" H. leather-textured black vinyl cabinet of ¾" stock; 120 v. or 240 v. AC operation; extruded aluminum front panel. 52 lbs.

**American Made Harmony-By-Heathkit Guitars**
All wood parts factory assembled, finished and polished . . . you just mount the trim, pickups and controls in predrilled holes and install the strings . . . finish in one evening.

**These Valuable Accessories Included With Every Guitar Kit**



Each guitar includes vinylized chipboard carrying case, cushioned red leather neck strap, connecting cord, Vu-Tuner® visual tuning aid, tuning record, instruction book and pick . . . worth $19.50 to $31.50 depending on model.

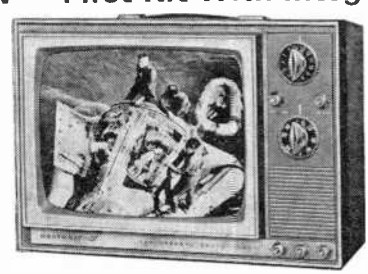
**[B] Deluxe Guitar . . . 3 Pickups . . . Hollow Body**
Double-cutaway for easy fingering of 16 frets; ultra-slim fingerboard — 24¼" scale; ultra-slim "uniform feel" neck with adjustable Torque-Lok reinforcing rod; 3 pickups with individually adjustable pole-pieces under each string for emphasis and balance; 3 silent switches select 7 pickup combinations; 6 controls for pickup tone and volume; professional Bigsby vibrato tail-piece; curly maple arched body — 2" rim — shaded cherry red. 17 lbs.

**[C] Silhouette Solid-Body Guitar . . . 2 Pickups**
Modified double cutaway leaves 15 frets clear of body; ultra-slim fingerboard — 24¼" scale; ultra-slim neck for "uniform feel"; Torque-Lok adjustable reinforcing rod; 2 pickups with individually adjustable pole-pieces under each string; 4 controls for tone and volume; Harmony type 'W' vibrato tail-piece; hardwood solid body, 1½" rim, shaded cherry red. 13 lbs.

**[D] "Rocket" Guitar . . . 2 Pickups . . . Hollow Body**
Single cutaway style; ultra-slim fingerboard; ultra-slim neck, steel rod reinforced; 2 pickups with individually adjustable pole-pieces for each string; silent switch selects 3 combinations of pickups; 4 controls for tone and volume; Harmony type 'W' vibrato tailpiece; laminated maple arched body, 2" rim; shaded cherry red. 17 lbs.

## NEW 12" Transistor Portable TV — First Kit With Integrated Circuit

Unusually sensitive performance. Plays anywhere . . . runs on household 117 v. AC, any 12 v. battery, or optional rechargeable battery pack ($39.95); receives all channels; new integrated sound circuit replaces 39 components; preassembled, prealigned tuners; high gain IF strip; Gated AGC for steady, jitter-free pictures; front-panel mounted speaker; assembles in only 10 hours. Rugged high impact plastic cabinet measures a compact 11½" H x 15¾" W x 9⅜" D. 27 lbs.



Kit GR-104 $119^{95}

responding reduction in loading. This circuit, therefore, provides an even better selectivity, although overall stage gain (sensitivity) may be less, due to the negative feedback signal developed across *R2*.

As a general rule, one must "trade off" sensitivity for improved selectivity. A three-stage r.f. amplifier, with each stage having good selectivity, but only moderate gain, may provide better overall performance than a two-stage high-gain design, although both circuits have the same overall gain.

That covers the "solid state" picture for now. Until next month . . .

*—Lou*

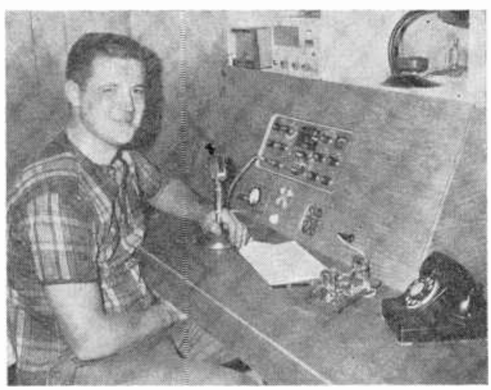
## AMATEUR RADIO

(*Continued from page* 85)

Kit TR-108 transceiver performs well and is competitively priced at $144.95, complete with microphone but less crystals and antenna. The V-107 VFO kit is $19.95. The table-top mounting base is $6.95, and a mobile mount is available for $7.50.

**Code Practice Transmissions.** The only known way to increase one's code copying speed above a few words per minute is with regular copying practice. As a public service, the stations listed below send copy practice material at the times and on the frequencies given:

**W1AW,** ARRL, Newington, Conn., daily at 7:30 p.m., EST (0030 GMT), and 9:30 p.m., EST (0230 GMT). Speeds on the early sessions are 10, 13, and 15 wpm. Speeds on the later sessions are 5-25 wpm



Michael R. Hagans, WA4ZGI, of Panama City, Fla., will soon be sharing this attractive station with his wife, Peggy, who is presently waiting for her Technician license. The Heathkit SB-100 transceiver, "Twoer," and "Sixer," and Lafayette HE-50 feed assorted antennas supported on a 65-foot tower.

(Sundays, Tuesdays, Thursdays and Saturdays) and 15-35 wpm (Mondays, Wednesdays, and Fridays). Frequencies used: 1.805, 3.55, 7.08, 14.1, 21.1, 50.7, and 145.6 MHz.

**W2--,** Rochester Amateur Radio Association, Rochester, N.Y., Monday through Thursday, at 7 p.m., local time, on 21.15 MHz. A different club member transmits each night.

**W3CL,** The Mount Airy VHF Radio Club, Philadelphia, Thursdays, from 7 to 7:30 p.m., local time, on 50.2 MHz.

**WØFA,** Denver Radio Club, Tuesdays and Thursdays at 7:30 p.m., local time, on 3.755, 29.53, and 145.5 MHz. Speeds are 10 to 13 wpm the first half hour, and 20 wpm the second half hour.

**WØOUI,** Denver Radio Club, Mondays and Wednesdays, at 7:30, local time, on 28.7, 50.4, and 144.94 MHz. This is a beginner's course. It starts from "scratch," and builds up to 10 wpm using mixed voice and modulated CW.

## NEWS AND VIEWS

**Mike Campbell, WA4IUH,** 206 Goff Drive, Leitchfield, Ky., started his amateur career as a Novice at the age of 13. Two years later, he is now a General with 49 states and 30 countries worked. The hold-out state is Alaska. A 2-element, home-built, 15-meter quad antenna and a 40-meter dipole accept power from a Knight-Kit T-150A transmitter for world-wide distribution. A Hallicrafters S-76 receiver completes the station . . . **Jon Hunter, WA7DYH,** 397 West 400 South, Cedar City, Utah, is another 49-state man. He needs New Hampshire; I wonder how many hams need Utah? Jon has 15 countries worked. A Heathkit "Marauder" transmitter and a Drake 2-B receiver handle the inside job. A Mosley TA-33 tri-band beam; a Hy-Gain 14-AVQ vertical; and a 40-meter, inverted-V do the outside work . . . Going still further west, **Mike Flavin, WN6TQS,** 10730 Dempsey Ave., Granada Hills, Calif., has really kept the electrons in his dipole agitated during his three-month amateur career. Using a Johnson "Ranger" transmitter and a Drake 2-B receiver, Mike has 39 states and seven countries, plus Hawaii and Alaska worked. Since Alaska and Hawaii are considered both states and countries, his country total may actually be nine.

**Daniel Goodman, WA9QJW,** 4044 Greenwood St., Skokie, Ill., uses a National NCX-5 transceiver to drive a home-built 2-element beam, 25′ high. Dan usually works 15-and 20-meter CW with the aid of an electronic keyer, but he does switch to 10-meter phone when "10" is really hot—which means he has been doing a lot of 10-meter work this winter. His record is 67 countries and 24 states worked. Dan is also trustee of the Niles North High School Amateur Radio Club Station, WA9RZF, which is on the air every day after 3:30 p.m. Equipment at the club includes a Johnson "6-N-2" transmitter, Hammarlund HQ-170 receiver, and a Mosley TA-33 rotary beam . . . **Murray Fortune, VE3FMF,** 139 Little John, Dundas, Ont., Canada, worked 13 states in four weeks on 80 meters running 125 watts into a surplus BC-457 transmitter feeding a 125′ long-wire antenna and receiving on a huge army-surplus job. The transmitter then became very sick; so he built a 2-watt, 40-meter transmitter from "junkbox" parts and bought an old Hallicrafters S-38 receiver. With this equipment and the old antenna, he has added six states to his total and he works the West Coast frequently. Murray enjoys the surprise that his power brings

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to the operators he contacts—but he has been bitten by the high-power bug again. He is planning a 15-watter now!

**Andrew Furlong, WA2FGK,** 6 Evagrod St., Somerville, N.J., works everything from the "d.c. bands" up. He is WAS on the lower frequencies and has worked 55 countries on "20" with a dipole antenna. But it is on the VHF's and UHF's that Andy's station and records are outstanding. He runs a kilowatt on 144 MHz, 250 watts on 220 MHz, and 50 watts on 432 MHz, using home-built equipment. His antennas are impressive; they include a 196-element beam on 432 MHz, 15 elements on 220, and 80 elements on 144 MHz. WA2FGK has worked 24 states on 144 MHz and keeps "moon-bounce" skeds with VK3ATN in Australia, although they have not yet established successful two-way contact. In addition, WA2FGK is always very near the top in VHF and UHF contests. When you read this, Andy will have just graduated from college and will be starting his career as a high-school teacher of electricity and electronics. Bet he organizes a ham club, too . . . **James Thompson, WA3FXW,** 266 W. State St., Oakdale, Pa., credits his father, George, WA3CGY, for getting him started in amateur radio. Dad George was active way back in 1925, when he worked the world on 20 meters with a 7½-watter and has the cards to prove it! He is still active on 40-meter CW with a 150-watter, a National NC-77X receiver, and a 40-meter dipole. Son Jim works 80-, 40-, and 20-meter CW using a 150-watt home-built transmitter and a Lafayette HA-63 receiver in conjunction with a 3-band dipole and a 40-meter vertical.

**Jim Jerzycke, WN9THB,** 1004 Winthrop, Joliet, Ill., is the first product (he says) of the radio club organized by WA9NVF and other amateurs. Jim runs 74¾ watts to a Heathkit DX-60A transmitter and receives on a Hallicrafters SX-146. His antenna is a 40-meter dipole which works best on 15 meters. Fifteen meters is Jim's favorite band, but he claims it suffers from underpopulation. Join him . . . **Dave Grossman, WN2ZFC,** 39 Joan St., Elmont, N. Y., also sports the CB call of KMD4202 and P.E.'s SWL monitor identification, WPE2OPQ. As WN2ZFC, he has worked 18 states with his Globe HG-303 transmitter and Lafayette HE-30 receiver. Dave uses a 1-element, 15-meter rotary "beam" turned by an AR-22 rotator for "15" and a Hy-Gain 18-V on 80 meters.

Now would be a good time to send us your "News and Views" and a clear picture of you and your station. Thanks for keeping the club bulletins coming. The address is: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P. O. Box 678, Gary, Ind. 46401.

73, *Herb, W9EGQ*


"It's a real fine gift, Ma. But what could I do with a WALKIE-talkie?"

## SHORT-WAVE LISTENING

*(Continued from page 83)*

### CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports are as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to SHORT-WAVE LISTENING, P.O. Box 333, Cherry Hill, N.J. 08034, in time to reach your Short-Wave Editor by the fifth of each month; be sure to include your WPE Monitor Registration and the make and model number of your receiver. We regret that we are unable to use all of the reports received each month, due to space limitations, but we are grateful to all contributors.

**Ascension Island**—A letter from Richard Buckby, ZD8RB, of the *BBC,* here, lists this schedule as being in effect at press time: 15,180 kHz at 2000-2245 with Eng. World Service, and 15,375 kHz at 2300-0015 in Portuguese (both beamed to 207°); 15,105 kHz at 1745-1830 with Eng. World Service, at 1830-1930 in French, at 1930-1945 in Hausa, and 15,140 kHz at 2000-2245 with Eng. World Service (both beamed to 27°). Late listening indicates two additional frequencies in use: 15,140 kHz at 2143 with the World Service, and 21,610 kHz from 1628 to past 1645 with a relay of the N. A. Service.

**Bolivia**—A station noted on 5112 kHz around 0100 may possibly be *R. Universidad Zenica,* Oruro. Other Bolivians logged recently include *R. Emisoras Bolivia,* 4760 kHz, and La Paz stations *R. La Cruz del Sur,* 4985 kHz, *R. Universo,* 5015 kHz, *Radiodifusoras Altiplano,* 5045 kHz, and *R. Fides,* 6154 kHz, all around 0100.

**Brunei**—A surprising logging in the Midwest was "This news is coming to you from *Radio Brunei*" noted at 1315-1328 in Eng. on 4865 kHz.

**Bulgaria**—*R. Sofia* has Spanish at 0000-0030 and Bulgarian to 0100 to South America on 5920 and 9817 kHz, both of which are new channels. Each segment features news, commentary, talks, and music.

**Cambodia**—Phnom-Penh has extended its schedule and possibly raised power. The 9695-kHz outlet is noted now from 1130 s/on to as late as 1500 s/off, with all local programs.

**Canada**—DX'ers needing Newfoundland for the DX Awards Program should try for CBT, Grand Falls, 540 kHz, in the medium-wave band. This 10-kW station can often be logged evenings (local time) in Eastern N. A.

**China**—*People's Liberation Army (Chungkuo jen min fan chun fuchien chien hsien jen min kwang po tien tai),* Fukien Province, 5900 kHz, is noted at 1055-1130 with "human-wave-type" bugle marches, screaming, and talks in Chinese. Does anyone know the exact location of this station in the province?

**Costa Rica**—Religious programs in Eng. are given by TIFC, *Lighthouse of the Caribbean,* San Jose, 9645 kHz, from 0300 to 0405 s/off. Reports should be sent to TIFC, Box 2710, San Jose.

**Cuba**—Havana's often-changing Eng. schedule now reads: to Europe at 2010-2140 on 6015 kHz; to South America at 2050-2150 on 15,270 and 15,300 kHz and at 0100-0600 on 11,760 kHz; to N.A. at 0100-0600 on 6170 kHz, at 0330-0600 on 6135 kHz and at 0630-0800 on 9655 kHz; and to Africa at 1800-1900 on 15,340 kHz.

**Ecuador**—Station HCJS1, *Ondas del Angel,* was noted on 4830 kHz at 0200 requesting reports to

Apartado de Correos 16, El Angel; it can also be heard well opening at 1100, though it fades rapidly shortly thereafter. Station HCVA4, *La Estacion de la Alegria,* is on 2495 kHz after 0200 with listeners' request music and Ecuadorian folk songs.

**Germany (East)**—*R. Berlin International,* 17,755 kHz, presents an Eng. DX program on Saturdays at 1553 but may have QRM from WNYW, New York.

**Greenland**—Mainly for DX'ers in Europe but possibly receivable by listeners in Northeastern U. S. & Eastern Canada is Godthab, 570 kHz, and Godhavn, 650 kHz, both medium-wave channels. Tune carefully from 0030.

**Guatemala**—*R. Santa Cruz,* Santa Cruz del Quiche, has reactivated the 4872-kHz channel; first heard during the 1965 Christmas season, it was silent during most of 1966 and is now back on the air around 0000 and later with religious talks and marimba music.

**Hungary**—*R. Budapest* has an outlet on 3995 kHz, noted at 2230 tuning; this xmsn is beamed to Europe in German. You're likely to find considerable QRM from the 75-meter amateur phone stations when you look for it.

**India**—The present schedule from *All India Radio,* Delhi, to the United Kingdom and Europe is: 1745-2230 on 7215 kHz, 1745-2030 on 11,905 kHz, and 1945-2230 on 9912 kHz. One West Coast reporter listed 11,760 kHz at 2300-2330 in Eng., but with a poor signal that soon faded out.

**Korea (North)**—Pyongyang has been logged as follows: on 11,763 kHz from 0125 to 0151 s/off with news; on 9875 kHz (replacing 9935 kHz) from 2330 to 2355 in Korean, opening with a seven-note IS, a short anmt, then a short march, and news; on 6250 kHz with second Home Service program in Korean from 1645 to 1700 s/off; on 6540 kHz in Russian at 1705-1735; and on 17,920 kHz at 2300-2347 with a test xmsn in Spanish, and at 0020-0126 with Korean to 0051, open carrier (no s/off) to 0100, then into Spanish.

The listening post of David Pollick, WPE2ONO, Long Beach, N.Y., features a Lafayette HA-230 receiver. His antenna is a 80' long-wire "T." David has 29 states, 19 countries, 5 continents verified.

**Monaco**—*Trans World Radio,* Monte Carlo, was

# SHORT-WAVE MONITOR CERTIFICATE APPLICATION

ALL radio listeners interested in furthering the hobby of SWL'ing—regardless of whether you DX on the BCB, VHF, TV, SW, or FM bands—are eligible to apply for a POPULAR ELECTRONICS "Certificate of Registration." You must have verified (have QSL cards from) a minimum of five radio stations, of which one was outside the borders of the United States. There is no age limit, or special equipment qualification; the only requirement is that the applicant have a sincere interest in radio communications.

All certificates are filled in and lettered before mailing; they are mailed flat and unfolded. If you want to register and receive your WPE identification sign, fill in the application blank below. Mail with 50 cents in coin (or stamps) to: MONITOR, P.O. Box 333, Cherry Hill, N.J. 08034. (Personal checks will not be acceptable). Canadians should use their own currency, and other applicants not in the U.S.A. should use 10 International Postal Reply Coupons. Allow 4-6 weeks for processing.

(Please Print) (Do not fill out)

Name ..............................................

Street, City and Zone ..............................................

State and Zip ..............................................

Receivers in use Make .................... Model ....................

Make .................... Model ....................

Age Occupation ..............................................

Ham/CB call-letter assignment(s) ..............................................

I listen mostly to SW Broadcast Hams CB BCB VHF VLF ..............................................

I use the following antennas ..............................................

I have QSL cards and countries verified. Check if subscriber to P.E. ..............................................

Signature Date ..............................................

logged at 0429 with a Russian ID after a religious program on 9545 kHz, and later on 9540 kHz. Neither frequency is listed officially.

**Norway**—*R. Norway* can now be heard on two different frequencies in the 11-meter band: on 25.900 kHz at 0745-0815, 1100-1230, and 1300-1430; and on 25.730 kHz at 1100-1230, 1300-1430, and 1500-1630. The station reports good reception in the U.S.A., Europe, and Australia.

**Pakistan**—Karachi has Eng. dictation-speed news at 1355 on 21,590 kHz, replacing the former 17,948-kHz outlet.

**Rumania**—*R. Bucharest* has Eng. to Europe at 1930-2030 on 9510, 7225, and 5990 kHz and at 2230-2300 on 7195 and 6190 kHz; to Asia at 1500-1530 on 15,250 kHz; to Africa at 1500-1530 on 15,380, 11,885, and 11,810 kHz; and to N. A. at 0130-0230, 0300-0330, and 0430-0500 on 11,940, 11,885, 9590, 9510, 6190, and 6150 kHz. The station is inviting all listeners to apply for its six new QSL cards; to obtain them you must submit six different reception reports, marking them from 1 to 6.

### SHORT-WAVE CONTRIBUTORS

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David Palfrey, Kearny, N. J.
Edward Shaw, Roanoke, Va.
Bob Sutton, Wilbraham, Mass.
*Sweden Calling DX'ers* Bulletin, Stockholm, Sweden

**Saudi Arabia**—Late listening indicates that Riyadh is being heard on 7220 kHz from 0345 with native and pop music; this is a high-powered xmtr but the frequency is heavily QRM'ed.

**South Africa**—*R. RSA*, Johannesburg, at press time, has changed frequencies to 15,205, 11,785, 9720, and 9675 kHz (replacing 15,220, 11,900, 9690, and 9525 kHz, respectively). The current schedule reads: at 2100 to Ghana on 15,205 kHz; at 2200 to United Kingdom and Europe on 11,785 and 9720 kHz; at 2330-0025, 0030-0125, 0130-0225, and from 0230 to 0325 s/off to N.A. on 9675 and 11,880 kHz. Other frequencies logged include: 15,285 kHz with Eng. news at 2100; and 7185 kHz (Commercial Service from *Springbok Radio*) at 0350-0410 with commercials in Eng. and Afrikaans, pop music to 0430, then a newscast.

**Surinam**—Paramaribo is being reported on 725 kHz (medium wave) at 0100-0130 with Eng. ID's every 15 minutes. Further details are requested.

**Switzerland**—Berne is using two new 250-kW xmtrs for overseas services. An experimental Eng. program (with non-directional antennas and a power of 250 kW) is being aired weekdays only at 0700 on 6165 kHz, and reports are requested. The station also states that 3985 kHz, an unlisted channel, is used at times for portions of the European Service (this service is listed for 0600-2300 but no specific times for the use of the 3985-kHz outlet are given); the xmtr is an old 350-watter —has anyone ever logged it?

**Trucial Coast**—*The Voice of the Coast from the Trucial Amirates* at Sharjah broadcasts at 1230-1330 on 6183 kHz. (This is an overseas listing and is *not confirmed* as yet; can anyone provide further information on this station?)

**U.S.A.**—The *VOA* is using a pair of 11-meter channels: 25,670 kHz to 1530 s/off in Indonesian and 25,950 kHz at 1500 in Urdu. The VOA's present low-powered schedule reads: Munich, on 3980 kHz (8 kW) at 0300-0730 and 1400-2345 to Europe; Philippines, on 6170 kHz (7.5 kW) at 2100-0330 to Philippines, on 7135 kHz (15 kW) to S. E. Asia, and on 7275 kHz (7.5 kW) at 1000-1600 and 11,735 kHz (15 kW) at 0900-1630, both to South China (the latter also to Indonesia & E. Asia); Colombo, 7275 kHz, at 1700-1800 and 15,285 kHz, at 1130-1700 (both 10 kW), both beamed to S. Asia; and Okinawa, 9740 kHz (15 kW) at 1000-1600 to S. China.

Station WWV, the National Bureau of Standards Time and Standard Frequency station, is now operating from Fort Collins, Colo. (as announced by voice) with the time being given in GMT (in Morse code) and Mountain Standard Time (in voice). Operation is on 2500, 5000, 10,000, 15,000, 20,000, and 25,000 kHz.

**U.S.S.R.**—*R. Tbilisi*, Georgia, was noted at 0159 with chimes and anthem, and to 0259 (more chimes) with Russian talks and music; news is given at 0400-0410, music to past 0430. Two long-wave xmsns noted on the West Coast are from Vladivostok on 245 kHz to 1400 s/off and Petropavlovsk-Kamchatka on 182 kHz to 1300 s/off. The Soviet time station, RWM, Moscow, was logged on 10,000 kHz at 0600-0605, completely overriding WWV and WWVH; the voice anmt, in Russian, is evidently given only on the hour.

A West Coast monitor made a check for us on Soviet stations being heard there. A partial resume is given here: *R. Moscow*, on 9810 kHz at 2100-2125

## SHORT-WAVE ABBREVIATIONS

| | |
|---|---|
| anmt—Announcement | N.A.—North America |
| BBC—British Broadcasting Corporation | QRM—Station interference |
| Eng.—English | R.—Radio |
| ID—Identification | s/off—Sign-off |
| IS—Interval signal | s/on—Sign-on |
| kHz—Kilohertz | VOA—Voice of America |
| kW—Kilowatts | xmsn—Transmission |
| | xmtr—Transmitter |

in Arabic to Algeria, at 2205-2300 in Spanish, then Portuguese; on 9675 kHz at 2205-2305 in Eng. to N.A., Sundays only; on 9775 and 9785 kHz at 2205-2300 in Spanish, then Portuguese; on 9793 kHz at 2205-2305 with the Russian Home Service; and on 15,505 kHz at 0210-0230 in Russian with classical music (all from European xmtrs). Numerous outlets were noted to N.A. at 0100-0600 from European xmtrs. Khabarovsk, on 7200 kHz, was noted at 1725-1735 with the Russian Home Service and on 17,880 kHz at 0120-0235 in Spanish to West Coast N. A.; *R. Moscow,* on 7445 kHz, in Eng. to Africa at 0450-0505; RV102, *Stantsiya Imeni,* Petropavlovsk-Kamchatka, on 4485 kHz at 0735-0745 with Russian local service; RV441, Vladivostok, on 5015 kHz at 0740-0750 with Russian local service; Khabarovsk, on 9375 kHz, and Magadan, on 9500 kHz, both at 0445-0550 in Russian relaying Moscow's Home Service program to Far East and Siberia.

**Venezuela**—A new station announcing as *R. Mundo,* Maracaibo, has been noted opening at 1000 on 4860 kHz in Spanish, with a good signal until 1145. —30—

## ON THE CITIZENS BAND

*(Continued from page 81)*

### 1967 OTCB CLUB ROSTER

In order to keep our roster of active clubs current, all CB clubs, rescue teams, and special police groups who have not reported to us in the last 12 months should do so now. Include your current membership totals, officers, club activities, and sample decal and membership card, if available. Groups are urged to enclose photos of activities, emergency teams, and any unusual applications that would interest other CB users. And be sure to send us your club newspaper or bulletin on a monthly basis. Forward all material to Matt P. Spinello, CB Editor, POPULAR ELECTRONICS, One Park Avenue, New York, N. Y. 10016.

**Fort Lauderdale, Florida**—*Hurricane Citizens Band Assn.* This club recently published its first newspaper: *The Eye.* The publication is well prepared, interesting, and backed by a number of advertisers to keep it afloat. Club officers are: Bill Walker, KKP4058, president; Deb Gaddy, KMP3689, vice president; Betty Gaddy, KMP3689, secretary; Tom Towsley, KMP4612, treasurer; Ron Peeling, KOP0829, sergeant-at-arms; plus a 3-man board of directors, and a 6-man editorial staff led by co-editors Bob Palmer, KKX8613, and Frank Kamarata, KMP5229.

**Brantford, Ontario**—*Telephone City CB Association.* In operation for 2½ years, this club's motto is: "In the Public Interest." Its search and rescue team coordinated with over 500 mobiles last November in a search for two Department of Lands and Forests game wardens who drowned. The group also took part in four other searches for lost children in the fall of 1965. Last year they relayed federal election returns for the Brant County area to the local radio station and to the Brantford *Expositor* newspaper. Club membership is currently 45. Officers: Morley Van Sickle, XM-43-1760, president; James Turvey, XM-43-2700, vice president; Don McCormick, XM-43-1750, secretary; and E.L. Van Sickle, XM-43-220, chairman of search and rescue.

**Prince Albert, Saskatchewan**—*Northern Citizens Communications Club.* In addition to its monthly bulletin, this club recently printed a clean-cut, pocket-sized call book for Prince Albert and the surrounding area to raise funds for club crests to be worn by the membership. Club president is O. J. Borrowman, XM-34-807.

I'll CB'ing you, —*Matt, KHC2060*

# ELECTRONICS MARKET PLACE

**COMMERCIAL RATE:** For firms or individuals offering commercial products or services. $1.00 per word (including name and address). Minimum order $10.00. Payment must accompany copy except when ads are placed by accredited advertising agencies. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance.

**READER RATE:** For individuals with a personal item to buy or sell. 60c per word (including name and address). No Minimum! Payment must accompany copy.

**GENERAL INFORMATION:** First woro in all ads set in bold caps at no extra charge. Additional words may be set in bold caps at 10¢ extra per word. All copy subject to publisher's approval. Closing Date: 1st of the 2nd preceding month (for example, March issue closes January 1st). Send order and remittance to: Hal Cymes, POPULAR ELECTRONICS, One Park Avenue, New York, New York 10016.

## FOR SALE

**FREE!** Giant bargain catalog on transistors, diodes, rectifiers, SCR's, zeners, parts. Poly Paks, P.O. Box 942, Lynnfield, Mass.

**GOVERNMENT** Surplus Receivers, Transmitters, Snooperscopes, Radios, Parts, Picture Catalog 25¢. **Meshna**, Nahant, Mass. 09108.

**CANADIANS—GIANT** Surplus Bargain Packed Catalogs. Electronics, Hi-Fi, Shortwave, Amateur, Citizens Radio. Rush $1.00 (Refunded). ETCO, Dept. Z., Box 741, Montreal, **CANADA.**

**WEBBER LAB'S** Police—Fire Transistorized Converter kit 30-50mc. & 100-200mc. (1 mc. spread) $5.00 each. 26-200mc. on broadcast band using any type radio, crystal controlled $23.00 wired pp. tunable—crystal controlled $11.00 kit. 72 Cottage Street, Lynn, Mass.

**JAPAN** & Hong Kong Electronics Directory. Products, components, supplies. 50 firms—just $1.00. Ippano Kaisha Ltd., Box 6266, Spokane, Washington 99207.

**CANADIANS, TRANSISTORS AND PARTS.** Free catalogue contains reference data on 300 transistors. J. & J. Electronics, Dept. PE, Box 1437, Winnipeg, Manitoba.

**INVESTIGATORS, FREE BROCHURE, LATEST SUBMINIATURE ELECTRONIC SURVEILLANCE EQUIPMENT, ACE ELECTRONICS, 11500-L NW 7TH AVE., MIAMI, FLA. 33168.**

**CB-WPE-QSL CARDS.** Same High Quality, Beautiful, Glossy multi-color cards. New **LOW PRICES. 26 SAMPLES,** 25¢. Dick, W8VXK, 19QA0625, Gladwin, Mich. 48624.

**R.F. CONVERTERS.** World's largest selection. Also CCTV cameras, etc. Lowest factory prices. Catalog 10¢. Vanguard 196-23 Jamaica Ave., Hollis, N.Y. 11423.

**GIANT TESLA COIL—FORTY-INCH SPARKS!** Complete plans $5.00. Details, color photo 50¢ (deductible). Huntington Electronics, Inc., Box 9 Huntington Station, Shelton, Conn. 06484.

**ELECTRONIC "CRACKAJACKS,"** relays, transistors, photocells, etc. Guaranteed prizes. $1.00 ppd. **DART ELECTRONICS,** Box 214, Jericho, N.Y.

**RECTIFIERS,** transistors, other components. Catalog free. Electronic Components Co., Box 2902C, Baton Rouge, La.

**TELEPHONE VOICE SWITCH: (LS-500). ACTUATES AUTOMATICALLY AND UNATTENDED ANY TAPE OR WIRE RECORDER. PICTORIAL INSTALLATION INSTRUCTIONS INCLUDED. $23.75. POST PAID USA, WJS ELECTRONICS. 737 NORTH SEWARD, HOLLYWOOD, CALIF. 90038.**

**INVESTIGATORS: KEEP IN STEP WITH ADVANCEMENTS IN THE ART OF ELECTRONICS FOR THE PROFESSIONAL. SEND $1.00 FOR EQUIPMENT BROCHURE. WJS ELECTRONICS, 737 NORTH SEWARD, HOLLYWOOD, CALIF. 90038.**

**CLOSED-CIRCUIT** TV—industrial, educational. Factory-direct prices. Write for particulars. **ATV RESEARCH,** Box 396P, Industrial Division, South Sioux City, Nebr. 68776.

**SEE YOURSELF ON TV!** Exciting hobby lets you televise live pictures right in your own home. Kits from $18.95 to $149.50. Catalog 10¢. **ATV RESEARCH,** Box 396P, Amateur Division, South Sioux City, Nebr. 68776.

**BUG DETECTOR: WILL DETECT AND LOCATE SURREPTITIOUS TRANSMITTING DEVICES IN CONFERENCE ROOMS, HOME AND OFFICES, ETC. WRITE FOR DETAILS. WJS ELECTRONICS, 737 NORTH SEWARD, HOLLYWOOD, CALIF. 90038.**

**HOBBYISTS, EXPERIMENTERS, AMATEUR SCIENTISTS, STUDENTS . . . CONSTRUCTION PLANS**—All complete including drawings, schematics, parts lists, prices, parts sources . . . **LASER**—Build your own coherent-light optical laser. Operates in the pulsed mode, in the visible light range—$6.00 . . . **DIODE LASER**—Invisible light (infrared) can be continuously modulated—$3.00 . . . **REVERBERATOR (ECHO) UNIT**—Build your own. Use with your automobile radio, home radio or hifi, electric guitar, etc.—$3.00 . . . **RADAR**—Build your own ultrasonic doppler radar. Detect motion of people, automobiles, even falling rain drops. Transistorized, uses standard small 9-volt battery—$4.00 . . . **TV CAMERA**—Build your own. The real thing—no rotating disc. Uses 5 tubes plus videcon tube. Output: 72 ohms or receive on any TV set channel 2-6. Excellent circuit—good picture—$6.00 . . . **STROBOSCOPE**—Flash rate variable from about 10 to 1,000 flashes per second. Stop effect will allow you to view rotating or oscillating objects while in motion —$3.00 . . . **STEREO AMPLIFIER**—Uses two 6T9 compactrons—for stereo phono, tuner, etc.—$3.00 . . . **TWO-WAY TALK OVER FLASHLIGHT BEAMS**—Hand-held microphone, loudspeaker volume. Use in daylight or darkness —$3.00 . . . **VIBRATO UNIT**—Use with electric guitar and other musical instrument amplifiers. Uses two transistors and two 9V batteries—$3.00 . . . **VOLUME COMPRESSOR/EXPANDER**—Use with your HiFi—$4.00 . . . **LONG-RANGE "SOUND TELESCOPE"**—This amazing device can enable you to hear conversations, birds and animals, other sounds hundreds of feet away. Very directional. Transistorized. Uses 9V battery—$3.00 . . . **CIGAR BOX ELECTRIC ORGAN**—Portable, self-contained battery. Eight notes, one octave. Two transistors, 9V battery—$3.00 . . . **ANALOG COMPUTER**—Multiply, divide, add, subtract, square and find square roots. Uses two flashlight batteries—$3.00 . . . **BINARY READOUT**—Program in decimal numbers and readout binary—$3.00 . . . **SOLID STATE BINARY COUNTER (COMPUTER-ADDER)**—Uses transistor flip-flop stages. Lightbulb readout. Punch in pulses, read binary count. Five stage. Includes easy to understand discussion of decimal to binary arithmetic conversion. Excellent start in digital computer technology—$6.00 . . . **TECHNICAL WRITERS GROUP, Box 5501, STATE COLLEGE STATION, RALEIGH, N.C. 27607.**

**DYNAMITES LISTENING DEVICES.** Silently jams all Mikes, Plans $8.50. **MORE** Construction Plans: Telephone Equipment: $40 Answering Machine, $15 Bell System Speaker-phone, $10 Legal Telephone Connector. **NEW:** Telephone Scrambler, Call Limiter, Laser Communication System, $25 Automatic Dialer, Central Dial System. **TELEVISION:** $50 Camera, 3DTV Converter, $35 All Electronic Color Converter, Video Recorder, Hobbyist: Ultrasonic Dishwasher, Transistorized Teletype, Morse Code Copier, $75 Electron Microscope, Electronic Tranquilizer, Private Eye Tail Transmitter, Police Radar Detector plus legal jammer. Plans $4.95, each. Telephone Engineering Course $39.50. **NEW SUPER HOBBY CATALOG** 25¢; Don Britton Enterprises, 7906 Santa Monica Blvd., Hollywood, Calif. 90046.

**TV CAMERA PLANS.** Best available. Tube model, vidicon —$3.00; transistor—$5.00 (deductible). Flying spot scanner—$2.50. **ATV RESEARCH,** Box 396P, So. Sioux City, Nebr. 68776.

**TRANSISTORIZED** Products Importers catalog. $1.00. Intercontinental, CPO 1717, Tokyo, Japan.

**RADIO – T.V.** Tubes—33¢ each. Send for free catalog. Cornell. 4213 University, San Diego, Calif. 92105.

**CIRCUIT** Boards, Parts for "Poptronics" projects. Free catalog. **DEMCO,** Box 16297, San Antonio, Texas 78216.

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**McGEE RADIO COMPANY.** Big 1966-1967 catalog sent free. America's best values. HiFi Amplifiers—speakers—electronic parts. Send name, address and zip code number to McGee Radio Company, 1901 McGee Street, Dept. EG, Kansas City, Missouri 64108.

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**UNIQUE** relay to build variety of remote controls, model railroads, liquid level control, weather detector, burglar alarm, games, trick circuits. 20 design ideas included free. $3.95 prepaid. Dept. A, Alco, Lawrence, Mass.

**DIAGRAMS,** servicing information, Radio $1.00, Television $1.50. **BEITMAN,** 1760 Balsam, Highland Park, Ill. 60035.

**DECALS,** "Emergency Mobile Radio Unit", 2"x8½", Red on White, $1.00. Warren Straw, 61-A Presidio Avenue, Mill Valley, Calif.

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**FREE CATALOG** Transistors, Diodes, Parts. Solid State Pax, P.O. Box 206, Dorchester, Mass. 02124.

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## PLANS AND KITS

**"CRYSTAL SET CONSTRUCTION"** Handbook—50¢. Catalog. Laboratories, 12041-L Sheridan, Garden Grove, Calif. 92640.

**ALLWAVE RADIO KIT.** Tube, transistor included $5.00. Headset $2.50. Ekeradio, Box 131, Temple City, Calif.

**SUPER SNOOPER,** Printed circuit Kit $5.95. Others. Lectronix, Box 42, Madison Heights, Michigan 48071.

**INSTRUMENT** to Measure High Voltages up to 50 KV. can be built for $3. Plans and instructions $2. Redmond, 42 Dean Close, Portslade, Sussex, England.

**INTEGRATED** Circuit experiment kit, 2 IC's, Parts, Instructions, many Pages Experiments, Projects, Theory. $6.95. Other Construction Plans, Kits, P. C. Boards, Parts. Catalogue 10¢, Kaye, Box 3932, Long Beach, California 90803.

**BUILD** Melody Organ, Reverb, other projects. Complete plans. Free folder. Solotron Company, 29641 Gilchrist, Farmington, Michigan 48024.

## SHORTWAVE LISTENING

**1967 SWL PROGRAM GUIDE,** listings by the hour, $2.00. **ALL** books for SWLs. SWL Guide, 218 Gifford, Syracuse 2, N.Y.

**POLICE—FIRE—AIRCRAFT—MARINE—AMATEUR CALLS** on your broadcast radio with **TUNAVERTER!** Tune The Band! Economical! Guaranteed! Free Catalog! Salch Co. Dept. PE3, Woodsboro, Texas 78393.

**SWL SUPPLIES.** World Radio TV Handbook $4.95. 1967 How-To Listen to the World $3.50. N.A. Radio TV Station Guide, log sheets, reporting forms, calculators, 24-hour clocks, etc. Catalog. Gilfer Associates, Box 239 N, Park Ridge, New Jersey 07656.

## PRINTING

**EMBOSSED** business cards, $2.99——1,000, free samples. Gables—405T Clifton, Glenshaw, Pa. 15116.

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SELF-HYPNOTAPES. Send for FREE brochure, "WHAT'S IT ALL ABOUT." PERSONALIZED TAPES, Box 190PE, Quincy, Massachusetts 02169.

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**SCIENCE** Bargains—Request Free Giant Catalog "CJ" —148 pages—Astronomical Telescopes, Microscopes, Lenses, Binoculars, Kits, Parts. War surplus bargains. Edmund Scientific Co., Barrington, New Jersey.

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# MARCH 1967
# ADVERTISERS INDEX



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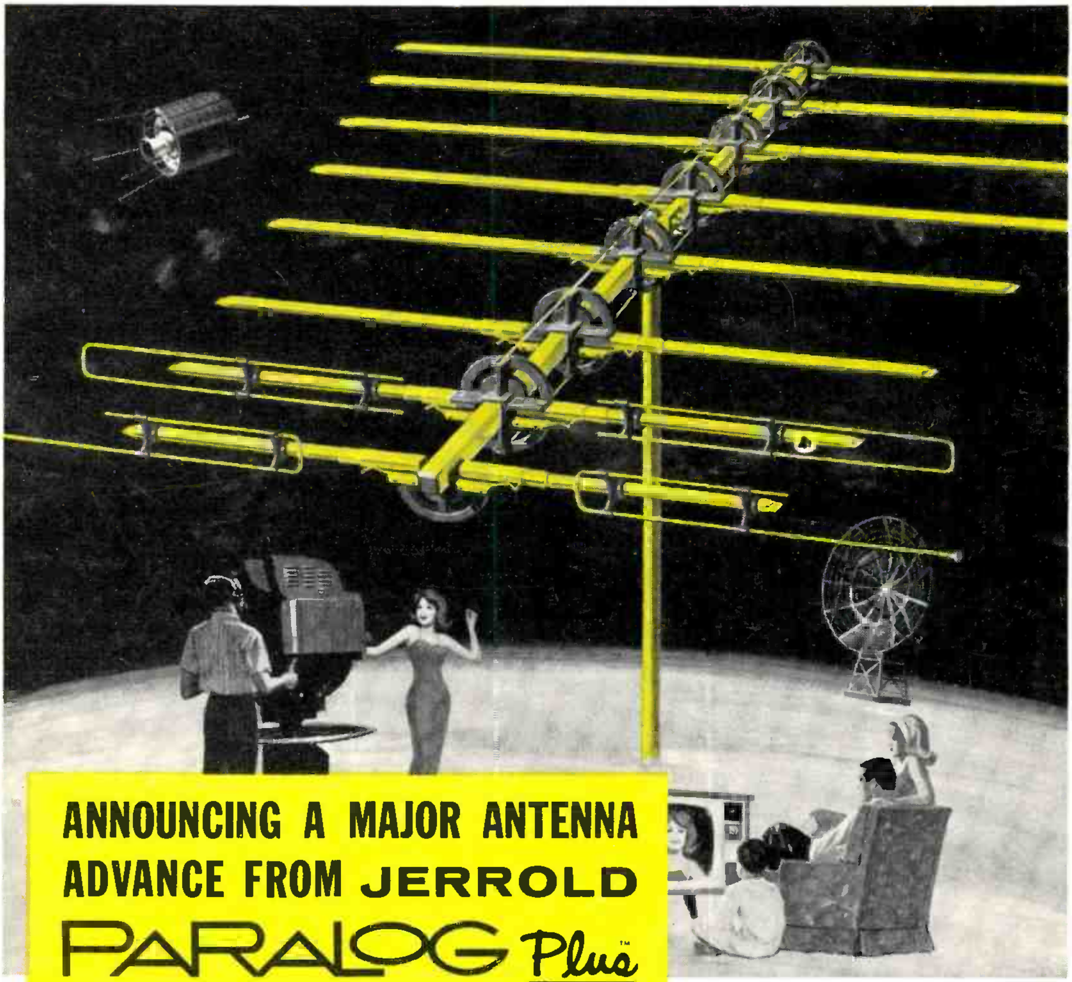

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CIRCLE NO. 25 ON READER SERVICE PAGE

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DON HOUSE, Lubbock, Texas

"Many thanks to NRI for the Electronics training I received. I hold a first class FCC License and am employed as a studio and master control engineer/technician with KXJB-TV."

RONALD L. WOOD, Fargo, N.D.

"I am a Senior Engineering Aide at Litton Systems, in charge of checkout of magnetic recording devices for our computers. Without the help of NRI I would probably still be working in a factory at a lower standard of living."

DAVID F. CONRAD, Reseda, Calif.

"NRI training enabled me to land a very good job as Electronic Technician with the Post Office Dept. I also have a very profitable spare-time business fixing Radios and TV."

NORMAN RALSTON, Cincinnati, Ohio

# POPULAR ELECTRONICS

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

VOLUME 25 — **DECEMBER, 1966** — NUMBER 6


## SCIENCE FAIR PROJECTS

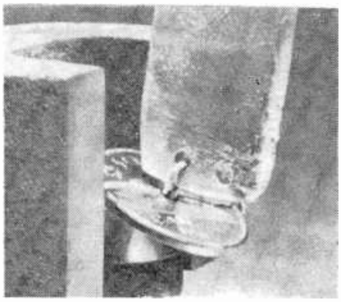


## FEATURE ARTICLES

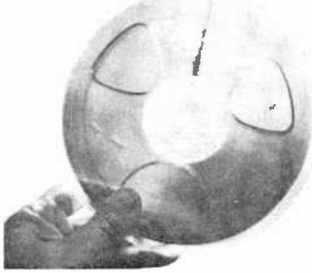


## DEPARTMENTS





Checking out the Curie temperature effect



Presenting a potpourri on tape recording


POPULAR ELECTRONICS is indexed in the Readers' Guide to Periodical Literature

This month's cover photo by Conrad Studios, Inc.





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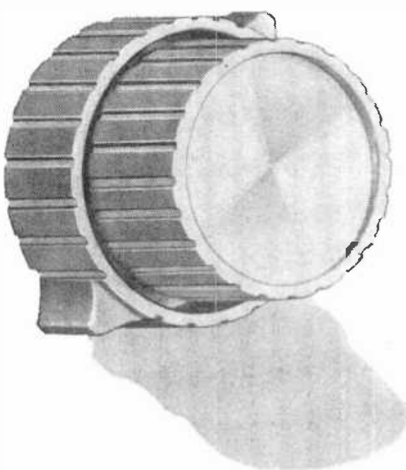

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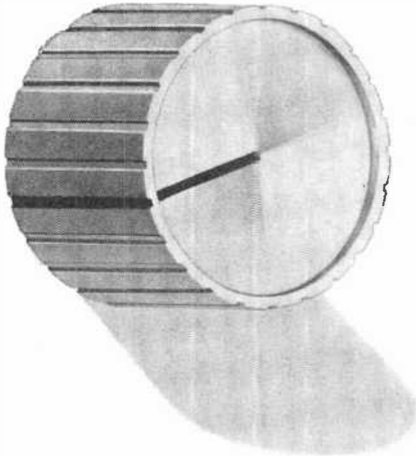


Channel

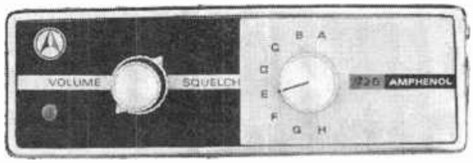
# Simple

The **new** 725 is two knobs simple. Push the left one, it's on; turn the right one to any of 8 channels. Now you're ready to broadcast on the first 5 watt mobile transceiver designed to be operated by any member of the family. Forget about noise. A built-in jack lets you use it with your headset to eliminate loud outside noises.

The 725 is packed with performance, too. Inside, this compact (8½" x 6" x 2") is loaded with solid state circuitry and 14 silicone transistors. Outside, it's designed with the high-style of standard dashboard equipment. At $119.95, it looks like the 725 belongs under the dashboard of your Ferrari, T-Bird . . . or your Chevrolet!

To learn more about the new 725—and the entire Amphenol solid state line—just drop into your nearest Amphenol two-way radio headquarters.

Or write Amphenol, Box 134, Broadview, Illinois 60153.

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CIRCLE NO. 2 ON READER SERVICE PAGE

# LETTERS
## FROM OUR READERS

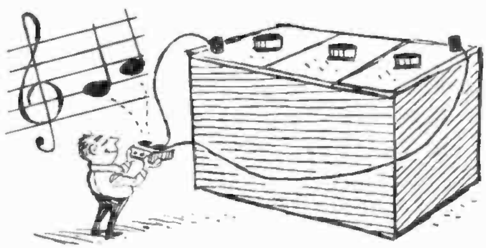
*Address correspondence for this department to:*
*Letters Editor,* POPULAR ELECTRONICS
*One Park Avenue, New York, N. Y. 10016*

### AUTO BATTERY-OPERATED TAPE RECORDER

A friend of mine says I can run my 6-volt tape recorder motor on a 6-volt automobile battery, and that the motor would just use the current it needs. But one of my teachers says that it would burn out the motor. Who is correct?

DALE R. TROTMAN
Mayo, Fla.

*We don't like to disagree with one of your teachers, Dale, but we can't see how you could possibly damage a 6-volt d.c. motor on a 6-volt battery regardless of the physical size of the battery. Your teacher might be taking into*



*account the voltage rise from the generator when the engine is running. Aside from possible tape speed variations, the tape recorder motor—if it is actually a 6-volt unit—should be able to handle a nominal increase in voltage. However, you can run into a problem with the transistors and other electronic components if a higher voltage source is used.*

### DROOPED DECIBEL GRAPH

In your article "What Are These Things Called Decibels?" (October, 1966), is the graph on page 76 in error? It looks as though the reference lines are displaced downward from where they should be.

O. R. HEINZ, K7KHA
Reno, Nevada

There seems to be a discrepancy in the "AC VOLTS TO DB GRAPH," or did I misinterpret the article?

ARTHUR S. DUBUAR
Toms River, N.J.

*See "Out of Tune" on page 89.*

### "SCROUNGING" FOR AN ANTENNA

I am a registered Short-Wave Monitor (WPE6GOC), and I am now studying for my

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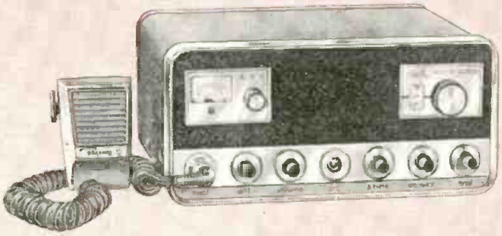

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This is the compact transistorized set with a long list of exclusives. The up front speaker, Collins mechanical filter, a dial system with channel numbers and big TO-3 power transistor are just a part of the construction features that make the Ranger the best of all CB mobiles. Join the rangers . . . you'll get your man on any of its 11 powerful channels!

**The 12 Channel Solid State Charger.......... $110.00**

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The economical CB transceiver that is at home in base or mobile installations. 11 crystal controlled channels on transmit and receive plus 23 channel tunable receiver. Works equally well on AC or transistorized DC power supply. The Pacer's illuminated "S" meter, spotter switch and adjustable squelch are extras that enable the Pacer II to give you so much for so little money.

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CIRCLE NO. 33 ON READER SERVICE PAGE

## LETTERS *(Continued from page 6)*

Novice license. I plan to get the Heathkit "Two-er" and operate phone on 2 meters, but I live on the first floor of a two-story apartment and have an antenna space problem.

DAVID KELLY
Los Angeles, Calif.

*Fortunately, David, 2-meter antennas are quite small, and there are a number of good antennas available commercially; but you might be interested in what you can do with a piece of flat 300-ohm transmission line—the kind used for TV work. Try rigging up "The Scrounge—An Instant J Antenna," described on page 46 in this issue. For 2 meters, the total length of the antenna is only 54.9 inches. The half-wave section is 38.2 inches and the quarter-wave section is 16.7 inches.*

### POPULAR ELECTRONICS INDEX

I have a complete set of P.E. issues from Vol. 1, No. 1 (October, 1954) to the present. I am constantly called upon in my work to come up with different electronic devices to solve all kinds of problems, and I have found many solutions and shortcuts in your fine publication. Would it be possible for you to perforate the Table of Contents page in each issue so that I can tear them out and fit them into a suitable file?

AL DIAMOND
New York, N.Y.

*Al, your suggestion is appreciated. However, since most readers don't like to cut up their issues, we would rather spend the money*


*for editorial material than for perforations. Are you using our Volume Index which is published in the June and December issues? For the latest semiannual index, see page 112.*

### BARIUM TITANATE NOT OUT OF DATE

We do not believe that barium titanate is out of date as indicated by the letter in your July, 1966, issue from C.P. Germano of the Clevite Corp. Barium titanate (or the modified titanate) is the most commonly used ceramic piezoelectric transducer material in existence. Barium titanate has been replaced in the ceramic phono cartridge application by the newer lead zirconate-titanate material. This replacement was accomplished because the lead zirconate-titanate seemed to work better in the old standard designs. More

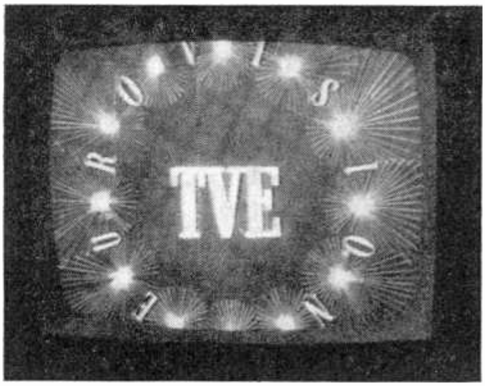
## LETTERS (Continued from page 9)

sophisticated designs with barium titanate elements have greatly outperformed the lead zirconate-titanates, but never gained wide popularity. In general, the lead zirconate-titanates exhibit both advantages and disadvantages when compared with barium titanate.

JAMES W. ANDERSON
Linden Laboratories, Inc.
State College, Pa.

### TV DX IN GREECE

The article on "Riding the TV DX Trail" (July, 1966) was interesting. During the summer, especially in the afternoons (Greek time), I have received transmissions on Channels 2 and 3 from Germany (920 miles), from




Spain (1470 miles), and from Italy and Czechoslovakia (980 miles). I enclose a picture from Spanish television TV-ESPANA which I took last year.

DIM. GAGOSSIS
Athens 811, Greece

### D.C. FLUORESCENT LIGHT

I thought you might be interested in my adaptation of the "D.C.-Operated Fluorescent Light" (July, 1965). Not having any use for a self-contained portable unit, I separated the power supply from the fluorescent tube holder in order to obtain a slim light source for mounting in a car. The lamp holder is made from two pieces of 12" x 1" aluminum angle, and has a piece of translucent fiberglass over the front. The lamp is mounted on a swivel Kleenex holder and can swing out to face the driver. It works like a charm.

JOHN W. KINDLEY
Birmingham, Mich.

### FLUX TO END ALL FLUX

In "Solid State," (March, 1966), page 90, second column, third paragraph, I read about "an ordinary alligator clip to which a piece of felt is soldered." Now, I thought I knew all about soldering, but apparently Lou Garner is way ahead of me. Can you tell me what

# Out where the test begins—a man needs HALLICRAFTERS reliability!


Beyond the last outpost . . . where communication is a necessity, not a parlor game . . . don't settle for less than the quality of workmanship and unfailing performance that have made Hallicrafters products known throughout the world as *"the radioman's radio"*.

CB-11A 10-transistor citizens band pocket portable. 100 mw. of power . . . range up to three miles . . . battery life indicator . . . Price: $74.95/pair.

**hallicrafters**

5th & Kostner Aves., Chicago, Ill. 60624
**Export:** International Div. **Canada:** Gould Sales Co.

**CIRCLE NO. 17 ON READER SERVICE PAGE**

## LETTERS (*Continued from page* 10)

type of flux your Semiconductor Editor uses when he solders felt?

BILL ROBERTS
Reno, Nev.

*Felt flux, of course, but we don't know where to get it. Bill, while we generally think of a metallic union when we think of solder, we can also get burned by the stuff, in more ways than one. Don't blame Mr. Garner for this slip of the typewriter; actually, if you look up the word solder in the dictionary, you'll find a definition reading: something that unites or cements. A problem of semantics?*

### HYDRONICS, HUM AND SKEPTICISM

It was with the greatest of skepticism that I constructed the Hydronics receiver described in the article "Is Plasmonics For the Birds?" (July, 1966). I was greatly surprised when I turned it on, and heard in my headphones chirps and short warbles. I used the dipole antenna which I held over the side of a rowboat in a lake at a day camp at Armonk,


N.Y., where I am a C.I.T., and act as an assistant to the science counselor. My congratulations to Mr. Minto on his interesting discovery.

ELLIOTT SHARP
White Plains, N.Y.

I built the Hydronics receiver, and it works fine with a microphone; but when I plug in the antenna, there is a loud hum. I have gone to all the TV and radio shops around town and nobody can help me. Can you?

D. A. STAN
Griffith, Ind.

I successfully detected several types of underwater signals using equipment similar to that described in your article: a 4′ dipole antenna with 2″ x 3″ copper plates, an Olson AM-260 300-mW, 5-transistor amplifier, and a 4″ speaker. Whenever the antenna was in the water (but not when it was out of the water), a 60-Hz hum could be heard. Also a crackling and popping sound was always present. There was never more than about a half a second interval between successive bursts of crackling. And I was unable to observe any directional effects in the intensity of the noise

(*Continued on page* 88)

NEW!

# 5-Band Portable CB Receiver/Direction Finder

Here is Nova-Tech's solid state 5 Band Portable. It picks up all CB channels, entire Marine Band, Low Frequency navigation beacons, weather stations, and standard broadcasts. It's also an accurate navigation instrument, used in thousands of planes and boats for position finding and homing.

## 5 Bands

1. **CB Low**
2. **CB High** — Tunes all 23 channels spread out on 2 bands for easy tuning and positive identification. You can monitor all CB channels wherever you go . . . including H.E.L.P. and R.E.A.C.T.
3. **L.F.** — 200-400 KC. Beacon/Weather. Hear accurate, up-to-the-minute weather broadcasts around the clock. FAA stations give all weather data for 200 miles around. Also tunes navigation beacons.
4. **S.W.** — 1.4-4.5 MC. Marine/Shortwave/Police. Listen to all marine communications: ship-to-ship, ship-to-shore, Coast Guard, fishing and pleasure boats. MAYDAY. Radio hams on 75 meter band.
5. **A.M.** — Standard broadcast band, music, news, sports. Sensitive receiver brings in stations ordinary radios just can't get.

### Hours Of Fascinating Listening

Technically, this unit is superb. The CB section uses a 2 crystal, double conversion circuit to shift the entire 27 Mc CB band down to the 200 Kc region and by means of a tunable IF strip and a narrow band mechanical filter, a stability is produced that rivals laboratory instruments. 1 microvolt sensitivity is produced by 2 RF transistors ahead of the mixer. The adjustable squelch control can be set so that as little as 3 microvolts will unlock the audio. The S meter also serves as a null meter when direction finding on the lower bands.

Nova CB combines a superb CB receiver with an outstanding portable direction finder, of which over 50,000 are now in use, more than all other makes combined. Useful and handsome, this unit will be valued for many years.

**Can operate 4 ways: from internal batteries, external dry cell, house current, or sun power from optional solar cells. ($40 extra.)**

A SPECTACULAR CHRISTMAS GIFT!


5 Band Portable CB Receiver / Direction Finder $149.95

**Over 50,000 Nova-Tech radio direction finders now in use all over the world . . . more than all other makes combined.**

Complete with 3 telescoping whip antennas, miniature earphone, leather carrying case, batteries, removable and adjustable mounting bracket. Only 8" x 5" x 2", smaller than an ordinary cigar box, it weighs just 2½ lbs. *And it also plugs into regular house current.*

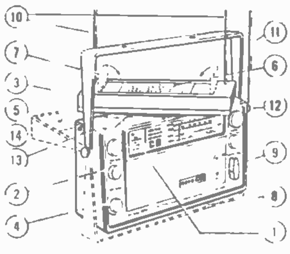
## 5 Band Nova CB $149^{95}

Budget terms available, $40 down $20 month or charge your Diners Card.


**UNCONDITIONAL MONEY BACK GUARANTEE**

If you are not completely pleased with your Nova CB return it within 10 days for full refund. No questions. No explanations.

**The new Nova-Tech NOVA CB is a long range 5-band receiver and radio direction finder with *exclusive* features.**




1. "NULL" METER. Locates direction instantly
2. SQUELCH CONTROL eliminates noise and static between CB transmissions.
3. ROTATING ANTENNA gives sharp, clean nulls to give accurate bearings. No need to rotate entire set.
4. DF LEVEL CONTROL adjusts needle sensitivity. Also prevents overload from strong signals which could prevent sharp, accurate nulls.
5. 180° LEFT-RIGHT BEARING SCALE gives accuracy of 10" diameter compass rose even though set is only 2½" thick.
6. MORSE CODE, a handy guide to help identify beacon signals.
7. CALIBRATED OPTICAL SIGHTS on rotating antenna flip up for taking visual bearings.
8. REMOVABLE BRACKET is adjustable for horizontal or vertical mounting and can be used as carrying handle.
9. TWO EXTERNAL HEADPHONE JACKS, one for standard headphone, one for miniature earpiece (included free).
10. TWIN PLUG IN EXTENDABLE ANTENNAS for the best mobile reception.
11. LONG RANGE EXTENDABLE REMOVABLE WHIP provides maximum signal input on ground.
12. BUILT IN EXTERNAL CB ANTENNA JACK for roof top or car top antenna. Provides greater range.
13. PUSH BUTTON DIAL LIGHT illuminates entire slide rule calibration scale for easy and accurate tuning at night.
14. BATTERY SAVER PLUG. External batteries can be connected. Also comes with house current adapter.

## NO RISK ORDER BLANK

**nova-tech** INC.

630 Meyer Lane, Redondo Beach, California 90278

Please send me
*with unconditional 10-day money back guarantee:*

5 Band Nova CB with house current adapter $149.95

☐ I enclose payment in full. ☐ Diner's No.________

☐ Budget terms: I enclose $40 down. ☐ Ship C.O.D.

Name ____________________

Address ____________________

City, State ____________________

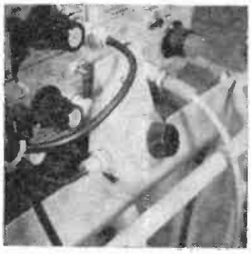
FE126

CIRCLE NO. 29 ON READER SERVICE PAGE

# PARTS METHODS IDEAS GADGETS DEVICES TIPS & TECHNIQUES

## SLOPE-FRONT BOX STOPS STOOP AND SQUINT

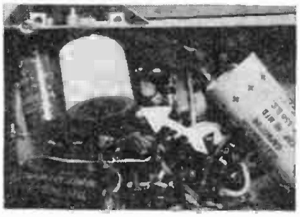
A small slope-front box for mounting potentiometers, pilot lamps, small meters, etc., at a convenient angle for reading or accessibility can be made from a small metal box. Hold and position one section of the box next to the other and move it around until you get the slant you want. Mark cut lines on both pieces, and use a hacksaw to cut away the metal that is in your way. After you file the burrs, you can mount the component on the sloping front



as shown. Jacks and other connectors can also be mounted on the box. Use self-tapping sheet metal screws to hold the two sections together. —*Roger White*

## TROUBLESHOOT THERMAL DRIFT WITH PLASTIC "ICE CUBES"

If you have some of those drink coolers that are made of plastic with water trapped inside, you can use them to cool off hot components when you're troubleshooting for thermal drift. The novelty plastic "ice cubes" are available in a variety of sizes and shapes, and they can snuggle right up to a suspected component and draw away the heat. If circuit operation is restored after the component has been cooled, you've found the defective part. —*Henry R. Rosenblatt*



## ROTATE YOUR RADIO FOR BETTER RECEPTION

Some of the more expensive AM portable radios on the market have antennas built

(*Continued on page* 20)

# POPULAR ELECTRONICS
## READER SERVICE PAGE

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Circle the number on the coupon below which corresponds to the key number at the bottom of the advertisement or is incorporated in the editorial mention that interests you.

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| 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 |
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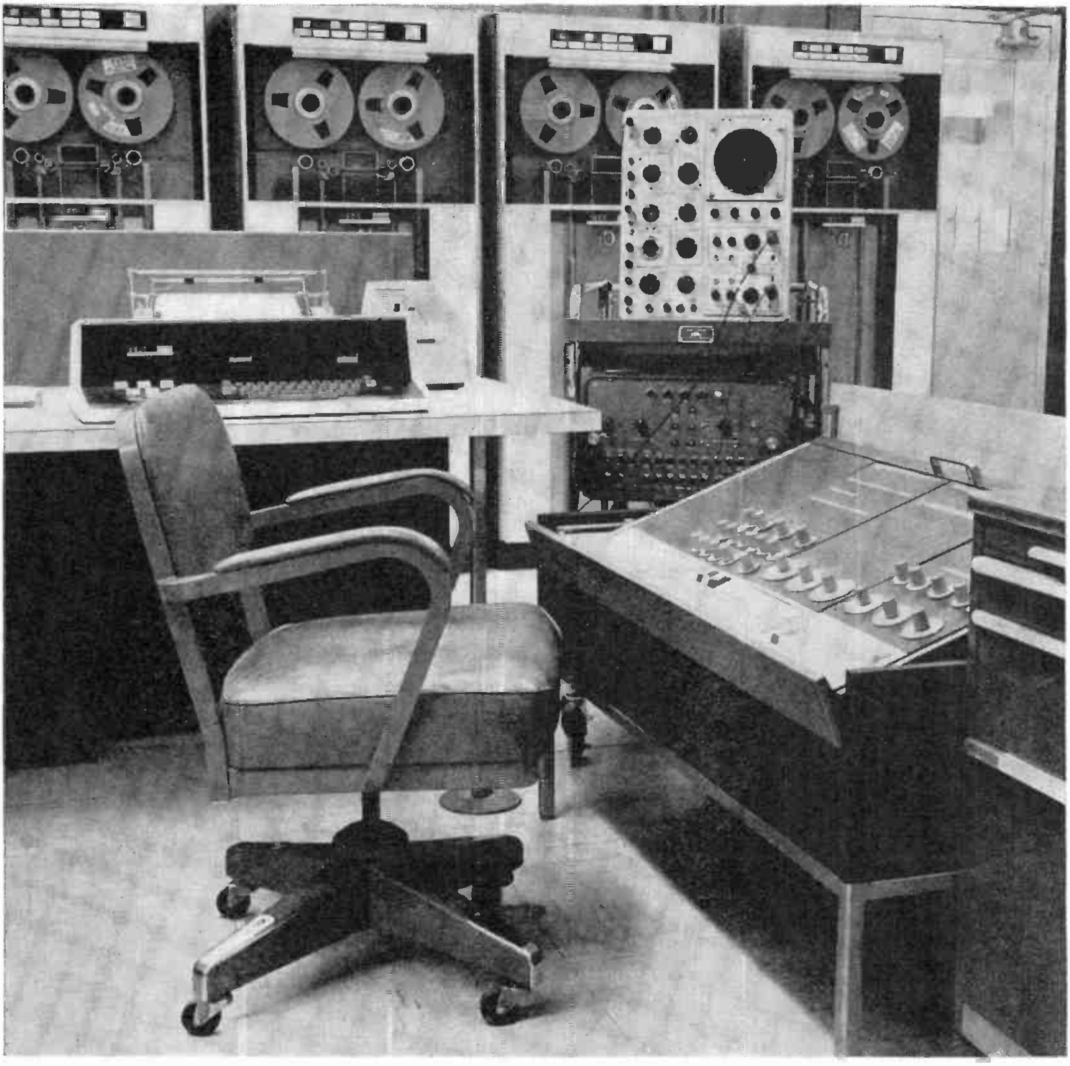
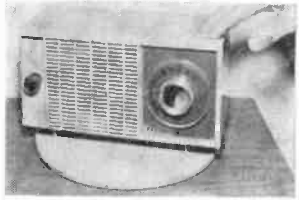


## TIPS (*Continued from page 14*)

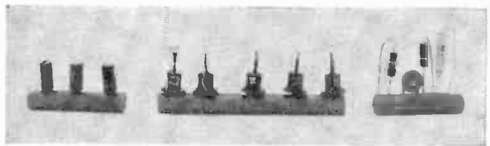
into their rotatable handles so that the antenna can be positioned for best reception. You can obtain the same results with your table radio if you set it on a plastic turntable (Lazy Susan) and rotate the whole thing. These "space - saver" turntables are sold at most dime stores



and department stores in a variety of sizes. Although metal turntables are more durable, you should avoid using them because they can cause interference; but select a stiff turntable to prevent the radio from shifting position with every vibration. —*Art Trauffer*

### HANDY HOLDERS FROM FLASHBULB PLASTIC PACKING

Split plastic tubing for AG-1 flashbulbs can be used on the workbench to hold small electronic components when you're constructing



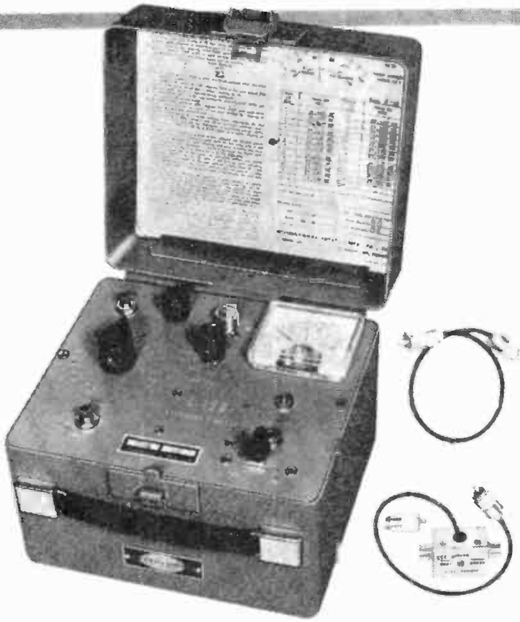
a project. They also keep resistors, capacitors and other small components in one place so that you don't have to dig through piles of assorted parts for the one you need. If you wish, you can glue a narrow strip of heavy cardboard to each tube to serve as a stand.
—*George E. Gates*

### MAKE YOUR TRANSISTOR RADIO A WRIST-STRAP SWINGER

If your pocket-size portable radio doesn't have a wrist strap, you're just not with it. All you need to join the swingers are a camera wrist strap and a suitable size solder lug. Remove the back of the radio, unsolder the earphone jack connections, and slip the jack out of its

mounting bracket. Place the solder lug over the threads, secure the jack, and resolder the wires. Then bend the lug to accommodate the strap, but leave enough room for the earphone plug. You can cut a notch in the plastic case if necessary, to prevent the solder lug from interfering with the back cover.
—*S. E. Gohl*

# If You Service Citizens Radio Transceivers . . .



## you should have

### AN INTERNATIONAL

# C-12B

### FREQUENCY METER

### *Four Instruments In One*

The C-12B is more than a frequency standard — it measures power output, measures AM modulation, and is a signal generator . . . all self contained in one convenient unit.

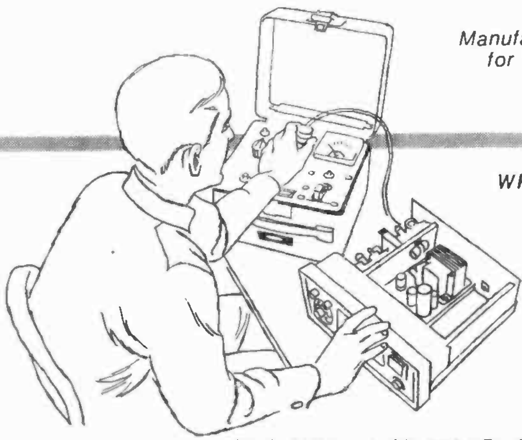
***check these features!***

- *Frequency Measurement* — Range 26.965 mc to 27.255 mc. Frequency stability ± .0025% 32°F to 125°F; ± .0015% 50°F to 100°F.
- *Power Measurement* — 0 to 5 watts, accuracy ± ¼ watt.
- *Counter Circuit* — Frequency range 0 to 3 kc. Residual error 100 CPS @ zero beat.
- *AM Modulation Measurement* — Range 0 to 100%. Accuracy 3% @ 400 CPS @ 80% modulation.
- *Signal Generator* — Frequency range 26.965 mc to 27.255 mc. Low output 1 microvolt through special pick-off box furnished with meter. High output 100 microvolts through output jack.
- *Panel Controls* — Channel selector, 24 positions • "Hi-Lo" frequency adjust • RF level control • Modulation set • Power • Meter calibration adjust • Function selector, 7 positions • Modulation • RF • Deviation • Calibration • Battery Test "A" • Battery Test "B" • Battery Test "C".
- *Battery Power Required* — 1½ vdc @ 60 ma, 67½ vdc @ 5 ma, 9 vdc.

The C-12B is capable of holding 24 crystals and comes with 23 crystals installed. Everything you need including connecting cable, PK box, dummy load, and batteries.

**Cat. No. 620-101 . . . . . . . . . . . . . . . . . . . . . $300.00**

*Manufacturers of precision electronic products for home, industry and aerospace needs.*



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**CRYSTAL MFG. CO., INC.**

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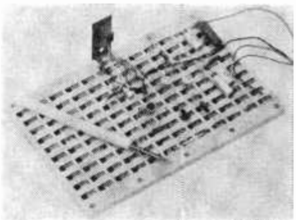
**CIRCLE NO. 20 ON READER SERVICE PAGE**

# NEW PRODUCTS

*Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15.*

## EXPERIMENTAL CIRCUIT BOARD

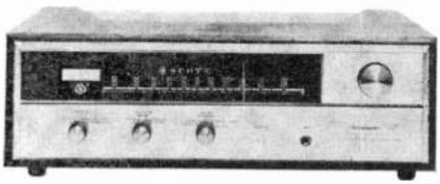
Want to eliminate worries about cold-solder joints, overheated devices, and burned insulation? "SPRINGBOARD," a new solderless experimental circuit board that permits the instant addition or removal of components without damage to leads is now in production at *Barry Instrument Corporation.* The Model BIS-100 SPRINGBOARD incorporates 120 ten-turn stainless steel springs that hold components securely and also act as connectors. All springs are electrically isolated from each other, but several can be joined with jumper wires as required by the circuit being constructed.



Circle No. 75 on Reader Service Page 15

## FET FM STEREO TUNER KIT

Field-effect transistor circuitry is incorporated in *H. H. Scott*'s LT-112B FM broadcast monitor tuner kit for maximum sensitivity (1.8 $\mu$V) and selectivity (45 dB) with minimum cross-modulation (rejection, 90 dB) and drift. An exclusive combination front-panel meter is used initially to align the tuner, and

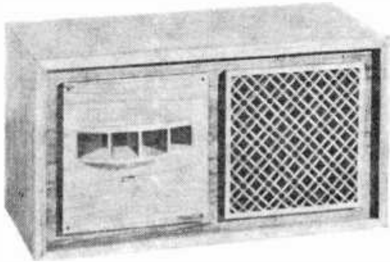


can be used to indicate signal strength, zero-center tuning, or multipath distortion. All difficult-to-wire or critical circuitry in the LT-112B is prewired, pretested, and prealigned at the factory. The kit comes with a full-color, "life-size" construction book, and with all wires precut and prestripped to the proper lengths.

Circle No. 76 on Reader Service Page 15

## THREE-WAY SPEAKER SYSTEM

Featured in the *Olson Electronics* Model S-777 "Ultima" system is a multi-cellular midrange horn speaker for wide-angle dispersion of mid-frequency tones. A 12" woofer is coupled to the multicell horn and a 2½" tweeter by an LC-type crossover; there are level controls on the midrange speaker and

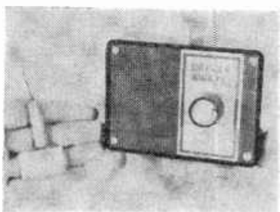


the tweeter. The midrange horn can be turned 90° in the cabinet, permitting the cabinet to be mounted either vertically or horizontally. Power-handling capacity: up to 50 watts. Impedance: 8 ohms. Frequency response: 30 to 23,000 Hz.

Circle No. 77 on Reader Service Page 15

## AUTO SAFETY ALARM

DRIVER AWAKE! That's the name of an auto safety alarm by *Executive Devices* which helps to keep you awake at the wheel on long drives. Its operation is based on the fact that a driver constantly moves the steering wheel back and forth slightly no matter how straight the highway. As the driver gets sleepy, however, the number of wheel movements declines. The DRIVER AWAKE stores your average rate of steering wheel movements, and if it senses a deviation from the normal, it sounds a warning alarm. Moving the wheel slightly either way turns it off. The unit can be installed under the dash in less than two minutes, and it does not interfere in any way with steering.



Circle No. 78 on Reader Service Page 15

## PORTABLE POWER SOURCE

Most conventional portable power sources can be used for only one specific device. The lightweight, 12-volt, rechargeable CRL-1200 "Power Pack" introduced by *Centralab* covers a wide range of applications and can be transferred easily from one appliance to another. It is said to power most battery-operated devices for longer periods—at lower cost—than any other power source, including the original equipment battery pack. The CRL-1200 can operate continuously up to 40 hours or more —it will power a small TV set for 10 hours on


### Introducing EICO's New "Cortina Series"!

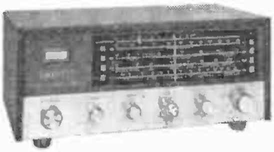
Today's electro-technology makes possible near-perfect stereo at moderate manufacturing cost: that's the design concept behind the new EICO "Cortina" all solid-state stereo components. All are 100% professional, conveniently compact (3⅛"H, 12"W, 8"D), in an esthetically striking "low silhouette." Yes, you can pay more for high quality stereo. But now there's no need to. The refinements will be marginal and probably inaudible. Each is $89.95 kit, $119.95 wired.

**Model 3070 All-Silicon Solid-State 70-Watt Stereo Amplifier:** Distortionless, natural sound with unrestricted bass and perfect transient response (no interstage or output transformers); complete input, filter and control facilities; failure-proof rugged all-silicon transistor circuitry.

**Model 3200 Solid-State FM/MPX Automatic Stereo Tuner:** Driftless, noiseless performance; 2.4μV for 30db quieting; RF, IF, MX are pre-wired and pre-tuned on printed circuit boards — you wire only non-critical power supply.

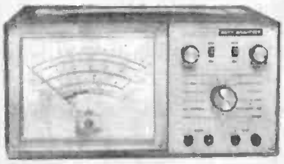
# 7 New Ways to make Electronics more Fun!

## Save up to 50% with EICO Kits and Wired Equipment.



You hear all the action-packed capitals of the world with the NEW EICO 711 "Space Ranger" 4-Band Short Wave Communications Receiver — plus ham operators, ship-to-shore, aircraft, Coast Guard, and the full AM band. 550KC to 30MC in four bands. Selective, sensitive superhet, modern printed circuit board construction. Easy, fast pinpoint tuning: Illuminated slide-rule dials, logging scale; "S" meter, electrical bandspread tuning, variable BFO for CW and SSB reception, automatic noise limiter. 4" speaker. Headphone jack. Kit $49.95. Wired $69.95.

More "ham" for your dollar than ever — with the one and only SSB/AM/CW 3-Band Transceiver Kit, new Model 753 — "the best ham transceiver buy for 1966" — Radio TV Experimenter Magazine. 200 watts PEP on 80, 40 and 20 meters. Receiver offset tuning, built-in VOX, high level dynamic ALC, silicon solid-state VFO. Unequaled performance, features and appearance. Sensationally priced at $189.95 kit, $299.95 wired.



## NEW EICO 888 Solid-State Engine Analyzer

**Now you can tune-up, troubleshoot and test your own car or boat.**

Keep your car or boat engine in tip-top shape with this completely portable, self-contained, self-powered universal engine analyzer. Completely tests your total ignition/electrical system. The first time you use it — just to tune for peak performance — it'll have paid for itself. (No tune-up charges, better gas consumption, longer wear) 7 instruments in one, the EICO 888 does all these for 6V and 12V systems; 4, 6 & 8 cylinder engines.

The EICO 888 comes complete with a comprehensive Tune-up and Trouble-shooting Manual including RPM and Dwell angle for over 40 models of American and Foreign cars. The Model 888 is an outstanding value at $44.95 kit, $59.95 wired.


New EICOCRAFT® easy-to-build solid-state electronic TruKits:® great for beginners and sophisticates alike. As professional as the standard EICO line — only the complexity is reduced to make kit-building faster, easier, lower cost. Features: pre-drilled copper-plated etched printed circuit boards; finest parts; step-by-step instructions; no technical experience needed — just soldering iron and pliers. Choose from: Fire Alarm; Intercom; Burglar Alarm; Light Flasher; "Mystifier"; Siren; Code Oscillator; Metronome; Tremolo; Audio Power Amplifier; AC Power Supply. From $2.50 per kit.

There's more PUNCH in the new EICO "Sentinel-Pro" 23-channel Dual Conversion 5-watt CB Transceiver. New advanced Big-Reach "Range Plus" circuitry lengthens "talk-power" reach. Automatic noise limiter super-sensitizes for weak signals. "Finger Tip" antenna loading and transmitter tuning controls. 23 crystal-controlled transmit and receive channels — all crystals supplied. Rear-illuminated S/RF meter. Transistorized 12VDC and 117VAC dual power supply. Wired only, $169.95. Positive-Negative Ground/Mobile Marine Modification kit (optional $5.95).

**Model 460** Wideband Direct-Coupled 5" Oscilloscope. DC-4.5mc for color and B&W TV service and lab use. Push-pull DC vertical amp., bal. or unbal. input. Automatic sync limiter and amp. **$109.95 kit, $149.95 wired.**

**FREE 1967 CATALOG** PE-12

EICO Electronic Instrument Co., Inc.
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Send me FREE catalog describing the full EICO line of 200 best buys, and name of nearest dealer. I'm interested in:

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☐ automotive electronics
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**Model 232** Peak-to-Peak VTVM. A must for color or B&W TV and industrial use. 7 non-skip ranges on all 4 functions. With exclusive Uni-Probe.® **$29.95 kit, $49.95 wired.**

**CIRCLE NO. 11 ON READER SERVICE PAGE**

## PRODUCTS *(Continued from page 22)*

a single charge—and as much as 40 amperes or 480 watts can be used intermittently. Charge loss during storage is only 3% per month. The CRL-1200 comes with built-in charger in a leather carrying case.

Circle No. 79 on Reader Service Page 15

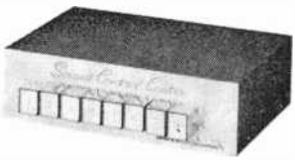
### STEREO TAPE DECK

The deluxe Model RK-880 stereo record/playback tape deck introduced by *Lafayette Radio Electronics* incorporates features usually associated with higher priced tape decks. Three heads provide four-track stereo and mono record/playback plus sound-on-sound and sound-with-sound features. In addition, the RK-880 utilizes adjustable control of playback and record equalization and bias current from the front panel. Frequency response is 30 to 22,000 Hz at 7½ in/s, ±3 dB; 40-12,000 Hz at 3¾ in/s, ±3 dB. Wow and flutter is less than 0.15% at 7½ in/s, less than 0.25% at 3¾ in/s. Signal-to-noise ratio: over 53 dB. The unit can be operated either horizontally or vertically.

Circle No. 80 on Reader Service Page 15

### SPEAKER SWITCHING SYSTEMS

Instant multiple-output selection of up to eight stereo speaker systems is possible with the Models 641 and 642 "Sound Control Centers" announced by *Switchcraft, Inc.* Model 642 is designed for situations where simultaneous distribution of sound to more than one stereo speaker system is desired; Model 641 restricts sound distribution to one stereo speaker system at a time. Frequency response through the internal switching network of both units is from d.c. to 30 kHz with negligible switching loss. No external power (other than the audio power being distributed) is required for operation. Power-handling capability is 100 watts maximum into a 4-ohm load.



Circle No. 81 on Reader Service Page 15

### AUTO "HASH HUSHERS"

"Hash Husher" kits have been developed by the *Hallett Manufacturing Company* to reduce the electrical interference to mobile receivers (hash) caused by ignition noise pulses. The kits consist of electronic RL filters that snap into place between spark plugs and leads, plus a special, filtered coil-to-distributor high-tension lead. Hash Hushers fit all standard gasoline engines, won't affect mechanical or electrical operation, and can be installed in minutes.

Circle No. 82 on Reader Service Page 15

### PLASTIC LIGHT GUIDE KIT

"CROFON" light guides are now available in a do-it-yourself kit from *Edmund Scientific Company.* These plastic fiber optics, recently developed by DuPont, transmit light around corners, to many outlets from a single source, and into remote and inaccessible places. Used with photocells, they will count, select, detect, and sort by size, shape, and color. The Edmund kit includes two 2-foot lengths of the light guides, one with 16 fibers, the other with 64—which transmits four times the amount of light; concentrating lens; penlight-type light source (less batteries); and adapter for connections. It also contains all material needed to polish and cap the ends of the guides—plus detailed instructions.

Circle No. 83 on Reader Service Page 15

### IN-CIRCUIT TRANSISTOR TESTER

Rather than pulling each transistor for out-of-circuit or substitute testing, *Sencore's* TR-139 lets you check any transistor or diode without disconnecting a single lead. The TR-139 provides two important readings: true a.c. *beta,* the gain factor of a transistor, and leakage current ($I_{cbo}$) in microamperes. In-circuit and out-of-circuit test procedures are identical. A specially designed circuit in the unit protects the most delicate low-current-type transistor or diode from damage even if the leads are accidentally hooked up backwards. And parameters of unknown transistors can be determined without a setup book or manual.


Circle No. 84 on Reader Service Page 15

### SCREWDRIVER KITS

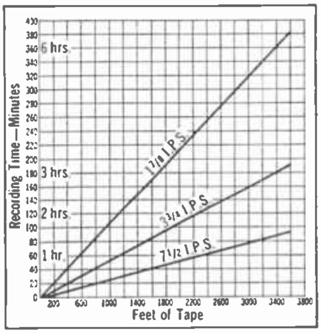
Two new Series 99 "Plastic View" kits, each with a $1\frac{1}{16}$" x 4⅛" handle and a selection of interchangeable, single-ended screwdriver blades have been introduced by *Xcelite.* A handy "hang-up" eyelet is provided in each compact, see-through, zipper case. Handles are of shockproof, breakproof amber plastic, and will accept any of the interchangeable screwdriver, nutdriver, and other blades in Xcelite's extensive Series 99 line. Blades are of high carbon steel with highly polished nickel-chrome finish.

Circle No. 85 on Reader Service Page 15

Some plain talk from Kodak about tape:

# Uninterrupted listening pleasure... and the answer to a searching question

Recording a pop tune or even the whole top ten isn't much of a problem with standard sound tapes. But people always want more—like getting a whole Wagnerian opus on a single reel. Actually, the problem of long playing time involves two variables: how fast you run the tape, and how much tape length you get on a reel. The following chart will give you an idea of running times with different lengths of tape:




**Some like it slow.** Taking it slow is the obvious way to get longer playing time. This works very well up to a point. As a matter of fact, it is the historical trend—from 15 ips to 7½ ips to 3¾ ips and so on. But as you cut speed, you make the microscopic perfection in the tape more and more important. Furthermore, at slow speeds the increased dependence upon short wavelength information and the concurrently reduced flux-carrying capacity of the tape makes head design more difficult. But even though improved quality slow-play tape recordings are strongly dependent upon improved equipment, you are still ahead with the built-in quality of KODAK Tapes—high output tape Type 34A, with its output and noise advantages, or low-print tape Type 31A.

**Some like it thin.** The other avenue is to go to a thinner tape . . . one that packs more length on the reel. This too is an appealing idea—one that explains the proliferation of double and triple play tapes. So what's the catch? Well, for one thing, very thin tapes require careful habits on the part of the home recordist. Your recording/playback heads should be in good shape, as thin tape is more liable to physical distortion and breakage. Strive for smooth starts and stops. You can help by turning the reels away from one another (gently, please) so as to take up any slack in the tape which may have occurred during threading. Also, forget the fast-rewind knob—store tapes "as played." Fast rewind can set up a lot of tension and often cause erratic winding. All this can result in "stretched" or "fluted" tapes. In a nutshell, treat thin tapes with loving care.

When you record, be careful not to overload on input (if you have a VU meter, keep the needle slightly below the record level you would normally use for regular tape).

Last but not least, make sure you get your tape from a reliable maker—like Kodak. It takes a lot of extra care in winding, slitting and over-all handling to come up with a superior triple-play tape like Kodak's famed Type 12P. Because of its highly efficient oxide, Type 12P gives you a signal-to-noise ratio better by close to 6 db compared to the other leading triple-play tape. Add to this the advantage of back printing (so you always know what type of tape you're using—even when it's in the wrong box), and a dynamically balanced reel that reduces the stress and strain on a thin tape, and you can see why KODAK 12P Tape is becoming so popular.


KODAK Tapes—professional types and the long-playing variety—are available at most electronic, camera, and department stores. If you've had trouble finding them at your favorite store, Kodak would like to help. Simply tell us where you'd like to buy KODAK Tape, and we'll see what we can do about having these stores stock it. In the meantime, we'll rush you the names of nearby Kodak dealers where you'll be *sure* to find KODAK Tape; also, a very informative booklet "Some Plain Talk from Kodak about Sound Recording Tape." Just fill out the coupon.

**Mail coupon today**

**Eastman Kodak Co., Dept. 940**
**Rochester, N. Y. 14650**

Gentlemen: I would like to be able to get KODAK Sound Recording Tape at the following stores:

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2)__________
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3)__________
Electronic supply store

Please send names of nearby outlets and my free copy of "Some Plain Talk from Kodak about Sound Recording Tape."

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Address__________

City & State__________Zip______

EASTMAN KODAK COMPANY, Rochester, N.Y.

**CIRCLE NO. 12 ON READER SERVICE PAGE**

# ELECTRONICS LIBRARY

## DIRECT CURRENT CIRCUITS AND MEASUREMENTS

*by Charles J. Anderson, Anthony Santanelli, and Fred R. Kulis*

Beginner and advanced student alike will find this book a noteworthy presentation of self-instructional material designed to equip the reader with a working knowledge of d.c. circuits, using only algebra and general science. The book is organized to permit a quick reference review of important fundamentals. Readers wishing to take a refresher course are easily programmed through the text by simple notations. One of the better books in programmed self-instruction.

*Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. 346 pages. Hard cover. $12.00.*

## ALLIED ELECTRONICS DATA HANDBOOK, Fifth Edition

The latest edition of the *Allied* (Radio) *Electronics Data Handbook* is about the most complete compact reference book on the market today—it's surprising how much information can be sandwiched into 112 pages. There is something in this handbook for everyone from the graduate engineer to the beginning student in electronics. The new edition is much larger than the last one and is chock full of specialized information as well, such as the tape recording and TV sections, to name only two. The handbook also has trigonometric tables and a cross-reference of American and foreign tubes. This book is a real time-saver and is highly recommended.

*Published by Allied Radio Corp., 100 North Western Ave., Chicago, Ill. 60680. 112 pages. Soft cover. 75 cents.*

## ABC's OF CAPACITORS

*by William F. Mullin*

What is a capacitor? How is it made? Where is it used? These and many more questions you might have about capacitors are answered in refreshingly readable language in William F. Mullin's new text. Technicians, servicemen and students will find this book a valuable aid in practical applications and classroom studies. *ABC's of Capacitors* is designed to tear away the shroud of mystery around capacitors.

*Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46206. 96 pages. Soft cover. $2.25.* —30—


# SOLDERING KITS

*for electrical soldering, household repairs, hi-fi building, hobbies and crafts*


**Dual heat soldering gun kit.** Includes 100/140 watt dual heat gun with 2 trigger positions, 3 soldering tips, soldering aid, tip wrench, flux brush, solder, rugged plastic case. Model 8200PK $8.95 list

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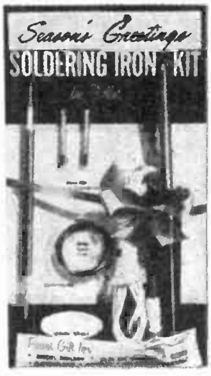
**Marksman soldering iron kit by Weller.** Featherweight 25 watt iron outperforms all other irons of its size and price. Kit includes 3 different tips, soldering aid and solder. Model SP23K $4.44 list




**WELLER ELECTRIC CORP., Easton, Pa.** *WORLD LEADER IN SOLDERING TOOLS*

**CIRCLE NO. 44 ON READER SERVICE PAGE**

# NEW LITERATURE

*To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15.*

"Scott Stereo" is the title of a new 16-page multi-color brochure published by *H. H. Scott, Inc.* It answers the question "What Is Stereo?" and tells you what to look for in buying stereo components. All Scott receivers, speakers, amplifiers, and tuners are pictured and described, both factory-wired and kit units, and complete specifications are included.

Circle No. 86 on Reader Service Page 15

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*Mark Products'* "Heliwhip" mobile amateur band antennas with "Static Sheath" are featured in a 4-page antenna catalog (plus inserts). "Static Sheath" is a durable dielectric plastic covering that acts as an electrical insulator and eliminates static interference caused by the precipitation effect. A complete line of antenna mounts and accessories is also covered.

Circle No. 87 on Reader Service Page 15

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In addition to the regular line of electronic kits, *Conar Instruments'* 1966 Christmas Catalog carries a considerably expanded line of general products, including some items just being introduced on the market. Products have been "departmentalized" and the index made more convenient. Featured are the Conar Model 800 CCTV camera, the "Audiocolor," and the "300" stereo system.

Circle No. 88 on Reader Service Page 15

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Bulletin No. 94025, put out by the *Clevite Corporation*, outlines major reasons why ceramic filters are finding new opportunities to replace LC, quartz, and mechanical filters in military and commercial equipment. Five different kinds of ceramic filters, representative of models in production, are illustrated and described in detail.

Circle No. 89 on Reader Service Page 15

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A data sheet on *Triplett Electrical Instrument Company's* recently introduced Model 630-APLK volt-ohm-milliammeter emphasizes its solid-state switching circuit which guards against accidental burnouts and bent pointers and provides overload protection. Other technical features and specifications are listed, and optional carrying cases and attachments are also described.

Circle No. 90 on Reader Service Page 15

# OPERATION ASSIST

*Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information, write him directly—he'll appreciate it. If you need help, send a postcard to Operation Assist,* POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name, model number, year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

**Crosley** Model 616 receiver, ser. 1136823; tunes s.w. from 540 kHz to 20 MHz on 3 bands; has 6 tubes. Schematic and source for parts needed. (Cliff Briere, Rt. 4, Box 283, Mechanicsville, Va. 23111)

**Eicor** Model 400 tape recorder, ser. T 1347; has 5 tubes. Schematic and plug-in erase/record/playback head needed. (Harold E. Reinbold, 123 S. 6 St., N. Wales, Pa. 19454)

**Lettine** Model 240 transmitter; covers bands from 160 through 10 meters; has 6 tubes. Schematic, operating manual, and parts list needed. (F. J. Burgess, 15318 Deerfield, E. Detroit, Mich. 48021)

**Rogers Majestic** Type 20 receiver, circa 1935; tunes 145 kHz to 19 MHz on 4 bands; has 11 tubes. Schematic, alignment data, and service manual needed. (Mike Thompson, 3388 E. 27 Ave., Vancouver 12, B.C., Canada)

**Patterson Radio Co.** Model 223 PR-10 receiver, circa 1930; tunes BC band to 15 meters; has 10 tubes. Schematic needed. (Arnold R. Achille, 896 Kingston St., Aurora, Colo. 80010)

**Dumont** CR oscillograph, type 303, ser. #1086, circa 1950. Schematic and instruction manual needed. (Larry A. Yonkey, Rt. 2, 1759 7 Mile Rd., Pinconning, Mich.)

**Packard Bell** Model 602 receiver; tunes BC; has 6 tubes. Schematic needed. (Wayne Hellstrom, 2716 E. Melrose, Walla Walla, Wash. 99362)

**BC-721-B/SCR-585-B** receiver, made by Galvin. Schematic, operating manual, and source for parts needed. (A. Tasker, 72 Belmont St., Reading, Mass. 01867)

**Crosley** Model 50 receiver. Schematic and WX12 tube needed. (John Schwerbel, Rt. 1, Box 215, Catskill, N.Y.)

**Just-Tone** Model 30417 receiver; tunes AM and FM. Schematic needed. (Bruce Conrad, Rt. 1, Windsor, Vt.)

**Johnson Service Co.** Model ML-310G/AMT-1 radiosonde modulator. **Molded Insulation Co.** Model T-69C/AMT-1 radiosonde transmitter. Schematics and instruction manuals needed. (Richard Teh, McCallsburg, Iowa 50154)

**National** Model SW-3 receiver and power supply, circa 1934. Schematic and operating manual needed. (L. Mueller, 12700 Elliott Ave., SP287, El Monte, Calif. 91731)

**Sparton** Model 7-36 receiver; tunes 1.6 kHz to 18 MHz on 3 bands; has 7 tubes. **Emerson** Model CS-268 receiver; tunes on 2 bands; has 6 tubes. Schematics and parts lists needed. (Carl Mason, Box 311, Rt. 1, Holmdel, N.J. 07733)

*(Continued on page 32)*

## ASSIST *(Continued from page 30)*

**Garod** neutrodyne receiver, ser. 6000, circa 1923; has 4 tubes. Operating manual, power supply, antenna data, and source for C-301A and CX200-A tubes needed. (Harry J. Donovan, 199 Nesbitt Terrace, Irvington, N.J. 07111)

**Golden-Leutz** "Super Pilotdyne" receiver, type 9, ser 140, circa, 1923; has 9 tubes. (R. Borduas, 8060 Vidal St., St. Hyacinthe, Quebec, Canada)

**Grebe** CR-11, CR-15, and CR-17 receivers. Schematics and/or operating manuals wanted for personal collection of historical radio receivers. (J. C. Gillespie, Box 239, Park Ridge, N.J. 07656)

**Stewart-Warner** Model 11-7A receiver. Schematic needed. (Jack A. Merrell, SFC NCOIC, Radio TV Repair Shop, U.S. Army, Disciplinary Barracks, Ft. Leavenworth, Kan.)

**Midwest** Model 916 receiver, series 16; tunes AM and FM; has 16 tubes. Operating manual needed. (Mike Peterson, N. 5207 Post, Spokane, Wash.)

**Supreme** Model 665 composite video generator, ser. 288. Schematic and instruction manual needed. (J. P. Maley, 95 Fairbank Ave., Toronto 10, Ont., Canada)

**Hickok** Model 228X crystal-controlled FM-AM signal generator. Schematic and service manual needed. (Daniel Gibbons, Box 84, Talara, Peru, S.A.)

**REP 10D-1428** receiver, surplus, made by RCA for Royal Canadian Air Force. Schematic and service manual needed. (H. W. Baurne, Box 693, Campbellford, Ont., Canada)

**Stewart-Warner** Model 91-1117 receiver; has 10 tubes and magic eye. Schematic, alignment procedure, knobs, and dial holder needed. (Clyde Propst, Rt. 2, Sellersville, Pa. 18960)

**Triplett** Model 1632 signal generator, circa 1940. Operating manual needed. (W. Taylor, 11 Terrace Ave., Willowdale, Ont., Canada)

**Sparton-Withington** Model 10Y21 receiver-phono combination, circa 1942; tunes AM and s.w.; has 2 tubes and magic eye. Schematic needed. (Fred Budig, 315 E. 93 St., New York, N.Y. 10028)

**Collaro** Model RC54 record changer. Source for replacement needle needed. (Mark Handley, 31 Mohawk Dr., Clarendon Hills, Ill. 60514)

**DeForest** oscilloscope; has 4 tubes plus cathode-ray tube and 8 controls and 4 input jacks. Schematic and operating manual needed. (Henry Warchall, 4055 W. Melrose, Chicago, Ill.)

**RK34** tube needed. (David Hamilton, River Rd., Rt. 1, Paw Paw, Mich. 49079)

**Philco** receiver, chassis P29758 (?), circa 1935; tunes 530 kHz to 7.4 MHz on 2 bands; has 5 tubes. Schematic and power supply filter capacitors needed. (Stanley Blair, Rt. #3, Ballston Spa, N.Y. 12020)

**Atwater-Kent** Model 60C receiver, circa 1929; tunes BC; has 8 tubes. Schematic, parts list, and service information needed. (Frank V. Carr, 2210 Eufaula Ave., Birmingham, Ala. 35208)

**Radio Craftsman** Model C-800 tuner-preamp, ser. H33855, circa 1953; tunes AM and FM; has 15 tubes plus tuning eye. Schematic and operating information needed. (M. Denno, 1661 Taylor St., San Mateo, Calif.)

**Sterling** "B" battery eliminator, type R-81; has Raytheon BH tube. Schematic or operating manual needed. **Magnavox** Model 151 B radio-phono combination; tunes AM and s.w. Schematic or service notes needed. (Brian Kennedy, 2875 Kenmore Pl., Santa Barbara, Calif. 93105)

**Harvey-Wells** Model "Bandmaster Deluxe" 50D transmitter, circa 1950; tunes 3.5 to 144 MHz on 8 bands. Schematic, operating manual, and VFO needed. (G. F. Huffines, 2073 Ahneita Dr., Pleasant Hill, Calif.)

**Emerson** Model OP-8QS-509A receiver; tunes 550 kHz to 18 MHz on 2 bands; has 6 tubes. Dial cord information needed. **Atwater Kent** amplifier, type TA; has 2 audio stages. Schematic, battery and receiver connection information needed. (Chuck Ridenour, Rt. 1, Box 408, London, Ohio 43140)

**Rocket** Model 8HL TV receiver, made by Egawa Electric Lab Co. Inc. of Tokyo, Japan. High-voltage transformer ZC105726 needed. (E. J. Bunker, 1804 Thornbury Rd., Baltimore, Md. 21209)

*(Continued on page 38)*

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## *INDUSTRY WELCOMES N.T.S. STUDENTS AND GRADUATES*

## ASSIST *(Continued from page 32)*

**Millen** secondary frequency standard, type 90501, ser. 1151. Schematic and service manual needed. (Harry M. Hammond, 1095 Arlington Ave., Teaneck, N.J. 07666)

**CFT-46154** receiver, made by Federal Radio Telegraph Co. Parts list and operating manual needed. **CRV-20130** power supply, used with CFT-46154, made by RCA. Schematic and manual needed. (Robert H. French, 450 38 St., Bellaire, Ohio 43906)

**Hallicrafters** Model S-22-R receiver. Output transformer needed. (Richard Harris, Box 284, Camilla, Ga.)

**Atwater-Kent** Model 55C receiver; has 7 tubes. Operating manual, parts source, and celluloid tuning dial and cabinet needed. (James Chew, 900 N. 4 St., Jeannette, Pa. 15644)

**Atwater-Kent** Model 33 receiver. Sockets and coils needed. **Atwater-Kent** Model 20. Two audio transformers with 3 hole mounts needed. (J. N. Clapp, 1516 Elm St., Davenport, Iowa 52803)

**Firestone** Model R-316-A receiver, ser. 116047; tunes s.w. Schematic and tube complement information needed. (Wayne Aho, 13 Memorial St., Baldwinville, Mass. 01436)

**F.M. Link** Model 1905 receiver; has 13 tubes. Schematic and alignment information needed. (R. Leon Bridwell, Box 176, Antlers, Okla. 74523)

**Millen** syncroscope, type CJA-60ACM, surplus. Conversion diagram needed. (Fred Jahn, 1675 Oriole St., San Leandro, Calif. 94578)

**B & K** Models 500 & 550 tube testers. Tube checker adapters needed. (Bill T. Brinson, 608 N. Shartel, Oklahoma City, Okla. 73102)

**Atwater-Kent** Model 44 receiver; has 8 tubes. Source for tubes needed. (Dave Beal, 501 Pleasant Hill Ct., Rt. 1, Duluth, Ga.)

**Hickok** Model 530-B tube tester, circa 1939. Instruction manual needed. (R. L. Trott, 1690 Sharkey St., Tallahassee, Fla. 32304)

**Cossor** Model 1035 oscilloscope, circa 1954. Schematic and operating manual needed. (J. F. Rich, 94 Neilson Dr., Etobicoke, Ont., Canada)

**Creative Electronics** Model "Transcon 10" transmitter and converter, circa 1957. Schematic and operating manual needed. (Dick Hutchinson, 1705 Kaywin Ave., Bethlehem, Pa. 18018)

**Motorola** Model PA-8343-A receiver; tunes FM from 152 to 174 MHz. Source for parts needed. (G. D. Griffin, 322 W. State St., Ithaca, N.Y. 14850)

**CW-50124** demodulator, surplus, circa 1948. Operating manual and tube source needed. (Gery Sasko, Box 552, Rt. 1, Monongahela. Pa. 15063)

**Weidenhoff** Model 1004 ohm-capacity meter, ser. 5994. Schematic, operating and alignment information needed. (Michael Sidey, 427 Grace Ave., Garfield, N.J. 07026)

**Superior** Model 670-P VOM. **McMurdo-Silver** Model 900 "Vomax" VTVM. Schematics needed. (R. S. Davey, Box 58, Frankfort, Ind. 46041)

**Superior** Model TW11 tube tester. Tube chart roll needed. **Feiler** Model TS9 VTVM. Schematic needed. (Leo Pencok, 10678 St. Charles Rd., Sumner, Mich.)

**Grunow** Model 1291 receiver, chassis 12B; tunes 550 kHz to 18 MHz on 2 bands; has 12 tubes. Schematic needed. (Robert McDaniel, 711 4 St., Fairbury, Nebr.)

**Zenith** Model 5S-29 receiver, ser. N225899; tunes 550 kHz to 18 MHz. **Motorola** TV receiver, chassis 27E90129, circa 1948; has 14 tubes. Schematics needed. (Joe Rock, Jr., Box 162, Knoxville, Md. 21758)

**Gonset** "Communicator II" transceiver, ser. CM 7357. **Hallicrafters** Model S-38D receiver, ser. F 129310. Operating manuals needed. (James Lincoln, 12 Crestview Terrace, Wallingford, Conn. 06492)

**Airline** Model 14BR904A receiver; tunes on 5 bands; has 10 tubes. Schematic and operating manual needed. (Mike Timmons, 14200 S.W. 184 St., Miami, Fla.)

**Electronic Research Associates** Model 50TM power supply. Schematic and operating manual needed. (Thomas McCarthy, 367 Bergen Blvd., Oradell, N.J.)

*(Continued on page 87)*

*Looking for Hi-Fi equipment, but in the dark about which to buy? Well you can always . . .*

**1** Ask your Uncle Fred. He used to fix your toaster.....

**2** Inquire from store to store to store to store to store.....

**3** Choose the one that looks nicest. And cross your fingers...

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If you think buying hi-fi equipment has to be a game of "musical chairs" . . . chance not choice . . . we've got news for you! Now there's a quick, easy, foolproof way to plan your next equipment purchase: with the all-new 1967 STEREO/HI-FI DIRECTORY.

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**CIRCLE NO. 26 ON READER SERVICE PAGE**

COVER STORY


SCIENCE FAIR PROJECT

# THE LOGIC DEMON

USING INTEGRATED CIRCUITS (IC'S), THE DEMONSTRATOR DUPLICATES THE LOGIC FUNCTIONS OF GIANT ELECTRONIC COMPUTERS

By DON LANCASTER

EVER wondered how is it that electronic computers are able to exhibit such a distinctively human characteristic as making logical decisions? Ask the "Logic Demon" and it will tell you that, very simply, the answer lies in the truth of logic—computer logic.

And what IS logic? It is the process of determining, by deductive reasoning, the means of obtaining a desired result from a given set of conditions. Consider the following paradoxical dialogue involving *formal* logic which dates back to Aristotle:

*Socrates:* "What Plato is about to say is false."

*Plato:* "Socrates has just spoken the truth."

Now, if Socrates spoke the *truth,* then Plato's statement must be *false.* But if Plato's statement is *false,* then Socrates *did not* speak the truth and, hence, what Plato said must have been *true.* If Plato spoke the *truth,* then Socrates also spoke the *truth,* and hence what Plato said is *false.* Needless to say, this circular process could go on and on. But can this formal logic be reasoned out mathematically?

The Logic Demon, utilizing the latest in resistor-transistor logic (RTL) circuitry, can serve as a demonstrator/trainer in computer logic—the same logic used by the giant sophisticated digital computers. And you can build the Logic Demon for under $10 to show off at your next Science Fair.

**Computer Logic.** Computer logic, also known as Boolean Algebra, translates Aristotle's *formal* logic to a *mathematical* logic which can be used for reasoning out problems. Developed by Augustos De Moran and George Boole over 100 years ago, Boolean Algebra (computer logic) was crystalized in 1938 by Claude E. Shannon who, while studying for his Master of Science degree at M. I. T., applied it to the solution of switching problems.

As an example of Shannon's application of computer logic to solve practical problems, consider the simple series circuit shown in Fig. 1. Two switches (*A* and *B*) are in series with lamp *I* and a battery. If you ask which switch must be closed in order for current to flow and light the lamp, the answer would be that *both* switches—*A* AND *B*—must be closed. Thus, the circuit is called an AND *gate*. A gating circuit is one that operates as a switch to apply or eliminate a signal.

Following a logical procedure, a table can be made listing all possible switch combinations to prove that switches *A* and *B* must be closed at the same time or current will not flow. Thus,

| Switch "A" Closed | Switch "B" Closed | Lamp "I" Lights |
|---|---|---|
| No | No | No |
| No | Yes | No |
| Yes | No | No |
| Yes | Yes | Yes |

As shown in the table, a "yes" appears in the lamp column only when a "yes" appears in both switch columns. The table can be simplified by substituting a "0" (zero) for a "no" and a "1" for a "yes." This allows us to establish a convention to symbolize that a statement or condition is *false* when a 0 is represented, while a 1 can be used to denote that a statement or condition is *true*. The simplified table is as follows:

| Switch "A" Closed | Switch "B" Closed | Lamp "I" Lights |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

In computer logic (also called symbolic logic), the preceding table is known as a *truth table* for the logical AND for it represents the simple true statement that the lamp lights only when both *A* AND *B* are closed at the same time.

If the same switches are rearranged and connected in parallel as shown in Fig. 2, the following table can be pre-

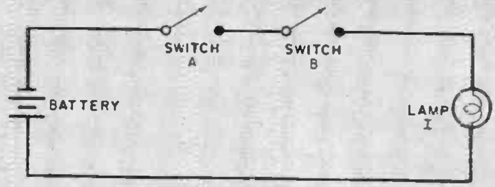



Fig. 1. Switches A and B in series with a battery and lamp can represent the logical AND circuit.

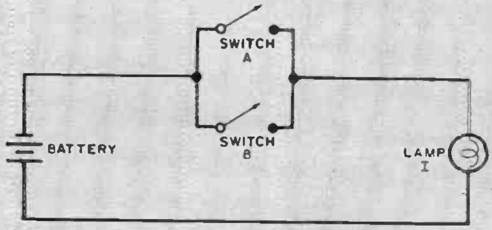
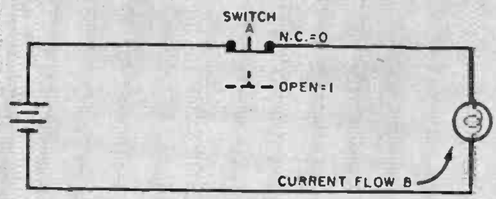



Fig. 2. In the logical OR circuit, current flows if either switch A or switch B, or both, are closed.




| SWITCH A | CURRENT B |
|---|---|
| 0 | 1 |
| 1 | 0 |

Fig. 3. In this circuit, the lamp lights when A is NOT pushed; the circuit is called a NOT gate.

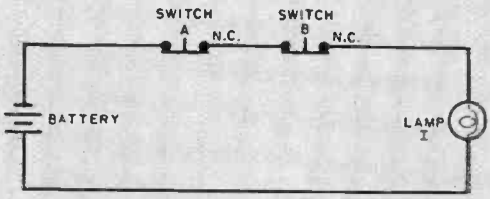



Fig. 4. A NOR gate is represented by adding one or more switches to the NOT gate described above.

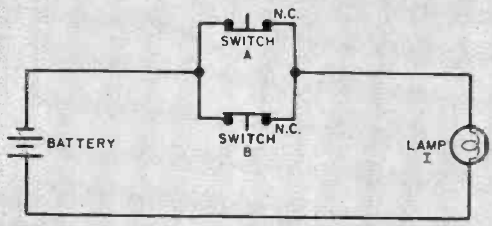



Fig. 5. The NAND function can be depicted by normally closed parallel-connected switches A and B.

pared to show for what switch combination the lamp will light:

| Switch "A" Closed | Switch "B" Closed | Lamp "I" Lights |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

The lamp lights when either one or both of the switches are closed. Thus, logically, *I* is 1 (true) whenever *A* OR *B* (OR *A* and *B*) is true (closed), and the circuit is called a logical OR gate.

Consider the circuit of Fig. 3. Unactuated, normally closed (NC) switch *A* represents a 0, but when pressed, the switch represents a 1. The corresponding truth table asserts that *B* (current flow) is 1 whenever *A* is 0, and that *B* is 0 whenever *A* is 1. In other words, the lamp lights (is 0) when the switch is NOT pushed, and is extinguished when the switch is pushed (1). The circuit is characterized by a single switch, and is called a NOT gate (inverter).

By adding one or more switches to the NOT circuit, we come up with what is called a NOR gate (Fig. 4). A truth table for this circuit would state simply that *C* (current through the lamp) is true only if both *A* and *B* are false, and that *C* is false if either *A* or *B* is true. Since these conditions represent the opposite (negative) of the OR—NOT OR—it is called simply a NOR gate.

The opposite (NOT) of the AND gate can be represented by the circuit of Fig. 5. The NOT AND, or briefly, NAND, function can be depicted by the normally closed parallel-connected switches (*A* and *B*). The lamp lights if *either* or *both* switches are left in their "0" position. But it will be extinguished if both switches are "1" (pressed) at once.

**Applying Computer Logic.** A computer is capable of carrying out a long string of YES-NO decisions without having to repeatedly ask for more information as the operation progresses.

Depending on the complexity of the problem to be solved, thousands upon thousands of such decisions, may be needed for mathematical problems requiring addition, subtraction, multiplication, and division. Programmed instructions, stored in the computer's memory, coordinate all operations, time them for proper sequence, and route the information in the proper sequence to the various registers and output devices.

Logic gates can be constructed with such devices as relays, switches, tubes, and transistors. But in this era of microminiaturization. integrated circuits (IC's) offer the greatest advantage because they occupy very little space, consume little power, are extremely reliable, are quick-acting, and inexpensive.

Of the many varieties of logic IC's on the open market, the *resistor-transistor logic* (RTL) variety is probably the most popular. It can easily drive other

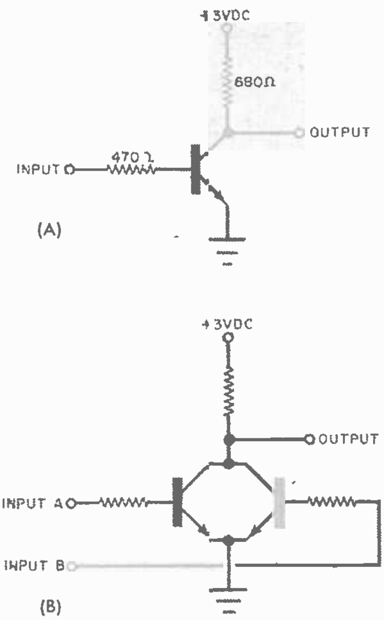



Fig. 6. NOT operation can be performed by a one-input RTL gate shown in (A). A two-input gate (B) can serve either as NOR or NAND circuit.

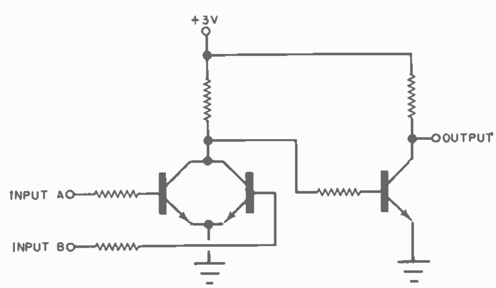



Fig. 7. The AND function is obtained by the addition of a NOT gate to output of a NAND gate.

IC's, and operates with voltage levels that are compatible with the requirements of external circuits. Typical one- and two-input RTL gates are shown in Fig. 6. If additional inputs are required, more transistors are added.

Operation of the gates is simple. If a transistor receives an input, it turns *on* to produce 0 output at the collector. The one-input gate, shown in Fig. 6(a), is the NOT circuit. If +3 volts are applied to the input, the output becomes 0. The absence of a voltage at the input produces +3 volts at the output. Observe that the output is always opposite in state to the input.

Now consider the two-input gate shown in Fig. 6(b). By first establishing that the presence of +3 volts at the input represents a 1, and the absence of this voltage represents a zero, the gate will function as a NOR gate since a 1 at either input produces a 0 at the output. If an OR gate is desired, a NOT circuit (one-input gate) can be added to the output to reverse the state.

If, on the other hand, it is established that the presence of +3 volts at the input represents a 0, while the absence of this voltage represents a 1, then the circuit will function as a NAND gate so long as the +3 volts appears on *both* inputs. Once again, the adding of a NOT circuit reverses the function to produce an AND response. See Fig. 7.

We can now proceed to build the "Logic Demon" around the circuits discussed so far by including a suitable selector switch and a transistor lamp-

## PARTS LIST

*B1—1.5-volt size "D" flashlight cell (2)*
*I1—3.2-volt, 160-mA pilot light (GE #1490 or similar)*
*IC1—Fairchild μL914 epoxy Micrologic dual two-input gate (Data sheet and list of distributors available from: Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif.)*
*Q1—Motorola MPS 834 transistor, or 2N834, or similar type (Data sheet and list of distributors available from Motorola Semiconductor, Box 955, Phoenix, Ariz. 85001)*
*S1, S2—S.p.d.t. switch or two-circuit NO/NC push-button switch*
*S3—4-pole, 5-position non-shorting selector switch (similar to Mallory 1325L)*
*1—5" x 4" x 3" cabinet (similar to Bud CU-2105A or Premier PMC-1005)*
*1—Metalphoto dialplate (optional)**
*1—Scalectro TS-800 IC 8-pin socket (available from Federated Purchasers, Inc., or Arrow Electronics, Inc., both in New York City)*
*Misc.—Battery holder, bracket for Q1 (optional—see text), bar-type knob, 5/16"-i.d. rubber grommet, transistor socket for Q1, nylon or rubber feet with hardware (4), rivets or screws for battery holder*

*Available from Reill's Photo Finishing, 4627 N. 11 St., Phoenix, Ariz. 85014; in silver color—$2.75; blue, red, or copper—$3.25; postpaid in the U.S.A.

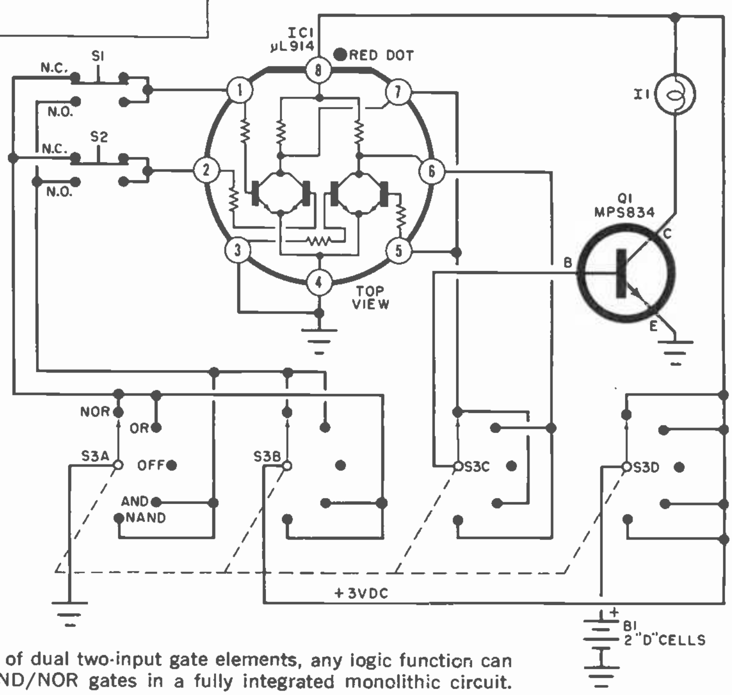



Fig. 8. Through exclusive use of dual two-input gate elements, any logic function can be generated from basic NAND/NOR gates in a fully integrated monolithic circuit.

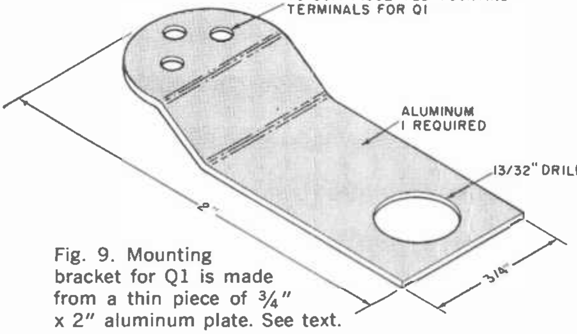
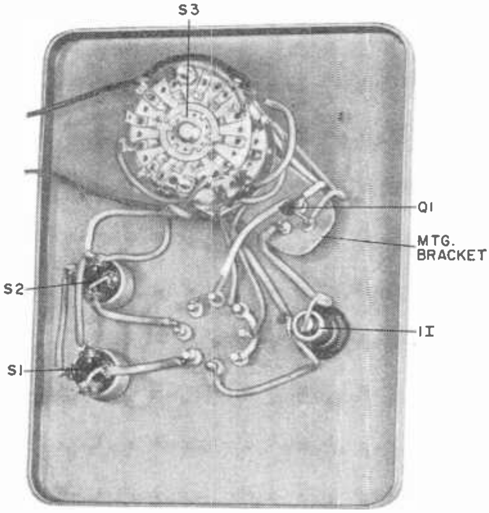



Fig. 9. Mounting bracket for Q1 is made from a thin piece of 3/4" x 2" aluminum plate. See text.

driver stage. After designing and building the Logic Demon, it can be used to perform real computer logic operations.

**About the Circuit.** The "brain" of the Logic Demon is integrated circuit *IC1* which contains dual RTL two-input gates (Fig. 8). One input is eliminated from one of the gates by grounding pin 3. Thus, a two-input gate and a one-input gate remain.

When the output (which drives *Q1*) is taken directly from the two-input gate, the circuit performs the NOR/AND functions. However, by feeding the output of the first gate to the one-input gate (which acts as an inverter or NOT gate) and then taking the output from the latter gate, the OR and NAND functions are obtained.




The Logic Demon can be wired using the schematic diagram and component layout shown in this photo.

A selector switch defines the input logic states and routes the lamp-driving transistor (*Q1*) to the appropriate gate output. If desired, separate slide or toggle switches can be used to produce the same logic functions.

**Construction.** The unit can be assembled on a metal chassis or in a wooden or plastic container. However, the use of a 5" x 4" x 3" metal box will give the project a neat appearance.

Except for the two dry cells which are mounted in battery holders that can be pop-riveted or screwed to the base, the switches, IC, and indicator lamp are mounted on the enclosure cover. If you use the prefabricated dialplate (see Parts List), the appearance of the project will be enhanced, and the dialplate can also serve as a drilling template for the holes that must be made in the cover to accommodate the switches, lamp, and the IC. The mounting hardware for the switches can be used to hold down the dialplate on the cover.

The IC shown here is mounted on individual Teflon insulated feedthrough connectors, but an alternate—and better—method is to use a single 8-pin Press-Fit IC socket as specified in the Parts List. Pin 8 of the IC case is usually coded with a red dot, or it may simply be beside the flat side of the case. Viewed from the top of the case, the pins are counted counterclockwise.

Transistor *Q1* is mounted on stand-off insulators inserted in a fabricated aluminum bracket (Fig. 9) which is secured on the inside of the enclosure cover by the rotary switch. However, this mounting procedure need not be followed since *Q1* can be mounted on a transistor socket in any convenient location in the enclosure.

The pilot lamp fits in a 5/16"-i.d. rubber grommet that mounts in a hole through the dialplate, and leads are soldered directly to the bulb. After making all the wiring connections (Fig. 8), you can proceed to test the unit.

**Operation.** If the unit is wired correctly, it will obey all the logic rules indicated on the dialplate. With the switch in the NOR position, the bulb lights and is extinguished by pressing either push

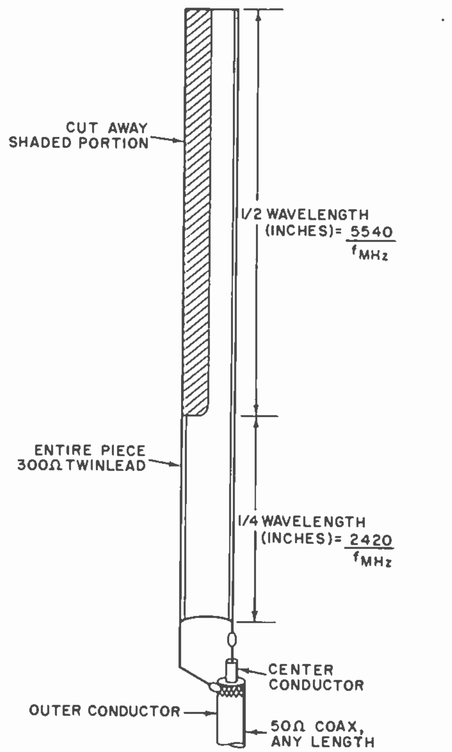
(*Continued on page* 93)

# The "Scrounge" —an Instant "J" Antenna

YOU CAN WHIP A VHF ANTENNA TOGETHER IN 30 MINUTES

By **ALBERT S. VON TROTT**, W3UIX/6

THE "J" style antenna has been around for years and years. Hams, police, forestry and fire radio stations started using the "J" back in the 1930's, and even today it is not uncommon to see a Business Radio system using "J" antennas. The advantages of the "J" are the omnidirectional characteristic of the radiated pattern and the vertical polarization—two important requirements in working mobile and vertically polarized stations. The short wavelengths of the very high frequencies also favor the use of these vertical antennas.



This simple antenna can be fashioned from a single length of 300-ohm twin lead.

If you are going on 6 or 2 meters, you will probably find the vertically polarized antenna a welcome addition to your antenna farm. Also, if you are an SWL tuning for the radio services between 150 and 170 MHz, the "J" antenna will be a practical and valuable asset.

**You can build** a "J" antenna from a short length of 300-ohm twin lead à la "Sneaky Pete" in just about 30 minutes. A very desirable feature of the "J" antenna is the built-in quarter-wave matching section which lets you use a regular 52-ohm coax transmission line; VSWR's of less than 1.3:1 are not unusual.

The drawing shows the simple layout of the "Scrounge" with notations for determining its length. If you are working a band of frequencies, cut the antenna to resonate in the center of the band. If you are interested in listening on 156 MHz, for example, simply divide the figure 5540 by 156 to determine the length of the half-wave section (35½"). This is the radiating portion of the "J." Add to this dimension the length of the quarter-wave matching section ($2420 \div 156 = 15.5$) to find the total length (approx. 51"). The higher the frequency, the shorter the antenna.

The rest is simple. Cut one conductor 35½" from the end of a 51" piece of 300-ohm twin lead and remove it. You can use a knife to cut the insulation, or you can strip out the undesired lead by getting a good grip on the cut end and pulling. Don't try it with your fingers or your teeth; use a pair of diagonals or pliers.

Tape your "Scrounge" to a wooden pole, solder the wires at the bottom of the "J" to your coax feed line, and you're in business.

(*Continued on page* 94)


# SINGLE BATTERY-OPERATED 2-TRANSISTOR DIPPER SPANS 3 TO 30 MHZ ON 5 BANDS

**By ROBERT N. TELLEFSEN**
W7SMC/Ø

ONE OF THE MOST useful instruments a ham, CB'er, or experimenter can own is a Grid Dip Oscillator (GDO). The GDO is a versatile instrument which makes the job of finding the resonant frequency of an unknown tuned circuit a snap, as well as detecting oscillations, tuning and neutralizing transmitters, finding unknown values of coils and capacitors, and performing a host of other tests.

The *Emitter Dipper* (EDO) does all the things a GDO does, but unlike the GDO's with their a.c. line cords, the EDO operates on a small 9-volt battery. Its frequency range is continuously variable from 3 MHz to 30 MHz, and—for suitable bandspread—is divided into five different bands. A sensitivity control and more than adequate current flow lets you start with a full-scale reading on all bands. Inexpensive home-brew plug-in coils are used, and the entire project costs about $15 to build.

**How It Works.** The *Emitter Dipper* has two simple transistor circuits: a Colpitts oscillator (*Q1*), and an emitter-follower (*Q2*). Variable capacitor *C1* provides the EDO with a VFO capability, and any frequency within range can be quickly obtained. Frequency of oscillation is determined by the value of the plug-in coil (*L1*) and the setting of *C1* (see Fig. 1). Capacitors *C2* and *C3* form the feedback network to sustain oscillation. Capacitor *Cx*, mounted in four of the five plug-in coils, helps estab-

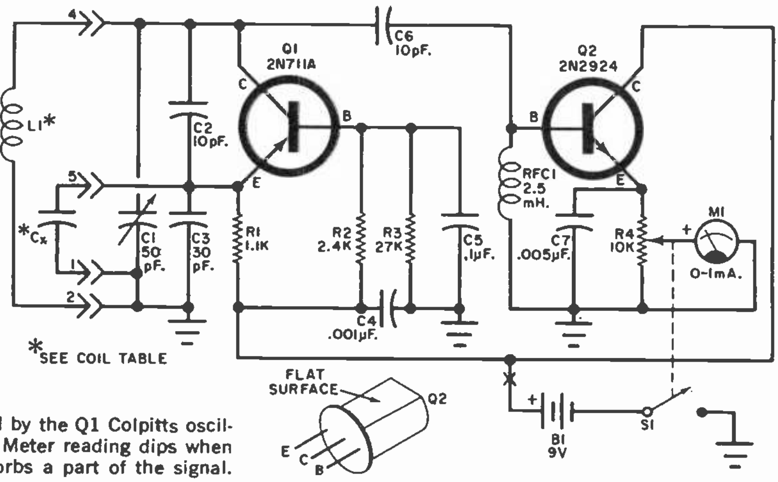



Fig. 1. Signal generated by the Q1 Colpitts oscillator circuit drives Q2. Meter reading dips when an external circuit absorbs a part of the signal.

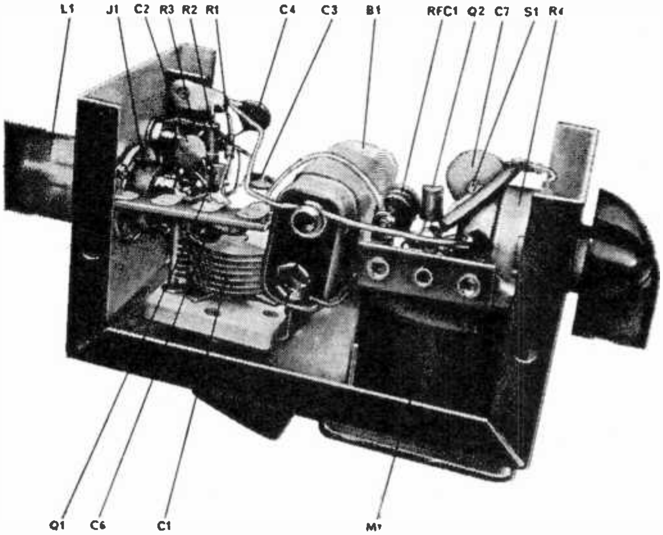
lish the proper level of feedback for each frequency range.

The r.f. signal from the oscillator is coupled to *Q2*. The meter across *R4* serves as an emitter current indicator. Variable potentiometer *R4* is used as a sensitivity control and is adjusted to obtain a full-scale meter reading when the plug-in coil is operating in the "clear."

When the coil is held close to a tuned circuit and the EDO is operating at the resonant frequency of the tuned circuit, some of the r.f. energy is absorbed by the tuned circuit. Amount of absorption depends on the degree of coupling. The resultant drop in signal strength from the *Q1* oscillator circuit shows up as a decrease in emitter current, and causes the meter pointer to dip. The meter reading will be maximum above and below the resonant frequency.

**Construction.** Except for the plug-in coils, all components are mounted inside a 4" x 2¼" x 2¼" metal box. Parts layout is not critical. Drill appropriate-size holes in the cabinet to accommodate the meter, jack, and other components. You can follow the layout shown in Fig.

Fig. 2. Parts layout is not critical, but avoid excess component lead length. Strap the battery firmly in place to prevent short circuits.



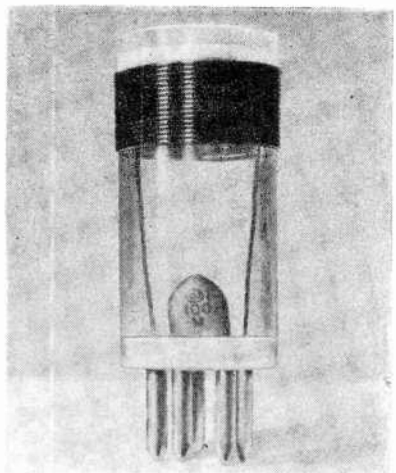



Fig. 3. Wind all coils as shown, and in accordance with the Coil Table. Four of the five coils require a small capacitor (Cx).

## PARTS LIST

*B1—9-volt transistor battery*
*C1—50-pF variable capacitor (Hammarlund HF-50)*
*C2, C6—10-pF disc capacitor*
*C3—30-pF disc capacitor*
*C4—0.001-µF disc capacitor*
*C5—0.1-µF, 10-volt disc capacitor*
*C7—0.005-µF disc capacitor*
*Cx—See Coil Table*
*J1—5-pin miniature socket (Amphenol 78-S5S)*
*L1—See Coil Table*
*M1—0 to 1.0-mA meter*
*Q1—2N711A transistor, or similar*
*Q2—2N2924 transistor, or similar*
*R1—1100-ohm, ½-watt resistor*
*R2—2400-ohm, ½-watt resistor*
*R3—27,000-ohm, ½-watt resistor*
*R4—10,000-ohm potentiometer, linear taper (Mallory U-20 Midgetrol)*
*RFC1—2.5-mH choke, 25 to 50 mA coil (Millen or Mallory)*
*S1—Add-on s.p.s.t. switch for R4 (Mallory US-26)*
*1—2¼" x 2¼" x 4" metal box*
*Misc.—3-lug terminal strip, center lug mounting; 3-lug terminal strips, end-lug mounting (2); pointer knobs (2); sheet metal or plastic strip, nuts and screws*

## L1 COIL TABLE

| NUMBER OF TURNS | WIRE SIZE* | VALUE OF Cx | FREQUENCY RANGE (MHz) |
|---|---|---|---|
| 47½ | #28 | 470 pF | 3 to 4.4 |
| 32½ | #24 | 470 pF | 4.4 to 7.6 |
| 17½ | #24 | 100 pF | 7.4 to 11.6 |
| 12½ | #16 | 100 pF | 11.5 to 18 |
| 6½ | #16 | none | 18 to 30 |

**Enamel-coated solid conductor*

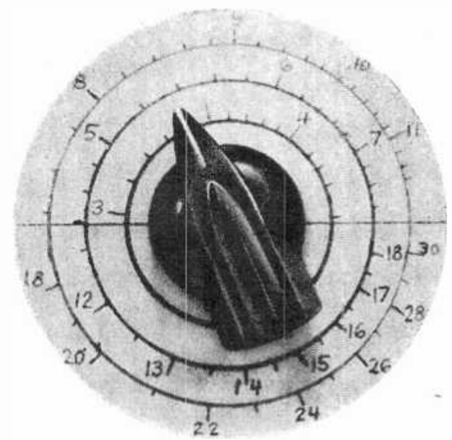


Fig. 4. Dial markings should be made when you calibrate your EDO. Align the knob pointer horizontally when C6 is fully meshed, and tighten knob in shaft. Photo shows actual size of dial scale on prototype.

2. You may have to modify a terminal strip to fit, but that is easily accomplished with a pair of cutters.

A 1" x 4" piece of sheet metal or plastic strap holds the battery in place. If you wire *S1* into the circuit at the point marked "X" instead of between the battery and ground, as shown in the schematic, you can connect the negative side of the battery directly to ground.

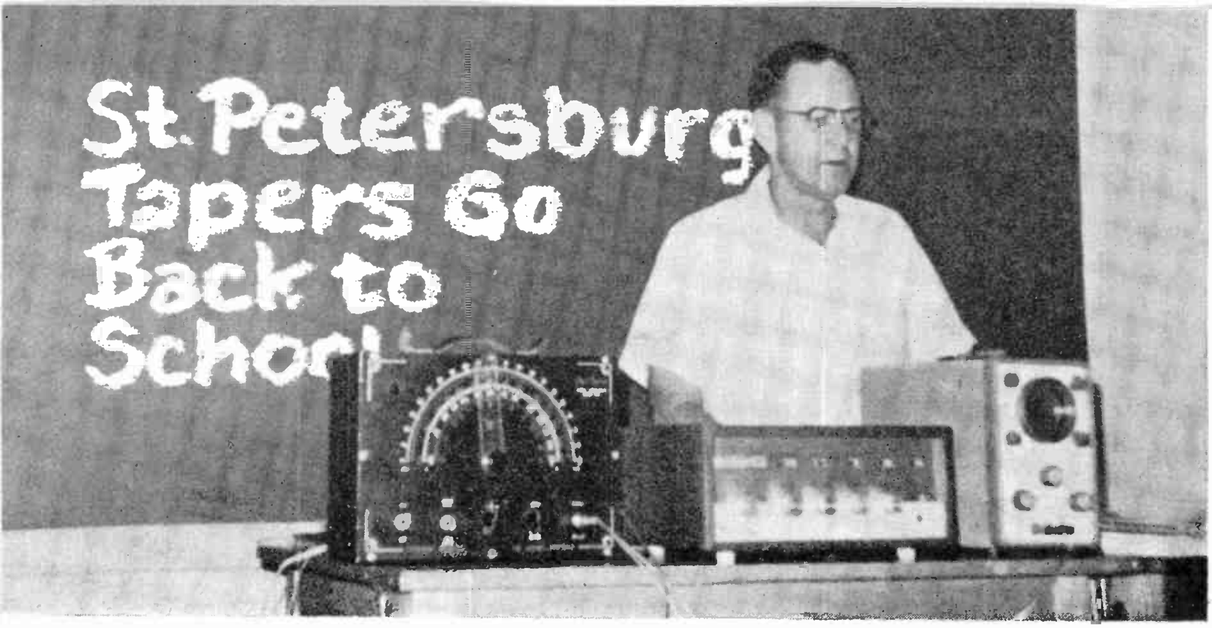
Wind the coils on ¾"-diameter polystyrene plug-in forms according to the information given in the Coil Table. See Fig. 3. Don't use a different wire size or make any other changes in the coil winding data if you want to obtain the indicated tuning range. Before soldering any of the pins, heat-sink them to prevent melting the coil form.

You can make a 2¼"-diameter circular dial out of a piece of heavy paper or cardboard. Draw three concentric circles on the dial, 3/16" apart, starting ¼" from the outer edge. The frequency range and intermediate points of the five plug-in coils can then be marked on these circles, without crowding. To mount the dial on the cabinet, cut a ½"-diameter hole in the center of the dial, remove the hex-nut from the shaft of *C1*, center and paste the dial over the opening, and replace the nut. Mount the knob securely on the shaft, and calibrate the dial. See Fig. 4.

**Calibration.** Accuracy of the EDO can be no better than the accuracy of your calibration procedure, or the calibration equipment you are working with. An accurately calibrated receiver or a crystal-controlled generator can be used.

If you are working with a receiver, turn on the receiver's BFO, plug in the 3-MHz to 4.4-MHz coil switch on the EDO and place the coil end close to the receiver's antenna. Tune the receiver to 3 MHz, rotate *C1* until you hear a tone in the receiver, and mark the EDO dial. (Tune for zero beat.) Advance the receiver's tuning in 100-kHz steps, advance *C1*, and mark the dial as you go. Do the same for the other coils.

Mark a different semicircle on the dial for each plug-in coil. It makes no difference which half of the dial you use. Mark the dial just like a ruler (short and long marks) with numerical callouts at 1-MHz positions. —30—



# St. Petersburg Tapers Go Back to School

By J. W. NELLIGAN

COMPREHENSIVE ADULT EDUCATION COURSE COVERS PRACTICALLY EVERY PHASE OF TAPE RECORDING

THE IMPACT on one community of an idea that struck Lon Cooper, an electronics jobber in St. Petersburg, Florida, has set into motion currents of energy that may have significance for tape recording enthusiasts everywhere. Lon was reading a brochure sent out by the Pinellas County (Fla.) Board of Public Instruction. As he glanced over the listing of all the courses offered by the adult education department, he thought, "Why not a class in tape recording techniques?"

Cooper's long career in electronics and his reputation as an authority on magnetic recording would qualify him for certification as a part-time instructor. So, a few days later, Lon met with school officials and presented his idea to them.

The educators were impressed with his reasoning that: "Probably no single piece of electronic equipment available today has greater usefulness or can provide more entertainment than the tape recorder. It has infinite applications in school, in business, and in recreational activities."

"Okay," they said, "If we can enroll a minimum of ten students, we'll schedule a class."

**The new course** was officially called "The Tape Recorder—Its Use and Care." Within a few days after it was announced in a local newspaper, 20 students had enrolled. Then registration reached 25—the maximum permitted. Eventually, Cooper was compelled to start a waiting list and schedule another class.

Who enrolled? A teen-ager and an 80-year-old retired engineer were among the first to pay the established $2 fee. Then there were several audiophiles, and a former star of the Chicago Opera Company who intended to record professionally. But most of the enrollees were just people with a yen for tape recording who wanted to learn more about it.

Cooper's new class had neither precedent to follow nor a published text avail-

Unique course in recording techniques was conceived by Lon Cooper, shown at far left demonstrating fundamentals of sound. In the "lab," (above), students record from various sources and practice programming.

able. In preparing the curriculum, he had to rely largely upon his own knowledge supplemented by material from such books as *Tape Recorders—How They Work,* by Wescott and Dubbe, and *Magnetic Recording for the Hobbyist* by Arthur Zuckerman. But others came forward with assistance. For example, Audio Devices, Inc., a pioneer in the development of quality recording tape, furnished much of the material used in sessions on recording tape.

Audio-visual equipment was also made available—an overhead projector proved to be indispensible during lecture periods. Other equipment included a combination signal generator-amplifier-speaker-oscilloscope arrangement used to demonstrate audio principles.

**Starting with the history** of magnetic recording, the course touches on the fundamentals of sound, treats the students to a small dose of theory, and continues logically through transport mechanisms, motors, recording indicators, bias oscillators, heads, amplifiers and speakers, recording tape and microphones. In the "lab," students learn head alignment, investigate testing procedures, record from various sources, and practice programming—including mixing, editing, and splicing.

The class makes three field trips: (1) to a local church which uses magnetic recording; (2) to Radio Station WLCY to watch program taping; and (3) to the sound room of the Cooper Radio Company, where the students are instructed in the proper use of connectors and cable hookups, and are given an opportunity to use tape recorders in conjunction with other types of audio equipment.

Finally, the class receives instruction in the methods of evaluating tape recorders, tape, and accessories. The students learn to read "specs," are told what to look for in choosing a tape recorder and are cautioned against "bargain basement" tape.

**At this writing,** three classes have been graduated in St. Petersburg, and a fourth is in progress. In addition, plans have been completed for an advanced class.

But of special significance to tape recording enthusiasts outside the St. Petersburg area is the interest shown in these classes by Superscope, Inc., marketing agency for Sony tape recorders. Superscope is exploring the possibilities of making Lon Cooper's course available to all amateur tapers—wherever they may live. —30—

# SMALL TAPE RECORDERS

MAN WAS MADE FOR BETTER THINGS TO DO—
LET THE TAPE RECORDER HELP YOU GET GREATER PRODUCTIVITY AND MORE LEISURE

By HERB HOWORKA, Jr.

SMALL TAPE recorders can be used for entertainment, private-eye work, correspondence, conference recording, dictation, voice training, and can be made to perform many other practical—and many not so practical—functions. They do have certain limitations, but their portability, low price, and ability to work—after a fashion—under the most adverse conditions, make them highly desirable.

What can be done with a small tape recorder depends upon its features and usually its cost. Some small machines record and play back only at "one" speed, accommodate only small 2½-inch reels, work only on batteries and cost as little as $10. Some $35 recorders operate on 117-volt, a.c. power, at two speeds (1⅞ in/s and 3¾ in/s), and accommodate larger reels. Some have a switch on the microphone for remote control, and some have outlets for extension speakers and earphones.

**Capstan or Direct Drive.** When shopping for an inexpensive tape recorder, be aware of the fact that not all recorders drive the tape in the same manner, and that tapes recorded on one machine cannot always be played back properly on another machine. Two methods in general use are capstan drive and direct drive.

Capstan drive offers a greater degree of uniformity of tape speed. It rotates at a predetermined fixed speed, such as 1⅞ in/s or 3¾ in/s, and draws all the tape through the recorder at the same rate of speed regardless of the size of the reels or the amount of tape on the reels. Tapes recorded on a capstan drive recorder can be played back on another capstan drive recorder providing that the tape speed is the same and the geometry of the recorded sound track is compatible with the playback heads.

In a direct-drive recorder, the take-up reel is the driving element and it revolves at a set speed, but actual tape speed varies constantly. Beginning tape speed could be at the rate of about 1½ inches per revolution, depending upon the diameter of the reel's hub, and ending tape speed greater than 9 inches per revolution on a 3-inch reel.

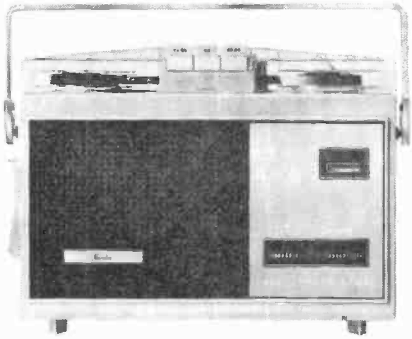
When a direct-drive recorded tape is played back on a capstan-drive recorder, the first part sounds like a flock of monkeys; somewhere toward the middle of the tape, the sounds become intelligible; and near the end, the sounds become a series of grunts and growls.

In a great many instances, tapes recorded on a direct-drive tape recorder must be played back on the same recorder, or on another machine of the same make and model. Forget about splicing a section of tape recorded at the beginning of one reel into the middle or end of a tape on another reel.

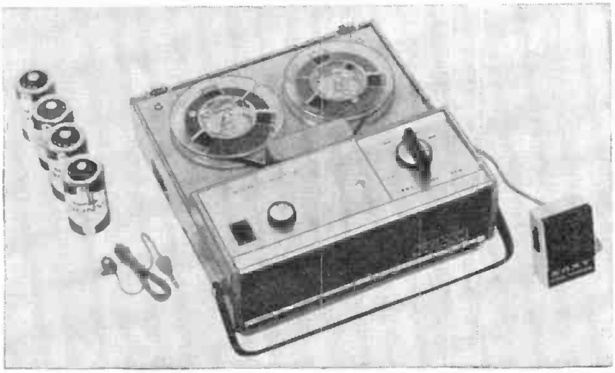
**Mike Fright.** With a small recorder, you can tape all sorts of interesting "people talk"—when the people are relaxed and speak freely. However, if you put a microphone in front of some people, they "clam up." Try hiding the recorder and

(*Continued on page* 91)

SMALL BATTERY-OPERATED TAPE RECORDERS HAVE BEEN GREATLY IMPROVED WITHIN THE PAST TWO OR THREE YEARS, AND QUALITY UNITS ARE AVAILABLE AT REASONABLE PRICES. PRICES FOR THE UNITS SHOWN HERE RANGE FROM $39.95 TO $79.50.



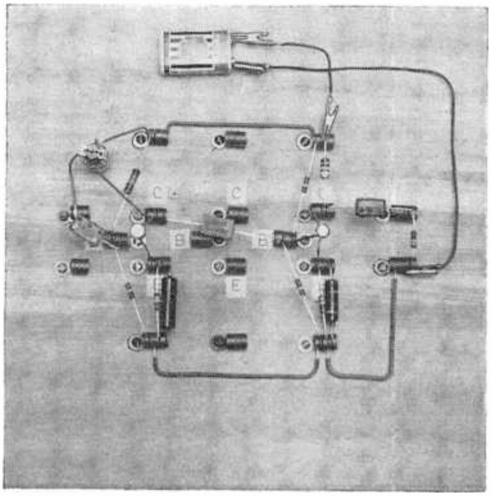
Norelco "Continental 101" 4-inch reel; 2 tracks; $1\frac{7}{8}$ in/s speed; operates on 6 "D" cells for 40 hours; has combination audio level and battery condition indicator, and can be remotely controlled; 8" x 11" x $3\frac{3}{4}$"; 7 lb.



Sony "Sony-Matic 907" $3\frac{1}{4}$-inch reel; 1 track; 2 speeds ($3\frac{3}{4}$ and $1\frac{7}{8}$ in/s); operates on 4 "D" cells for 20 hours; has automatic record level circuit (a.v.c.), and can be remotely controlled; $8\frac{3}{4}$" x $8\frac{3}{4}$" x $5\frac{1}{2}$"; $5\frac{1}{2}$ lb.

Craig "212" $3\frac{1}{4}$-inch reel; 2 tracks; 2 speeds ($3\frac{3}{4}$ and $1\frac{7}{8}$ in/s); operates on 6 "C" cells; has automatic level control and fast wind and rewind; can be remotely controlled; $7\frac{7}{8}$" x $9\frac{3}{4}$" x $3\frac{1}{8}$"; $4\frac{1}{2}$ lb.

RCA "YHS12" 3-inch reel, 2 tracks; 2 speeds ($3\frac{3}{4}$ and $1\frac{7}{8}$ in/s); operates on 4 "C" cells for 20 to 40 hours intermittently and 10 hours continuously; can be remotely controlled; $9\frac{3}{4}$" x $9\frac{1}{4}$" x $2\frac{3}{4}$"; 4.9 lb.



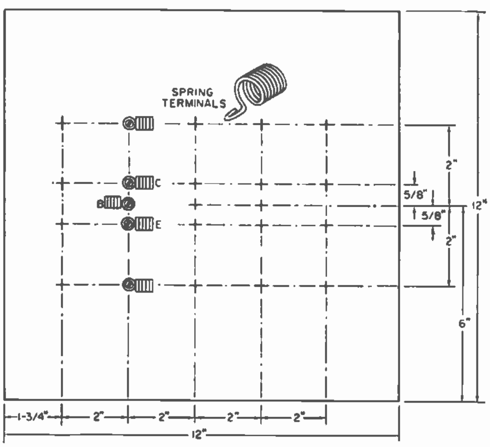
# SOLDERLESS BREADBOARD

CUT UP A
SCREEN DOOR RETURN SPRING
AND MAKE YOUR OWN
QUICK-CONNECT TERMINALS

**By A. A. MANGIERI**

TRANSISTORS are wonderful devices for the experimentally-minded electronics hobbyist. They are small and easy to work with, the power supply requirements are absolutely minimal, and the associated components are usually standard items. All sorts of transistorized circuits can be whipped together in a few hours, checked out, and put in operating order if you use a "breadboard" similar to the one shown here.

**Construction.** The base for your breadboard can be a 12" x 12" x 1" piece of white pine. Varnish or shellac the board for the sake of improved appearance. Lay out screw holes according to the diagram and make spring terminals from short lengths of 3/8"-diameter door spring—the kind used to close a summertime screen door. Make each spring length about 12 turns and bend the last turn at a right angle to form an eye for a wood screw.



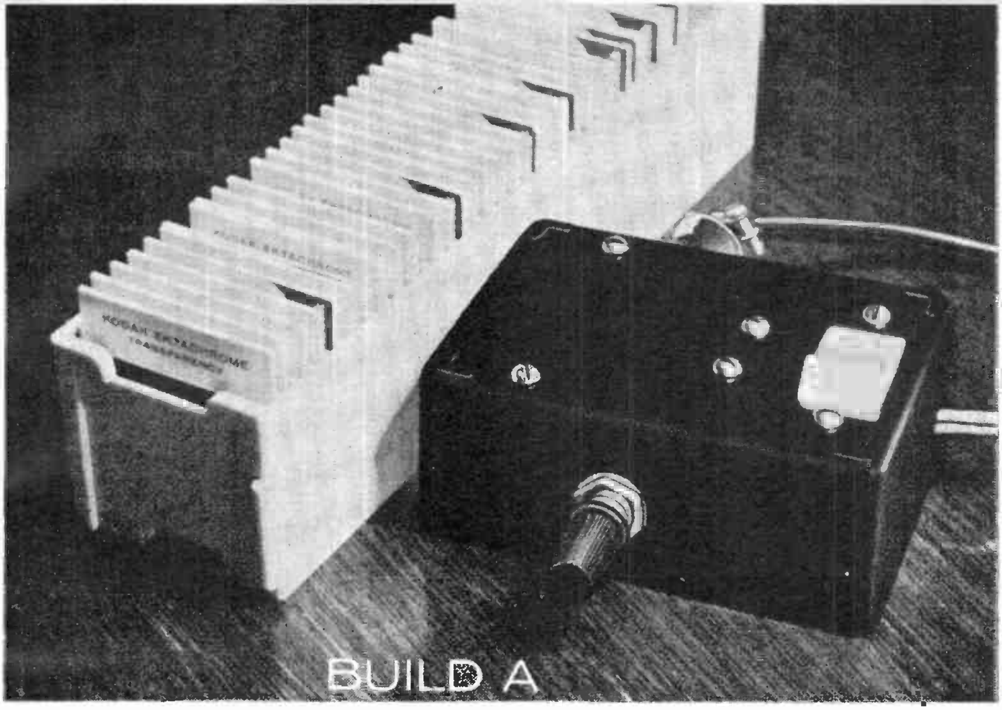

This arrangement will enable experimentation with 1, 2, or 3 transistors in control or audio circuits.

Screw the terminals to the board using small wood screws and flat metal washers. Face the "base" connections for your transistors to the left and all other springs to the right. Twenty-three springs is about right for nominal small-scale experimenting with transistors. You can add assorted brackets of 1/16" aluminum to support volume controls, inductors, tuning capacitors, etc., as required.

**Using the Breadboard.** The preferred method of using a breadboard is to lay out the circuit according to the arrangement in the schematic. Practically every transistorized circuit schematic reads from left to right, and the transistors are positioned so that the collector is toward the top of the board and the emitter toward the bottom. Use the top row of springs for the collectors and the bottom row for the emitters. Of course, the springs can be loosened and rotated to face any direction.

Miniature transformers fit between transistor terminal groups; larger transformers are mounted at the top of the board. Transistors with short clipped leads will require sockets; to solve this problem, solder some leads to a "universal" transistor socket and attach the socket to the board and the leads to the appropriate springs.

To install or remove a component from the spring terminals, simply push the blade of a small screwdriver into the coil and slip wire lead in or out. -30-



# BUILD A "Relaxatrol" to Automate Your Slide Projector

VARIABLE TIMER CONVERTS PUSH-BUTTON MACHINES TO FULLY AUTOMATIC OPERATION

**By GARY W. TOWNER**

LOOK, NO HANDS—here's a low-cost way to fully automate a push-button semi-automatic slide projector. Build a "Relaxatrol," set the speed of operation, and join the audience. It is an ideal accessory for continuous repeat-performance applications.

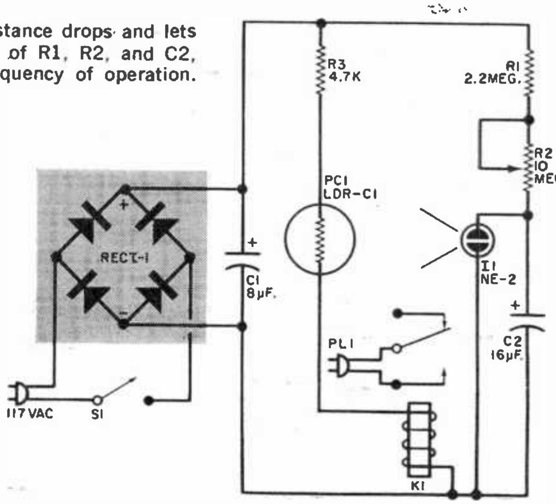
Actually, the Relaxatrol can be used to automatically control at preselected intervals almost any device which is operated manually with switches—without modifying the equipment. The only requirement is that the control be hooked across the switch on the equipment. The control can be overtaken or "dropped out" of the equipment at any time without any additional connections or disconnections.

**How It Works.** A simple relaxation oscillator consisting of *R1*, *R2*, *C2*, and *I1* (Fig. 1) periodically energizes *K1* to trigger the projector. Capacitor *C2* takes on a charge through *R1* and *R2*, until the voltage across it is sufficient to fire *I1* (usually on the order of 60 to 70 volts).

When the lamp fires, it discharges *C2* until the voltage drops sufficiently to black out the lamp. The frequency of lamp ignition depends upon the values of *C2*, *R1* and *R2*, as well as the voltage across the entire circuit. Variable resistor *R2* makes it possible for you to adjust the frequency according to your needs.

Neon lamp *I1* is close-coupled to a

Fig. 1. When PC1 "sees" the light from I1, its resistance drops and lets enough current flow to energize K1. Time constant of R1, R2, and C2, as well as the applied voltage, determines the frequency of operation.




light-dependent resistor (*PC1*). When the lamp lights, *PC1*'s resistance drops and allows enough current to flow through *K1* to energize it. In the absence of light, the combined resistance of *R3* and *PC1* is enough to keep the relay in its *off* position. The relay simply does what the slide-change push button on the projector would normally do, if the relay contacts are wired in parallel with the push button.

A bridge rectifier can be made up of four individual diodes, but you may find it more convenient to use the commercially available module described in the Parts List. Capacitor *C1* serves as a power supply filter.

## PARTS LIST

*C1—8-µF, 150-volt electrolytic capacitor*
*C2—16-µF, 150-volt electrolytic capacitor*
*I1—NE-2 neon lamp*
*K1—10,000-ohm, 4.5-mA relay (Allied Radio 75 U 774, type LB-5 or similar)*
*PC1—LDR-C1 light-dependent resistor (Allied Radio 7 U 565, or similar)*
*PL1—2-terminal plug (small size; use with matching socket)*
*R1—2.2-megohm, ½-watt resistor, ± 10%*
*R2—10-megohm linear potentiometer*
*R3—4700-ohm, ½-watt resistor, ± 10%*
*RECT-1—Rectifier bridge (International Rectifier 10DB3A, or similar)*
*S1—S.p.s.t., 6-ampere switch*
*Misc.—Black alligator clip insulator, 2⅞" x 4" x 1 9/16" plastic case, 2-terminal strips (4), line cord, hookup wire, knob, etc.*

**Construction.** Layout is not critical and it may be possible to assemble all the parts inside your projector. If you do, be sure to keep the parts away from the hot lamp. However, in most instances, it is better to build a separate unit.

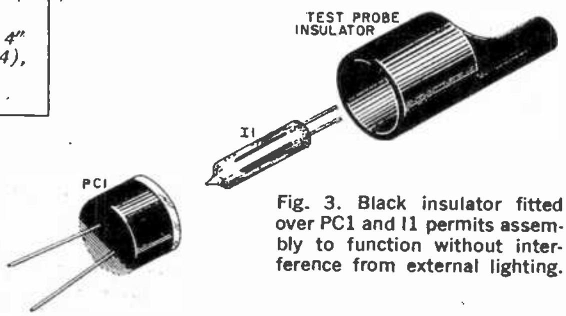



Fig. 3. Black insulator fitted over PC1 and I1 permits assembly to function without interference from external lighting.

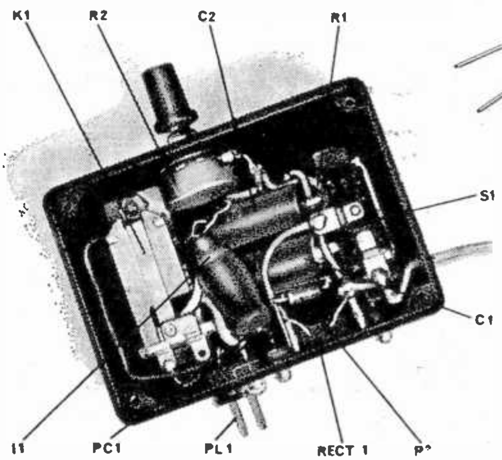



Fig. 2. Parts layout is not critical. Small plastic box helps insulate relay and other components from a.c. line. A line cord can be substituted for PL1.

The small plastic meter box shown in Fig. 2 is inexpensive, easy to work with, and looks good. A test probe insulator, the kind usually placed over an alligator clip, couples the light from the neon lamp to *PC1* and shields the assembly from "outside" light. (See Fig. 3.) You may cut away some of the insulator at each end if it is too long. Assemble the unit as shown in the drawing, and do your best to obtain a light-tight assem-

(*Continued on page* 93)

WANT
TO BUILD AN

# INTEGRATED CIRCUIT BINARY COUNTER?

By DON LANCASTER


10 = 1 0 1 0

COUNTING IN THE BINARY SYSTEM IS SIMPLE:
YOU START WITH "ZERO, ONE" . . . AND YOU'VE
USED UP ALL OF THE BINARY DIGITS

NOW you can build a demonstration binary counter using inexpensive integrated circuit (IC) industrial flip-flops with ordinary pilot lamps serving as readout devices. The binary counter described on the following pages can be used to demonstrate basic digital computer principles including the addition of binary digits. It also provides an opportunity to utilize integrated circuits for storing binary information.

In order to use the binary counter, however, you must understand the concepts of binary arithmetic. Most of us are familiar with the decimal number system which needs just 10 symbols—digits 1 through 9, and 0—to express any quantity. And while some earlier computers did use this system for computing, the complexity of the circuits dictated the need for a simpler system, one requiring fewer digits. So a number system using two digits only—1 and 0—was devised: the binary (base-2) number system.

**Binary Number System.** To learn how the binary (base-2) system works, consider Fig. 1 in which four groups of blocks are shown. The first one-block on the right is preceded by a group containing two blocks, which is preceded by a group containing four blocks, preceded by an eight-block group.

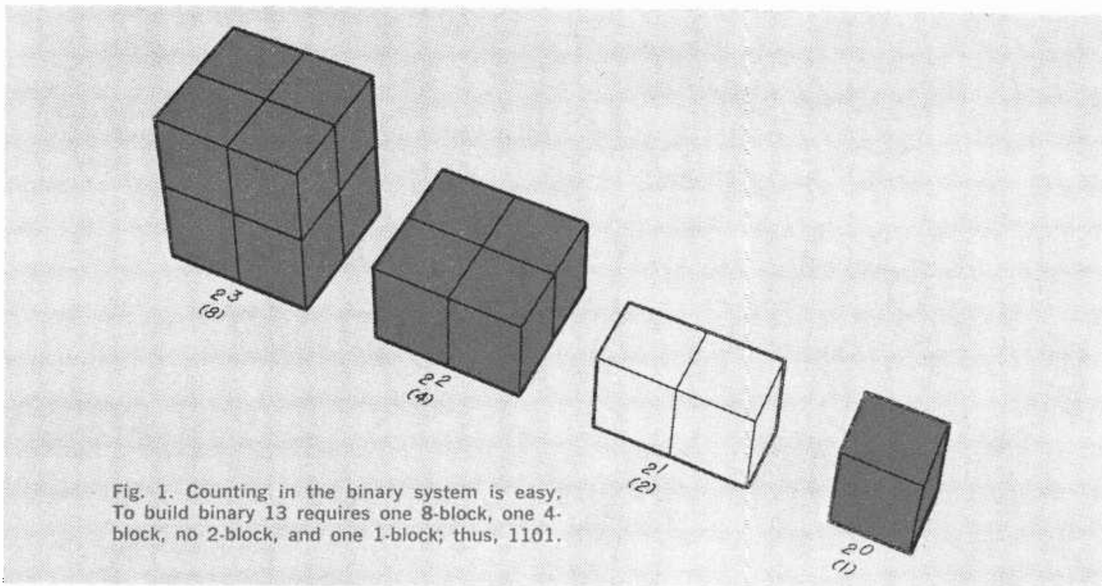



Fig. 1. Counting in the binary system is easy. To build binary 13 requires one 8-block, one 4-block, no 2-block, and one 1-block; thus, 1101.

Now, since we are working with a base-2 number system, we could change things a bit by writing the same group of blocks in this order: $2^3$, $2^2$, $2^1$, $2^0$. The superscript numerals (3, 2, 1, and 0) are referred to as the powers of the base number which, in this case, is 2. The power of a base tells the number of times the base must be multiplied by itself or, putting it another way, the power to which it is raised. For example, $2^3 = 2 \times 2 \times 2 = 8$. The mathematicians tell us that a number raised to its 0 power is 1; thus, $2^0$ becomes 1. But we can also write: 8, 4, 2, 1 to represent the blocks.

To express 3 in the binary system, we need *no* 8 block, *no* 4 block, *one* 2 block, and *one* 1 block. In binary notation this is written as 0011. Similarly, the number 10 is written as 1010. And that is all there is to the binary number system.

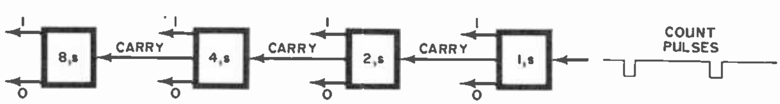
The convenience of this system is immediately apparent, considering that any number in the decimal system can be converted to a series of 1's and 0's. Thus, to "write" a number on a punched card, you either have a hole or no hole —a 1 or a 0. Putting it another way, a YES or a NO. If lights are used as a readout device, it could be established that if the lamp lights it means a 1, and if it doesn't, it means a 0.

**Binary Addition.** Adding 5 and 3 gives us 8 in the binary system just as it does in the decimal system, except that the numerical process is different. The following decimal-to-binary conversion table will save you some time in working out a few examples of binary addition.

| DECIMAL NUMBER | BINARY NUMBER |
|---|---|
| 0 | 000 |
| 1 | 001 |
| 2 | 010 |
| 3 | 011 |
| 4 | 100 |
| 5 | 101 |
| 6 | 110 |
| 7 | 111 |
| 8 | 1000 |

Three basic rules govern binary addition: (1) 0 plus 0 equals 0; (2) 1 plus 0 equals 1; and (3) 1 plus 1 equals 0 with a 1 carry to the next left-hand column. Applying these rules to the sample problem 5 + 3 will give you

Fig. 2. This four-stage flip-flop has a counting limit of 15. Adding stages increases count capacity.



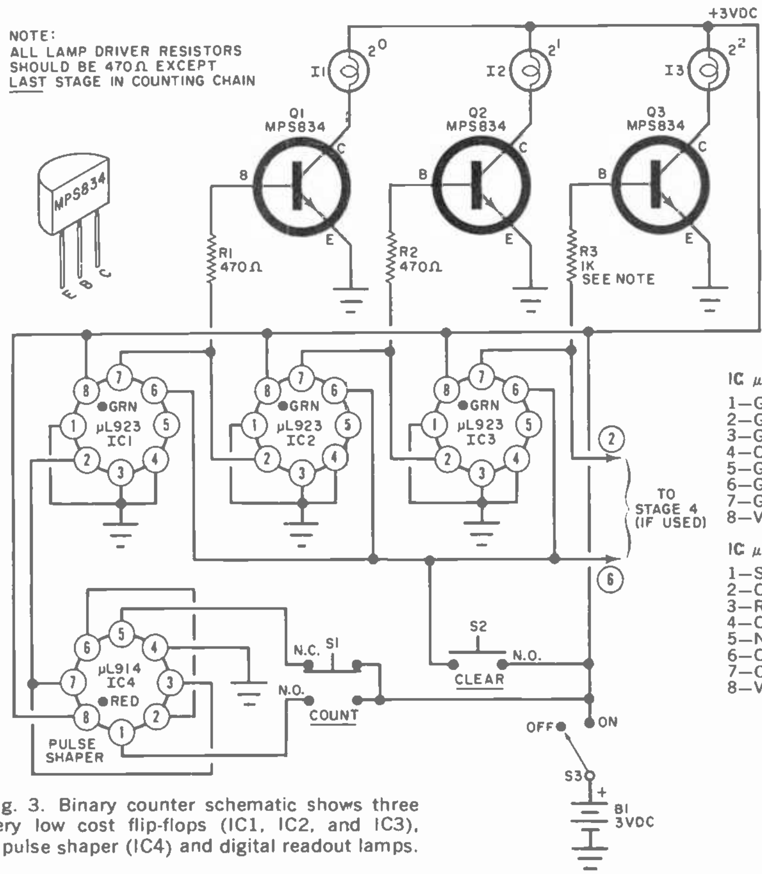



Fig. 3. Binary counter schematic shows three very low cost flip-flops (IC1, IC2, and IC3), a pulse shaper (IC4) and digital readout lamps.

**IC μL914 IDENTIFICATION**

1—Gate A, Input 1
2—Gate A, Input 2
3—Gate B, Input 1
4—Common
5—Gate B, Input 2
6—Gate B, Output
7—Gate A, Output
8—Vcc + 3 Volts D.C.

**IC μ923 IDENTIFICATION**

1—Set Input (Gnd.)
2—Count Input
3—Reset Input (Gnd.)
4—Common
5—Not used
6—Clear Input
7—Output
8—Vcc + 3 Volts D.C.

## PARTS LIST

*B1—1.5-volt, C-size cells (2)*
*I1, I2, I3—#49 pilot light (2.0-volt, 60-mA)*
*IC1, IC2, IC3—μL923 epoxy JK flip-flop (Fairchild*)*
*IC4—μL914 dual two-input gate (Fairchild*)*
*Q1, Q2, Q3—2N834 transistor (Motorola MPS834)*
*R1, R2—470-ohm, ¼-watt resistor*
*R3—1000-ohm, ¼-watt resistor—see text*
*S1—S.p.d.t. push-button switch*
*S2—S.p.s.t. push-button switch*
*S3—S.p.s.t. slide switch*
*1—6" x 4½" x 1¼" aluminum box with cover (Zero Z64-104A-20 and Z64-104A-COT-5) or 5" x 7" x 2" box chassis (Bud AC-402)*
*1—METALPHOTO dialplate, hard anodized aluminum, with POPULAR ELECTRONICS trademark, available from Reill's Photo Finishing, 4627 N. 11 St., Phoenix, Ariz. 85014; in silver color for $2.75; blue, red, or copper for $3.25; postpaid in U.S.*
*1—2" x 3" sheet of aluminum or perforated phenolic board*
*1—1⅛"-diameter aluminum disc (optional—see text)*
*4—Sealectro 8-lead IC sockets for TO-5 case (optional, available from Arrow Electronics or Joseph Kurzan, Inc., both in New York City)*
*Misc.—Teflon insulated terminals (52, optional), insulated feedthroughs (4, optional); battery holder for two C-size cells, ½"-o.d. rubber grommets (3), pop rivets or #6 hardware, 6-32 x ⅜" threaded spacers (4), rubber feet (4), wire, solder, #6 mounting screws (4)*

**Data sheets and distributor list available from Fairchild Semiconductors, 313 Fairchild Dr., Mountain View, Calif.*

$$\begin{array}{r} 101 \\ +\ 011 \\ \hline =1000 \end{array}$$

To define the above addition, starting with the right-hand column you have 1 + 1 = 0 with a carry of 1. Place the carry above the second column so that it now contains 1, 0, and 1. Thus, the second column is also 0 with a 1 carry. The carry added to the third column also produces a 0 with a 1 carry. Since there

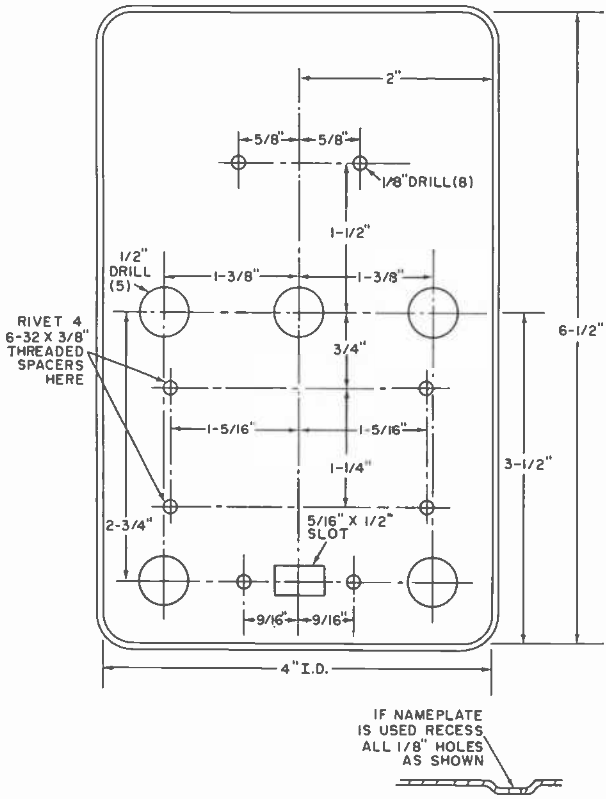
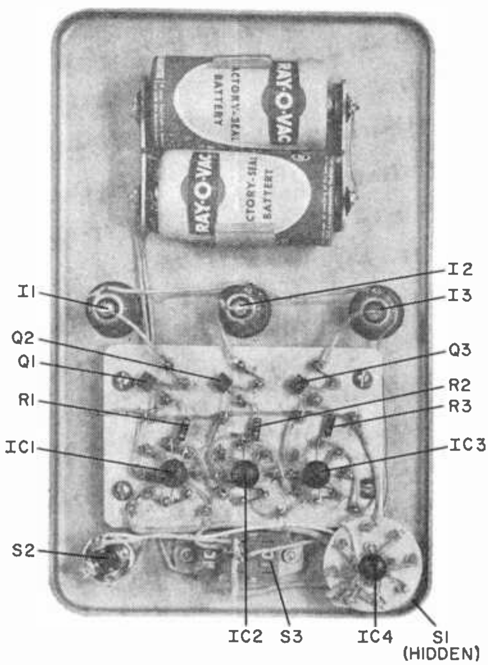



Fig. 4. You can use these dimensions to duplicate the front cover layout. Hole sizes should be made to accommodate your hardware and fittings.

Fig. 5. The flip-flop IC's, and transistors and resistors, are first mounted on a subassembly supported on standoff spacers. IC4, shown on an aluminum disc, is supported by the push-button COUNT switch (S1).




is no fourth column in the problem, the carry is brought down as the fourth or most significant digit of the sum. The answer then becomes 1000 or 8.

When adding more than two binary numbers to produce a single sum, the numbers should be added in pairs. In other words, the sum of the first two numbers is added to the third number. The fourth number is then added and so forth until the last number is added to the sum of the previous two numbers to produce the total sum.

**Electronic Counters.** The essential difference between an electronic counter and earlier counters with mechanical wheels is that the electronic counters add pulses instead of gear teeth. But in addition to its ability to add, a counter must also have a way of storing the discrete digits representing the numbers.

A decimal counter, for example, must be able to store ten counts—0 through 9—before the next count resets the

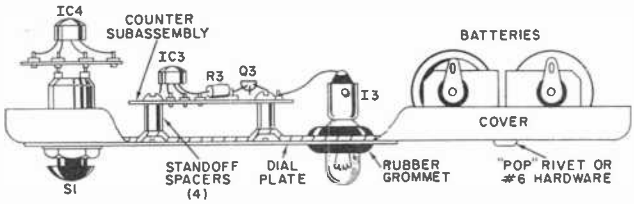



Fig. 6. This cutaway view of the front cover shows how the subassembly is mounted on the spacers. Observe that the mounting screw holes are recessed a bit so the dialplate can lay flat on the cover assembly.

counter to 0 with a 1 carry. Similarly, a binary counter is required to store only two counts—1 and 0—before it is reset. The electronic circuit used for counting is a simple flip-flop with its "set" state representing a 1, and its "reset" representing a 0.

The block diagram of a four-stage flip-flop binary counter that provides a count of up to 15 is shown in Fig. 2. Additional stages can be added to increase the count limits. For example, if one more stage is added, the count is increased to 31, while adding two more stages increases the count to 63.

During operation, pulses are applied to the count input of the 1's stage. A carry output from this stage is passed on to the count input of the 2's stage, and so on down the line to the last stage. With each incoming pulse, the 1's counter is alternately set to one, then reset to 0, set to 1 again, and so on.

The 2's counter also alternates between 1 and 0 each time it receives a count, but this happens only during every other input pulse when the 1's counter develops a carry signal. This process continues to activate each counter up to the last pulse in the string.

**The IC Counter.** Figure 3 shows the schematic of the IC counter. The innards of *IC1-4* have been deliberately left out to simplify matters. *IC1*, *IC2*, and *IC3* are the counting flip-flops, while *IC4* is a medium-power dual two-input resistor-transistor logic gate serving as a pulse shaper to eliminate the effects of contact bounce when the *COUNT* push button (*S1*) is pressed to produce the count pulses.

The modified output from the pulse shaper is applied to the count input of first counter stage *IC1*. The output of *IC1* is applied to the count input of *IC2*, whose output in turn is applied to *IC3*. Indicator lamps *I1* through *I3*, driven by *Q1* through *Q3*, visually denote the presence or absence of a 1 in each counting circuit. When a flip-flop circuit goes into its 1 state, a positive voltage is applied to the base of its respective output transistor through the proper base resistor (*R1*, *R2* or *R3*). The voltage causes the transistor to conduct, lighting the lamp.

Observe that *R3* is of a larger value than either *R1* or *R2*. If it were not so, lamp *I3* would burn brighter than *I1* and *I2* since *IC3*'s output is not loaded by the input of any other flip-flop, as is the case with *IC1* and *IC2*. Thus, if additional counting stages are added, bear in mind that the larger base resistor must appear in the last stage, although the base resistor of the other stages are of equal value.

*CLEAR* switch *S2* provides immediate reset capabilities by simultaneously applying a "1" pulse to the *CLEAR* input of each counter, resetting it to the 0 state.

**Construction.** The binary counter can be assembled in any small metal, wood, or plastic container. It is shown assembled in a 6" x 4½" x 1¼" aluminum box. A prefabricated METALPHOTO dialplate (see Parts List) can be put on the container cover to give the project a professional appearance. Layout and dimensions for drilling the cover are shown in Fig. 4. You can, however, lay out the counter differently, if you wish, since neither parts arrangement nor lead dress will affect operation of the unit.

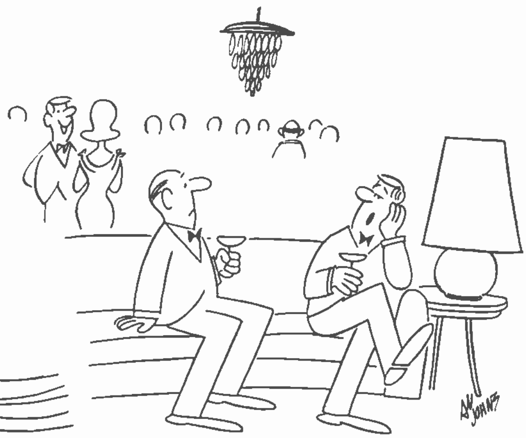
Use a low-wattage soldering iron when assembling the unit to minimize the possibility of overheating and destroying the transistors and IC's. For ease of assembly, the IC's and transistor circuitry can be preassembled on a 2" x 3" aluminum plate, or phenolic circuit board. Then the plate or circuit board can be mounted on standoffs in the container cover. Interconnection is made from the

(*Continued on page* 90)

# ALL ON QUARTER-INCH MYLAR

## SOME COMMENTARIES ON THE TAPE RECORDING SCENE

**By AL JOHNS**

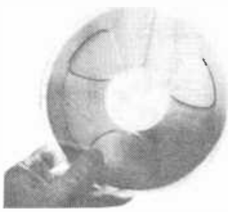


"I bug offices . . . what do you do for a living?"



". . . and this device will eliminate your flutter and WOW!"

# How to Conduct an Interview With a Tape Recorder*



NO MORE PENCILS,
NO MORE PAD,
NO MORE MISQUOTES
TO MAKE YOU MAD

**By LEWIS A. HARLOW**

ARE YOU an attentive listener? Do you enjoy relaxed and easy conversation, and can you pose interesting and intelligent questions? If these qualities describe you, and you own a tape recorder, you have the makings for a fascinating hobby or another source of income.

Unlike the old BTR (Before Tape Recorder) days when an interviewer barely had time to get a few questions answered because of the limitations of pencil and pad, modern interviewers are able to capture 100% of all that is said. Freedom from note-taking lets the interviewer concentrate fully on the subject matter and maintain complete control of the proceedings.

**Much of the material in this story also applies to office conferences, such as the one attended by staff members of* POPULAR ELECTRONICS *in photo above. Note automatic Concord Model 350 battery-operated recorder in background.*

Almost any standard medium-sized tape recorder in reasonably good condition can be used to record an interview. The recorder should accept a 5-inch tape reel and be easy to carry.

**Omnidirectional microphones** are perhaps the best to use for a large group because they can pick up sounds coming from all directions. However, the microphone supplied with your recorder is usually quite suitable for interviews.

If you have a choice, avoid recording with a hand-held microphone. The main disadvantage of the hand-held mike is the constant fluctuation of mouth-to-mike distances which produce variations in volume and pitch.

The best microphone position for most indoor recording is near the center of the room with the mike pointed away from the window to minimize background noise. Prepare an extension cable for your microphone so that the tape recorder can be tucked away in a corner where it won't attract attention during the interview.

Round out your equipment with a good supply of empty tape reels, an editing kit, and an ample supply of tapes. Select your tapes carefully and don't let the "look-alike" appearances fool you. Tapes vary in quality and price and there could be an enormous difference in footage among tapes for any given size reel. If your primary interest is to get maximum playing time from a reel of tape, select a thin tape, such as 0.5 mil. A 7-inch reel of 0.5 mil tape, played at a speed of 3¾ inches per second, will give over two hours of unattended playing time per track—ample enough for most interviews.

**A relaxed atmosphere** is a must for interviews. Before you attempt to set up your first appointment, practice with your family and friends until you build up your confidence. Also, invest in one of the many paperback books which explain the mechanics of interviewing. Professionals usually jot down key questions on a small card (3″ × 5″) which can be held in the palm of the hand and glanced at without distracting the person being interviewed.

Basic to all interviews is the requirement that you know as much as possible about the story you are after. It also helps to know a little about the background of the person you plan to interview. If he is a public figure, newspaper files can usually provide you with all the information you need to have about his career. Most people are impressed when someone takes the time and effort to learn about them. To be sure, the best way to inspire confidence is to first start out by praising the achievements of your subject.

Half the battle is won with the proper placement and handling of your microphone. If possible, use a stand mike which permits easier control of mike-to-subject distance and eliminates finger-tapping noises that are invariably produced by hand-held mikes. The mike should be placed on a table approximately equidistant from each person involved in the interview. Experiment to determine an appropriate distance and the required recording level for the room acoustics.

**After preparing the room** and setting up your recorder and mike, all you should have to do is flip the record switch to be "on the air." Once the interview is started, keep it going in a normal conversational tone.

Look directly at the person being interviewed, and by no means keep looking at the mike. The line of questioning should not lead to "yes" or "no" replies, but rather to a "here's my point of view" dialogue. If the person being interviewed wanders off on an unrelated track, act interested, and don't interrupt him. You can always edit the tape later.

If you are shown clippings or other prized possessions, read them into the microphone, and return them immediately. Also, any off-the-record comments should be kept confidential. By all means, when you edit the interview, destroy these passages. Your integrity must never be questioned.

Let the tape recorder run without your attention and do not stop the recorder with every pause. When the tape runs out and you can hear it flapping, show some concern, but make it appear that it would pain you if some important point in the interview were missed.

When the interview is over, you will know it because there will be nothing more to talk about. Thank the person you interviewed for taking so much of his or her valuable time, and pack up.

**Editing the interview tape** can be a time-consuming yet rewarding experience. All unrelated material and pauses which produce blank tape should be spliced out. This is where the empty reels come into play.

Identify the deleted tape you want to keep with written captions, and wind it on a separate reel. You can even rearrange the dialogue so that it follows a plausible, continuous line of thought.

The edited tape should play smoothly from start to finish without any apparent jumps or "blips." If your first attempt is not wholly successful, don't be discouraged. As you become more experienced, your taped interviews will take on a more professional quality. –30–


# PARLOR GAME

By LEWIS A. HARLOW

IF THAT OLD hidden microphone gag has just about worn thin at your social get-togethers, why not pull a switcheroo? It's a lot more fun to do, and it can be a bigger party perker-upper than those replays.

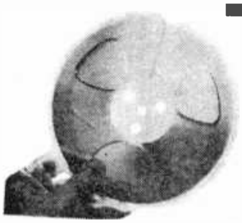
Prerecord about 90 minutes worth of tape with pauses between attention-getting phrases spoken a little louder than normal conversation. About eight minutes of pause is the limit if you want to keep your guests' attention. Don't make it too short, though, or you'll lose the whole effect.

Shown above and below are examples of the type of dialogue you can use. Tailor your dialogue to fit the company you plan to have over.

When the guests have begun to gather into small groups for the inevitable small talk, mute your hi-fi and start the tape going. Allow an initial eight minutes of blank running time so that anyone who might have seen you turn the recorder on will have forgotten it.

When the dialogue starts, watch the party perk up and the small talk turn to a discussion of your switcheroo. —30—

# A TAPE RECORDER KIT —DELUXE



NEW HEATHKIT AD-16 PUTS TOP-QUALITY FOUR-TRACK TAPE RECORDER IN THE HI-FI/STEREO BIG LEAGUES

THE FELLOW at the Heath Company who thought up the idea of putting someone else's accepted manufactured product into a kit deserves a pat on the back. Heath introduced this new philosophy a few years ago with a couple of electronic organs (Thomas). A 21" color TV kit followed which looked suspiciously like an RCA, and a few months ago Heath announced a deluxe tape recorder kit that is really the Magnecord 1020 in kit guise.

POPULAR ELECTRONICS built one of the first of the new Model AD-16 recorders and can report that the Heath/Magnecord marriage is a happy one. Within 17½ hours, the AD-16 was assembled and ready for tape head alignment. Another hour, and the recorder was mounted and playing as perfectly as any hi-fi enthusiast might desire.

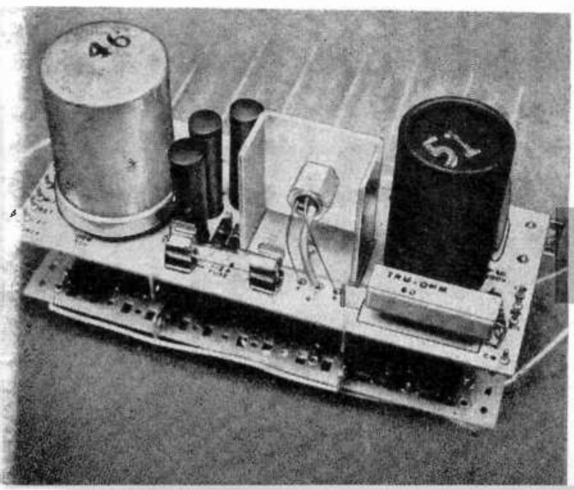
**Why Build a Tape Recorder?** There are three important reasons to start you on your way to building an AD-16. First, there is a significant monetary saving. The AD-16 is selling as the Magnecord 1020 for 45% more than you pay for the kit. Since 16-18 hours of construction time is about average, you're getting a bonus equal to $10 per hour for your spare time.

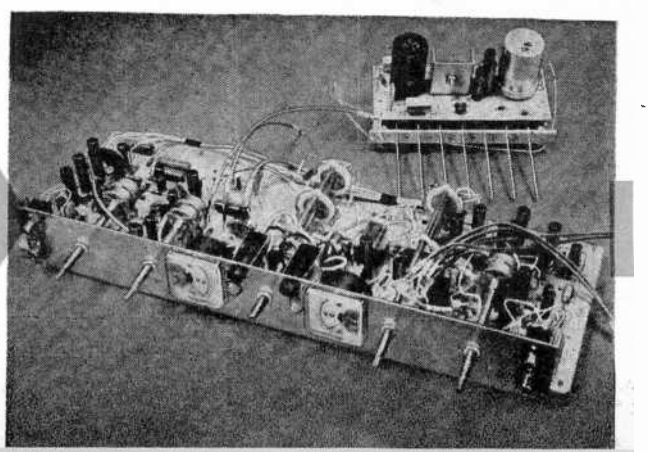
Secondly, the AD-16 cum 1020 is the Rolls-Royce of the tape recording industry. This *IS* a deluxe tape recorder—all solid-state circuitry (21 transistors) and ready for instant operation (no warmup). Third—and this is important—when you build a piece of gear like a tape recorder, you *learn*. You *learn* how the whole recorder operates; you *learn* the mechanics of the transport; and when maintenance is required, you have the experience and a manual with all the facts right at your fingertips.

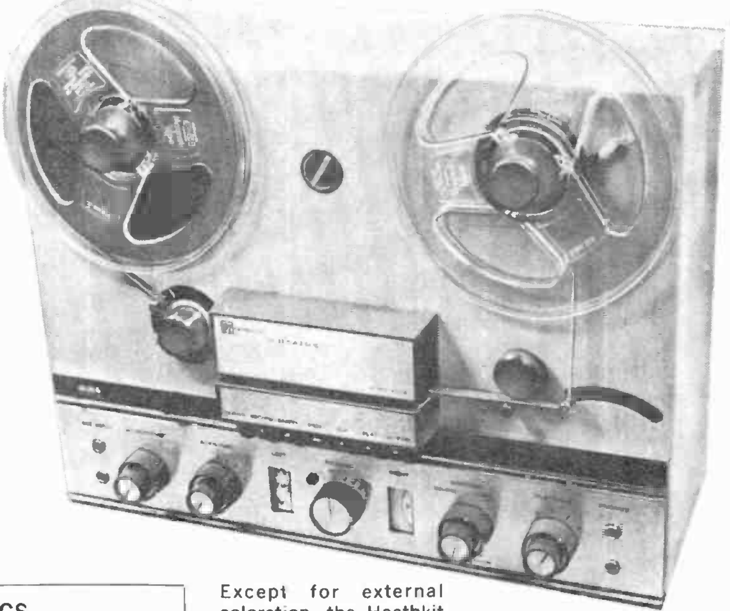
**No Need To Be a Mechanic.** If you have ever opened up a tape recorder and been startled by the maze of flywheels, linkages, drive belts and cams, you can be excused for thinking that building a

(*Continued on page* 92)

First step in building the AD-16 tape recorder is wiring the power supply circuit board (left), which takes about 2 hours. Next in line is the major printed circuit board (below), with the remainder of the electronics. The average builder should reach this point in about 3 to 9 hours of working time.



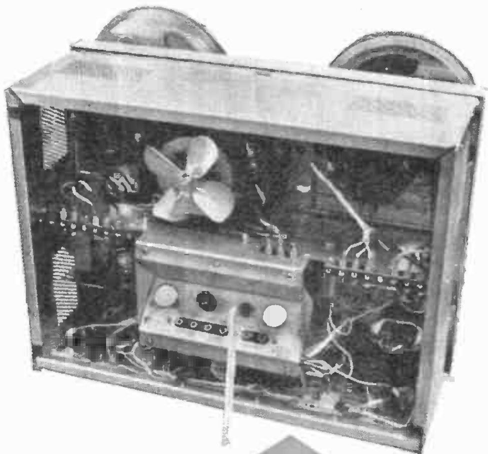


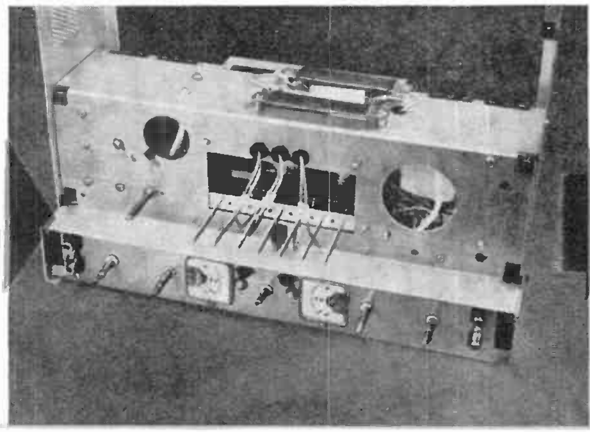
Except for external coloration, the Heathkit AD-16 has the physical appearance of a Magnecord 1020, at a price saving of about $175.00.

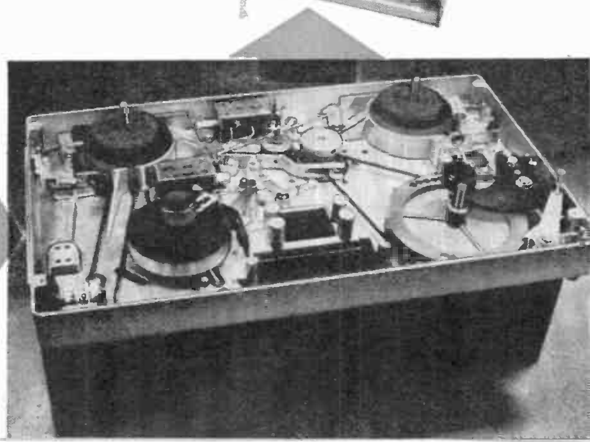
## SHORT SPECS

- Two-speed ($7\frac{1}{2}$ and $3\frac{3}{4}$ in/s), 4-track record and playback, with provision for sound-on-sound or sound-with-sound recording.
- The AD-16 accepts $\frac{1}{4}$"-wide tape; 1.5, 1.0, 0.75, or 0.5-mil thickness. Use 7" NAB reels or special $8\frac{1}{4}$" Magnecord reels.
- Measured frequency response at $7\frac{1}{2}$ in/s exceeded 45-17,500 kHz at $\pm$ 2 dB.
- Unit draws 140 watts maximum, measures $13\frac{3}{32}$" x $17\frac{5}{8}$" x $8\frac{1}{4}$".
- Price: $399.50. Base, $19.95, extra.

Mounting the two electronics assemblies on the main frame also involves mounting the power transformer, filter capacitors and bleeder resistors. By the time your AD-16 looks like the photo, below, work time will be just under 12 hours. Another 3 hours is spent assembling the transport mechanism (below, right). After the heads are mounted, the recorder will look something like the rear view photo at right, in just about $17\frac{1}{2}$ hours. The small inset panel is for connections to the tape auxiliary input, monitoring, and tape output. The silver knobs are for winding up the a.c. power cable. Microphone and headphone jacks are all on front panel.



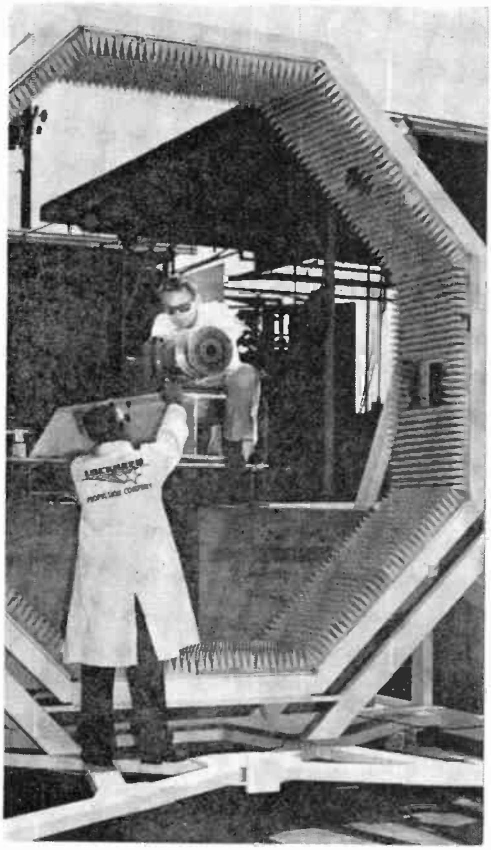


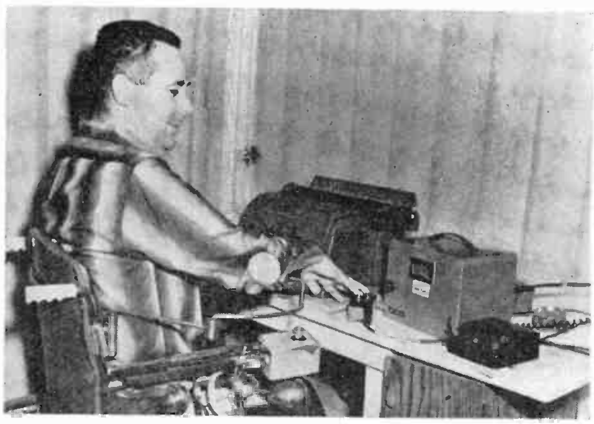


# ZERO-BEATING THE NEWS

TOM THUMB WEATHER STATION—With its state-of-the-art accuracy in measuring basic weather variables, the AN/TMQ-22 Meteorological Measuring Set made for the U.S. Army by Cambridge Systems, Inc., is said to be the most advanced portable weather unit to go into the field to date. One man can set it up in less than 5 minutes.

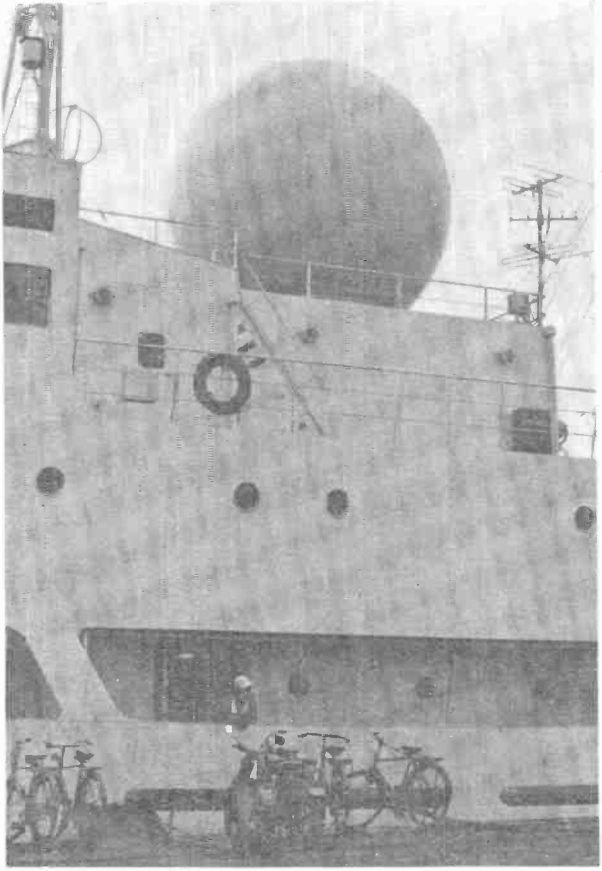
HOT STATIC COOLER—Tremendous heat and tiny particles in rocket exhausts often produce communications-blanketing static. This giant octagonal ring, developed by Lockheed Propulsion, is used to study these effects in an effort to design rockets that do not generate static.





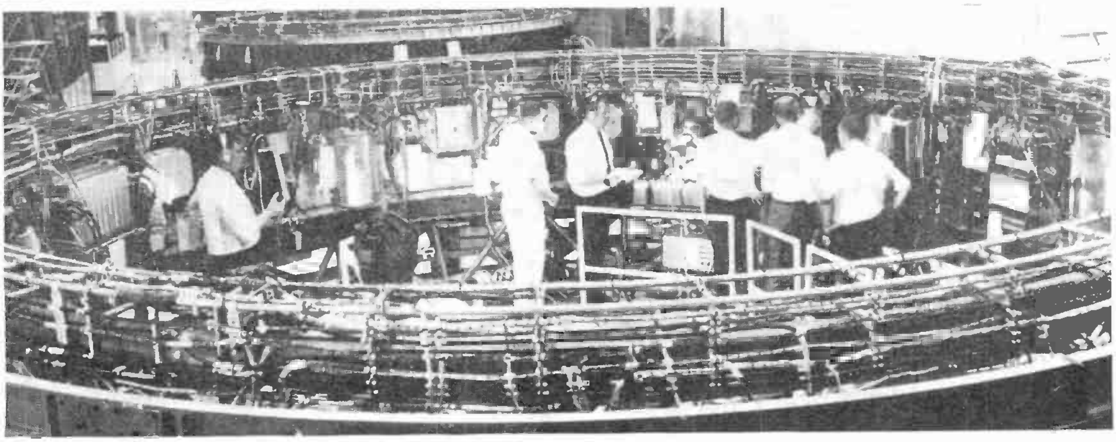
"REHABAPHONE"—Among the unusual equipment designed by General Telephone and Electronics Corp. are dials in Braille for the blind, telephones that answer themselves for the paralyzed, and telephones in oversized booths at convenient heights for wheelchair patients. Shown above is the "Rehabaphone" which requires only a slight pressure on a switch for dialing.

WORLD'S LARGEST—The largest weather radar system ever to be placed aboard a ship is installed on the "Ryofu-Maru." The system was designed and built for the Japanese Ministry of Transportation by Toshiba, and it incorporates many new features, one of which is a device that maintains desired antenna angle, compensating for pitching and rolling in heavy seas.

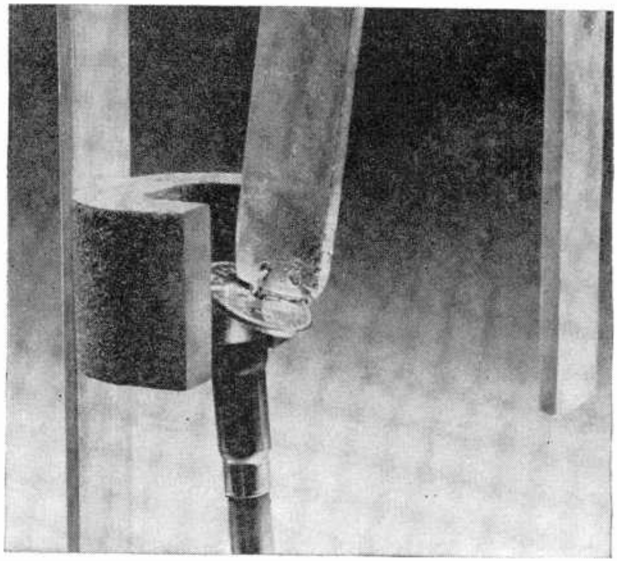


MULTIPLEXED TEACHER—Educasting Systems, Inc., has developed a new method by which educational programs are multiplexed on one regular FM or CATV channel. Four separate supersonic subchannels which correspond to the choices of answers make it possible for the student to press one of the four buttons on a special Sylvania-built receiver to indicate his answer. If a wrong answer is selected, the correct answer is given plus the reasoning behind it.

SATURN SANDWICH TO GO—The more than 60 component parts which make up an Instrument Unit are assembled and hung inside 3'-thick slices of a Saturn rocket. The slices are fitted between the propulsion stage and the payload. The Instrument Unit will guide a Saturn vehicle on a suborbital flight. IBM engineers and technicians check the slices out prior to delivery to Cape Kennedy.



SCIENCE FAIR PROJECT



# TESLA'S THERMOMAGNETIC MOTOR

## A LITTLE-KNOWN INVENTION BY THAT CONTROVERSIAL GENIUS

**By ARTHUR S. COOKFAIR**

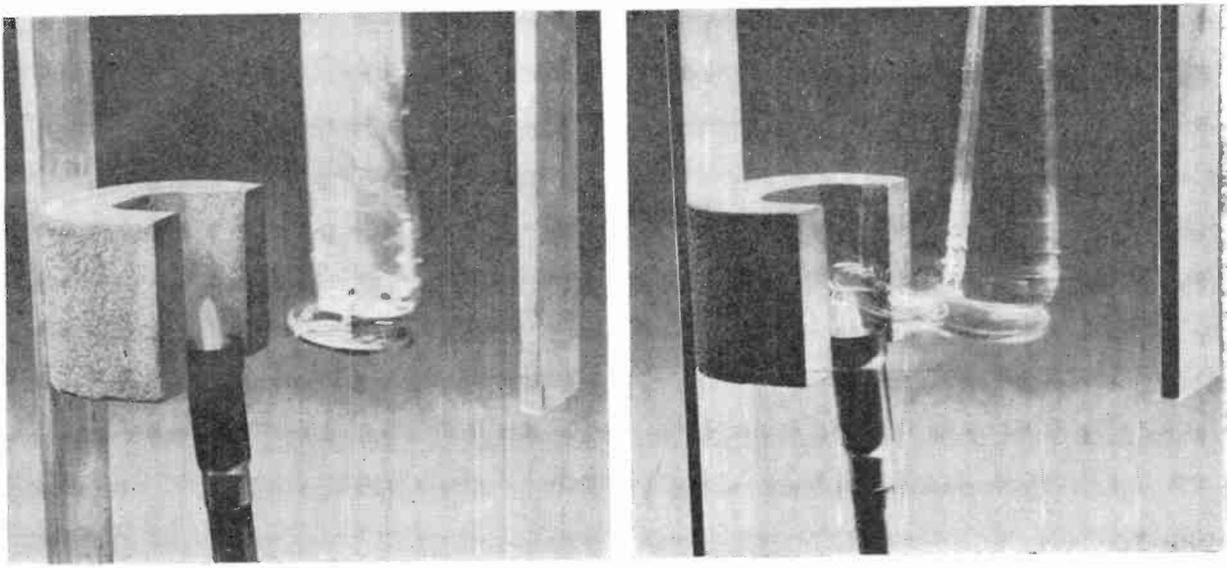
MENTION Nikola Tesla to any electronics hobbyist and the chances are his first thought will be of the Tesla Coil. Upon reflection, he may recall that Tesla had something to do with developing alternating current power transmission, or the invention of the induction motor. The fact is that in the early days of electricity and magnetism, Tesla's active mind was probing in many directions to find ways of putting these forces to use. The thermomagnetic motor was one approach.

Unlike the induction motor (Tesla's most useful contribution), the thermomagnetic motor was destined to obscurity. It is a little known invention buried among the millions of inventions in the archives of the U.S. Patent Office. The motor itself is easy to construct and provides a simple—yet interesting—science fair project or demonstration device to show the effects of temperature on magnetism.

**Theory.** Tesla's thermomagnetic invention is based on the phenomenon known as *Curie temperature* (after its discoverer, Pierre Curie—of radium fame). The Curie temperature is the point at which permanent magnetic properties of certain metals go down the drain.

A Curie temperature transformation occurs in both *hard* and *soft* magnetic materials. Hard magnetic materials—such as alnico or hard steel—are those which are used in the manufacture of permanent magnets. Soft magnetic materials, such as soft iron, are those metals which are easily magnetized when placed in a magnetic field, but tend to lose their magnetism rapidly when removed from the field. Since permanent magnets can be damaged by excessive heat, Tesla's thermomagnetic motor was designed so that heat would be applied only to a soft magnetic material.

The Curie temperature varies for different metals. Iron loses its magnetism at 770° C, nickel at 360° C, and cobalt



The above sequence shows how Tesla's motor operates. As the gas flame heats the nickel, a point is reached when the attraction to the alnico magnet is cancelled. A weak spring pulls the arm and nickel away from the flame. When the nickel cools, the magnetic attraction is restored and the nickel returns to its original position. This oscillation should be at a rate of about 20 strokes per minute. Be careful not to heat the magnet.

at 1120° C. Alloys such as nickel-iron may lose their magnetism at temperatures ranging from below room temperature as high as 770° C, depending on the ratio of nickel to iron. Place any one of the above metals or alloys near a magnet, at ordinary temperatures, and it will be attracted. Heat it above the Curie temperature and the attraction is lost. As it cools, the magnetic attraction returns. Alternate heating and cooling creates an alternating magnetic force.

**How It Works.** In operation, a facsimile of Tesla's motor consists of a movable rider made of a soft magnetic material that is pulled in one direction by a spring and in the opposite direction by a magnet—the magnet being the stronger of the two forces. The rider is pulled by the magnet to a position where it can be heated by a flame (or other heat source).

When the rider reaches the Curie temperature, it is no longer attracted by the magnet and is pulled away from the flame by the spring. The rider cools rapidly to below the Curie temperature, regains its magnetic properties, is again attracted by the magnet to a position over the flame; and the cycle repeats itself.

The frequency of the rider oscillation depends on the heating and cooling cycle. Once the operation has started, the magnetic rider will remain close to the Curie transformation point and will lose and regain its magnetic properties by variations of only a few degrees above or below that temperature.

A Bunsen burner or hand propane torch will do an excellent job of heating. If these are not available, a candle will serve the purpose. Or, if you want to keep up with the latest trends in science, you can demonstrate the conversion of solar energy by heating the rider with a small magnifying glass.

**Construction.** The frame of the motor shown (above and on page 114) was made of aluminum since it is easy to work and the non-magnetic qualities of aluminum will not be attracted by the magnetic field. You can build the motor to operate with almost any size of magnet. Small alnico magnets are available in hardware stores. Naturally, a more powerful magnet is easier to use—it will pull from a greater distance, and it also permits the use of a heavier spring. In a model similar to that shown, a 2-ounce

(*Continued on page* 114)

# JUST WHEN I FORGOT MY (SOLDERING) GUN! Sequel 3

CURBING THE TIDE of entries to our contest on nonsensical remarks about electronics has the appearance of an impossible task. And why not? Surely you've heard a wild, implausible, or inane remark about electronics. Send it in and you may win a soldering gun—so you'll be able to turn the heat on when the next remark is made in your presence.

Typical remarks have appeared in the July, September, and November issues.

**Best of the Lot.** Since our last "Sequel," the comment that got the biggest reception here was one made by a bright-eyed secretary who, when asked (over the telephone) if a missing carton of capacitors had arrived, replied, *"No, but there's a box full of farads."*

**Talk About TV.** About half of the entries received in the past month have been about TV—installation or repair. As might be expected with such a popular topic, there are innumerable duplications.

The most common TV tale is about the housewife who sees all of the dust inside the TV set. Since most wives are unnerved at the sight of such filth, they set forth and wash out the insides with Soilax—or a similar cleaner—whereupon the husband in question tightens all loose screws and bolts. As far-fetched as this might sound, it apparently has happened from coast to coast—many times over.

Confusion about color TV is a dominant topic and we couldn't help laughing at the recommendation not to use 300-ohm twin lead because it *"flattens out the picture."* Or at the story of the housewife who, having moved back into the hills where electric service was not available, asked the technician to *"change her TV over to gas."*

**Now Come the Puns.** Possibly because some of the "real life" remarks are too silly to be believed, many readers are submitting puns and other jokes. It's impossible to resist publishing some of them although this was not the original intent of the "No Gun" contest.

The editorial staff particularly liked the letter from a bionic laboratory that asked for a soldering gun because they *"wanted to attach a resistor to the stove—they always wanted an ohm on the range."* And the one about the electronics technician who had been working late and arrived home to be greeted with, *"Oh, Henry, wire you insulate?"*

The "classic" pun is so terrible that only engineers will get it; but, as the story goes, a case of butter was missing from a ham club banquet. The problem was solved when one member remarked, *"After all, what's Butterworth to Chebyshev?"*

**Winners.** This month soldering guns went to Thomas Collins, J. Engel, M. J. Ehrenburg, Robert MacElvain, Kevin Garrity, Walter F. Smith, and Donald Strachan.

Send as many entries as you wish to "Gun Contest," POPULAR ELECTRONICS, One Park Avenue, New York, N.Y. 10016. The date of the postmark determines the winner in case of a tie. -30-

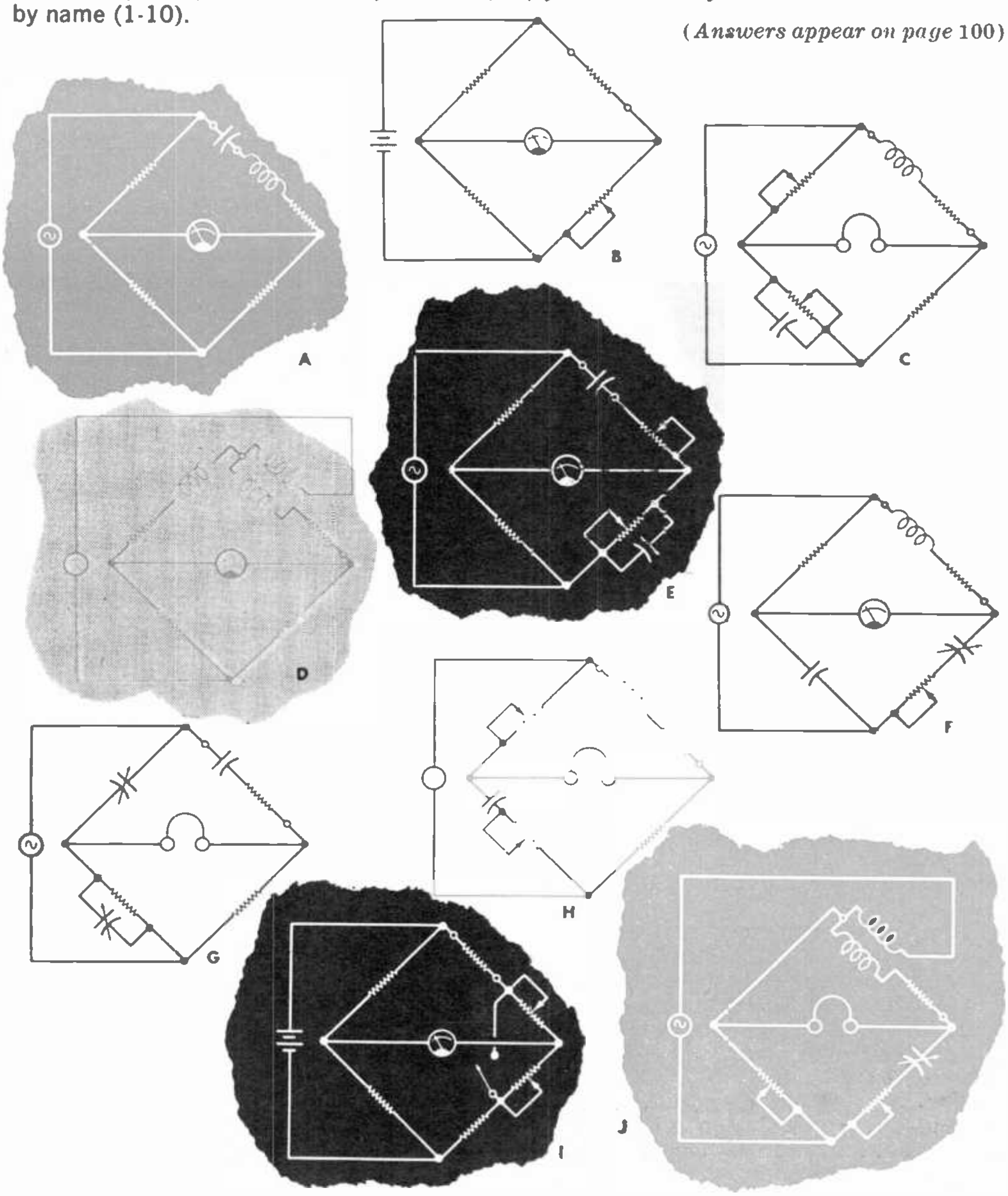
# BRIDGE CIRCUIT QUIZ

**By ROBERT P. BALIN**

Most electronic technicians are familiar with the widely used Wheatstone bridge. But many are not so familiar with other types of bridges commonly used in the laboratory for measurement of impedance—resistive, reactive, inductive, or capacitive—at frequencies well up into the UHF band. Bridges employ the so-called null method to measure an unknown quantity, either directly or by computation. In the latter case, values of some of the fixed and adjustable components in the bridge are substituted in an applicable equation, which is then solved for the unknown quantity. See how many circuits (A-J) you can identify by name (1-10).

1 CAREY FOSTER
2 HAY
3 HEAVISIDE
4 KELVIN
5 MAXWELL
6 OWEN
7 RESONANCE
8 SCHERING
9 WHEATSTONE
10 WIEN

(*Answers appear on page* 100)



# SOLID STATE

By LOU GARNER, Semiconductor Editor

GIFT-GIVING during the holiday season can be a brain-wracking, time-consuming chore, or a relatively pleasant, rewarding experience—depending on your financial status, and on the recipient's interests. For example, if your friends are all electronics hobbyists, the task is bound to be a simple one, since suitable gifts are available in every price range, and the electronics hobbyist who "has everything" is as rare as the dodo bird.

The catalogs put out by mail-order houses like Olson Electronics, Radio Shack, Lafayette Radio, Allied Radio, and Burstein-Applebee make excellent "wish books" and gift-selection guides. (If you want to "drop a hint" to a parent, relative, or friend, simply put a check mark against the items you'd like, insert necessary page markers, and leave the catalog in a conspicuous place.)

If you are operating with a tight budget, consider giving one of the many books on electronic theory that are offered by semiconductor manufacturers—or a subscription to POPULAR ELECTRONICS.

Also available are books on electronic construction projects by Motorola, Semitronics, G. E., Texas Instruments, International Rectifier and others, that can be used as guides in choosing more unusual—though perhaps costlier—gifts. Simply select a project and make up a package containing the book and all the components specified in the parts list. Or, you could limit your gift to the "special" components called for—this might include a selection of the required semiconductor devices.

With a fatter pocketbook, your gift might be a Conar, Heath, EICO, Allied Radio (Knight-Kit) or Lafayette test equipment kit . . . or a CB transceiver, hi-fi component, antenna rotator, transistorized d.c. power supply, or an automatic "bug" . . . depending on the recipient's special interests.

If you have an unlimited budget, you can pull out all the stops and let your imagination be your guide.

**Reader's Circuit.** A reader with the surprising—but familiar—name of Patrick Henry (2408 Queenstone Dr., San Rafael, Calif. 94903) submitted the four-transistor audio amplifier circuit illustrated in Fig. 1. Pat indicates that he made up the amplifier by combining the best features from a number of commercial circuits and suggests its use be limited to low-to-medium power applications.

At first glance, the circuit seems akin to the four-transistor design featured in the "Update to Solid State" project in the September, 1966, issue of POPULAR ELECTRONICS. However, a closer examination reveals a number of important differences. Pat used single-ended class B output amplifiers rather than the push-pull arrangement described in the article, and uses a phase-inverter driver and a different type of biasing network.

An audio signal at *J1* is applied to the base of *Q1*, serving as a common-emitter preamplifier, through d.c. blocking capacitor *C1*, and *GAIN* control *R1*. Resistor *R2* supplies the base bias, and *R5*, bypassed by *C2*, provides stabilization. Resistor *R3* is the collector load.

The amplified output at the collector of *Q1* is coupled through *C3* to *Q2*, a split-load phase inverter. Base bias for this stage is furnished through voltage divider *R4-R6*, with *R7* and *R8* acting, respectively, as collector and emitter loads.

The output signal from *Q2* is direct-coupled to power amplifiers *Q3* and *Q4*, biased by respective voltage developed across *R7* and *R8*. Emitter resistors *R9* and *R10* act to stabilize and balance the power amplifier stage. The output signal is applied to the speaker through d.c. blocking capacitor *C4*. Operating power is furnished by battery *B1*, through switch *S1*.

Standard parts are used throughout the circuit. Transistors *Q1* and *Q2* are 2N410's, while *Q3 and Q4* are 2N456's. Potentiometer *R1* is a 500,000-ohm audio taper unit and *J1* is a standard phono jack. The capacitors are all 15-WVDC electrolytics, although a higher voltage rating (up to 25 volts) can be used. Except for *R9*, which is a 1-watt resistor, and *R10*, which is a 1.3-ohm filament choke, all resistors are half-watt types. Switch *S1* can be combined with *R1*, or can be a separate slide or toggle type.

The amplifier can be assembled on a met-

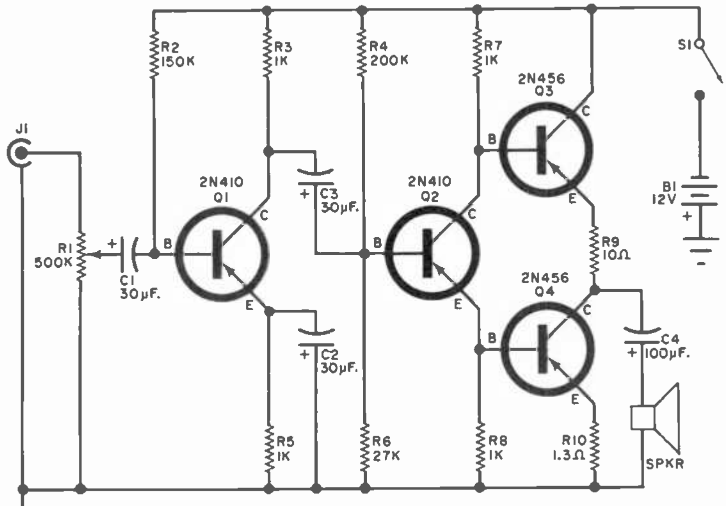



Fig. 1. Reader Patrick Henry came up with this design for a four-transistor amplifier by combining good features from selected commercial circuits. Output is in the medium power range.

al chassis or on a phenolic board, as preferred. One advantage of using a metal chassis is that it can also serve as a heat sink for *Q3* and *Q4*, which *must* be heat-sinked. The completed amplifier can be used with any standard PM speaker having a 3.2- to 16-ohm voice coil. In general, the higher the speaker impedance, the better the system's low frequency response; and remember that larger speakers (6-to 8-inch) are more efficient than the miniature types. Battery *B1* can be a 12-volt lantern type, or it can be made up of eight flashlight cells in series.

**Manufacturer's Circuit.** Many electronic equipment circuits, including stabilized oscillators, signal generators, transistorized test meters, characteristic curve tracers, and calibrated amplifiers, call for regulated d.c. power supplies. The simple voltage-regulator circuit shown in Fig. 2 is one of several power transistor circuits discussed in a recently published bulletin by Bendix's Semiconductor Division (Holmdel, N.J.).

This circuit is capable of maintaining a constant output voltage even with relatively wide variations of input voltage or load conditions. Due to its utter simplicity, it can be added to an existing power supply, or can serve as an integral part of a regulated power supply design.

Employing the principles of conventional series regulation, the circuit utilizes the internal collector-emitter resistance of *Q1*, which varies with changes in the applied voltage or in circuit loading, to provide automatic voltage regulation. The regulation is controlled essentially by a stabilized base bias that is furnished and maintained by resistor *R1* and zener diode *D1*.

Component values will, of course, vary with design requirements, but with a nominal 12-volt d.c. source, Bendix suggests a B-5000 *npn* power transistor for *Q1* and a 1N2044-3 zener diode for *D1*. Resistor *R1* is a 22-ohm, 5- or 10-watt unit. With these values, the circuit maintains a steady out-

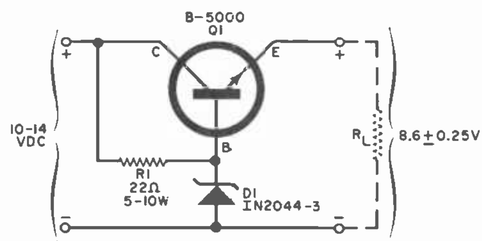



Fig. 2. Voltage regulator by Bendix maintains a relatively constant output, notwithstanding wide variations of input voltage or load conditions.

put of 8.6 ± 0.25 volt across a 180-ohm load, with a d.c. input of from 10 to 14 volts. In fact, the output will drop less than 1 volt even if the load is reduced to *only 4 ohms*.

The regulator circuit can be assembled in a small metal box for test purposes or on a suitable phenolic board or etched circuit board for addition to an existing power supply. An adequate heat sink should be provided for *Q1*.

**New Developments.** A solid-state, positive-temperature-coefficient thermistor in a new hermetically sealed, hard-glass package is now being produced by Texas Instruments, Inc. (13500 N. Central Expressway, Dallas, Texas). The new unit (Fig. 3) is only one-third the volume of the earlier molded type shown. Dubbed a *Sensitor*, and identified as type TG1/8, the ⅛-watt silicon unit is ideal for temperature-sensing applications and for temperature compensation in transistor bias control and amplifier circuits. The TG1/8 features a linear resistance curve with temperatures between −55° and +125° C, and is available in 32 ohmic values, ranging from 10 to 2700 ohms.

If you like to work with UHF circuitry—whether as a ham or an an advanced student—you'll be interested in a new *npn* silicon planar epitaxial transistor recently announced by the Amperex Electronic Corp. (Slatersville, R.I. 02876). Designated as Type A485, the transistor has a gain-bandwidth product ($f_T$) of 1500 MHz and can

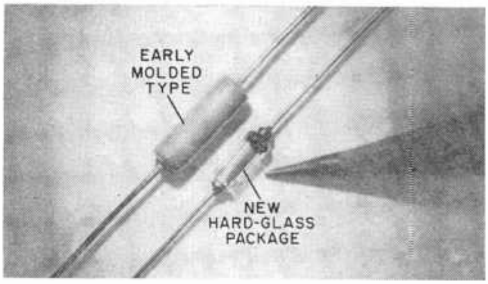



Fig. 3. The new positive-temperature-coefficient thermistor by Texas Instruments is only one-third the size of the earlier molded type, as shown here.

provide gain up to 200. Its noise figure is a low 3.5 dB at 200 MHz and only 4.5 dB at 450 MHz. A low-power device, the A485 is suitable for use in receivers, r.f. amplifiers, signal generators, test circuits, telemetry equipment, and other projects requiring high gain and low noise.

**Transitips.** How do you select your transistor audio transformers? By price? By size? By impedance ratios? By power rating? By brand name?

In practice, any one of these criteria, taken alone, can lead to disappointing results; for there is no such "animal" as a "perfect" transformer. At best, any standard commercial transformer design represents a compromise between such factors as cost, overall size, weight, frequency response, efficiency, and power-handling capability.

For example, take the output stage illustrated in Fig. 4. Although a push-pull amplifier, it can be considered as a single-ended stage if the lower half of the circuit (*Q2*) is blocked out. In this circuit, output transformer *T1* must: (1) provide a d.c. path for *Q1*'s collector current; (2) act as a collector load for the transistor; (3) match the stage's output impedance to the loudspeaker's voice coil; and (4) transfer power efficiently from the primary to secondary windings.

Equally important, the transformer must *not:* (1) introduce excessive power losses; (2) discriminate against specific frequencies

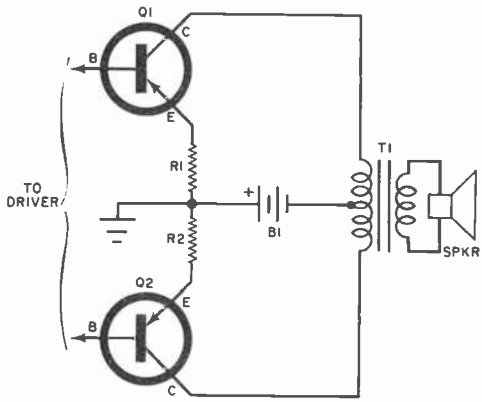



Fig. 4. A transistor audio transformer represents a compromise between ideal circuit requirements and factors of physical size, weight, and cost.

within its operating range; (3) introduce unwanted signals, such as spikes; (4) distort or otherwise change waveform of reproduced signals; (5) discriminate against signals of different amplitudes, such as transferring a high-level signal more efficiently than a low-level signal; and (6) produce a strong magnetic field that can couple to nearby components.

A good-quality audio output transformer is one which: (1) has the required impedance ratio, (2) has comparatively low d.c. resistance, and (3) can tolerate relatively large direct current levels. Unfortunately, these desirable characteristics can be obtained only at the expense of increased cost, size and weight.

To obtain a low d.c. resistance, the manufacturer must use a large size wire in the windings. This calls for more copper (which is expensive), and requires more space. Similarly, for maximum efficiency and good low-frequency response, the transformer must exhibit resistance to saturation by large signals. This means that the manufacturer has to use more iron in the transformer's core, and here again this calls for an increase in the size, weight, and cost of the transformer.

Inasmuch as wire and core size both affect a transformer's overall size, a good rule of thumb to follow—space permitting—is: the larger the transformer, the better.

Until next year—Happy Holidays!

*—Lou*

# AMATEUR RADIO

By **HERB S. BRIER**, W9EGQ
Amateur Radio Editor

## GETTING THE MOST FROM YOUR DIPOLE OR BEAM ANTENNA

IT IS a well-known fact that a horizontal, center-fed, half-wave dipole, with or without traps, radiates best in a fairly wide pattern broadside to its length and poorest off its ends. But comparatively few people know the actual difference in signal strength or actual difference in how well they get out in various directions because of the orientation and directional characteristics of their antennas.

Here are some figures. Under normal conditions, the difference between broadside and end-fire signal reports when you're using a half-wave dipole averages less than half an "S" unit on the 3.5-MHz band and about one "S" unit on 7 MHz. On 14 MHz, the difference goes up to two to three "S" units; and on 21 MHz and higher, it averages about three "S" units.

From a practical standpoint, it is unimportant in what direction you string a horizontal, ½-wave, 3.5- or 7-MHz dipole; but for working all states from most areas of the U.S. on the higher frequencies, stringing a ½-wave dipole north and south is probably the best compromise. On the 14-, 21-, and 28-MHz bands, however, where directivity is more pronounced, a ½-wave dipole is 33′, 22′, and 16½′ long, respectively; and many locations can accommodate two such antennas mounted at right angles to each other. By switching from one to the other, a rotating beam antenna effect can usually be obtained—especially on DX.

On the other hand, a small rotary beam requires less room than the two dipoles and provides power gain as well as directivity.

AMATEUR STATION OF THE MONTH

Just count those TV screens! Bob Dreste, K7VOR, Phoenix, Arizona, operates on 440-MHz amateur TV with a Blonder-Tongue vidicon camera chain, iconoscope slide camera, and a home-brew transmitter feeding a 10-element beam antenna atop a 65′ tower. Bob also works 50 MHz (22 states confirmed), is an ARRL Assistant Director, and an Official Bulletin Station; the 50-MHz antenna is a 6-element beam. K7VOR will receive a one-year subscription to POPULAR ELECTRONICS for submitting this winner for December in our Amateur Station of the Month contest. If you would like to enter the contest, send us a clear picture of your station with you at the controls and some information about your radio career and the equipment you use. Even if you don't win, your photo may be used if space permits. Entries should go to: Amateur Radio Contest, c/o Herb S. Brier, P.O. Box 678, Gary, Indiana 46401.

Larry Trummel, WA9OMD, Lane, Ill., uses a dipole antenna, and George W. Moran, W2DGZ, Woodhaven, N. Y., (right) finds a simple vertical antenna satisfactory for 40-, 20-, 15-, and 10-meter operation. George's antenna gets nourishment from a Drake T-4X transmitter feeding a Heathkit HA-14 linear amplifier, which, in turn, feeds a Drake R-4A receiver. Larry transmits on a Johnson "Viking-II," with a VFO, and receives on a Hallicrafters SX-111. Their records: Larry worked 49 states in five months as a Novice, and as a General has added many foreign contacts; George counts WAC, WAS, and RCC among his various certificates.

But a beam is not much good unless it is aimed properly. While you don't have to aim it within half a degree, an error of more than ten degrees is too much.

The first step in aiming a beam accurately is locating true north from your location. Sighting the North Star will locate it within a degree. Also, a magnetic compass will locate magnetic north, and if you add the proper amount of variation for your area, you can readily determine true north.

Next, you need a world DX map drawn on a polar projection which identifies countries both by name and by call-letter prefix. When you hear a station called or mentioned, a glance at the map will identify the country and indicate where to aim your beam. But be sure to get a polar map; directions and distances indicated on a common Mercator map can be most confusing. For instance, Japan appears to be east of the United States on a Mercator world map. By the Great Circle route—the way radio signals usually travel—Japan is actually northwest of the United States. Similarly, Australia appears to be southeast of the U.S. on a Mercator map; actually, it is west.

There may be times when the shortest route between two stations is not the best way to beam your antenna. Propagation conditions could be such as to make it more desirable to rotate your beam 180° and shoot your contact the long way around. You won't notice any difference with a bidirectional dipole, but a beam with a good front-to-back ratio will give you some ammunition for rag-chewing when you go west instead of east.

The American Radio Relay League's "Amateur Radio Map of the World" and the *Call Book*'s "Great Circle Chart of the World," available from amateur supply houses, are both excellent DX maps. In addition, hanging these maps on the wall really dresses up a ham shack.

**Code Practice.** Whether you have just memorized the code and your aim is 5 wpm for a Novice or Technician license, or you are aiming for 13 wpm to upgrade your license to General, or even 20 wpm for Extra Class, the only way you can improve your copying ability is by regular practice. Station W1AW, the headquarters station of the American Radio Relay League, Inc., makes the practice easy to get if you have a shortwave receiver.

For those who are not familiar with W1AW's schedule, code practice material is sent twice a day simultaneously on 1.805, 3.555, 7.08, 14.1, 21.075, 50.7, and 145.6 MHz at the following times and speeds. Early session: daily at 0300 GMT (7:30 p.m., EST; 6:30 p.m., CST; 5:30 p.m., MST; 4:30 p.m., PST) at speeds of 10, 13, and 15 wpm. Evening session: daily at 0230 GMT (9:30 p.m., EST; 8:30 p.m., CST; 7:30 p.m., MST; and 6:30 p.m., PST). Speeds on Sunday, Tuesday, Thursday, and Saturday evenings are 5, 7½, 10, and 13 wpm; on Monday, Wednesday, and Friday, they are 15, 20, 25, 30, and 35 wpm.

Approximately 10 minutes of code is sent at each speed. The start of each session is announced by "QST QST QST DE W1AW W1AW W1AW," repeated over and over.

(*Continued on page* 101)


# ON THE CITIZENS BAND

By **MATT P. SPINELLO,** KHC2060, CB Editor

## CB HELP PLAN TESTED

THE AUTOMOBILE Manufacturers Association and the General Motors Research Laboratories have announced operating test programs of the Highway Emergency Locating Plan (HELP). In the initial test, the City of Detroit Department of Streets and Traffic and the GM Research Labs have inaugurated an experimental CB radio emergency service along the John C. Lodge expressway from Cobo Hall to Eight Mile Road. The system is designed to improve the flow of traffic along a main city traffic artery through use of CB radio by private motorists.

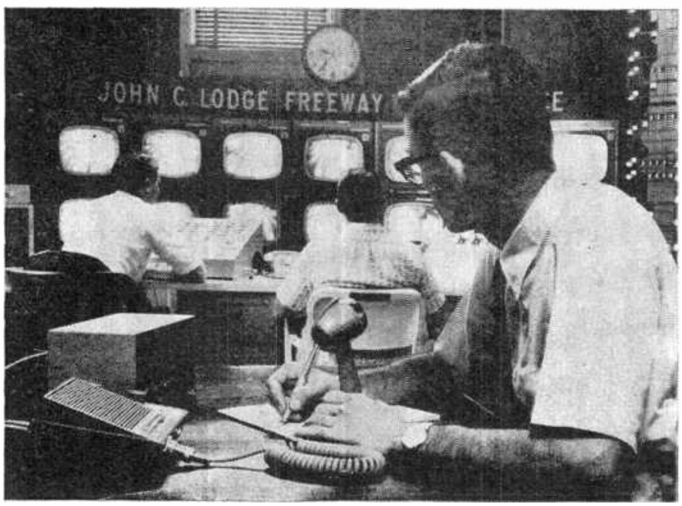
Under the experimental program, the Department of Streets and Traffic maintains a base station in the Herman Kiefer Hospital headquarters of the National Proving Ground for Freeway Surveillance. The GM Research Laboratories has supplied 100 CB transceivers for the system hookup. Some have been installed in City of Detroit vehicles, others in cars of selected GM employees who commute daily on the expressway. Operators of both City and GM CB-equipped vehicles have been instructed to call the base station only for expressway emergencies. The base station then directs the police expressway patrol to the scene of the emergency.

Michigan's highway department has installed special markers along the freeway route from downtown Detroit to Lansing as well as signs advising that the highway is being monitored by CB radio. Special display banners also have been posted at each of the monitoring centers where HELP literature is being handed out to interested parties.

The purpose of the test programs is to gather data in support of the AMA petition to the FCC requesting that two new CB channels be reserved for highway emergency use. The FCC had indicated earlier that more information was necessary to determine whether such exclusive channels were needed.

A somewhat similar experimental CB system is now operating in the Kokomo, Ind., area where GM's Delco Radio Division has a CB base station in its plant. Calls for help received at the station are relayed to the city police or county sheriff's department. The calls received at Delco so far have concerned automobile accidents and motorists stalled for lack of gas. Researchers indicate, however, that the Kokomo system has proved that first aid for injured motorists can be expedited by HELP.

(*Continued on page* 98)




In HELP test program set up by the City of Detroit and GM Research Labs, operators of mobile CB transceivers call base station (at right) when an emergency occurs along the John Lodge expressway, and the base station directs the police expressway patrol to the scene.

# ENGLISH-LANGUAGE BROADCASTS TO NORTH AMERICA
## FOR THE MONTH OF DECEMBER

**Prepared by ROBERT LEGGE**

### TO EASTERN AND CENTRAL NORTH AMERICA

| COUNTRY | CITY | TIME—EST | TIME—GMT | FREQUENCIES (MHz) |
|---|---|---|---|---|
| AUSTRALIA | Melbourne | 7:15-8:15 a.m. | 1215-1315 | 11.71 |
| CANADA | Montreal | 7:15-8:15 a.m. | 1215-1315 | 5.97, 15.32 |
| DENMARK | Copenhagen | 7:30-8 a.m. | 1230-1300 | 15.165 |
| FINLAND | Helsinki | 7:15-7:45 a.m. | 1215-1245 | 15.185 (Tues., Sat.) |
| GREAT BRITAIN | London | 10:30 a.m.-12:30 p.m. | 1530-1730 | 15.26,17.81 |
| SWEDEN | Stockholm | 9-9:30 a.m. | 1400-1430 | 17.84 |
| | | EVENING BROADCASTS | | |
| ALBANIA | Tirana | 7-7:30 p.m. | 0000-0030 | 7.265 |
| BULGARIA | Sofia | 7-8 p.m. | 0000-0100 | 6.07 |
| CHINA | Peking | 8-10 p.m. | 0100-0300 | 11.945, 15.06 |
| CUBA | Havana | 8-11 p.m. | 0100-0400 | 6.17, 11.76 |
| CZECHOSLOVAKIA | Prague | 8-9 p.m. | 0100-0200 | 5.93, 7.115, 7.345 |
| ECUADOR | Quito (HCJB) | 9-11:30 p.m. | 0200-0430 | 9.745, 11.915 |
| EGYPT | Cairo | 8:30-10 p.m. | 0130-0300 | 9.475 |
| GERMANY | Berlin | 8-9 p.m. | 0100-0200 | 6.16, 9.73 |
| | Cologne | 8:30-9:50 p.m. | 0130-0250 | 6.075, 9.64 |
| GREAT BRITAIN | London | 4:15-10:30 p.m. | 2115-0330 | 6.195, 7.13, 9.51 |
| HUNGARY | Budapest | 8:30-9:30 p.m. | 0130-0230 | 6.235, 9.833 |
| ITALY | Rome | 8-8:20 p.m. | 0100-0120 | 6.01, 9.63 |
| JAPAN | Tokyo | 6:45-7:45 p.m. | 2345-0045 | 11.78, 15.135 |
| LEBANON | Beirut | 9:30-10 p.m. | 0230-0300 | 9.71 |
| NETHERLANDS | Hilversum | 8:30-9:30 p.m. | 0130-0230 | 9.59 (Bonaire relay) |
| PORTUGAL | Lisbon | 9-9:45 p.m. | 0200-0245 | 6.025, 6.185 |
| ROMANIA | Bucharest | 8:30-9:30 p.m. | 0130-0230 | 6.15, 9.57 |
| SOUTH AFRICA | Johannesburg | 7:30-8:30 p.m. | 0030-0130 | 9.525, 11.90 |
| SPAIN | Madrid | 8-9:30 p.m. | 0100-0230 | 6.13, 9.76 |
| SWEDEN | Stockholm | 8:15-9:45 p.m. | 0115-0245 | 5.99 |
| SWITZERLAND | Berne | 8:15-9-15 p.m. | 0115-0215 | 5.965, 6.12, 9.535 |
| U.S.S.R. | Kiev | 7:30-8 p.m. (Mon., Thurs., Fri.) | 0030-0100 (Tues., Fri., Sat.) | 7.12, 7.31, 9.665 |
| | Moscow | 5-5:30 p.m. & hourly to 12-1 a.m. | 2200-2230 & hourly to 0500-0600 | 7.15, 7.31, 9.665 |
| VATICAN | Vatican | 7:50-8:10 p.m. | 0050-0110 | 5.985, 7.25, 9.645 |

### TO WESTERN NORTH AMERICA

| COUNTRY | CITY | TIME—PST | TIME—GMT | FREQUENCIES (MHz) |
|---|---|---|---|---|
| ARGENTINA | Buenos Aires | 10-11 p.m. (Mon.-Fri.) | 0600-0700 (Tues.-Sat.) | 9.69 |
| AUSTRALIA | Melbourne | 5-7 p.m. | 0100-0300 | 15.22, 17.84 |
| BULGARIA | Sofia | 8-8:30 p.m. | 0400-0430 | 6.07 |
| CHINA | Peking | 7-9 p.m. | 0300-0500 | 9.457, 11.82, 15.095 |
| | Taipei | 6:50-7:50 p.m. | 0250-0350 | 11.86, 15.345 |
| CUBA | Havana | 10:30-12 p.m. | 0630-0800 | 6.10 |
| CZECHOSLOVAKIA | Prague | 7:30-8:30 p.m. | 0330-0430 | 5.93, 7.115, 7.345 |
| GERMANY | Berlin | 7:45-8:15 p.m. | 0345-0415 | 5.96, 9.65 |
| | Cologne | 9-9:40 p.m. | 0500-0540 | 6.145, 9.735 |
| HUNGARY | Budapest | 7-8 p.m. | 0300-0400 | 6.235, 9.833 |
| JAPAN | Tokyo | 6-7 p.m. | 0200-0300 | 15.135, 17.825 |
| KOREA | Seoul | 7-7:30 p.m. | 0300-0330 | 11.925 |
| PORTUGAL | Lisbon | 8-8:45 p.m. | 0400-0445 | 6.025, 6.185 |
| SOUTH AFRICA | Johannesburg | 6:30-7:30 p.m. | 0230-0330 | 9.525,11.90 |
| SWEDEN | Stockholm | 7:15-7:45 p.m. | 0315-0345 | 5.99 |
| SWITZERLAND | Berne | 8:15-9-15 p.m. | 0415-0515 | 5.965 |
| U.S.S.R. | Moscow | 7-10:30 p.m. | 0300-0630 | 9.54, 9.735, 11.755 |

# SHORT-WAVE LISTENING

By **HANK BENNETT,** W2PNA/WPE2FT
Short-Wave Editor

## BROADCASTING STATION NEWS AROUND THE WORLD

THE Australian Administration Territorial Government recently opened its sixth new broadcasting station. This regional station is located at Mount Hagen, Papua, and the call-sign is VL8CH. The schedule calls for transmissions in English and native languages at 0700-1100. Station VL8CH should prove to be a difficult catch for North American DX'ers, since the frequency being used is 2450 kHz, and the power rating is only 250 watts.

According to *Radio New York Worldwide,* a new radio station (reportedly backed by American money) is already on the air in South Korea. Its announced purpose is to transmit the truth to millions of listeners in Communist sections of Asia. The station is called *Radio Free Asia* and is run by the Korean Cultural and Freedom Foundation. This is a private, non-profit organization with headquarters in Washington, D.C. At present, *Radio Free Asia* is using the facilities of a 500,000-watt station run by the South Korean government; however, the construction of a transmitter is planned.

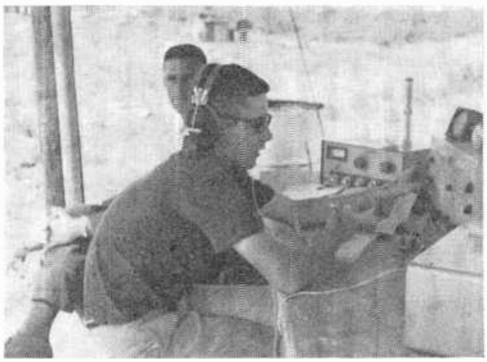
*The Voice of the Himalayas,* Katmandu, Nepal, will begin testing soon, if it has not already done so, with two 100,000-watt transmitters, probably on or near 7105 kHz.

When the tiny British possession in the South Atlantic, Tristan da Cunha, celebrated its 150th anniversary, a new radio station was inaugurated to mark the occasion. Details are lacking, but in view of the fact that the population of Tristan da Cunha amounts to only several hundred people, the station is more likely to be a utility station than a regular broadcaster.

Word has been received that the Armed Forces Caribbean Network broadcasts on 1200 kHz from its main studio in El Morro at Fort Brooks, Puerto Rico. All programming is rebroadcast from satellite stations at Roosevelt Roads Navy Base and Fort Allen, Ponce, as well as from an affiliated station at Ramey Air Force Base. The latter operates on 870 kHz with 50 watts, according to Major C. F. De Smet, Information Officer.

DX'ers all over the world are receiving surprises nowadays in the form of verification cards from *Radio Aparecida,* Brazil. Some of these QSL's are in confirmation of reports sent in more than 15 years ago! Responsible for the change is a 23-year-old student, Jose Dinys, who is now acting as International Correspondence Chief for the station. He says that all reports will be verified and that one or two IRC's will be appreciated from those who would like to have airmail replies. Mr. Dinys is also interested in exchanging stamps with other collectors. Reports should be sent to: Praca N. S., Aparecida 315, Aparecida, Sao Paulo,

(*Continued on page* 106)



In San Angelo, Texas, Explorer Post 382 of the Boy Scouts of America took part in a field day exercise. Scout Robert Montgomery is shown at the controls of a Hammarlund HQ-120 receiver (above) with advisor Roy Baker in the background. Below, Scout Joe Milam takes his turn at a Hallicrafters SX-110. All participating Explorers helped with the various chores, from digging of post holes for antenna towers to laying of wire for electrical power.

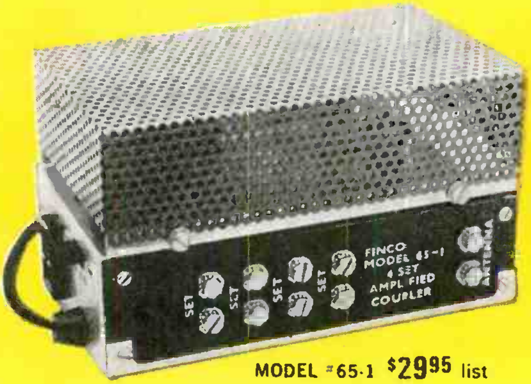
# FOREIGN-LANGUAGE BROADCASTS TO NORTH AMERICA

**Prepared by BILL LEGGE**

| LANGUAGE | STATION | TIME—EST | TIME—GMT | FREQUENCIES (MHz) |
|---|---|---|---|---|
| ARABIC | Cairo, Egypt | 6:30-7:30 p.m. | 2330-0030 | 9.475 |
| | Damascus, Syria | 8-9 p.m. | 0100-0200 | 9.605 |
| BULGARIAN | Sofia, Bulgaria | 8-8:30 p.m. | 0100-0130 | 6.07 |
| CHINESE | Peking, China | 8-10 p.m. | 0100-0300 | 9.92, 12.01, 15.095 |
| | | 10-12 p.m. | 0300-0500 | 9.48, 12.01, 15.08 |
| CZECH/SLOVAK | Prague, Czechoslovakia | 8:30-9 a.m. (Sun.) | 1330-1400 | 15.285, 17.825 |
| | | 10-10:30 p.m. | 0300-0330 | 7.345, 5.93, 7.115 |
| DANISH | Copenhagen, Denmark | 7-7:30 a.m. | 1200-1230 | 15.165 |
| | | 8-9 p.m. | 0100-0200 | 9.52 |
| DUTCH | Brussels, Belgium | 6:15-8 p.m. | 2315-0100 | 9.615 |
| | Hilversum, Holland | 9:30-10:50 p.m. | 0230-0350 | 9.59 |
| FINNISH | Helsinki, Finland | 7:15-10:10 a.m. | 1215-1510 | 15.185 |
| FRENCH | Brussels, Belgium | 6:15-8 p.m. | 2315-0100 | 9.615 |
| | Lisbon, Portugal | 9:15-10 p.m. | 0215-0300 | 5.985 |
| | Paris, France | 4-5 p.m. | 2100-2200 | 11.885, 15.13 |
| | Rome, Italy | 8:20-8:35 p.m. | 0120-0135 | 6.01, 9.63 |
| | Vatican City | 8:10-8:35 p.m. | 0110-0135 | 5.985, 7.25, 9.645 |
| GERMAN | Berlin, Germany | 8:30-9:30 p.m. | 0130-0230 | 5.96, 9.73 |
| | Cologne, Germany | 7-10 p.m. | 0000-0300 | 6.10, 9.545 |
| | | 10 p.m.-1 a.m. | 0300-0600 | 6.10, 9.64 |
| | Vienna, Austria | 7-9 p.m. | 0000-0200 | 9.77 |
| HUNGARIAN | Budapest, Hungary | 7-7:30 p.m. | 0000-0030 | 6.235, 9.833 |
| | | 9-10:30 p.m. | 0200-0330 | 6.235, 9.833 |
| ITALIAN | Rome, Italy | 5:30-8 p.m. | 2230-0100 | 6.01, 9.63 |
| JAPANESE | Tokyo, Japan | 7:15-7:30 a.m. | 1215-1230 | 9.505, 9.605 |
| | | 8:30-9 p.m. | 0130-0200 | 15.135, 17.825 |
| NORWEGIAN | Oslo, Norway | 10-11:30 a.m. | 1500-1630 | 15.175 |
| | | 4-5:30 p.m. | 2100-2230 | 9.61 |
| PORTUGUESE | Lisbon, Portugal | 7-9 p.m. | 0000-0200 | 6.025, 6.185 |
| | | 9:45-11 p.m. | 0245-0400 | 6.025, 6.185 |
| RUMANIAN | Bucharest, Rumania | 6:15-7 p.m. | 2315-2400 | 6.15, 9.57 |
| | | 10:30-11 p.m. | 0330-0400 | 6.15, 9.57 |
| RUSSIAN | Moscow, U.S.S.R. | 7 a.m.-12:30 p.m. | 1200-1730 | 15.15 |
| | | 6:30-7 p.m. | 2330-0000 | 7.15, 7.31 |
| | | 8:30-9 p.m. | 0130-0200 | 7.15, 7.31 |
| SPANISH | Buenos Aires, Argentina | 8-9 p.m. | 0100-0200 | 9.69 |
| | | 11-12 p.m. | 0400-0500 | 9.69 |
| | Havana, Cuba | 6 a.m.-4 p.m. | 1100-2100 | 6.135, 15.30 |
| | | 5-11 p.m. | 2200-0400 | 6.135, 9.55 |
| | Quito, Ecuador | 6-9 a.m. | 1100-1400 | 9.745, 11.915, 15.115 |
| | | 7:30-9 p.m. | 0030-0200 | 6.05, 9.745, 11.915 |
| SWEDISH | Stockholm, Sweden | 8-8:45 p.m. | 0100-0145 | 5.99 |
| | | 9:30-10:15 p.m. | 0230-0315 | 5.99 |
| UKRAINIAN | Kiev, U.S.S.R. | 7:30-8 p.m. | 0030-0100 | 7.11, 7.31 |

# FINCO

# "has 'em both"

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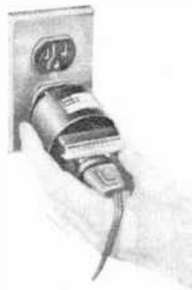

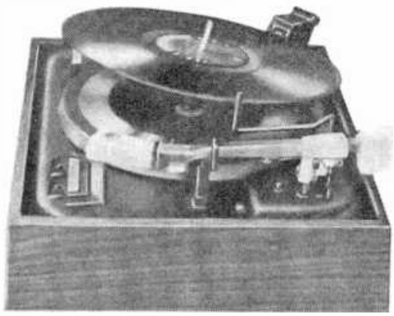

HOW do you know when it's time to change your hi-fi cartridge stylus, or demagnetize your tape recorder head, or overhaul the engine on your boat? By logging operating time in a book? Now there's a better way. A new 1¾" x ⅜" direct-reading elapsed time meter developed by Curtis Instruments, Inc., Mt. Kisco, New York, can log up to 5000 hours of operating time before recycling.

The timer consists of a glass tube with two columns of mercury separated by an electrolyte gap. When a small direct current is passed through the tube, mercury is transferred through the gap from anode to cathode, the displacement being a linear measure of the hours of operation.

For a.c. operation, the timer is combined with a small epoxy-encapsulated transformer and rectifier, and the device to be timed is plugged into the assembly. Prices start at $8. Data sheets and distributor list are available free from the manufacturer.

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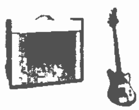
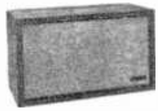


25-Channel, Solid-State C.B. Transceiver Model HB-600

New! Criterion Hi-Fi Bookshelf Speakers



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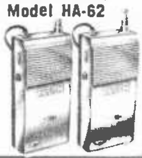
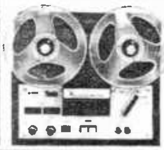


New! All Solid-State Tape Recorders and Decks—Model RK-830



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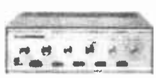
50-Watt Solid-State Stereo Amplifier, Model LA-248



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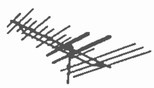

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 *(Continued from page 38)*

**Detrola** auto radio, circa 1932; has 5 tubes. Schematic needed. (Leroy Gross, 150 W. Alachua, Cocoa Beach, Fla. 32931)

**Gilfillan Bros.** Model 56A receiver, circa 1946; tunes BC; has 5 tubes. Schematic and specifications needed. (Bill Denton, Rt. 1, Box 612B, Arroyo Grande, Calif. 93420)

**Silvertone** Model 101.772-1 wire recorder; has 6 tubes. Spring for cam lever assembly and stainless steel recording wire needed. (Jim Holland, 2641 Elmdale Ct., Palo Alto, Calif.)

**RME/Electro-Voice** Model 4350 receiver. Instruction manual or schematic needed. (John E. Spiegel, 1586 Moravia Ave., Holly Hill, Fla. 32017)

**Stromberg-Carlson** Model 1121-PL receiver; tunes BC, FM and s.w.; has 11 tubes. Schematic and source of power transformer needed. (Steve Ordinetz, RFD #2, Chester Depot, Vt. 05144)

**ID-6 A/APN-4** oscilloscope, surplus. Schematic, operating manual, and power supply data needed. (William Weir, 406 Prospect St., Berea, Ky. 40403)

**Supreme** Model 599A tube checker. Schematic needed. (Lou E. Smith, 2405 5 St., Meridian, Miss.)

**Hammarlund** "Super-Pro" receiver, type RHV-2; tunes 1300 kHz to 40 MHz. Schematic and alignment data needed. (M.J. Vandermolen, Rt. 2, Box 33, Perkins, Okla. 74059)

**Zenith** Model 26-201 receiver, ser. S357088, circa 1940; tunes 550 kHz to 24 MHz on 3 bands; has 6 tubes and magic eye. Schematic needed. (D.H. Lord, 411 Red Chimney Dr., Warwick, R.I. 02886)

**McMurdo Silver** Model 904 capacitance resistance bridge, Model 900 volt ohm Vomax, Model 905 signal tracer gain test set. Schematics and operating manuals needed. (Melvin V. Berninger, 16 Grand St., Reading, Mass. 01867)

**Hickok** Model 202B volt-ohm-milliammeter, Series B. Schematic needed. (George M. Kistler, 2956 Loyola St., Sacramento, Calif. 95826)

**Philco** Model 39-116 receiver, code 121, circa 1939; has 13 tubes. Schematic, dial face plate, and source for parts needed. (George A. Bingaman, Box 685, Glenrock, Wyo. 82637)

**Philco** Model 42-350 receiver; circa 1930; tunes AM and FM on 3 bands; has 6 tubes. Schematic needed. (Gary Schneider, 4413 Carnation, Cincinnati, Ohio 45238)

**Meissner** Model 9-1065 phono-recorder p.a. system. Operating and instruction manual needed. (Barry Weisman, 112 Ridge Ave., Newton, Mass. 02159)

**Motorola** Model T41G-1A, T51G transceiver, circa 1954; tunes FM from 30 to 54 MHz. Operating manual and TK206 adapter chassis needed. (Robert W. Merdler, 196 S. Jefferson, Saginaw, Mich. 48601)

**Stewart-Warner** Model 206BBS receiver. Schematic needed. (William M. Wilmoth, 230 N. Eufaula Ave., Eufaula, Ala. 36027)

**Hickok** Model RFO-5 oscillograph, circa 1950. Schematic and operating manual needed. (Barry Lowry, 1102 Holgutni St., Lancaster, Calif. 93534)

**Surplus** mine detector Model SCR-625-C-2915-Phila-45-08. **BC-1141-E** amplifier, made by Horni Signal Mfg. Corp. Operating manuals needed. (William W. Rigden, 103 Madison St., Milton, Fla. 32570)

**Philco** Model 39-25 receiver, code 121; tunes BC and 3 to 18 MHz. Schematic needed. (John Boxhorn, 13650 Tremont St., Brookfield, Wis. 53005)

**Elgin** Model D receiver; tunes BC and 5.5 to 20 MHz; has 7 tubes. Schematic, service data, and K-38-B-2 tube needed. (Mike Wheeler, 3523 Altamont Dr., Klamath Falls, Ore. 97601)

**Atwater-Kent** Model 20 receiver, ser. 226289; tunes BC; has 5 tubes. Schematic and source for parts needed. (SSgt. Orville Gallimore, AF 55287149, 2140th Comm. Sqdn., AFCS, Box 2162, APO, New York 09223)

**Hickok** Model 450 VOM. Schematic and operating manual needed. (Brad Woelke, 11422 Marion, Detroit, Mich. 48239)

**T 193B/VRC-2** transmitter, made by Utility Electronics Corp. for Signal Corps, order #20591-PH-49. Schematic or booklet #TM-11-607 needed. (Eric Smitt, 609 Oakfield La., Philadelphia, Pa. 19115) —30—

## LETTERS (*Continued from page* 12)

when the dipole was rotated. The sound was equally intense when observed from shore or from a boat in the middle of the lake (Lake Eau Claire, S.E. Eau Claire County, Wis.)

On two occasions, both after sunset, distinct "ping" sounds could be heard in addition to the crackle. On one other occasion, a sunny afternoon, a few whistles were heard. On that same afternoon, I also heard something which I can best describe as a rather low-pitched cricket-type sound. All sounds ceased as soon as the antenna was removed from the water. Passing motor boats did not create any detectable signal.

GEORGE R. ROSSMAN
Eau Claire, Wis.

I am an experimenter who is always looking for something unusual to build. I had all the equipment for the Hydronics receiver, so I built it. It works fine in large bodies of water but when I put it in my aquarium the only thing I get is the local radio station (KXKW).

DAVID YOUNGBLOOD
Lafayette, La.

*David, that's one way to listen to your local radio station. George, did you try putting these sounds on a tape recorder and then listening to the recording at a slower speed? D.A., your unit seems to be working fine; apparently, what you need is a large body of water. Elliot, glad you lost your skepticism, but we still don't know if Plasmonics is for the birds. For what it's worth, Minto is still working away at this project in an effort to find a method of long-range "radio" communication under water.*

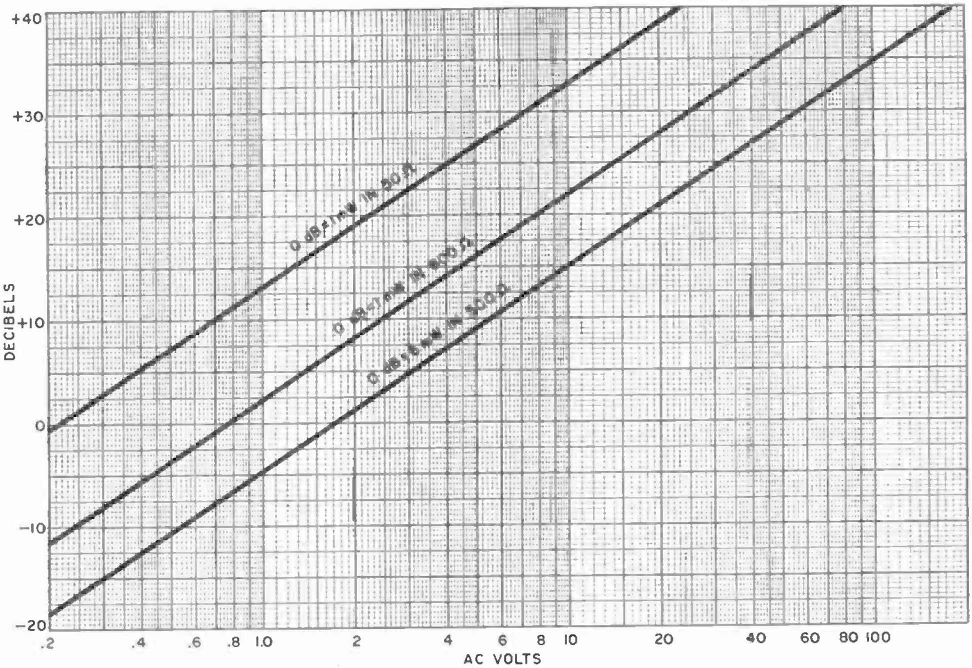
## OUT OF TUNE

**Powerhouse 2-Tube Short-Wave Receiver** (*August*, 1966, *page* 62). In Fig. 4, *L3* and *L4* should be transposed; also transpose *L3* and *L4* in the Parts List.

**Static-Free Thermistorized Aquarium Heater** (*September*, 1966, *page* 74). Resistor *R4* should be 10,000 ohms and *R7* should be 56,000 ohms.

**Four On The Floor** (*November*, 1966, *page* 75). Dimensions on the drawing are correct but in the Bill of Materials the wood for the exterior sides should be listed as 13⅛" x 34" x ¾"; for the exterior top as 13⅛" x 19" x ¾"; and for the exterior bottom as 12⅞" x 17½" x ¾".

**Update to Solid State** (*September*, 1966, *page* 44). Caption under bottom photo should read small "metal" clamps rather than small "plastic cable" clamps. Metal clamps serve as a heat sink.




**What Are These Things Called Decibels?** (*October*, 1966, *page* 76). The three heavy black rules on the "AC Volts To dB Graph" slipped out of registration in some copies of the October issue. See corrected graph above. The "0 dB=1 mW in 600-ohm" line should show 0 dB for 0.775 volts, and 28 dB for 20 volts. Space between the rules remains the same. —30—

## BINARY COUNTER

(*Continued from page* 61)

preassembled circuit board to the readout lamps, push-button switches, and supply battery.

The IC's and the transistors can be mounted on insulated Teflon press-fit terminals as shown in the layout of Fig. 5, or on "flea" clips (push-in terminals) if a perforated phenolic board is used. The use of regular 8-pin IC sockets and 3-terminal transistor sockets will provide greater ease of assembly, and reduce the possibility of the solid-state devices being damaged due to overheating at the terminals.

The IC packages are coded by a flat side or a green or red dot indicating pin 8. When viewed from the top, the pins are counted counterclockwise.

Figure 5 shows *IC4* mounted directly on one of the push buttons by means of a circular plate with feedthrough terminals, but you'll find it more convenient to mount *IC4* on the same circuit board with the other units.

Switch *S3* and the battery holder can be fastened to the case with #6 hardware, or can be pop-riveted in place. Switches *S1* and *S2* are mounted with hardware provided. The lamps are held by ½"-o.d. rubber grommets mounted in the holes provided. If a dialplate is used, it can be secured to the cover with the mounting hardware for the push-button switches. A cross-section view of the assembled unit (Fig. 6) shows mounting details of major components. Rubber feet can be attached to the container base.

**Operation.** Insert the batteries and flip the power switch to *ON*. With each depression of the *COUNT* push button, the binary count is advanced by one. To demonstrate binary addition, clear the binary counter to 000 with the *CLEAR* push button, and press the *COUNT* button to enter your first number. If it's a 2, enter binary 010 by depressing the *COUNT* push button twice. Now enter your second number. If it's a 3, enter 011 by pressing the *COUNT* push button three times. The answer 101 should appear on the readout lamps. —30—

## SMALL TAPE RECORDERS

(*Continued from page* 52)

the mike, or pretend that the recorder is not working. Use the phony cord trick.

For instance, suppose some one asks you what's in that little box you are carrying. Don't hesitate to tell him it's a tape recorder. If he stops talking, pull a line cord out of your pocket and offer to show him how it works if you can find an a.c. outlet. As soon as he is convinced that the recorder is not working, he'll start talking again. What he doesn't know is that the machine is operating on batteries.

**Voice Letters.** Very often the written word can be misconstrued, but a tape of your voice with all its inflections, your laughing, or sobbing—which is really you by nature—will get through with full meaning. And a taped letter can become a group project, with comments and sounds of an entire household—truly a family letter.

Taped conversations in a barber shop, a beauty parlor, between a couple of friends meeting on the street, or between two motorists fighting for the same parking space, are vastly different from even a most vivid description of these events in a written letter. Chances are that once you get into the habit of taping letters, you will stick to it.

**Other Applications.** If you are a student, let your tape recorder do your note-taking so that you can concentrate on what is being said. When you get home, you can transpose your notes into writing if you have to. You can cut down your library time considerably if you have to transcribe reference works. Find a corner in the library where you won't disturb anybody, and read the works into your tape recorder.

You can also add another dimension to your home movie-making; just turn on your tape recorder (without telling anybody) and start shooting pictures.

From the busy executive on the go, dictating in a car, train, or plane, to the man on the street capturing the sounds of the town, the small tape recorder serves its purpose admirably. —30—









# TAPE RECORDER KIT—DELUXE

*(Continued from page 66)*

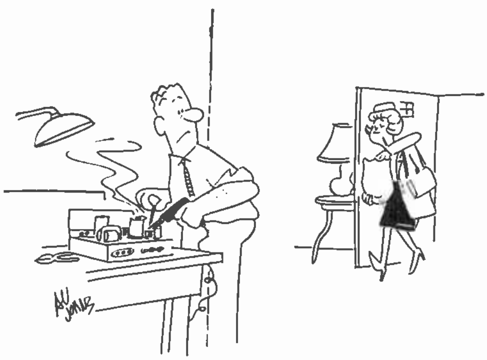
tape transport is too big a job for the electronics technician. But you may not know that a high percentage of tape recorders use a single motor. That motor must be linked up to perform the functions of rewind, drive, and fast forward. The Heathkit AD-16 uses three separate synchronous motors and each does just one job. Linkages and drive belts are few and far between in the AD-16.

To further eliminate the complexity that you see in some tape transport mechanisms, the AD-16 is all-solenoid-operated. You push a button on the front panel and the solenoid plungers do all the work—starting and stopping the tape, lifting tape off heads, etc.

**How Good Is Good?** If you have never heard a good tape played back on a good tape recorder, words are not adequate devices to insure a good description. About the best we can do without resorting to hyperbole and superlatives is to mention the dynamic range and obvious purity of sound.

A tape recording is much, much closer to an original performance than even the very best disc recording—and, by the way, tapes are not gimmicked like the recordings of most major record companies. There's no reason to add distortion to compensate for distortion when you play nothing but tapes.

The AD-16 lets you hear everything on the tape just as perfectly as when it was recorded. —30—



"Instead of four 50-ohm resistors, I gotcha one 200-ohm—it was much cheaper."

## LOGIC DEMON

(*Continued from page* 45)

button. In the OR function, the bulb lights when either push button is depressed, while in the AND function, both push buttons must be pressed at the same time for the light to come on. With the switch in an NAND position, both push buttons must be simultaneously pressed to put out the light.

The Logic Demon can be used in a classroom or at a Science Fair to demonstrate the practical application of computer (symbolic) logic. Granted that a number of individual switches could be used to perform the same function as the single IC package, it can be seen that the use of integrated circuits greatly simplifies the project. The Logic Demon also demonstrates some practical applications of the use of integrated circuits in computer technology. –30–

## "RELAXATROL"

(*Continued from page* 56)

bly. Slip a piece of spaghetti over each of the leads to insulate them and prevent short circuits.

Exercise care and work slowly when drilling holes in the plastic case. Use a file to shape the opening for the switch. A bottom cover for the case can be made from a thin piece of plastic or stiff cardboard, if you don't already have one. Two precautions should be taken: observe polarity of the diodes or proper connections of the rectifier module; and don't compromise the insulation—the rectifiers and *S1* are connected directly to the a.c. line.

**Operation.** When the unit is completed, check the wiring for any errors, then secure the bottom cover. Plug the a.c. line cord into a wall outlet and switch on the unit. After a slight delay, the relay should pull in and out at a regular interval. Rotate *R2* to change the interval. Range should be from very fast (approximately 15 seconds) to very slow (approximately 2 minutes). If desired, the time intervals can be marked on a dialplate placed under the control knob.

Connect the push-button leads from the projector to *PL1* through a mating socket. Use a small caliber plug and socket for this purpose to prevent confusion with the a.c. line cord. Set up your projector as usual, and allow the Relaxatrol to go to work. If you want to view a particular slide for a longer period of time, simply turn the unit off until you are ready to start again. If you want to quickly dispose of a slide without upsetting the timing sequence, hit the push button just once.

You can shift the range of speeds by using a smaller or larger resistor in place of *R1* or by changing value of *C2*. -30-

## THE "SCROUNGE"

(*Continued from page* 46)

**You could hang** this antenna from a tree, or—if you want to get fancy—substitute aluminum or copper tubing, but maintain the same dimensions. If you support the lower part of the antenna with insulated standoffs, you'll have a first-class permanent installation.

If you hang the antenna from a tree or other high structure, you can reverse the connections to the coaxial cable to provide for some degree of lightning protection. With the leads reversed, the highest point of the antenna will be connected to the coaxial cable's shield, which is usually grounded at or near the equipment. Antenna action is not materially affected by this reversal because the quarter-wave section acts like a transformer.

As with any antenna work, there is no substitute for actual on-the-job tuning, adjusting, and other optimizing activities. The figures shown are close enough for most applications, and include some consideration for end effect. If you want to experiment using a cut-and-try technique, you can first try shortening the quarter-wave section about ½" at a time before modifying the half-wave section. Telescoping sections such as are found on a pair of TV "rabbit ears" could help you pin down the exact dimensions. -30-

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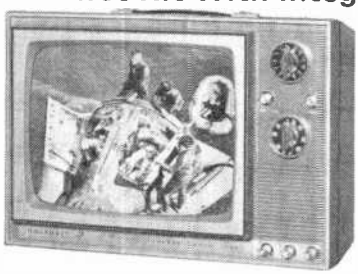

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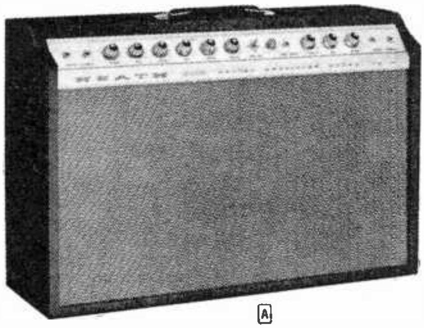

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**[A] NEW Heathkit Transistor Guitar Amplifier**
60 watts peak power; two channels — one for accompaniment, accordian, organ, or mike, — the other for special effects . . . with both variable reverb and tremolo; 2 inputs each channel; two foot switches for reverb & tremolo; two 12" heavy-duty speakers; line bypass reversing switch for hum reduction; one easy-to-build circuit board with 13 transistors, 6 diodes; 28" W. x 9" D. x 19" H. leather-textured black vinyl cabinet of ¾" stock; 120 v. or 240 v. AC operation; extruded aluminum front panel. 44 lbs.

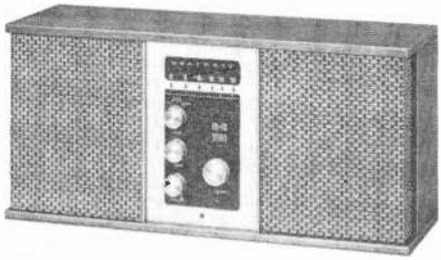
**American Made Harmony-By-Heathkit Guitars**
All guitars include instruction book, tuning record, pick, connecting cord, deluxe red leather cushioned neck strap and chipboard carrying case. All wood parts assembled and factory finished — you just mount metal parts, pickups & controls in pre-drilled holes and install strings.

**[B] Deluxe Guitar . . . 3 Pickups . . . Hollow Body**
Double-cutaway for easy fingering of 16 frets; ultra-slim fingerboard — 24½" scale; ultra-slim "uniform feel" neck with adjustable Torque-Lok reinforcing rod; 3 pickups with individually adjustable pole-pieces under each string for emphasis and balance; 3 silent switches select 7 pickup combinations; 6 controls for pickup tone and volume; professional Bigsby vibrato tail-piece; curly maple arched body — 2" rim — shaded cherry red. 17 lbs.

**[C] Silhouette Solid-Body Guitar . . . 2 Pickups**
Modified double cutaway leaves 15 frets clear of body; ultra-slim fingerboard — 24½" scale; ultra-slim neck for "uniform feel"; Torque-Lok adjustable reinforcing rod; 2 pickups with individually adjustable pole-pieces under each string; 4 controls for tone and volume; Harmony type 'W' vibrato tail-piece; hardwood solid body, 1½" rim, shaded cherry red. 13 lbs.

**[D] "Rocket" Guitar . . . 2 Pickups . . . Hollow Body**
Single cutaway style; ultra-slim fingerboard; ultra-slim neck, steel rod reinforced; 2 pickups with individually adjustable pole-pieces for each string; silent switch selects 3 combinations of pickups; 4 controls for tone and volume; Harmony type 'W' vibrato tailpiece; laminated maple arched body, 2" rim; shaded cherry red. 17 lbs.

## NEW! Deluxe Solid-State FM/FM Stereo Table Radio

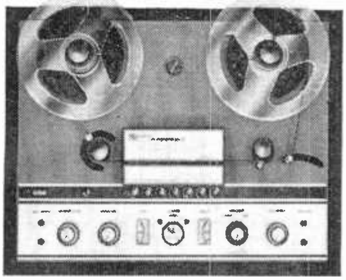


Kit GR-36
\$69.95

Tuner and IF section same as used in deluxe Heathkit transistor stereo components. Other features include automatic switching to stereo; fixed AFC; adjustable phase for best stereo; two 5¼" PM speakers; clutched volume control for individual channel adjustment; compact 19" W x 6½" D x 9¼" H size; preassembled, prealigned "front-end"; walnut cabinet; simple 10-hour assembly. 17 lbs.

# Something For Everyone

## NEW Heathkit® /Magnecord® 1020 4-Track Stereo Recorder Kit



Kit AD-16
**$399.50**
(less cabinet)

**Save $170 by doing the easy assembly yourself.** Features solid-state circuitry; 4-track stereo or mono playback and record at 7½ & 3¾ ips; sound-on-sound, sound-with-sound and echo capabilities; 3 separate motors; solenoid operation; die-cast top-plate, flywheel and capstan shaft housing; all push-button controls; automatic shut-off; plus a host of other professional features. 45 lbs. Optional walnut base $19.95, adapter ring $4.75

## NEW Deluxe SB-301 Amateur Receiver Kit
## NEW Deluxe SB-401 Amateur Transmitter Kit

Kit SB-301
**$260.00**
(less speaker)

New SB-301 receiver for 80 thru 10 meters with all crystals furnished, plus 15 to 15.5 MHz coverage for WWV; full RTTY capability; switch-selected ANL; front-paneling switching for control of 6 and 2 meter plug-in converters; crystal-controlled front-end for same rate tuning on all bands; 1 kHz dial calibrations, 100 kHz per revolution. 23 lbs. Matching SB-401 Transmitter, now with front-panel selection of independent or transceive operation . . . $285.00

## 2-Watt Walkie-Talkie

Assembled
GRS-65A
**$99.95**

New . . . Factory Assembled. Up to 6 mile range; rechargeable battery; 9 silicon transistors, 2 diodes; superhet receiver; squelch; ANL; aluminum case. 3 lbs. 117 v. AC battery charger & cigarette lighter charging cord $9.95. Crystals $1.99 ea.

## NEW Portable Phonograph Kit

Kit GD-16
**$39.95**

**All Transistor.** Assembles in 1 to 2 hours. Preassembled 4-speed automatic mono changer; 4" x 6" speaker; dual Sapphire styli; 45 rpm adaptor; olive & beige preassembled cabinet; 117 v. AC. 23 lbs.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CIRCLE NO. 18 ON READER SERVICE PAGE

## ON THE CITIZENS BAND

*(Continued from page 79)*

**"Thatman and Who?"** We were minding our own business, coming out of an electronics center after having made a purchase, and to our surprise found half-a-body hanging out of our sports car window, clad in a pair of tights and some very "different" looking shoes. The other half of the body projected into the interior of the car. On closer inspection through the windshield, we found the top half of the mysterious figure clad in a tight jersey, a pretty sharp looking cape, and (of all things) a black mask.

The gent emerged to inform us that he had become interested in our two-way CB gear under the dash. He then asked an assortment of questions on how CB'ers operate, the type of communications we become involved in, and the main purpose of the system. We were happy to oblige (see photo below).

In the middle of our discussion on the useful application of CB radio to emergency situations (he seemed very impressed, incidentally), a sleek, highly powerful looking black automobile(?) drove up alongside to pick up my friend. The driver of the vehicle was similarly clad in an assortment of close-fitting garments, but sported a hood and a large flowing cape, and the car itself was loaded with all sorts of devices, controls, and gadgets. Indicating that my

Photo by James Karr

friend should get in quickly, he mumbled something about a caper.

As the pair went off in a puff of exhaust, we thought we faintly heard them enthusiastically exchanging a series of words like: "Biff—Pow—Wup—Hmm . . ." Sometimes people make you *wonder, boy*!

**Club News.** The Western New York Pioneer Citizens Band Association, North Tonawanda, N.Y., reports that its Third Annual CB Jamboree was extremely successful. The event was held for the benefit of handicapped and retarded children, with monies raised to be distributed among area children's homes.

Honored guests of the day were 70 children from St. Rita's Home For Retarded Children. The children were brought to the jamboree by buses supplied by the Pioneer CB Club, and were escorted by 36 adults from St. Rita's who watched over them during their three-hour visit. They were treated to dinner, cotton candy and liquid refreshments, plus rides on the midway.

At the jamboree, the publicity director of the Pioneers, Vernon W. Batt, KIC5311, supervised the presentation of a bound copy of the June, 1966, issue of POPULAR ELECTRONICS to Lockport, N.Y., Mayor Roland T. Grant by James Trombino. (The Pioneer CB'ers had been praised in the OTCB column that month for their fund-raising activities.) Vern reported that the one-day affair realized a profit of approximately $4000 to aid needy children.

Photo by Al Shoen

In the week following the jamboree, the Pioneer membership approved the purchase of a tape recorder, slide projector and screen, and a 35-mm. camera, to be presented to St. Rita's Home. The officers and members of the club extended their sincere thanks to all persons involved with the jamboree, in addition to the following CB clubs that gave both personal and financial aid: Grape Belt CB Club, Dunkirk, N.Y.; The W.N.Y. Frontiersmen CB Club, Lockport, N.Y.; The Niagara Nuggets CB Club, Buffalo, N.Y.; and the Police Benevolent Association, Lockport.

**1967 OTCB Club Roster.** If your group was not placed on the 1966 OTCB roster of active associations across the U.S. and Canada, gather up the statistics and ship them off to us soon—in time for the first 1967 listing. Specify membership totals and club officers; detail recent public service assists and activities; and be sure to forward your club paper as soon as it's published. Include some photos of your group and a club decal and/or membership card, and we'll try to show them to the rest of our CB readers.

I'll CB'ing you!

*—Matt, KHC2060*

## BRIDGE CIRCUIT QUIZ ANSWERS

(*Quiz appears on page* 73)

1 — J The CAREY FOSTER bridge measures capacitance in terms of mutual conductance, and mutual conductance in terms of capacitance.

2 — H The HAY bridge measures the self-inductance of high-Q coils (Q greater than 10), and also determines unknown frequencies.

3 — D The HEAVISIDE bridge measures the mutual inductance of the coils of a transformer in terms of a known self-inductance and known resistances.

4 — I The KELVIN bridge is used when extremely low resistances—down to 0.001 ohm—are to be measured.

5 — C The MAXWELL bridge measures the self-inductance of low-Q coils (Q of 10 or less).

6 — F The OWEN bridge, like the HAY and MAXWELL bridges, measures the self-inductance of coils. The main difference between the OWEN and the other two bridges is that the OWEN bridge has the two adjustable components in the same arm.

7 — A The RESONANCE bridge measures capacitance, inductance, and frequency.

8 — G The SCHERING bridge measures capacitance in terms of a standard capacitor and known resistances.

9 — B The WHEATSTONE bridge, oldest of the bridge family, is used where accurate resistance measurements—in the range of 1 ohm to approximately 1 megohm—are to be made.

10 — E A WIEN bridge is used to measure capacitance by comparison with a standard capacitor, and inductance by comparison with a standard inductor.

# AMATEUR RADIO

(*Continued from page 78*)

## NEWS AND VIEWS

**Louis Laukich, WA/WN8SNF,** 107 7th St., N.W., Barberton, Ohio, works 40-meter CW and 2-meter phone with a rebuilt Knight-Kit T-150A transmitter. He receives on a Knight-Kit R-100A (aided by a Vanguard converter for "6"), and the outdoor work is handled by a 40-meter inverted-V antenna, a 24' home-brew vertical antenna, and a 6-meter beam. There are 35 states logged on Lou's "brag sheet." . . **SP/4 John W. Good, Jr., K3SIO/HS1,** U.S. Army Satcom Station, APO, San Francisco, Calif., says there is no VHF or UHF amateur activity within 500 miles of Bangkok: so he spends most of his time building and testing gear. His latest creation is a 6-meter receiver with a 6-dB signal-plus-noise to noise ratio at a —124 dBm signal. His next project is to "scrounge" some 1296-MHz gear. John can be heard on the Southeast Asia net on 14.322 MHz at 1200 GMT using an SBE-34 exciter, a 1000-watt amplifier, and a Telrex tri-band beam . . . K3SIO reports that **Don, WA8OBB/XV5,** Cam Ranh Bay, Vietnam, is also active on 14 MHz with a Drake TR-4 and a ½-wave dipole antenna.

**Alexandre Ermine, TAQ3RXTX,** Izmir, Turkey, studies electronics in the daytime and works in a radio shop at night. He would like to exchange letters with U.S. amateurs about getting on the air. Address letters c/o A3C Delbert Stout, AF-17701793, TUSLOG Det. 118, C.M.R. Box 342, APO, New York 09016 . . . **Dan Taylor, ex-WB6PJK,** c/o Ron Davis, 3907 Shadyhill Dr., Dallas, Texas, had rather an odd record while a Novice in Covina, Calif. Using a 5-watt, home-brew transmitter, he made 300 contacts—all in California—on 80 meters. Then with a 40-watter, he worked 10 states. When he became a General, a Johnson "Challenger" transmitter feeding a vertical antenna racked up 40 states and five countries. We don't know what Dan's new "5" call letters are . . . **Jim Rembiszewski, WN9SIK,** R.R. #3, Box 83A, Antigo, Wis., found out "the hard way" that the *pi*-net output tank circuit of a transmitter won't match just any old antenna. But his Knight-Kit T-60 transmitter and 32½' home-brew vertical antenna get along well on 40 meters. The antenna is constructed of ½" conduit and is fed with 52-ohm coaxial cable. Jim receives on a Knight-Kit R-55A. He has worked 13 states so far, and two Canadians.

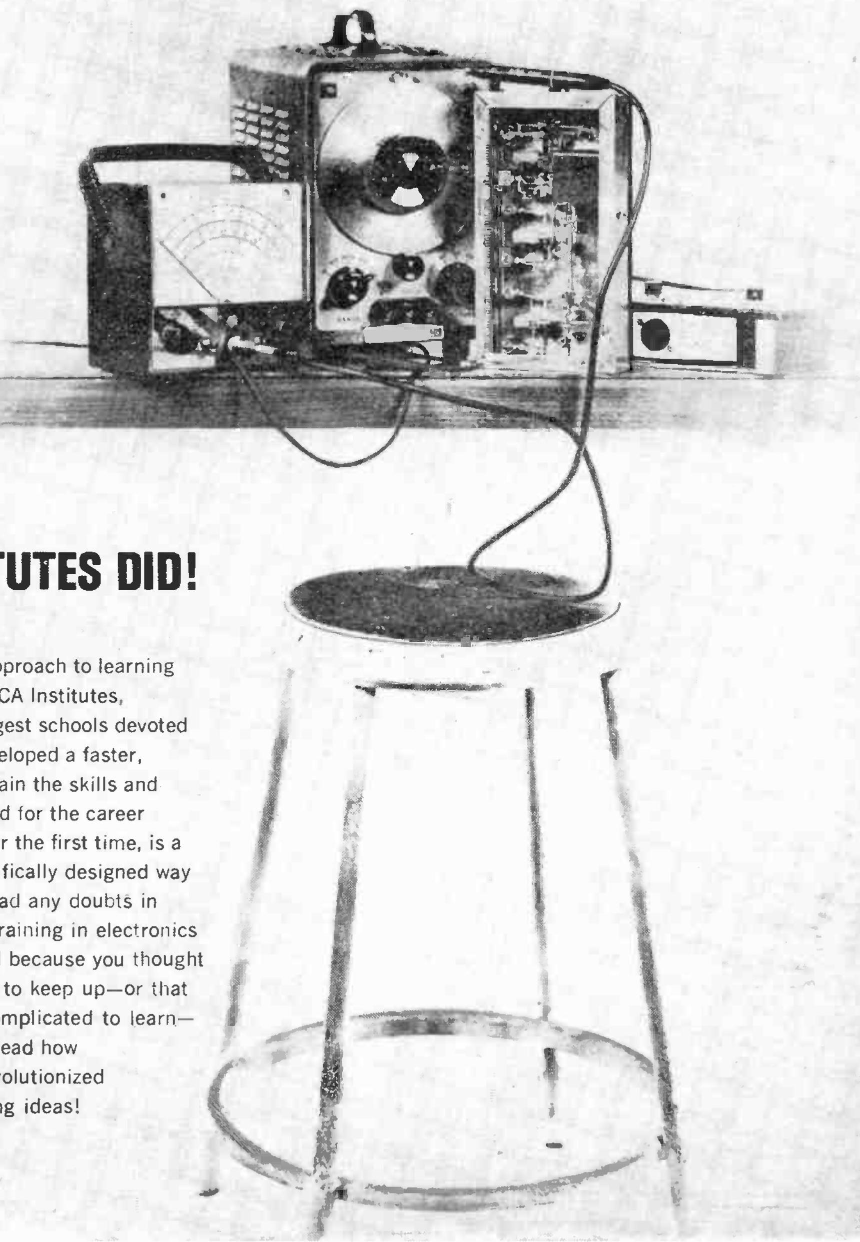
**Landon L. Chapman, W4VTU,** 204 Sunset St., Bristol, Tenn., and his local radio club are offering a QSO Award to amateurs who work five Tennessee amateurs (25 if you live in Tennessee). You can get the details from Landon for a stamped reply envelope. He will also answer questions about amateur radio for truly interested people. W4VTU works the lower frequencies with a Johnson "Ranger" transmitter and a Hammarlund HQ-110A receiver. For 2 meters, a war-surplus ARC-4 transmitter feeding a beam antenna and a converter ahead of the receiver do the work. He has a wall full of QSL cards to prove that he doesn't talk to himself . . . **Mike Czuhajewski, WA8MCQ,** Route 3, Paw Paw, Mich., believes that he worked a "KZ5" on the 80-meter Novice band in broad daylight recently. We hate to disappoint Mike, but we suspect that he worked a "bootlegger" in the neighborhood. Happier news: Mike found that adding radials to his Hy-Gain 18V antenna allowed him to work three W6's in a row on 40 meters. Before making the change, he had worked one "6" out of 1143 contacts . . . **Red Rowcliffe, WA6QMU,** 6271 Merced Lake Ave., San Diego, Calif., makes certain that recipients really look at his QSL card. It is a very attractive color photo of him and his station, with the call letters occupying a ¼" x ⅛" space in the picture. Red (who is former KØKOA) uses a Collins 32S3 driving a 30L1 amplifier into a Hy-Gain TH-3 rotary beam 70' high and a Collins 75S-3B receiver. Besides being good-looking, the equipment must work well, because Red keeps regular traffic schedules with KR6USA on Okinawa.

**Joe Patrick, WN3FDT,** R.D. #4, Box 104, Finleyville, Pa., uses a 35-watt transmitter built by WA3CWD. It shares time with a Hallicrafters SX-101A receiver on a 24' high, 40-meter inverted-V antenna. In six months of 40-meter operation, Joe has eight pages of contacts scattered from coast to coast . . . If you should run across **Howard Pyle, W7OE,** and **Lew, W7APS,** sending "crazy" CW on 3540 kHz, think nothing of it. They are using "land-line" Morse code. Join them if you can send and receive the stuff. Thanks to the 7th Call Letter District QRP Amateur Radio Club *Bulletin* for this information . . . **Dave "Top" Harmacek, WN8TOP,** 8364 Lincoln Drive, Chesterland, Ohio, knocked off 23 states and Canada his first five weeks on the air. An EICO 720 transmitter feeding dipole antennas and a "homemade" (yep, that's what the man said) Mosley CM-1 receiver on the 40- and 80-meter bands did the work.

Before we hit the bottom of the page, let us say "Merry Christmas and Peace on Earth" to all. If your chimney is too small for that new gear you asked for, leave the door unlocked. As always, we remind you that the first step towards representation in *your* column is mailing us your "News and Views" and photographs. Keep those club bulletins coming; and please let us know if you or your club conducts on-the-air code practice. The address is: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P. O. Box 678, Gary, Ind. 46401.

73, *Herb, W9EGQ*

# SOMEONE SHOULD DEVELOP AN EASY WAY TO LEARN ELECTRONICS AT HOME



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**Digital Techniques.** For a career as a Digital Techniques Electronics Technician; Industrial Electronics Technician; Industrial Laboratory Technician.

**Telecommunications.** For a job as TV Station Engineer, Mobile Communications Technician, Marine Radio Technician.

**Industrial Electronics.** For jobs as Industrial Electronics Technicians; Field Engineers; Maintenance Technicians; Industrial Laboratory Technicians.

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## SHORT-WAVE LISTENING

(*Continued from page* 81)

Brazil. The station is currently operating on ZYR44, 9635 kHz, and ZYR89, 3285 kHz.

*Trans World Radio*, Bonaire, Netherlands Antilles, now has a DX program for North American listeners on Fridays at 1205 on 11,820 kHz; for Europe on Saturdays at 0200 on 15,245 kHz; and another broadcast on Sundays at 0335 on 11,815 kHz. Al Stewart is in charge of the program.

Over the past three years, a number of DX'ers have asked us to help them identify the singer of the "Kiss Me Honey" record that, until recently, was the one and only recording of the *Kiss Me Honey* station on 11,695 kHz. (It has been changed to "Can't Buy Me Love," recorded by the Beatles.) The singer is Miss Shirley Bassey, and the record is an LP issued by Phillips of Australia in the "Party Dance Series," number PD29. The orchestra is believed to be that of Tony Osborne.

Mr. C. E. Chicarelli of the Anglo-Thai Corp., Ltd., states that *Radio Thailand* is now using an RCA "Ampliphase" 100-kW transmitter with a horizontal rhombic antenna beamed at N. A. over the North Pole. Current operations are on 11,910 kHz "most of the day with programs in Thai, French, and English." They are anxious to receive detailed reception reports from N. A., which should be sent to Thailand Overseas Broadcasting Station, Rangsit, c/o Public Relations Department, Rajadamnern Ave., Bangkok, Thailand. Mr. Chicarelli is in the Communications and Engineering Department.

### CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports are as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to SHORT-WAVE LISTENING, P.O. Box 333, Cherry Hill, N.J., 08034, in time to reach your Short-Wave Editor by the fifth of each month; be sure to include your WPE identification, and the make and model number of your receiver. We regret that we are unable to use all the reports received each month, due to space limitations, but we are grateful to everyone who contributes to this column.

**Ascension Island**—Look for the new service from the BBC relay station here at 2300-0215 beamed to South and Central America. This xmsn, on 15,375 kHz, is a relay of the BBC Latin American service.

**Bermuda**—DX'ers needing a QSL from this country should tune to the medium-wave outlet on 1235 kHz for ZBM1, Hamilton. While on a split channel between two "graveyard" frequencies, the station is often noted well in Eastern areas around 0500. A report with an IRC brought a prompt QSL.

**Bolivia**—*R. Amboro*, Santa Cruz de la Sierra, has been noted once again on 4898 kHz (varies) and announcing as 4915 kHz. Signal is very weak.

Latin American pop tunes are featured; there are a few ID's; and closing is around 0200.

**Burma**—The 5040-kHz outlet has been heard as early as 1115-1155 with Burmese music and what appears to be a newscast at 1146.

**Cambodia**—Phnom-Penh has a new frequency, 4910 kHz, for the Home Service, noted at 1230-1245 in French, at 1245 with Eng. news, and dance music with anmts in French at 1300 and 1330.

**Canada**—Those who have CBC schedule #56 should change the frequency of 11,725 kHz in the Caribbean and Latin American Service at 2258-0046 to 11,760 kHz.

**Colombia**—A new or "misplaced" station being heard on 6020 kHz is definitely Colombian and is located in Bogota. Check for it around 0230.

Station HJFW, *Transmisora Caldas*, Manizales, has moved up from 5020 to 5025 kHz, where the signal is much weaker. This may be a standby xmtr in use while the main one undergoes maintenance. Do not confuse with the Ecuadorian on 5023 kHz.

A new outlet is *R. Nacional de Colombia* on 15,-325 kHz. Noted all day, it runs "dual" to 3290, 4955, and 6180 kHz with the same programming, including "English By Radio" from the BBC at 2345. S/off varies from 0400 to 0500.

### SHORT-WAVE ABBREVIATIONS

| | |
|---|---|
| anmt—Announcement | kHz—Kilohertz |
| BBC—British Broadcasting Corporation | kW—Kilowatts |
| CBC—Canadian Broadcasting Corporation | N.A.—North America |
| Eng.—English | QRM—Station interference |
| ID—Identification | QSL—Verification |
| IRC—International Reply Coupon | R.—Radio |
| IS—Interval signal | s/off—Sign-off |
| | s/on—Sign-on |
| | xmsn—Transmission |
| | xmtr—Transmitter |

Newcomer Kevin Drost, of Union Lake, Mich., has already logged 30 countries—with a Hallicrafters SX-71 receiver—and has QSL's from 11 of them.

*R. Santa Fe*, Bogota, is widely reported from 0000 s/on to 1000 s/off on 4965 kHz, all-Spanish, with frequent and clearly understood ID's.

**El Salvador**—Station YSS, *R. Nacional*, San Salvador, reads all reports over the air in a special program called "Reports From Around The World" in Spanish on Sundays at 2330 and Mondays at 0100. This station transmits on 6010 and 9555 kHz at 1700-0500 with 5 kW.

**Germany (East)**—*R. Berlin International* has been logged on a new frequency of 17.880 kHz at 1650 in native language.

**Haiti**—Station 4VEH, Box 1, Cap Haitien, has been heard at 1211 with public service anmts in Eng., religious programming, and ID's on 9770 kHz. English is scheduled daily at 1130-1430, on Saturdays at 1130-1500, and on Sundays at 1130-1500 and 1900-2030. Other frequencies in use are: 11,835, 6120, 2450, and 1035 kHz. Reports are requested from regular monitors; write to the address given above or to 466 Weaver Road, Webster, N.Y.

**Haute Volta**—Ouagadougou, 4815 kHz, opens at 0600 in French with Balafon IS and dance music to 0635, then news. This s/on time was confirmed in a QSL.

**Honduras**—Station HRVC, *La Voz Evangelica de Honduras,* Tegucigalpa, 4820 kHz, has a program in Eng. called "Songs In The Night" from 0300 to 0330 s/off on Mondays. Normal s/off other days is 0300. This station is heard best on Mondays because XEJG, Mexico, is off the air then.

**Hungary**—*R. Budapest* opens in Eng. at 0030 on the seldom-heard frequency of 9540 kHz, dual to the N. A. program on 11,910 kHz. The latter has also been noted with a repeat of the same program at 0130.

**Indonesia**—Sorong, 3335 kHz, was caught in Indonesian at 1255-1300 with female speaker and piano recitals. Another female gave the news at 1300 after four time pips.

**Japan**—A new frequency for *Nippon Hoso Kyokai,* Tokyo, is 9670 kHz. It was observed at 1645 in Eng. with broadcast beamed to Africa.

**Korea (North)**—Pyongyang was noted on 7580 kHz in Eng. at 1141-1210 but QRM prevented good readability. A new or different Russian broadcast now opens at 1300 with an anthem; listed s/on times are 0300, 1000, and 1800. Another opening, with a 7-note IS on an instrument resembling an organ, is at 2335; this xmsn, in Spanish, is on 14,510 and 11,750 kHz—no Eng. noted.

**Lebanon**—*R. Lebanon,* Beirut, has the following schedule in effect: to Africa daily on 15,350 kHz in Eng. at 1830-1900, in Arabic at 1900-2000 and in French at 2000-2030; to South America daily on 15,325 kHz in Portuguese at 2300-2330, in Arabic at 2330-0030 and in Spanish at 0030-0100; to N. A. daily on 11,760 kHz in French at 0130-2000, in Arabic at 0200-0230, in Eng. at 0230-0300, in Arabic at 0300-0330 and in Spanish at 0330-0400. Omnidirectional xmsns are broadcast daily at 0430-0730 and 1415-1820 on 5980 kHz and at 0930-1400 on 9545 kHz.

**Malagasy**—Tananarive, 7105 kHz, was noted with Network II French at the odd time of 1410 to 1435 fade, with pop and dance music. Best day to log this one is Sunday, when schedule runs through from 0400 to 1930.

**Malawi**—Blantyre, 3380 kHz, was heard from 0359 to 0425 fade; drums IS to 0400, then a cock crowing and a native-language anmt, followed by news in native language at 0415.

**Malaysia**—*R. Malaysia* has a relay of BBC news

Two receivers are in use in the shack of H. Charles Fanjul, Jr., WPE4IVC, Miami, Fla.—a Lafayette HA-230 and a Heath GR-64. His record to date is 15 countries (10 verified), 4 states (verified).

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Bob Hill, Washington, D. C.
Mike Macken, Winthrop, Mass.
Bill McDaniel, Markham, Ill.
Canadian Broadcasting Corp., Montreal, Que., Canada
*Sweden Calling DX'ers Bulletin*, Stockholm, Sweden

at 1100-1110 daily, then local news to 1115 s/off, on 9750 kHz. Station returned to air at 1140 for a 17-minute xmsn in Eng. on the same channel. Reports go to Department of Radio, P. O. Box 1047, Kuala Lumpur, Federation of Malaysia.

**Mauritius**—*R. Mauritius*, Forest Side, now operates, as per the latest schedule, at 0230-1300 on 9710 kHz and at 1300-1830 on 4850 kHz, both with 10 kW.

**Morocco**—*Aqui Rabat, R. Diffusion TV Maroqui*, Rabat, opens on 15,390 kHz at 2230 with a piano selection, then a newscast, followed by pop records; all-Spanish. S/off is at 0000. Do not confuse this station with Rome, which opens shortly afterward on 15.385 kHz and runs far beyond 0000.

**New Caledonia**—Noumea is readable on 3335 kHz with a dramatic program at 1028 in French, semi-classical piano instrumentals at 1040, news summary at 1055, and s/off with "La Marseillaise" at 1058.

**Norway**—The new schedule from Oslo reads: to Western N.A. and the Middle East at 0400-0430 on 9550, 9610, and 11,850 kHz; to Pacific areas and E. Africa at 0745-0815, to Pacific areas, Africa, Europe and S. America at 1100-1230, to Middle East, S. Asia, Eastern N.A. and S. America at 1300-1430, to Europe and N.A. at 1500-1630, to Scandinavia, Pacific areas and Africa at 1700-1830 and to Europe and Africa at 1900-2030, all on 15,175, 17,825, and 21,670 kHz (also on 11,850 kHz at 0745 and 1900, 7240 kHz at 1100, and 21,730 kHz at 1300, 1500, and 1700); to N. Africa, Newfoundland, and S. America at 2100-2230 on 11,850, 15,175, and 17,825 kHz; to W. and S. Africa, Newfoundland, and

# DX STATES AWARDS PRESENTED

*To be eligible for one of the DX States Awards designed for WPE Monitor Certificate holders, you must have verified stations (any frequency or service) in 20, 30, 40, or 50 different states in the U. S. The following DX'ers have qualified for and received awards in the categories indicated.*

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Richard Markell (WPE6DXC), Los Angeles, Calif.
Reg Firth (WPE2GFO), Amsterdam, N. Y.
Allen Holmes (WPE7CLB), Alderwood Manor, Wash.
Dick Schier (WPE4HIO), Chattanooga, Tenn.
Doyle Simons (WPE4AGI), Taylors, S. C.
Frank Scolaro, Jr. (WPE2LUZ), Yonkers, N. Y.
Carl Durnavich (WPE9IFO), Riverdale, Ill.

**FORTY STATES VERIFIED**

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Paul Ochenkowski (WPE1FYY), Hamden, Conn.
Larry Zigrang (WPE9HLM), South Bend, Ind.
Douglas Messimer (WPE3FMZ), Enola, Pa.
Larry Himsel (WPE2NRR), North Bergen, N. J.
Bruce Reynolds (WPEØEKU), Warrensburg, Mo.
Joseph Aman (WPE4IFM), Clifton Forge, Va.
Dave Oester (WPE7CEZ), Deer Island, Oregon

**THIRTY STATES VERIFIED**

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Dwain Davis (WPE1GJO), Cranston, R. I.
Easy Barber (WPE5DTS), Fort Smith, Ark.
Elliot Straus (WPE2NOO), West Orange, N. J.
Jan Lichtig (WPE6EEO), Livermore, Calif.
Norris Alford (WPE8FYF), Winfield, W. Va.
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Barry Premeaux (WPE8HIP), Lansing, Mich.
Leo Baca (WPE5CLR), East Bernard, Texas
John Sgrulletta (WPE2MXF), Bedford Hills, N. Y.
David Bartlett (WPE1GQK), East Hartford, Conn.
Russell Feran (WPE5CXT), New Orleans, La.
Harry Dence, Jr. (WPE4IKY), Cynthiana, Ky.
Calvin Bright (WPE8ISA), Grass Lake, Mich.
Donald Lee (WPE3EVB), Lebanon, Pa.
Richard Cooper (WPE1GHI), Wayland, Mass.
W. E. Raczko (WPE8JBT), Toledo, Ohio
Kelly Andrews (WPE4IGA), Goldsboro, N. C.
Philip Smith (WPE8IIA), Kettering, Ohio
Jack Palladay, Jr. (WPE9EOE), Maxwell Air Force Base, Ala.
Alan Rhodes (WPE2OQU), Mountainside, N. J.

**TWENTY STATES VERIFIED**

David Crowe (WPE3FRC), Pittsburgh, Pa.
Richard Sears (WPE1FNM), Cambridge, Mass.
John Megas (WPE1GJL), Ellsworth, Maine
Frank Hames (WPE3CDM), Silver Spring, Md.
Robert Mayer (WPE9HQG), Winnetka, Ill.
Romona Hagerman (WPE2OBV), Delaware, N. J.
Mark Hosmer (WPE9HPM), Carmel, Ind.
Jerry Headen (WPE4HQL), Winston-Salem, N. C.
Jimmy Chocklett (WPE4IDH), Wilson, N. C.
John Tuomi (WPE2NNO), Brooklyn, N. Y.
Alan Petersen (WPEØEHF), Hampton, Iowa
Charles Angell (WPE3TP), Collegeville, Pa.
Robert Mayer (WPE9HQG), Winnetka, Ill.
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Robert Ruggley (WPE9HJH), Chicago, Ill.
Forrest Hudspeth (WPE3FWN), Glen Burnie, Md.
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Gary Herron (WPE8IQN), Fraser, Mich.
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Roger Taylor (WPEØEMD), Independence, Mo.
Ben Hughes (WPEØEMX), Seward, Nebr.
E. Kent (VE3PE2GF), Rexdale, Ontario, Canada
Harold Allen (VE2PE1JM), Arvida, Quebec, Canada
William Chrysler (VE6PE6K), Edmonton, Alberta, Canada
David Miller (WPE3GMH), Pittsburgh, Pa.
Leroy Ireland (WPE2MSY), Ventnor City, N. J.
Roger Greene (WPE2NFC), Bronx, N. Y.
Paul Emch (WPE6GBG), Trabuco Canyon, Calif.
David Lalor (WPE5EIQ), Corpus Christi, Texas
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Edward Greb-Lasky (WPE1GPQ), New Britain, Conn.
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W. F. Gilly (WPE3GNT), Allentown, Pa.
Albert Earnhardt (WPE4IJN), Charlotte, N. C.
Frank Colin (WPE2OPG), Suffern, N. Y.
Frank Eitler (WPE1GSE), Hamden, Conn.
Bruce Kesselman (WPE2OGO), Woodbridge, N. J.
Ron Hopkins (VE7PE7P), Trail, British Columbia, Canada
Drew Kalman (WPE8ILL), Dearborn, Mich.
Kenneth Hanna (WPE3GSY), Pittsburgh, Pa.
Jerome Wolf (WPE2NOQ), Rochester, N. Y.
J. R. Miller (WPE7CIA), Tigard, Oregon
Greg Shepard (WPE1GHL), Longmeadow, Mass.
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Jonathan Lisenco (WPE2MAC), Flushing, N. Y.
Leo Blouin (VE2PE1KJ), Quebec, Quebec, Canada
Steve Jones (WPE4IOW), Lawrenceburg, Ky.
Lawrence McManus (WPE2NAR), Spring Grove, Pa.
Ron Sibbett (VE3PE2HB), Cooksville, Ontario, Canada
H. K. Ogan (WPE7CIS), Mountain Home Air Force Base, Idaho
Frank Johnson (WPE2NAX), Union, N. J.
Robert Braunwart (WPE7CJQ), Moses Lake, Wash.
Helmut Meier (VE2PE1JZ), Sept-Iles, Quebec, Canada
Gregory Hendrix (WPE5EKJ), Galveston, Texas
Ernest Doane (WPE1DTE), Lynn, Mass.
Bradley Weekley (WPE8GPY), Wilbur, W. Va.
James Mason (VE3PE2FB), Hamilton, Ontario, Canada
Robert Blazeyewski (WPE2FZY), South Farmingdale, N. Y.
Norm Shacat (WPE1GTP), Malden, Mass.

S. America at 2300-0030 on 9550, 9610, and 11,850 kHz. A 30-minute program in Eng. is broadcast on Sundays at 1200, 1400, 1600, 1800, and 2000, and on Mondays at 0000 and 0400.

**Peru**—Station OBZ4M, *R. La Voz del Valle,* 3387 kHz, was heard at 0300 with Western music. Reports have been returned by the Peruvian post office with the notation that they cannot locate the station at Junin 834, Chaucha. Anyone have any better address for this station?

**Rwanda**—The *Deutsche Welle* relay station in Kigali was noted well on 15,435 kHz at 0020-0035 with music and anmts in German.

**Saudi Arabia**—The *Voice of Islam* has been heard on 15,150 kHz at 1430-1600 and on 9720 kHz at 0315-0445, both in Arabic. They reportedly s/on at sunset in their country. (Do not confuse the 15,150-kHz xmsn with the BBC Arabic Service on 15,140 kHz.) Their QSL arrived by registered airmail after 15 months. No schedule was received but the available channels listed were: Jeddah domestic short-wave on 7230, 9670, 11,855, and 15,150 kHz; Jeddah overseas service on 15,115 kHz; and Riyadh short-wave on 6000, 7220, 9720, and 11,950 kHz.

**Singapore**—*R. Singapura,* 7250 kHz, was noted from 1015 with teen music and anmts in Malay; at 1030 with Arabic vocal and instrumental music. News scheduled at 1045 was *not* presented as Arabic ran until 1100. The IS is the playing of the musical notes C, G, and E on chimes. The dual 6155-kHz channel was barely readable.

**South Africa**—*R. RSA,* Johannesburg, was heard beamed to Canada from 2330 s/on after bird chirp and musical selection on 11,925 kHz (fair) and on 9525 kHz (covered by Havana). Another outlet, on 11,785 kHz, was noted at 2210 with Eng. news. The United Kingdom and European Service beam on 9720 kHz can be heard at 2200-2255, dual to 7270 and 11,785 kHz.

**Sweden**—Recent changes: to Eastern N. A. in Eng. at 1400-1430 and 1445-1515, and in Swedish at 1515-1600 on 17,845 kHz (replacing 15,420 kHz). Swedish at 0100-0145 and Eng. at 0145-0215 on 11,805 kHz (replacing 11,880 kHz); to Canada in French at 1615-1645 on 17,845 kHz (replacing 15,420 kHz); and to Mexico and Central America in Spanish at 0400-0430 on 11,880 and 11,705 kHz (replacing 15,420 kHz).

**Uruguay**—Station CXA7, *R. Oriental,* 11,735 kHz, was noted at 0225-0300 with vocal music and many organ selections. Station CXA6, S.O.D.R.E., 9620 kHz, is again being heard from 0100 to 0300 s/off with organ music and a symphony. Both stations are in Montevideo.

**Vatican City**—*R. Vaticano,* 11,760 kHz, has been heard broadcasting in Spanish to South America at 2330-2345 and to Latin America at 0000-0015.

**Venezuela**—A new station is *Ondas Panamericanas,* El Vigia, 3215 kHz, noted at 0050-0130. Another station, on 9747 kHz, is being heard around 1100; overseas listeners list it as *R. Tovar.* The latter bears further checking.

**Vietnam (North)**—Hanoi has moved from 9775 to 9763 kHz with Eng. at 1000. —30—

**DX AWARDS PROGRAM RULES**

Here's an easy way to get a copy of the rules and regulations for each of the three phases of the DX Awards Program to date (Countries, States, and Provinces). Just supply a postage stamp or return envelope, and your Short-Wave Editor will send you a leaflet containing the rules for all three phases—plus a copy of the official Countries List for DX Awards. The stamp or envelope, with your request, should go to: DX AWARD RULES, P. O. Box 333, Cherry Hill, N. J. 08034.

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## THERMOMAGNETIC MOTOR

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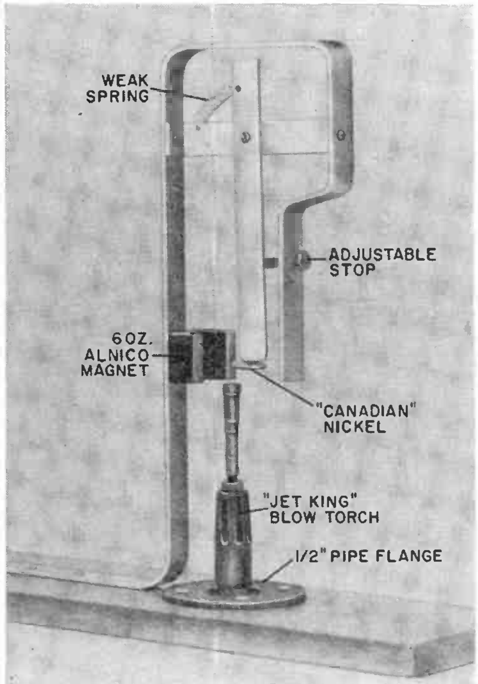


You can build motor frame with Reynolds stock aluminum, wood board, and pipe flange in half an hour.

alnico magnet, purchased at the local hardware store for $1.25, served the purpose admirably.

Almost any magnetic material can be used for the magnetic rider. Iron is an obvious choice because of its availability (nails, paper clips, and a host of other common items). However, nickel is better since it has a much lower Curie temperature. But don't bother trying to use United States nickels—they are made of a non-magnetic nickel-copper alloy. However, Canadian nickels are quite magnetic and will work very well.

A limitless number of variations of the basic thermomagnetic motor can be devised. A few of Nikola Tesla's variations can be seen in his patent drawings. Tesla was granted two patents (numbers 396,121 and 428,057) for his invention of the thermomagnetic motor, copies of which can be obtained for 50 cents each from the Commissioner of Patents, Washington, D.C. —30—

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# POPULAR ELECTRONICS

# DECEMBER 1966

# ADVERTISERS INDEX



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HOLOGRAMS—MAKE THEM WITH OUR LASER

# POPULAR ELECTRONICS

JANUARY 1970

50 CENTS

A ZIFF-DAVIS PUBLICATION

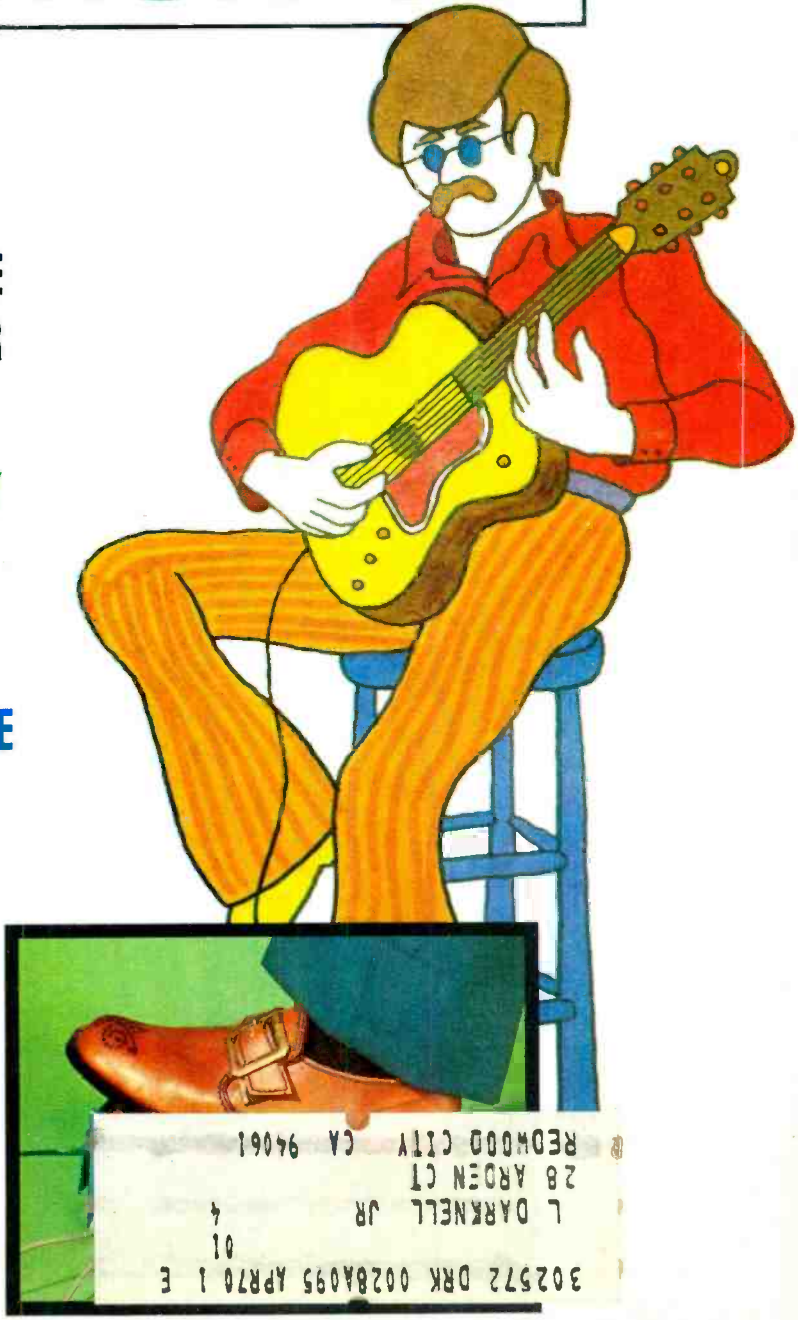
## QUADRASONICS: WHAT IT'S ABOUT

## BUILD SOLID-STATE AQUARIUM HEATER

## TIMER FOR HEADLIGHT SAFETY

## MINIATURE STEREO SPEAKERS

## CAN YOU MEASURE GRAVITY WAVES?



## BUILD THE WAA-WAA

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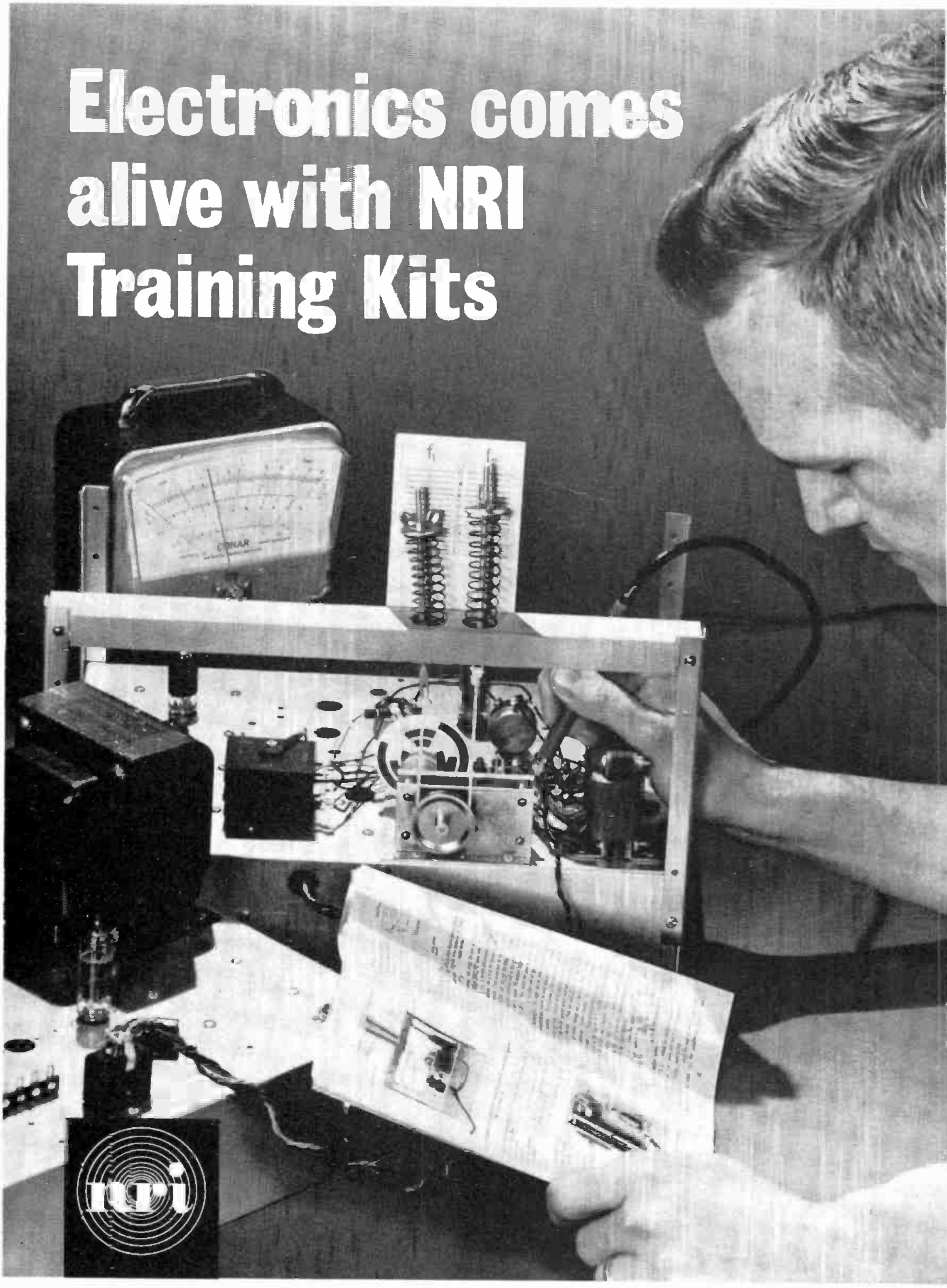
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# POPULAR ELECTRONICS

VOLUME 32 NUMBER 1 **JANUARY, 1970**

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE


## SPECIAL FEATURE



## FEATURE ARTICLES



## DEPARTMENTS




POPULAR ELECTRONICS is indexed in the Readers' Guide to Periodical Literature

This month's cover drawing by Bob Korn





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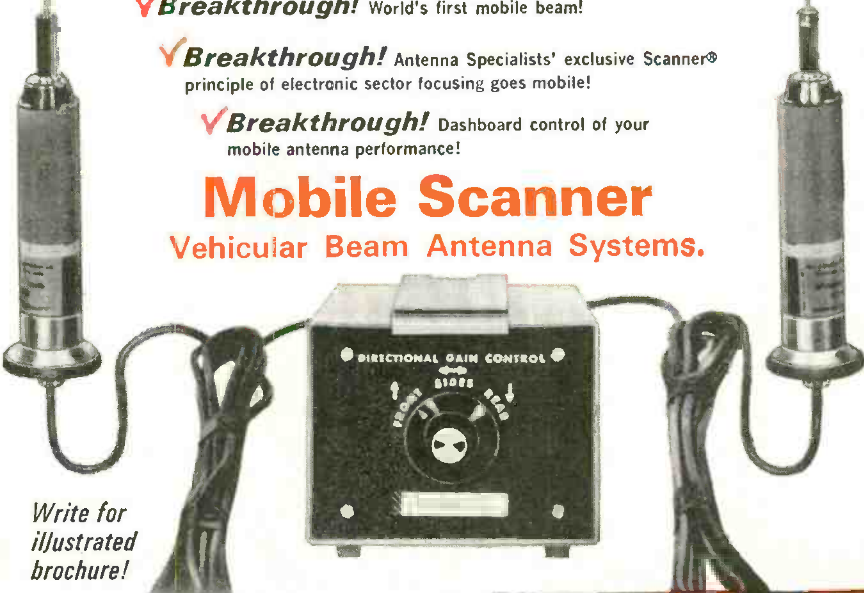


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**CIRCLE NO. 5 ON READER SERVICE PAGE**

# letters

## FROM OUR READERS

### ANGRY READERS ANGER READERS

In regard to the "Angry Voice" article in the September issue and subsequent reader letters in November, I want equal time to comment.

Misguided people of the extreme right are noted for their prolific letter writing as one of the sinister means of undermining our American democracy. The reasonable middle-of-the-road outlook is our only hope for a better future. In this space-age world we cannot live with a system that stagnates at the horse and buggy.

JOHN MILLER
Dallas, Texas

The reader response is a great surprise. WINB must certainly give a negative view of American culture. Surely the readers must realize that overseas listeners are not influenced by anti-communist propaganda any more than we are by the harangues of Radio Peking.

JACK YEAGER
Montreal, P.Q.

I am amused at the reader response. It displays the usual intolerance of those that rebel against communism, but deny others the right of freedom of speech. It all reminds me of the play "The Crucible".

NAME WITHHELD

I'm delighted you accepted responsibility for comment on the abuse of shortwaves. I wrote FCC Commissioner Johnson deploring the WINB violation of FCC regulations.

WILLIAM KIRALY
Cleveland, Ohio

I re-read the WINB story and failed to find the evil motivations. The FCC has the responsibility to insure that the airwaves (which are mine just as much as WINB) are used for the public good.

D. K. KING
Wichita, Kansas

### WINB OWNER RESPONDS

It seems Mr. Kent is parroting some of the "liberal press" when he writes about WINB. Let me give you a play-by-play account:

(1) I started WGCB in October of 1950 and Dr. McIntire aired his first broadcast on our station in January 1958. I am sure I gave some credit to Dr. McIntire in helping me ac-

quire WINB which was started in the fall of 1962, in that he and several friends of mine bought air time in advance and paid cash for it so that I could get under way.

(2) Up until several years ago I was the sole owner of WINB. I incorporated WINB to include my son, my attorney and myself. I feel certain that the Kent article was published to discourage advertisers that are doing business with us.

Much seems to be made of the fact that many American-made programs are aired on WINB. It is our belief that you should tell the truth to the best of your ability. It is not true that WGCB and WINB have entered into the business of editorializing. One might say that Dr. McIntire's dissent in certain areas is not acceptable as programming for international stations; however, this could be wrong since he is President of the International Council of Christian Churches with affiliates both here and abroad.

A one-point-of-view culture is unthinkable in this land of ours.

REV. JOHN M. NORRIS
WGCB AM-FM, WINB

### READER SERVICE

Thank you for the Reader Service Page published in each issue. Using this Service I am able to keep up with all the new products.

R. E. ADAMS
Nashville, Ga.

*We are glad that reader Adams has found the Service page useful. Manufacturers usually respond to Service inquiries within a short period of time. It is an excellent method of finding out just what products have features you most desire.*

### WRONG WIRE WRAPPING

I hope the picture of the wire wrapping ("Stereo Scene", November, page 70) is a reject—it's a classic example of don'ts! The specs for a good wrap are 1½ turns of insulation followed by a minimum of 5 turns of bare wire.

B. STOVALL
Opelika, Ala.

*Reader Stovall is correct and our photo retoucher has been sent to school.*

## OUT OF TUNE

"Build A Capacitance Meter," October 1969. The B1 and B2 terminals of *Q2* in Fig. 1 on page 67 are incorrectly identified; simply transpose the numbers. Also, reverse the polarity of diode *D1*.

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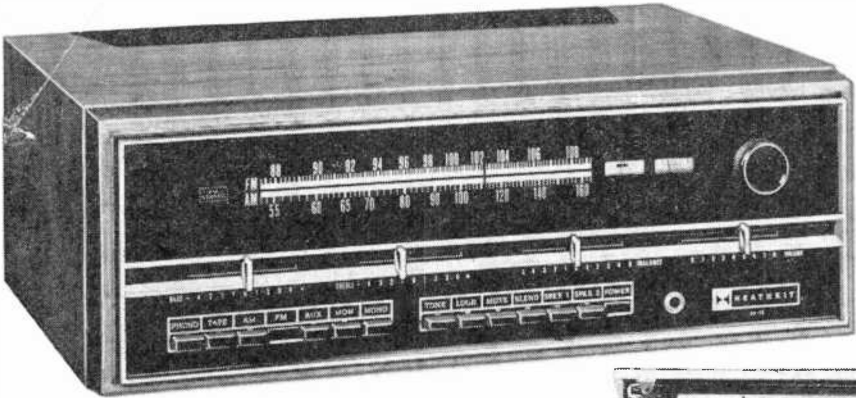
## Introducing The Advanced New Heathkit 60-Watt AM/FM/FM Stereo Receiver




**Heathkit AR-19**

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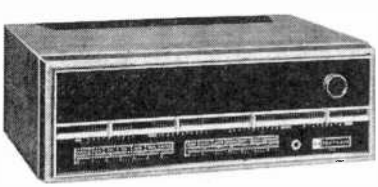

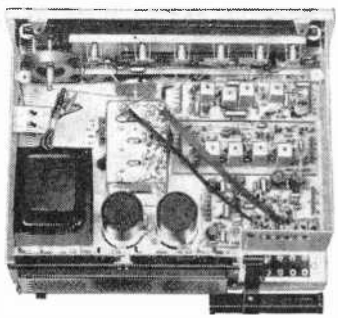

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**Ahead of its time . . .** those who want to hear stereo high-fidelity as it will sound in the 70's can begin right now, at a modest price, with the Heathkit AR-19. Its design is an extension of the advanced circuitry concepts first introduced in the AR-15. These receivers are truly of a new generation . . . they've expanded audio engineering horizons and set the pace for the 70's.

**Field Effect Transistor And Integrated Circuit Design.** The AR-19 uses advanced semi-conductor circuitry . . . including five integrated circuits, with a total of 108 transistors and 45 diodes. The pre-assembled FM tuning unit uses an RF field effect transistor to provide high sensitivity and low cross modulation with no overloading on strong local stations. In the AM RF circuit also, field effect transistors give superior sensitivity and large signal handling capacity.

**Ideal For Most Home Stereo Installations.** The AR-19 is just right for the medium and high efficiency speaker systems that are so popular today. It can form the nucleus of a fine stereo system . . . and will probably be the most attractive part, thanks to its rich oiled pecan wood cabinet and to the "Black Magic" front panel. The scale and dial readings appear only when the power is on.

**Features To Aid The Kit Builder.** All 8 circuits of the AR-19 snap in and out in seconds. Think of the resulting convenience and ease of assembly! In addition, the AR-19 has built-in test circuitry . . . two test probes with the front panel meter for indications. With it, the user can check out circuit parts without the need for expensive external test equipment. Proper use of this feature is fully covered in the manual.

**Don't Wait For Something Better To Come Along . . .** it'll be a long wait. Up-grade your stereo system now, with this outstanding receiver value.

**Kit AR-19, 29 lbs. .......................................... $225.00***
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**PARTIAL AR-19 SPECIFICATIONS — AMPLIFIER: Continuous power output per channel:** 20 watts, 8 ohms. **IHF Power output per channel:** 30 watts, 8 ohms. **Frequency response:** (1 watt level) —1 dB, 6 Hz —35 kHz **Power bandwidth for constant 0.25% THD:** Less than 5 Hz to greater than 30 kHz. **Harmonic distortion:** Less than 0.25% from 5 Hz to 20 kHz at 20 watts rms output. Less than 0.1% at 1000 Hz at 1 watt output. **IM Distortion:** Less than 0.25% with 20 watts output. Less than 0.1% at 1 watt output. **Hum and noise:** Phono input, —65 dB. **Phono input sensitivity:** 2.4 millivolts; overload, 155 millivolts. **FM: Sensitivity:** 2.0 uV. IHF. **Volume sensitivity:** Below measurable level. **Selectivity:** 35 dB. **Image rejection:** 90 dB. **IF Rejection:** 90 dB. **Capture ratio:** 2.5 dB. **Total harmonic distortion:** 1% or less. **IM Distortion:** 0.5% or less. **Spurious rejection:** —90 dB. **FM STEREO: Separation:** 35 dB at midfrequencies; 30 dB at 50 Hz; 25 dB at 10 kHz; 20 dB at 15 kHz. **Frequency response:** ±1 dB from 20-15,000 Hz. **Harmonic distortion:** 1.5% or less @ 1000 Hz with 100% modulation. 19 kHz & 38 kHz. **Suppression:** 50 dB. **SCA Suppression:** 50 dB. **AM SECTION: Sensitivity:** Using a radiating loop, 130 uV/M @ 1000 kHz. **Selectivity:** 25 dB at 10 kHz. **Image rejection:** 60 dB @ 600 kHz. 60 dB @ 1400 kHz. **IF Rejection:** 60 dB @ 1000 kHz. **Harmonic distortion:** Less than 2%. **Hum & noise:** —40 dB.

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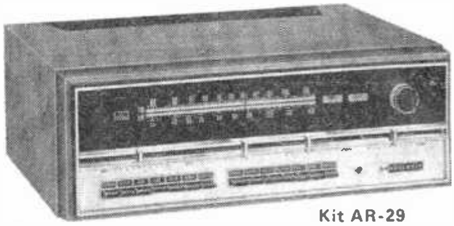
World's finest medium power stereo receiver . . . designed in the tradition of the famous Heathkit AR-15. All Solid-State . . . 65 transistors, 42 diodes plus 4 integrated circuits containing another 56 transistors and 24 diodes. 100 watts music power output at 8 ohms — 7 to 60,000 Hz response. Less than 0.25% distortion at full output. Direct coupled outputs protected by dissipation-limiting circuitry. Massive power supply. Four individually heat sinked output transistors. Linear motion bass, treble, balances and volume controls. Push-button selected inputs. Outputs for 2 separate stereo speaker systems. Center speaker capability. Stereo headphone jack. Assembled, aligned FET FM tuner has 1.8 uV sensitivity. Two tuning meters. Computer designed 9-pole L-C filter plus 3 IC's in IF gives ideally shaped bandpass with greater than 70 dB selectivity and eliminates alignment. IC multiplex section. Three FET's in AM tuner. AM rod antenna swivels for best pickup. Kit Exclusive: Modular Plug-In Circuit Boards . . . easy to build & service. Kit Exclusive: Built-In Test Circuitry lets you assemble, test and service your AR-29 without external test equipment. The AR-29 will please even the most discriminating stereo listener.

**Kit AR-29, (less cabinet), 33 lbs....................................$285.00***

**AE-19, Assembled oiled pecan cabinet, 10 lbs.....................$19.95***



Kit AR-29

$285*

## New Heathkit Deluxe 18-Watt Solid-State Stereo Phono

Looks and sounds like it should cost much more. Here's why: 16-transistor, 8-diode circuit delivers 9 watts music power per channel to each 4½" high-compliance speaker. Speaker cabinets swing out or lift off . . . can be placed up to 10' apart for better stereo. Has Maestro's best automatic, 4-speed changer — 16, 33-1/3, 45 & 78 rpm. It plays 6 records, shuts off automatically. Ceramic stereo cartridge with diamond/sapphire stylus. Has volume, balance & tone controls. Changer, cabinet & speaker enclosures come factory built . . . you build just one circuit board . . . one evening project. Wood cabinet has yellow-gold & brown durable plastic coated covering. This is a portable stereo you can take pride in.

**Kit GD-109, 38 lbs...............................................$74.95***

Kit GD-109

$74.95*

## New Heathkit 80-10 Meter 2 KW Linear Amplifier

Incomparable performance and value. The new SB-220 has 2000 watts PEP input on SSB & 1000 watts on CW and RTTY. Uses a pair of Eimac 3-500Z's. Pretuned broad band pi input coils. Requires only 100 watts PEP drive. Solid-state power supply operates from 120 or 240 VAC. Circuit breaker protected. Safety interlocked cover. Zener diode regulated operating bias. Double shielded for max. TVI protection. Quiet fan — fast, high volume air flow. Also includes ALC to prevent over-driving. Two meters: one monitors plate current; the other is switched for relative power, plate voltage and grid current. Styled to match Heath SB series. Assembles in about 15 hours.

**Kit SB-220, 55 lbs..............................................$349.95***

Kit SB-220

$349.95*

## New Heathkit Solid-State Portable Fish-Spotter

Kit MI-29

$84.95*

Costs half as much as comparable performers. Probes to 200 ft. Spots individual fish and schools . . . can also be used as depth sounder. Manual explains typical dial readings. Transducer mounts anywhere on suction cup bracket. Adjustable Sensitivity Control. Exclusive Heath Noise-Reject Control stops motor ignition noise. Runs for 80 hrs. on two 6 VDC lantern batteries (not included). Stop guessing — fish electronically.

**Kit MI-29, 9 lbs...........................................$84.95***

Kit MI-19

$69.95*

## New Heathkit Solid-State Depth Sounders

Let its flashing indicator light guide you through strange waters . . . day or night. Sounds to 200 ft. Has Noise Rejection and Sensitivity controls. Operates from your 12 VDC boat battery. Sun-shielded dial. All solid-state.

**Kit MI-19-1, (with thru-hull transducer), 7 lbs...............$69.95***

**Kit MI-19-2, (with high speed transom mount), 7 lbs.......$69.95***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CIRCLE NO. 14 ON READER SERVICE PAGE

TAKE ONE

# new literature

*To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15 or 97.*

The 1970 Burstein-Applebee radio-TV electronics catalog, No. 701, now available on request, lists thousands of items from brand-name manufacturers. The 260-page catalog features home items such as radios and TV receivers, hi-fi equipment, electrical appliances, tools, etc. There are items listed for the ham, CB'er, SWL'er, and experimenter/hobbyist. Spotted throughout the catalog are special interest items, such as cameras and other optical equipment, electronic musical instruments, intercom systems, typewriters and adding machines, and even a portable electric refrigerator. A complete line of electronic components, test equipment, and accessory equipment round out the listings.

Circle No. 75 on Reader Service Page 15 or 97

Unique Lighting Handbook No. 9100 is available from Edmund Scientific Co. (380 Edscorp Bldg., Barrington, N.J. 08007) for $3. It is a compilation of information on the techniques and equipment used for making large- and small-scale lighting effect displays for musical accompaniment, out-of-this-world "psychedelia" shows, and simple mood setting. The effects explained range from black light to flashing xenon-discharge tube setups. The booklet explains in detail how each effect is produced, gives specifications on the items and equipment needed, and shows how to make your own light displays. Anyone who is interested in lighting will want this handbook.

## ZIP COMES TO CRYSTALS

Purchasing certain products through retail outlets is sometimes a difficult procedure if the product is not on hand—with the result that, too often, the purchaser settles for a substitute. Communications equipment is no exception and crystals, in particular, are often hard to find. Zip Crystal Certificates are now available at distributors and retailers to permit the purchaser to get the crystal he wants directly from the manufacturer (Crystek, Fort Myers, Fla.). The buyer simply purchases a certificate, mails it to Crystek, and the crystal is sent by first class mail directly to him.

# FEEDBACK ON THE MOVE

JOHN OVERLEY
Senior Engineer

*One of a series of brief discussions by Electro-Voice engineers*

Basic physics tells us that if you move a coil of wire in a magnetic field, a voltage will be created that is exactly proportional to the velocity of the coil. It is this voltage (back EMF) that has recently been harnessed by Electro-Voice to provide motional feedback control of speaker action.

The essence of the E-V development is a network that is inserted between the amplifier output and the speaker. It is capable of balancing out the driving voltage, leaving only the back EMF generated by the speaker as a product.

Output of this circuit provides a feedback voltage (reflecting cone motion) to the amplifier input. In practice it serves the same purpose as conventional inverse feedback circuits except that it includes the tranducer in its path. The benefits of motional feedback are likewise similar to other feedback circuits: significant reduction of total harmonic and intermodulation distortion, and positive control of frequency response.

Since the low frequency acoustic output of a speaker in a sealed enclosure is proportional to cone acceleration, and since the feedback circuit corrects response on the basis of speaker velocity, an additional network is required. This circuit equalizes bass at a rate of 6 db/octave to achieve acoustically flat output.

The technique permits exceptionally flat response in an integrated system, subject to the limits of available amplifier power, maximum cone excursion, and voice coil heat dissipation. Useful low frequency output can be extended an octave or more below normal speaker design limits. And careful balance of system parameters assures adequate power handling for normal listening volumes.

One notable benefit of motional feedback is the elimination of the response peak (with resulting poor transient response) at speaker cone resonance. The feedback circuit continues to provide effective control of cone motion with rising frequency up to the point where cone breakup occurs. There is no theoretical lower limit, although in practice a sharp cutoff is provided to eliminate excessive noise output below the useful range.

Currently the concept described is available only in an integrated system, the Electro-Voice Land Mark 100™ now being introduced. Other applications for motional feedback are also under study in the E-V laboratories.

*For reprints of other discussions in this series, or technical data on any E-V product, write: ELECTRO-VOICE, INC., Dept. 103P, 630 Cecil St., Buchanan, Michigan 49107*

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**CIRCLE NO. 11 ON READER SERVICE PAGE**

# ELECTRONICS library

QUIET

## FUNDAMENTALS OF DIGITAL COMPUTERS

*by Donald D. Spencer*

Digital computers play such an important and widespread role in modern society that every person should understand something about them. Consequently, this book was undertaken to provide a good fundamental text that covers all aspects of the general field of electronic computing. It is intended as a basic introduction to the subject of computers and to open the door for those people who wish to continue into more advanced courses or careers in the field of computer science. The text is simple and understandable, and a comprehensive glossary of computer terms is included to familiarize the uninitiated with computer jargon.

*Published by Howard W. Sams & Co., 4300 West 62 St., Indianapolis, Ind. 46206. Soft cover. 256 pages. $5.50.*

## ELECTRONIC APPLICATIONS OF THE SMITH CHART

*by Phillip H. Smith*

The Smith Chart, like the slide rule and nomographs, is a mathematical aid in waveguide, circuit, and component analysis. Although much has been published about this truly versatile chart, the descriptions have generally been too restrictive and have failed to give a broad picture of its enormous possibilities in the field of electronics. In this book, however, the author and originator of the Smith Chart presents a comprehensive discussion on the construction and uses of his chart in a manner that even a non-specialist will understand. Also furnished with the book (in an envelope attached to the inside rear cover) are three fundamental types of Smith Charts and one Carter Chart, each on a write-on-and-erase plastic sheet.

*Published by McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036. Hard cover. 222 pages. $17.50.*

## INSTALLING & SERVICING HOME AUDIO SYSTEMS

*by Jack Hobbs*

This book serves as an up-to-date "passport" to the lucrative field of audio equipment servicing—including sales and installation. The down-to-earth "brass tacks" information presented contains all the techniques and ex-

# POPULAR ELECTRONICS READER SERVICE PAGE

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1 a

## LIBRARY (*Continued from page 14*)

plains the necessary skills employed by those who have succeeded in home audio system work. Included in the text are technical descriptions of the latest hi-fi equipment, accompanied by servicing data in each case. Thorough descriptions of all the various types of gear, illustrations of typical circuits used, and directions on how to go about locating troubles are all a part of the well-presented book.

*Published by Tab Books, Blue Ridge Summit, Pa. 17214. 256 pages. $7.95 hard cover; $4.95 soft cover.*

### COMMERCIAL RADIO OPERATOR'S LICENSE STUDY GUIDE (Three Volumes)

*by Julius and Jack Berens*

Ever since the FCC revised the commercial radio operator licensing exams a few years ago, an authoritative study guide containing the new information covered by the exams has been sorely needed. This new three-volume set fills that need. The set is up-to-date, covering every area of electronics in which the prospective licensee is likely to be tested —including solid-state electronics theory. Volumes I through III are titled "Radiotelephone Third Class," "Radiotelephone Second Class," and "Radiotelephone First Class," respectively. This breakdown allows the prospective licensee to select the license level at which he wishes to stop, since each successive volume is a new building block.

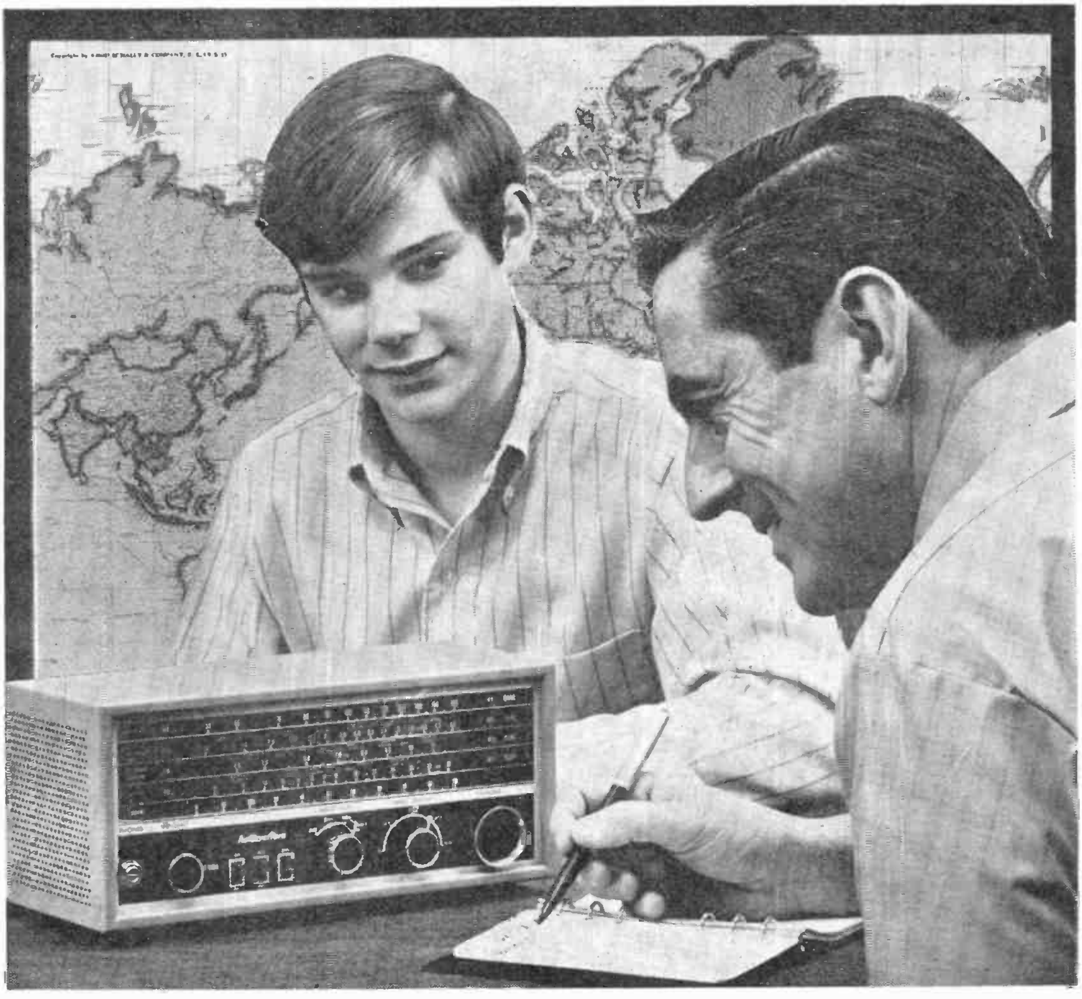
*Published by Chilton Book Co., 410 Walnut St., Philadelphia, Pa. 19106. Volume I—Hard cover. 160 pages. $6.50. Volume II—Hard cover. 255 pages. $7.50. Volume III—Hard cover. 255 pages. $7.50.*

### DIGITAL COMPUTER METHODS IN ENGINEERING

*by Shahen A. Hovanessian and Louis A. Pipes*

This comprehensive book provides an exceptionally lucid introduction to the numerical methods of solving engineering problems with digital computers. Written primarily for practicing engineers, the book covers basic digital computer methods applicable to all fields, rather than one specific practice. Throughout the book, numerical methods are illustrated with digital computer programs and numerical examples. The computer programs are written in FORTRAN and BASIC programming language. Also included in each chapter are problems which are extensions of previously covered examples, specifically designed to show "how to do it." From cover to cover, this book is packed with a wealth of helpful, detailed engineering applications.

*Published by McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036. Hard cover. 400 pages. $14.50.*



# One of our students wrote this ad!

**Harry Remmert decided he needed more electronics training to get ahead. He carefully "shopped around" for the best training he could find. His detailed report on why he chose CIE and how it worked out makes a better "ad" than anything we could tell you. Here's his story, as he wrote it to us in his own words.**

Harry Remmert on the job. An Electronics Technician with a promising future, he tells his own story on these pages.

## By Harry Remmert

AFTER SEVEN YEARS in my present position, I was made painfully aware of the fact that I had gotten just about all the on-the-job training available. When I asked my supervisor for an increase in pay, he said, "In what way are you a more valuable employee now than when you received your last raise?" Fortunately, I did receive the raise that time, but I realized that my pay was approaching the maximum for a person with my limited training.

Education was the obvious answer, but I had enrolled in three different night school courses over the years and had not completed any of them. I'd be tired, or want to do something else on class night, and would miss so many classes that I'd fall behind, lose interest, and drop out.

### The Advantages of Home Study

Therefore, it was easy to decide that home study was the answer for someone like me, who doesn't want to be tied down. With home study there is no schedule. I am the boss, and I set the pace. There is no cramming for exams because I decide when I am ready, and only then do I take the exam. I never miss a point in the lecture because it is right there in print for as many re-readings as I find necessary. If I feel tired, stay late at work, or just feel lazy, I can skip school for a night or two and never fall behind. The total absence of all pressure helps me to learn more than I'd be able to grasp if I were just cramming it in to meet an exam deadline schedule. For me, these points give home study courses an overwhelming advantage over scheduled classroom instruction.

Having decided on home study, why did I choose CIE? I had catalogs from six different schools offering home study courses. The CIE catalog arrived in less than one week (four days before I received any of the other catalogs). This indicated (correctly) that from CIE I could expect fast service on grades, questions, etc. I eliminated those schools which were slow in sending catalogs.

### FCC License Warranty Important

The First Class FCC Warranty* was also an attractive point. I had seen "Q" and "A" manuals for the FCC exams,

*CIE backs its FCC License-preparation courses with this famous Warranty: graduates must be able to pass the applicable FCC License exam or their tuition will be refunded in full.

and the material had always seemed just a little beyond my grasp. Score another point for CIE.

Another thing is that CIE offered a complete package: FCC License and technical school diploma. Completion time was reasonably short, and I could attain something definite without dragging it out over an interminable number of years. Here I eliminated those schools which gave college credits instead of graduation diplomas. I work in the R and D department of a large company and it's been my observation that technical school graduates generally hold better positions than men with a few college credits. A college degree is one thing, but I'm 32 years old, and 10 or 15 years of part-time college just isn't for me. No, I wanted to *graduate* in a year or two, not just *start*.

If a school offers both resident and correspondence training, it's my feeling that the correspondence men are sort of on the outside of things. Because I wanted to be a full-fledged student instead of just a tagalong, CIE's exclusively home study program naturally attracted me.

Then, too, it's the men who know their theory who are moving ahead where I work. They can read schematics and understand circuit operation. I want to be a good theory man.

From the foregoing, you can see I did not select CIE in any haphazard fashion. I knew what I was looking for, and only CIE had all the things I wanted.

### Two Pay Raises in Less Than a Year

Only eleven months after I enrolled with CIE, I passed the FCC exams for First Class Radiotelephone License with Radar Endorsement. I had a pay increase even before I got my license and *another* only ten months later. I'm getting to be known as a theory man around work, instead of one of the screwdriver mechanics.

These are the tangible results. But just as important are the things I've learned. I am smarter now than I had ever thought I would be. It feels good to know that I know what I know now. Schematics that used to confuse me completely are now easy for me to read and interpret. Yes, it is nice to be smarter, and that's probably the most satisfying result of my CIE experience.

### Praise for Student Service

In closing, I'd like to get in a compliment for Mr. Chet Martin, who has faithfully seen to it that my supervisor knows I'm studying. I think Mr. Martin's monthly reports to my supervisor and generally flattering commentary have been in large part responsible for my pay increases. Mr. Martin has given me much more student service than "the contract calls for," and I certainly owe him a sincere debt of gratitude.

And finally, there is Mr. Tom Duffy, my instructor. I don't believe I've ever had the individual attention in any classroom that I've received from Mr. Duffy. He is clear, authoritative, and spared no time or effort to answer my every question. In Mr. Duffy, I've received everything I could have expected from a full-time private tutor.

I'm very, very satisfied with the whole CIE experience.

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All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now, check box on reply card or coupon for G.I. Bill information.

Every penny I spent for my course was returned many times over, both in increased wages and in personal satisfaction.

Perhaps you too, like Harry Remmert, have realized that to get ahead in Electronics today, you need to know much more than the "screwdriver mechanics." They're limited to "thinking with their hands"...learning by taking things apart and putting them back together...soldering connections, testing circuits, and replacing components. Understandably, their pay is limited—and their future, too.

But for men like Harry Remmert, who have gotten the training they need in the fundamentals of Electronics, there are no such limitations. As "theory men," they think with their heads, not their hands. For trained technicians like this, the future is bright. Thousands of men are urgently needed in virtually every field of Electronics, from two-way mobile radio to computer testing and troubleshooting. And with this demand, salaries have skyrocketed. Many technicians earn $8,000, $10,000, $12,000 or more a year.

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CIRCLE NO. 9 ON READER SERVICE PAGE

# NEW PRODUCTS

*Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15 or 97.*

### DISTINCTIVE TURNTABLE MODULE

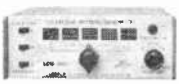
The quiet elegance of fine-grain natural wood and Swiss gold finish combine in the *Empire Scientific Corp.* Model 598 to make a truly rich looking turntable system. The Troubador 598 has a turntable that reaches full speed in less than one-third of a revolution and locks onto the a.c. line frequency to maintain speed accuracy with zero error. The tone arm is Empire's Model 990 that features

"Dyna Lift," a micrometer calibrated anti-skate control, five-wire ground loop elimination circuit, −90 dB rumble, 0.01% wow and flutter, perfect cueing, and as low as 0.1 gram tracking force. When used with the Empire 1000ZE stereo cartridge, the entire turntable system meets the demands of the low-tracking-force cartridges currently available.

Circle No. 77 on Reader Service Page 15 or 97

### ABSOLUTELY STABLE COLOR BAR GENERATOR

The Model LCG-390 color bar generator made by *Leader Instruments Corp.* employs binary counters and gates in the logic circuitry to achieve absolutely stable patterns. The ultra-compact instrument is capable of generating completely stationary patterns regardless of temperature extremes, line voltage con-



ditions, or transmitter signals. The LCG-390 is designed for convergence and synchronizing adjustments in color and monochrome TV receivers and can be used for linearity checks on TV monitors. The five basic patterns displayed by the generator are: gated rainbow color bars; R-Y, B-Y, and −(R-Y) color bars; dots; crosshatch; and a single cross centered on the raster. Gun killers are provided for convergence adjustments. The color bar generator employs plug-in computer-style printed circuit cards and a fully regulated power supply.

Circle No. 78 on Reader Service Page 15 or 97

### MONITOR RECEIVER HAS AUTO SCAN

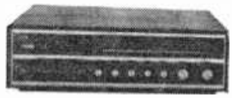
Automatic scan monitoring of any combination of eight crystal-controlled VHF channels in the 148-174-MHz band is featured in the Model TMR 8 "Monitoradio/Scanner" developed by *Regency Electronics, Inc.* Readout lights for each frequency show the progress of the receiver's search for a transmitted signal. Upon finding an active channel, the re-

ceiver locks onto it and "listens" to the entire message, then resumes scanning. The scan feature can be disabled for continuous monitoring of any specific channel or manual search. Programming is accomplished by activating push buttons for any combination of channels, allowing the operator to hear both sides of duplex and simulcast base/mobile networks. Technical specifications—0.5-$\mu$V sensitivity; 50 dB at 15 kHz selectivity; 5-watt audio output at 1 kHz; 0.05 sec/channel scan rate; 117-volt a.c./12-volt d.c. operation; built-in speaker.

Circle No. 79 on Reader Service Page 15 or 97

### 140-WATT STEREO FM RECEIVER

The Nocturne Model 820 stereo FM receiver available from *Harman-Kardon, Inc.*, stresses wideband sound to provide a frequency response at normal listening levels from below 5 Hz to beyond 60,000 Hz for flawless audio reproduction. Distortion in the 820 is maintained below 0.5% at full power



output from 20 to 20,000 Hz. Power output of the receiver is 140 watts ±1 dB, 110 watts IHF into a 4-ohm load. The front end which employ's MOSFET's and a linear four-ganged tuning capacitor has amazing rejection of unwanted signals and a usable sensitivity of 1.8 $\mu$V (IHF). The use of IC's plus wideband crystal filters in the receiver yields unprecedented noise figures, while the tuning characteristic is said to be as precise as switching the channel selector of a TV receiver. Piano-type switches are used for all important functions.

Circle No. 80 on Reader Service Page 15 or 97

### DELUXE THREE-ELEMENT CB BEAM ANTENNA

A deluxe three-element beam antenna for CB radio, the Model PA-311 "Paragon Beam," is now available from *Mosley Electronics, Inc.* The Paragon Beam features a three-piece boom and perfectly balanced elements with swaged tubing to reduce vibration in the wind. Its improved gamma matching system includes a molded gamma base and connector for greater convenience and durability. Technical specifications—forward gain: 8 dB to reference dipole, 10.1 dB over isotropic source; front-to-back ratio: 24 dB; SWR: 1.5:1 or better; feed impedance: nominal 52 ohms; elements: three; maximum element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CIRCLE NO. 17 ON READER SERVICE PAGE

 (*Continued from page 22*)

length: 19′ 2½″; turning radius: horizontal 11′ 3⅝″, vertical 6′; wind surface: 2.6 sq ft horizontal, 3.8 sq ft vertical; wind load (EIA standard 80 mi/hr): 52 lb horizontal, 76 lb vertical; assembled weight: 11 lbs.

Circle No. 81 on Reader Service Page 15 or 97

## SIX-BAND PORTABLE RECEIVER

*Allied Radio Corporation*'s Model 2660 six-band portable receiver offers functional versatility and the most advanced design features at a popular price.

The new solid-state receiver tunes the 5-12-MHz and 12-24-MHz international shortwave bands; 30-50-MHz and 147-176-MHz police/public service bands; and 88-108-MHz and 540-1600-kHz FM and AM broadcast bands, respectively. A large slide-rule dial simplifies tuning, while a fine-tuning control helps to separate stations on shortwave. A squelch control silences the speaker between VHF calls, and a switchable a.f.c. prevents drift on FM. Other features include local/distance switch, tone control, built-in ferrite AM and telescoping FM/SW/VHF antennas, jack for external shortwave antenna, momentary-action dial light, and an earphone.

Circle No. 82 on Reader Service Page 15 or 97

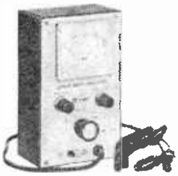
## IMPROVED TRACKABILITY STEREO CARTRIDGE

*Shure Brothers, Inc.*, is making a new version of the company's famous V-15 Type II "Super Trackability" phono cartridge, which delivers even greater trackability in bass and mid-frequency ranges than does the earlier model. The improved model represents a significant advance in trackability not only at select and discrete frequencies, but across the entire audio spectrum, at the lowest possible tracking forces. It is capable of tracking the majority of records at ¾ gram, including those records that contain heavily modulated bass drum, tympani, organ pedal, bassoon, tuba, or piano passages. Hence, there is no need to readjust tracking force of the cartridge to avoid bass flutter or i.m. distortion. Also available separately (for owners of the original V-15 Type II) is the Model VN15E Improved elliptical stylus alone.

Circle No. 83 on Reader Service Page 15 or 97

## ALL-IN-ONE AUTO ANALYZER KIT

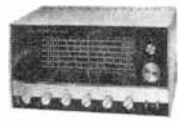
Designed for fast, easy tune-ups and simplified troubleshooting, the *Knight-Kit* Model KG-303 portable solid-state auto analyzer is available in easily assembled kit form. The "Junior Auto Analyzer" has a full-size 2½″ meter which has four r/min ranges from 0 to 6000 r/min; two dwell angle ranges from 0° to 60°; and a 0-16-volt meter range. The analyzer can be used on 4-, 6-, and 8-cylinder engines with either 6- or 12-volt, positive or negative ground, ignition systems. Tachometer scales indicate engine r/min, help set idling speed and automatic transmission shift points. The dwell meter tests points and spark advance. Technical specifications—accuracy: 6%, full scale; 0-16 volts meter range; 0-1200, 1600, 4500, 6000 r/min tachometer ranges; 0-45°, 60° dwell meter ranges; 9-volt battery power source (self-contained).



Circle No. 84 on Reader Service Page 15 or 97

## SSB/AM/CW AMATEUR RECEIVER

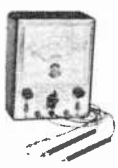
Three FET's and two mechanical i.f. filters to assure high selectivity with superior r.f. overload and noise suppression are among the features found in *Lafayette Radio Electronics'* Model HA-800 amateur receiver. The six-band AM/CW/SSB receiver is capable of tuning 80 through 6 meters. And its all-solid-state circuitry has a built-in zener-regulated power supply for line operation (can also be operated on 12 volts d.c.). Other features include an "S" meter, product detector, and a crystal calibrator (less crystal). Technical specifications—better than 1 μV sensitivity on 80, 40, and 20 meters, 0.5 μV on 15 meters, and 2.5 μV on 6 meters; −6 dB at ±2 kHz, −60 dB at ±6 kHz selectivity; 2.608 MHz first i.f. and 455 kHz second i.f.; 455 kHz ±2.5 kHz BFO frequency; better than −40 dB image rejection; 50-ohm antenna input impedance.



Circle No. 85 on Reader Service Page 15 or 97

## SOLID-STATE VOLT/OHMMETER

The new battery-powered solid-state volt/ohmmeter, Model 116, made by *Electronic Measurements Corp.* features laboratory accuracy, wide range, and small size. The meter's FET design achieves low loading (11 megohms on d.c. and 1 megohm on a.c.) as well as sensitivity that is 500 times that of an ordinary 20,000 ohms/volt VOM. In addition, the 4½″ meter movement and solid-state circuitry are fully protected. The Model 116 is available in both factory-wired and kit form. Technical Specifications: 0-3.3, 33, 330, and 1200 volts peak-to-peak a.c. ranges; 0-1.2, 12, 120, 1200 volts a.c. rms ranges; 0-1.2, 12, 120, 1200 volts d.c. ranges; 0-1 k, 100 k, 10 meg, 1000 meg resistance ranges; −24 to +56 dB range.



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## New Messenger 124 full-function, 23-channel base station. $289^{95}

(less mike)

*If you're an operator with a purpose . . .* consider this, the most sophisticated of all Johnson 27 MHz base stations . . . from the largest and most experienced of all manufacturers of citizens and industrial two-way radio.

To the advanced CB operator, the Messenger 124 means complete mastery of the equipment—a degree of control and measurement that permits, for the first time, full utilization of all the enormous power, hairline selectivity, sensitivity and noise suppression of which the incomparable Johnson circuitry is capable.

Whatever your requirement, the Messenger 124 offers a new experience in base station performance.

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• ±3 kHz Delta fine tuning • Adjustable microphone gain with modulation adjustment to 100% • 2½" four-way professional meter, measures SWR, output, % modulation and receive • 4.3 MHz crystal filter for unequalled selectivity • Built-in speech compression • Panel-controlled, series-type threshold noise limiter • Built-in tone control • Built-in 117 VAC/12 VDC power supply • 14 tuned circuits • FET for superior gain • Dual conversion receiver

**E. F. JOHNSON COMPANY**
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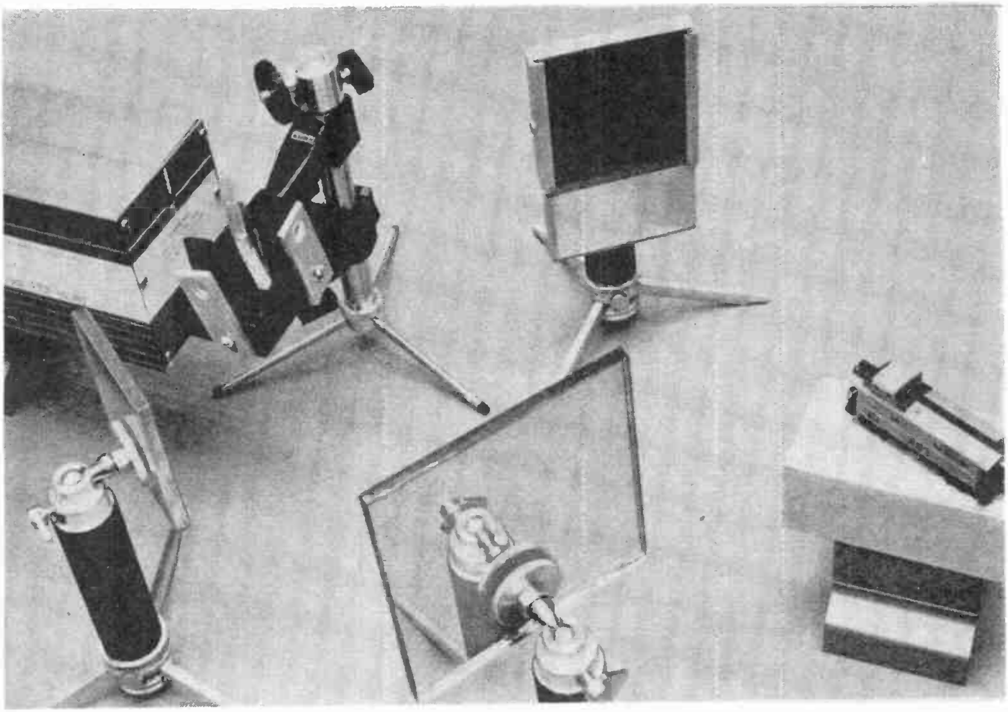


# DO IT YOURSELF
# LASER HOLOGRAPHY

TRUE THREE-DIMENSIONAL IMAGES ON FILM

BY C. HARRY KNOWLES

THE BASIC CONCEPT of the camera was first developed in the 10th century and ever since, man has attempted to make a photographic record of himself and the world around him. The camera and photographic techniques have improved continuously over the years and no one can say that the clarity and beauty of today's full-color photographs are not truly remarkable.

But there's something lacking! Using standard photographic techniques, it is still impossible to capture on film the three-dimensional quality that characterizes life itself. Many attempts have been made to create the three-dimensional illusion, including the use of multiple cameras and projectors, special glasses for the viewer, special filtering, and a large number of other, lesser-known methods. Most have eventually been discarded.

In the late 1940's, Dr. Dennis Gabor, working with an optical system, demonstrated that, by using coherent monochromatic light, it was possible to imprint a true three-dimensional image on photographic film emulsion. There was only one problem—a source of coherent light was hard to find. When the laser was discovered, a practical, dependable source of coherent light became available; and Dr. Gabor's brainchild, the hologram, was reborn.

Holography is based on the principle of recording interference patterns set up by a reference beam of laser light and the reflected light from a target. The result, a hologram (captured on film), is a true three-dimensional re-

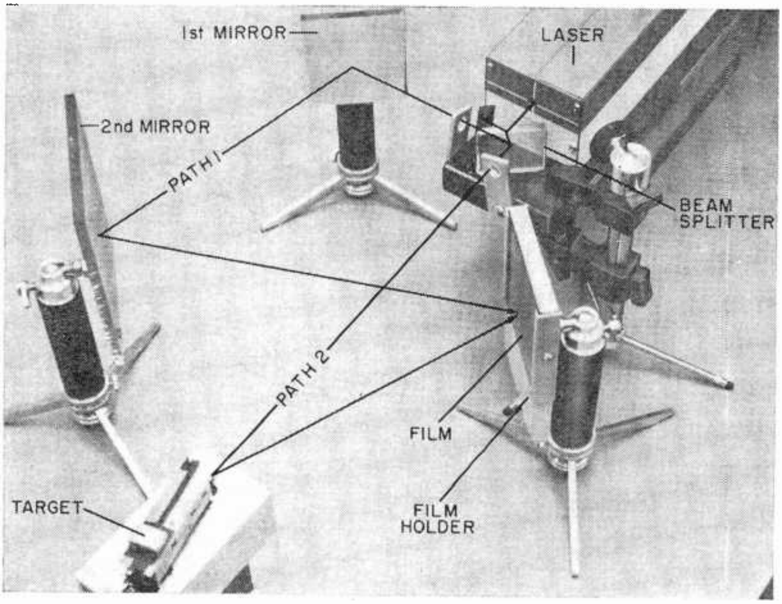


Fig. 1. The basic optical setup showing the two beam paths used to make a hologram. The mounting tripods are conventional camera tripods found in most camera shops. Remember that the most important item is stability—of both laser and optics.

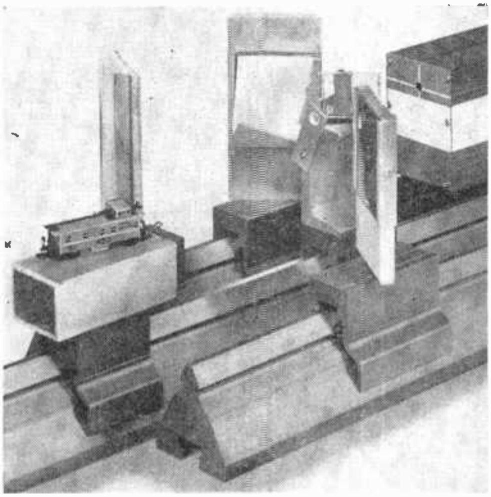
production of the target. The display technique requires no imaging lenses within the system, but does require a laser. (See "What Is a Hologram?" on page 30)

Although many uses have already been found for holograms, the technology is still essentially in its infancy and promises to play a very important role in our future as laser techniques continue to be developed. For instance, holographic road signs are being developed so that drivers in different traffic lanes will get directions applicable only to them. A system of credit card validation is being developed in which each card contains a very small hologram of its identifying number. The card is inserted in a holder containing a laser which projects the number onto a large-size master transparency. Within microseconds the number is compared with all delinquent account numbers stored on a master and, if a match occurs, an alarm is given.

One major tire manufacturer uses holographic interferometry in a routine inspection of its products. Holographic memories are being developed rapidly—your telephone number and all related information may soon be stored holographically. RCA recently announced a low-cost system of video recording using transparent tape containing holograms. When the tapes are passed between a laser (one quite similar to the one used here) and a TV camera, the images are converted to conventional video. In this low-cost system, the holograms are stored in cassette-type containers. Even color recording is practical.

Three recent developments now make holography a practical project for the electronic experimenter: the introduction of the safe, low-cost laser (POPULAR ELECTRONICS, December 1969); a new high-resolution, high-contrast, high-speed film (Agfa 10E75); and a low-cost high-quality optical kit complete with optics, film, and chemicals.

The experimenters' holographic system described here requires a working knowledge of electronics, basic optics, and photography. Assuming that the reader has the necessary background in electronics and optics, it is suggested that, before proceeding with construction and actual creation of holograms, he consult friends or some simple home photography manuals—particularly in the area of film development. A darkroom is required, both for setting up the holographic system and for developing the exposed film. It may also be used for proper viewing of a finished hologram.



This is a commercial holographic setup that uses heavy metal extrusions as stable base. The laser shown here, and in Fig. 1, is the low-cost laser mounted within a light-tight aluminum enclosure.

**Making the Optics.** There are six pieces of equipment required to make a hologram: a laser, a beam-splitter assembly, two reflecting mirrors, a film holder, and a platform for the target. A complete assembly is shown in Fig. 1.

The laser is the low-cost unit described in the December 1969 issue of POPULAR ELECTRONICS. It must be mounted in a light-tight enclosure made of wood or metal, painted flat black on the inside. Everything must be inside the enclosure with only a power cord coming out of it. Once the enclosure has been built, drill a small hole (about 1 mm) precisely in line with the exiting laser beam. Inside the enclosure, the laser should be placed so that its exit mirror is very close to the exit hole.

Mount the laser enclosure on a firm support. Stability is extremely important. Be sure that the enclosure does not rock or tilt in any direction. If necessary, place a weight on top of the enclosure to make sure that it sits firmly. Measure the distance from the supporting table or bench top to the laser exit hole. This distance above the table or bench establishes a horizontal plane which will be referred to frequently in the construction of the system.

The beam splitter assembly includes a glass beam splitter and a pair of diverging lenses. A piece of metal or a smooth block of wood about 2 inches square can be used for the beam splitter assembly mount. The height of the mount should be such that the laser beam will strike about the center of the beam splitter. The beam splitter is a small piece (about 1″ square) of highly polished optical glass having exactly parallel surfaces. Using pitch, epoxy or other hard-drying cement, affix the glass beam splitter to the top of the wood block as shown in

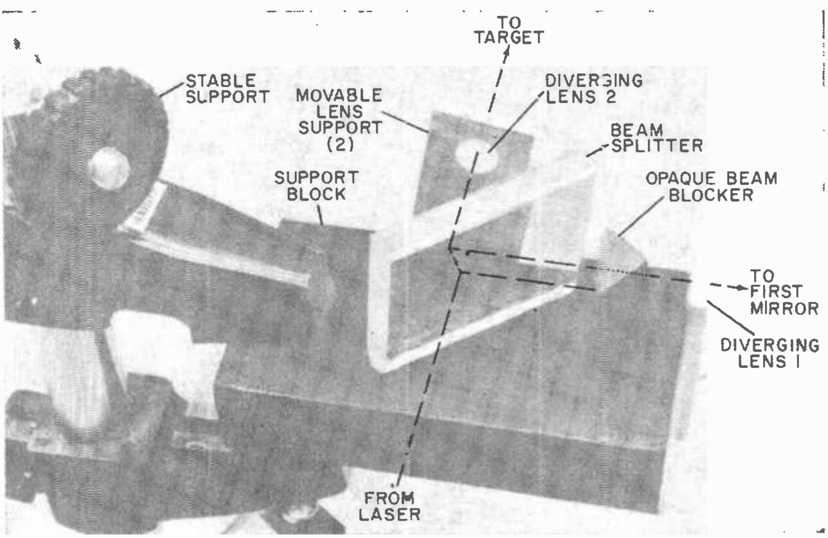



Fig. 2. Details of the beam splitter assembly. The opaque beam blocker is placed to cut out one beam from the glass splitter. The diverging lenses are oriented as required.

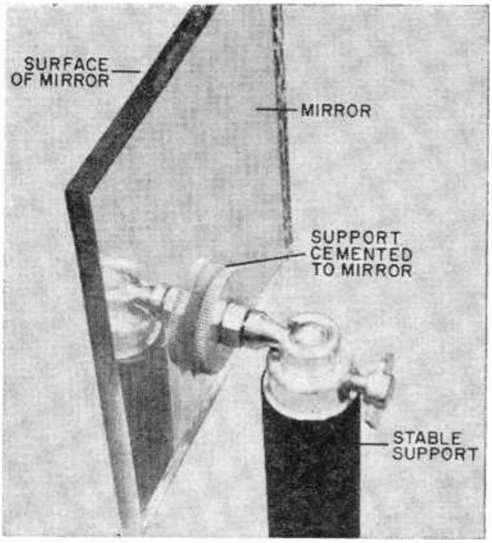



Fig. 3. Tripod support is removed and cemented to the rear surface of the front-surface mirror. Metal nut on tripod screw clamps the mirror tight.

Fig. 2. Mount the two diverging lenses in holes drilled in two pieces of aluminum ¾" wide, 2" long and ⅛" thick. The lenses can be glued or friction fitted in place. Cut half-inch slots in the other ends of the strips to accommodate mounting screws. When mounted, the aluminum strips should be capable of being moved up or down and to left or right when the mounting screws are slightly loose. The centers of the lenses must be movable about the laser beam. The wooden vertical block on the beam splitter assembly should be ignored for the moment as it will be installed later.

The two reflecting mirrors are made from front-surface optical flat mirrors. The first mirror should be about 2 inches square. The second, larger mirror is about 3 inches square. Using firm, stable supports attach the mirrors with pitch or epoxy so that they are vertical and their centers are in the horizontal beam reference plane (see Fig. 3).

The film holder should be designed to support a piece of film 2¾" square (70 mm) so that it fits flat against a back support. The easiest way to do this is to take a piece of solid aluminum stock ½" or more thick and 2¾" wide by 3" high. Use this to fashion a holder. Secure this to a wood or metal block so that the 3" length is vertical and the center of the piece of aluminum is on the horizontal

## WHAT IS A HOLOGRAM?

A hologram of an object bears absolutely no similarity to a conventional photograph of the same object. It is not even visible unless observed under special conditions. A hologram viewed under normal incoherent light looks like a slightly dirty transparency with absolutely nothing to indicate that it is a three-dimensional view of an object. Despite the fact that the hologram looks so bleak, it contains far more actual information than can be placed on an ordinary photograph. All of this information can be seen when the hologram is viewed in the coherent light from a laser. Of course the most important information that the hologram contains is the third dimension of the object—color is not yet obtainable in a hologram but the possibility is being investigated.

Another remarkable fact about the hologram is that each part of it contains all of the target information. If the hologram is cut in half, each half contains the complete image, including the third-dimension information. In fact, each portion can be cut in two again and the information is still intact. As the hologram is subdivided, although each small piece still contains a complete image, resolution suffers and a point is eventually reached where the image is no longer clear and distinct. Scratches and smears do not affect holograms as much as they do conventional negatives since all parts of the hologram contain all of the image information.

In viewing a hologram, the eye (or camera) can be focussed on different parts of the three-dimensional image. As the hologram is moved farther from the diverging lens during viewing, automatic enlargement of the image occurs. If the hologram is turned over while viewing, a very peculiar "inside out" view is obtained.

In the system used here to make holograms, two sources of light reach the film emulsion. One comes from the reference-beam mirrors and the other is reflected from the infinite number of points that make up the target. The light striking the target is exactly in phase with the light in the reference beam.

The frequency of the light from the helium-neon laser is 4.7 x $10^8$ MHz with a wavelength of 6328 A or 6238 x $10^{-10}$ meters. Thus one wavelength is very short so that the light reflected from different points on the three-dimensional target reaches the film at slightly different times, depending on the distance of each point from the emulsion. An interference pattern created by the phase relationships between the reference beam and the target reflections is created on the film. It is this interference pattern that is recorded.

Because the distances involved are so small, the film must be able to resolve interference lines spaced about a wavelength apart. This means that a film resolution of about 2000 lines/mm must be used to produce a useful image. (Conventional film can resolve only a few hundred lines per millimeter.)

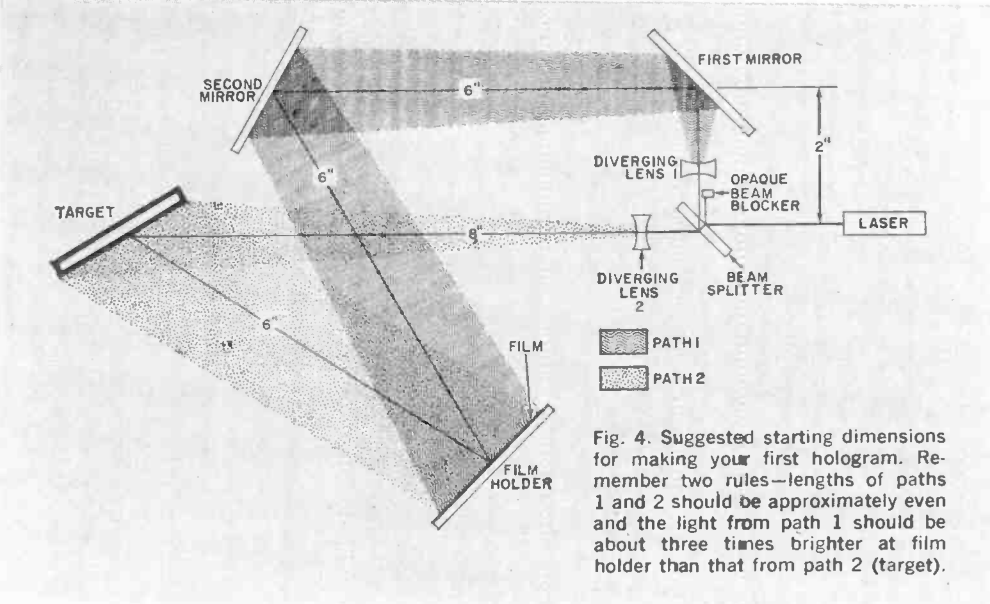



Fig. 4. Suggested starting dimensions for making your first hologram. Remember two rules—lengths of paths 1 and 2 should be approximately even and the light from path 1 should be about three times brighter at film holder than that from path 2 (target).

## BILL OF MATERIALS

*1—Beam splitter, plano-plano double-polished high-transmittance glass 1" x 2" x ¼" (Edmund Scientific 41,264, Edmund Scientific Co., 300 Edscorp Bldg., Barrington, N.J. 08007)*
*2—Diverging lenses, 10-mm diameter, 9-mm focal length, coated (Edmund Scientific 94,-726)*
*2—Front-surface mirror, high-reflectance coating on polished front surface, heavy glass, one 3" x 4", one 5" x 7" (Edmund Scientific 40,041 and 40,043, respectively)*
*Film (Agfa 10E75, Agfa-Gevaert Inc., Scientific Products Dept., 275 North St., Teterboro, NJ 07608)*
*Developer (Kodak D-19 or Metinol-U)*
*Hypo fixing bath*
*Developing trays (3)*
*Misc.—Mounting tripods for optics, adhesive, aluminum sheet ¼" x 2" x 3" and L brackets for film holder, metal strip for supporting lenses, alcohol and lint-free tissue for lens cleaning, stable, workbench, darkroom, acetic acid, etc.*
*Note—A complete kit of all items except those in Miscellaneous but including a test hologram and detailed instructions are available as Model 60-625 Holography Kit from Metrologic Instruments, Inc., 143 Harding Ave., Bellmawr, N.J. 08030, $34.75 postpaid. Mounting holders for optical components are also available for an additional $36. A complete holography kit plus a shock-mounted rigid base with three triangular tracks is available for $103 postpaid. For information on the laser and power supply, see the December 1969* POPULAR ELECTRONICS.

beam reference plane. Take two 3" lengths of L-shaped aluminum having one 3/16" lip and attach them to the 3" sides of the support so that the lips will hold both sides of the film (see Fig. 4). The target platform is a simple horizontal plate, made from metal or wood and mounted on a firm support so that the platform is about ½" below the horizontal beam reference plane.

**Cleaning the Optics.** All the optical surfaces must be cleaned very carefully. Any spots, smears, scratches or dust on any of the optical surfaces (including the transmission mirror of the laser) will show up as blotches or "noise" in a finished hologram.

An excellent way to clean the optics is with a fresh, untouched, lint-free facial tissue moistened slightly with pure alcohol. Take care not to let dust or fine grit that may be on a surface scratch the surface as you remove it. A soft cotton swab can be used to remove any residual particles that may be present before cleaning. After cleaning, make sure that no residue from the facial tissue is left on the optical surface.

Once cleaned, optical components should be protected with dust covers and should never be touched with the fingers.

**Preparing the Developing Chemicals.** Conventional darkroom techniques are

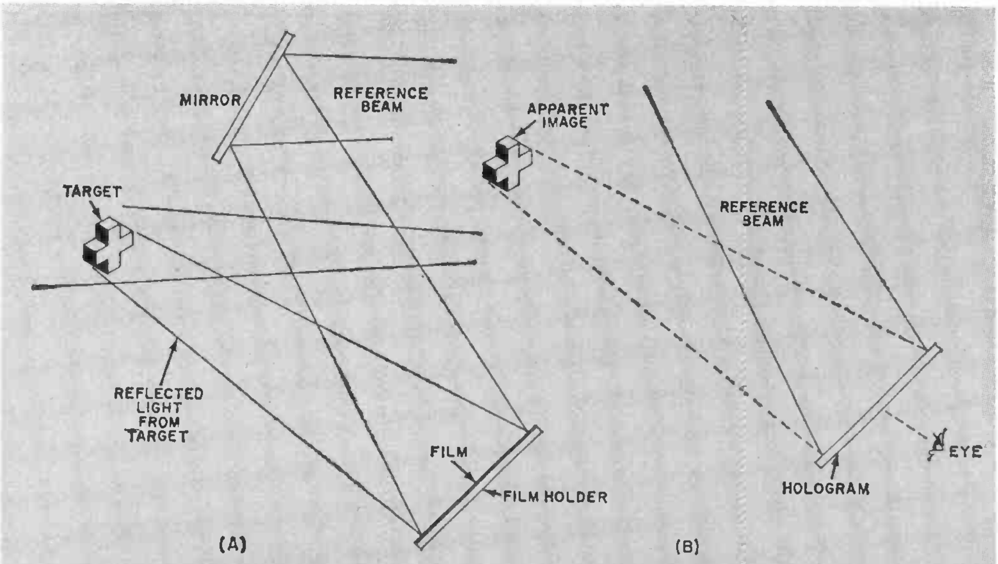



Fig. 5. To view the hologram, you must reproduce the optical arrangement used to make it, as shown in (A) and (B) above. The apparent image is difficult to see at first until you get used to it. Make sure the negative is positioned the same way it was taken and is straight. Viewing should be in a darkened room.

used in developing the hologram. Make up a solution of Kodak D-19 or Agfa Metinol-U developer in a tray. (Any other very fine-grain and high-contrast developer may be used.) Make up another tray of shortstop (dilute acetic acid) and one of fixer (ordinary hypo). Follow instructions provided with the chemicals.

A source of clean running water will be needed for washing finished negatives and you should have some type of darkroom timer to measure the seven or eight minutes required for developing. Allow all chemicals to stabilize to correct temperature. Now make sure that the darkroom can be made absolutely dark during hologram exposure and that all fans and air conditioners are shut off. Air in motion can ruin fine details on a hologram.

The film to be used is Agfa 10E75, which is very sensitive to red and blue light; therefore no safe light should be used while the film is being exposed and developed.

**Setting Up and Making a Hologram.** In making a hologram, you are dealing with distances as short as a wavelength of light—and shorter—so physical motion of the optical system and the air surrounding the experiment must be at a minimum. Select a very solid work surface that is not affected by building vibrations. The surface need be only a foot or two wide and about three feet long.

Position the laser at one end of the working surface so that the beam shines down the center of the area. Place the optical components as shown in Fig. 4. It is suggested that you use this layout to make your first holograms. Experiment later. Place the beam splitter about 2 inches from the laser beam exit hole, positioned so that it is at a 45-degree angle to the beam. With the laser operating, use a smoke cloud to show up the beam and note that there are three red lines. One passes directly through the beam splitter and shines on down the work table. Two others come off of the beam splitter at right angles. One of these two beams comes off the front surface of the splitter, while the other comes off the internal or rear surface. Position a wooden beam blocker so that it cuts off the beam coming from the surface closest to the laser. Now there should be only two beams—one shining straight down the work surface and one at right angles to it off of the splitter.

Position the first front-surface mirror (the smaller of the two) about 2 inches from the beam splitter and about parallel with the beam splitter surface. Orient this mirror carefully so that the beam from the splitter strikes close to the center of the mirror. Now there should be two separate parallel beams going down the table.

As can be seen from Figs. 1 and 4, two optical paths are required to make a hologram. One (path 1 called the reference beam) is from the beam splitter, through a diverging lens (to broaden the beam), through two front-surface mirrors, to the film holder. The other (path 2, called the target beam) comes from the beam splitter, through a diverging lens and shines on the target. The reflected light from the target shines on the film holder. The positioning of the target, the second reflecting mirror, and the film holder should follow two basic rules: (1) the lengths of paths 1 and 2 should be approximately the same; and (2) the light from path 1 should be about three times brighter at the film holder than the reflected light from the target.

For the target, it is best to use a bright, shiny white or red object less than two inches in any dimension. This type of target does not require long exposure times. A white or red chessman or an HO-gauge train car make good targets.

Once the optics are positioned as described, place a white card or piece of paper in the film holder. Adjust the mirrors in path 1 until the reference beam dot is centered on the film holder. Move the first diverging lens into position in the reference beam. The dot on the film holder should now be enlarged considerable. Do not use the exact center of the diverging lens to avoid unnecessary interference rings on the film plane. Adjust the reference beam mirrors so that the reference beam covers most of the white card in the film holder as uniformly as possible. The placement of the refference beam may also be adjusted by moving the first diverging lens.

Place the target in position and note that the path-2 beam strikes it. Position the second diverging lens for maximum coverage of the target by the beam. The reflected light from the target should cover the white card in the film holder. Block out the light from path 2 and note the level of light from path 1. Now block the light from path 1 and note that the path-1 illumination is about 3 times as strong as that reflected from the target.

Make sure that no stray light from the target illuminating beam strikes the second mirror. Also, check that extraneous light reflected from the optics or the target mounting does not fall on or near the film holder. To do this, remove the film holder and look into the reflected beams from the film holder position. (NOTE: It is quite safe to look into the *diverged* beam from a laser with power as low as this—less than 0.5 milliwatt. However, before looking into the beam or its reflection, *be sure* that the diverging lenses are in position.) Look at the target and the second reference-beam mirror—and other places—and make sure that only light from the reference beam and target strike the film plane. Use dull black paint to touch up any shiny spots and place dull-painted blocks to prevent any stray light.

Replace the film holder and recheck the beam illumination levels. The beam balance can be changed by moving the target one way or the other or by moving the reference beam mirrors. However, the length of the beam paths must remain equal within a couple of inches. You are now ready to expose the film—emulsion side toward the target and reference beams. But wait one more minute—observe these precautions! Since the film is extremely sensitive, the room must be absolutely dark. The laser must have been operating for at least a half an hour to allow it to stabilize. The movement of air in the room must be at an absolute minimum—no air conditioners or fans, no unnecessary body movement and no talking. Air turbulence destroys the fine fringes that make up the details of the picture.

Cut out a strip of black paper for use as a shutter to cut off the beam where it comes out of the laser. With this shutter in place and making sure that there are no other light leaks in the room, take a section of film, holding it by the edge, and place it, emulsion side out, in the film holder. Be sure not to buckle or touch the film emulsion. Allow a few moments for everything to stabilize—don't move or talk or allow air to move across

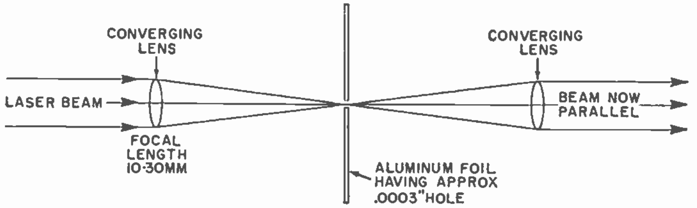



Fig. 6. A spatial filter cleans up laser beam to make better holograms. Sharp needle is used to make the fine hole required.

the beam paths. Now remove the shutter from the beam for 1½ seconds and then replace it. The hologram is now exposed and ready for development—but don't turn on the lights!

**Film Development.** Processing holographic film is not much different from normal photographic processing. The temperatures of the film storage area, the exposure area, and the chemical baths should be as nearly equal as possible. Handle the film as little as possible, taking care not to touch the emulsion. Place the exposed film in the developer for the recommended amount of time—about 7 or 8 minutes, usually. If anything, a little overdeveloping doesn't hurt. Then insert the film in the conventional stop bath and fixer. After fixing, the safe light can be turned on. Wash the film for about 10 minutes in running water.

Do not be surprised at what you see, or do not see, on a finished hologram. You are not recording a focussed picture

## THE STABLE BASE

A stable base is required for the optical system if you are to make a good hologram. Ideally, you should use a heavy bench having a thick slate or metal top and sitting on a thick concrete or cement floor isolated from building vibrations. Such vibrations come from elevators, heavy machinery, passing vehicles, or a walkway used by a number of people.

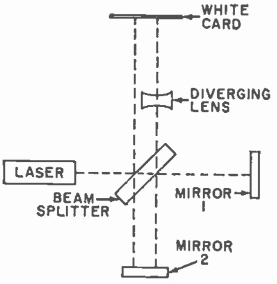
Unfortunately, such an ideal condition is difficult to find. As a substitute, find a location that is as close as possible to the ideal and then try either of the following vibration-reduction systems.

Partially inflate a truck or car inner tube and place it on top of your workbench. Obtain a piece of thick plywood—¾" or more—about four feet square and center it on the tube. Place heavy weights (stones or metal blocks) at each corner of the plywood and orient the weights so that the plywood is horizontal as indicated by a spirit level.

The second approach is the same as the first except that a thick layer of foam rubber—two inches or more—is used instead of the inner tube.

Once you have a stable platform, you can determine just how stable it is by using a simple interferometer setup as shown in the diagram. You can use the same equipment that is used to make a hologram.

Assemble the optical system, as shown, on the stable platform. The distances from the laser to the beam splitter and from the beam splitter to the white card are not important. However, try to make the distance from the center of the beam splitter to each mirror the same. Do not install the diverging lens at first. Turn on the laser. If things are properly positioned, two pairs of dots should be visible on




the white card. You can adjust the optics slightly to make both pairs visible. Further adjustment of the optics will cause one pair of dots to be superimposed on the other pair.

Now insert the diverging lens into one of the beam paths about three inches from the white card. One of the dots on the card will enlarge to a red area—actually, it is two areas superimposed on each other. If you examine the superimposed areas carefully, you will notice a number of black bars that may be stationary or slightly moving within the area. If you very gently touch one of the mirrors the black bars will move. These bars are the result of interference patterns and represent an optical "zero beat." Moving either mirror slightly changes the number of bars. Adjust one of the mirrors until a convenient and easily seen number of bars is visible. Leave the optical system alone and observe the bar pattern for a few minutes. The bars should not move more than about one quarter of the distance between bars over a few minutes' time. If you can obtain this type of vibration-free mounting, you can make good holograms.

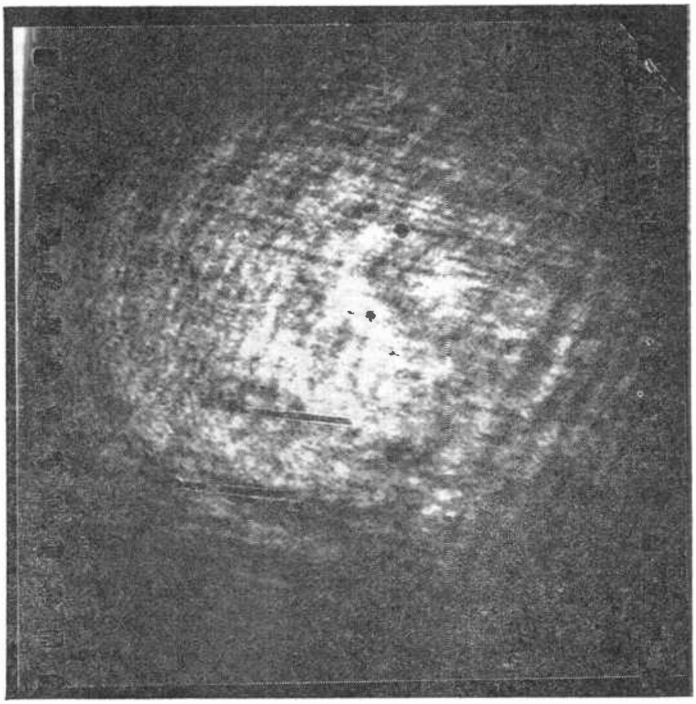
so there is no actual image on the film. The most that you will see is a somewhat smudgy negative full of whorls and lines. The dark areas are noise. The actual image is down at the molecular level and can be seen as interference fringes under a microscope.

**Viewing the Hologram.** This can be a little tricky until you get the hang of it. An important first step is to place the hologram (after it is air dried) in a metal frame so that it is flat. The frame should at least support the hologram by the two edges that have the most curl.

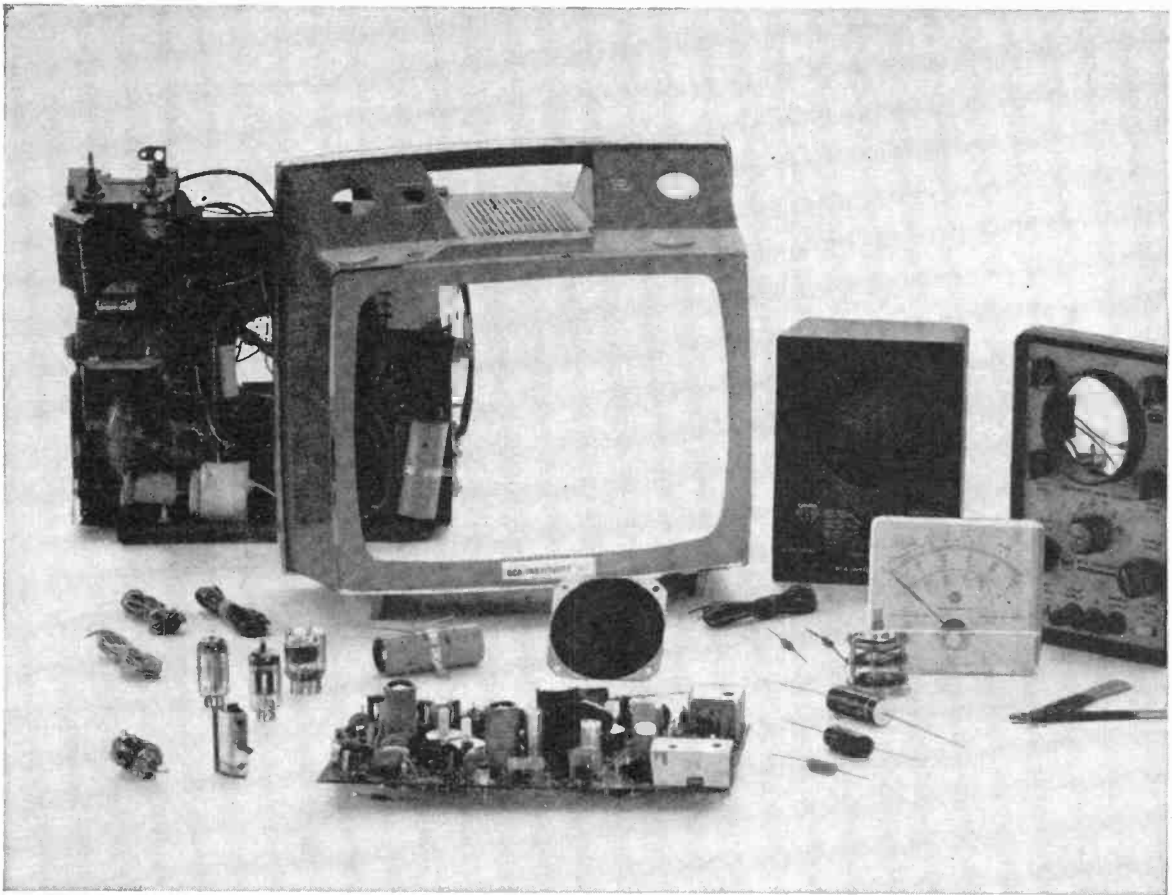
The hologram can be observed without disturbing the exposure setup. Looking at the exposure arrangement from the rear of the film holder, note the angles made to the film holder by the reference beam and the target reflection beam. Referring to Fig. 5, remove the film holder platform and place the hologram in the diverged reference beam at the point where the film was originally positioned. The image should appear where the original target was as you look through the back of the film. You may have to move the hologram around a little, and unless you remember the exact orientation of the film, you will have to turn it until you see the image. If the film is reversed, a weird, unrecognizable blown-up image will result. As previously mentioned, seeing the image is tricky until you are used to it. Have patience and try viewing a hologram that you know is good before giving up on the one you made. If you purchase the hologram optics kit mentioned in the Bill of Materials you will get a sample hologram to experiment with. Other holograms are available from Edmund Scientific Co., 300 Edscorp Building, Barrington, N.J. 08007.

**Troubleshooting.** If no picture can be found in the hologram, there are several possible reasons. The most probable is that something moved while you were making it. A relative motion of even a few millionths of an inch between target and other components can destroy the image. Also check the following: (1) Beam balance—ratio of approximately 3:1 must be maintained between reference and reflected beams. (2) Stray light from outside or from laser must be eliminated. (3) Exposure time may not be right. Keeping all conditions the same, vary the exposure time until you hit the

(*Continued on page* 90)



The finished hologram bears no resemblance to an actual picture. In fact, it may look like this. The hologram from this blotchy negative is quite an excellent three-dimensional image. The dark blotches, accentuated by the magazine printing process, are due to the random moding of the laser, and most can be cleaned up with a spatial filter. Small whorls and lines seen on the hologram are the result of small blemishes on the optics or dust motes on polished surfaces. They carry no picture information so they can be completely ignored. The actual hologram interference lines are so small they can be seen only with aid of a microscope.



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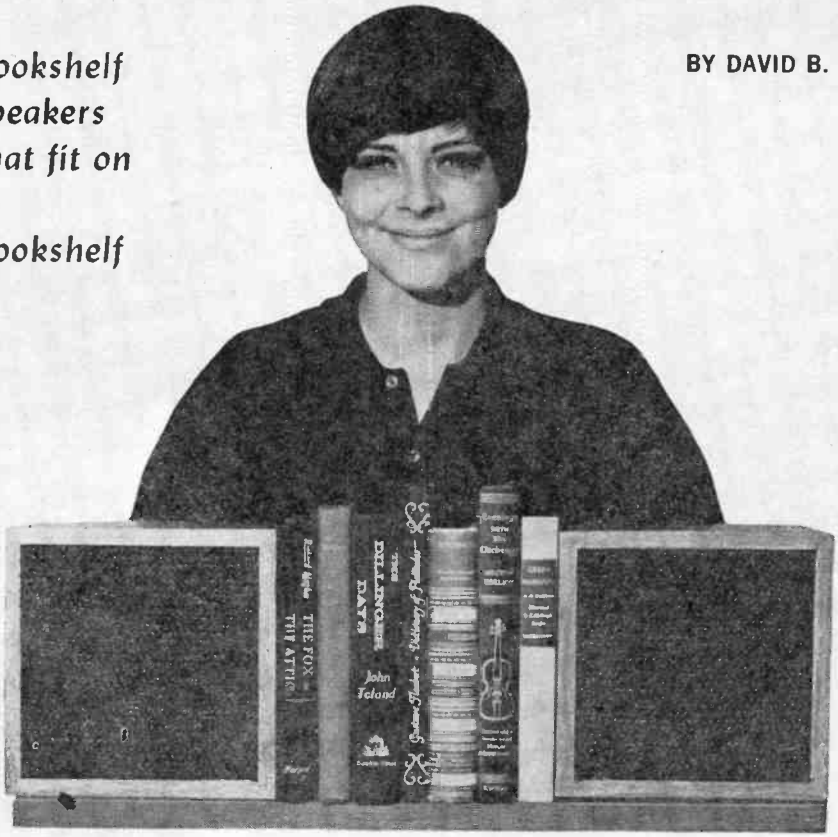
*Bookshelf speakers that fit on a bookshelf*

BY DAVID B. WEEMS



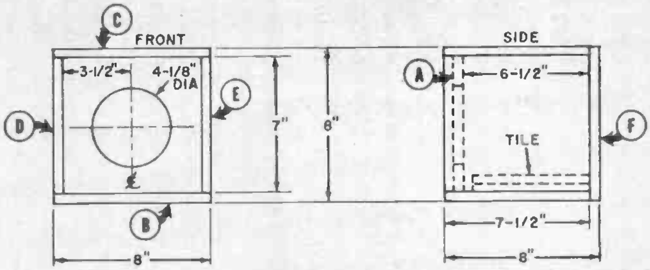
# A PAIR OF LOADED DICE

It is an established fact that many so-called bookshelf speaker systems are just too large to fit on a bookshelf. The "loaded Dice," a true stereo bookshelf speaker pair, not only have the right dimensions, they are also inexpensive and easy to build. And if you prefer not to put them on a shelf, you can always use them as bookends on a tabletop or desk. (To double as bookends, each enclosure is loaded with almost three pounds of ceramic tile.)

Although the cubic shape used for the Dice is not recommended for large speaker systems, in the case of a subminiature system, it works admirably. The difference is due to the ability of the acoustical damping material to better absorb the frequencies that would normally be accentuated by the small cube. For best results, the entire enclosure must be filled with acoustical fiberglass.

The speakers used in the Dice are low-cost versions of the currently popular high-compliance type. The small cones are suspended by a rolled edge, the design of which, when coupled with a large magnet, can produce good sound in a small sealed enclosure.

**Construction.** The enclosures can be built at little or no cost, depending on whether you have to buy new lumber or have scraps from a previous job that you can use. Just about the only tools you need for assembly are a hammer and a



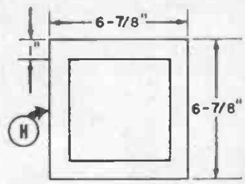




Fig. 1. Small cabinet size allows walls to be butt-jointed; sides are then finished with adhesive-backed vinyl covering. Grille frame fits directly into well in front of speaker.

## BILL OF MATERIALS

*1—Full-range speaker (No. XS-510 available from McGee Radio Co., 1901 McGee St., Kansas City, Mo. 64108. $3.49)*
*1—Two-lug screw-type terminal strip*
*1—8" x 8" piece of ½" plywood for rear panel*
*1—7" x 7" piece of ½" plywood for speaker mounting board*
*2—7½" x 8" pieces of ½" plywood for top and bottom panels*
*2—7½" x 7" pieces of ½" plywood for side panels*
*1—6⅞" x 6⅞" piece of ⅜" plywood for grille frame*
*2—6" x 6" x ½" patio tiles*
*1 yd. "Contact" plastic veneer*
*Misc.—#8 x ½" panhead sheet metal screws (4); #10 x 1½" wood screws (4); ¼" flat washers (4); ½ lb. #4 finishing nails; 12" zip cord; fiberglass wool; ⅛"-thick polyfoam; wood glue; water putty; silicone rubber caulking compound; sandpapers; etc.*

saw since small boxes do not require the same degree of bracing and careful joining of parts that are musts with large enclosures.

You can begin construction by cutting the five enclosure panels, speaker mounting board, and grille frame for each system you plan to build to the dimensions given in Fig. 1. Then, after making the speaker cutout, apply two coats of flat black paint to the sides of the cutout and front surface of the speaker mounting board.

Strike a line ½" in from and parallel

Fig. 2. Bolted down with woodscrews and washers, patio tiles load bottom of enclosure to prevent skidding when the speaker is employed as bookend.

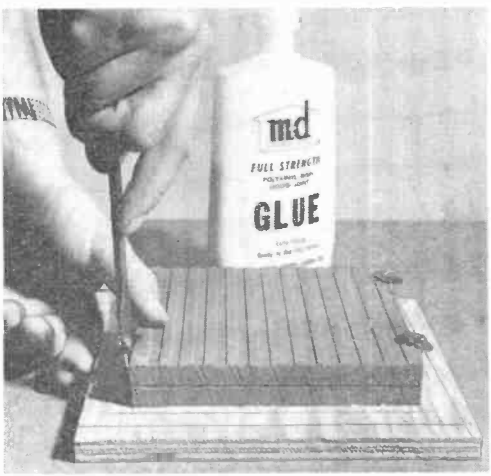



Fig. 3. Before assembly, start finishing nails into top, bottom, and rear walls of cabinet. Then apply beads of glue and hammer home nails as shown here.

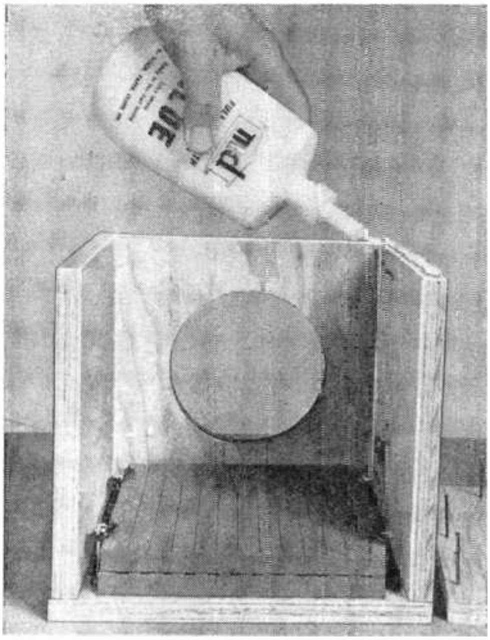


Fig. 4. Top should be last wall mounted to speaker mounting board. Note, at far right, nails partially driven into top wall to facilitate assembly.

to the front edges of the side and bottom panels to locate the position of the outer edges of the speaker mounting board. Set the speaker board onto the bottom plate, and strike another line on the bottom board along the rear edge of the speaker board. Then strike one more line 1" in and parallel to each side edge of

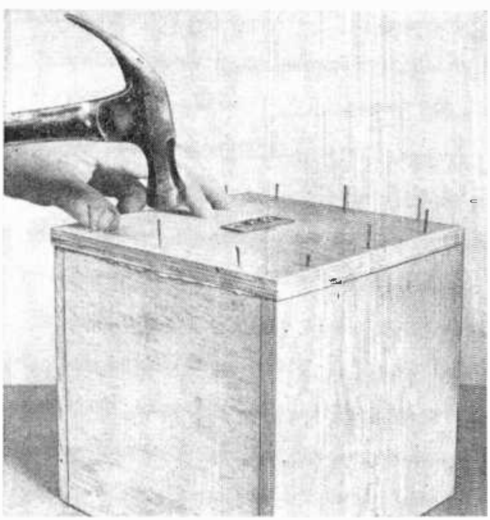


Fig. 5. Mount screw-type terminal strip to rear of cabinet; then glue and nail rear wall to cabinet shell, trueing up sides, top, and bottom as you go.

the bottom panel for the patio tiles.

Now set the patio tiles on the bottom panel, locating them within the lines previously drawn. Use glue and four #10 × 1½" woodscrews with ¼" flat washers to secure the tiles in place as shown in Fig. 2.

Next, glue and nail the bottom and one side panel to the speaker board as seen in Fig. 3. Then glue and nail the remaining side in place. Apply a liberal bead of glue to the top edges of the speaker board and enclosure sides; also start nails into the top panel (see Fig. 4). Lower the top panel onto the enclosure assembly, square it with the sides, and hammer home the nails.

Prepare the rear panel as follows. First determine the center-to-center distance between the two screws of a two-lug, screw-type terminal strip. This distance tells you how far apart the holes must be for the terminal strip to mount on the rear panel. Now, use a ¼" drill to bore holes through the center of the rear panel. Try the terminal strip for fit; if the holes are too small to accept both the screw ends and solder lugs, enlarge the holes with a hand reamer.

Separate the conductors for a distance of 2" at one end of a 12" length of zip cord. Remove ¼" of insulation from each conductor. Then pass one conductor through each hole, and solder them to the lugs on the terminal strip. Gently pull on the zip cord until the terminal strip is flat against the outside surface of the rear panel. Use small tacks or wood screws to anchor the terminal strip in place. Then drive the screws all the way into the terminal strip contacts.

Turn over the rear panel and fill the holes passing the zip cord with silicone rubber caulking compound. Then, glue and nail the rear panel to the enclosure shell as shown in Fig. 5. This done, use a pin or center punch to countersink all nail heads. Then fill the nail holes with "water putty" or plastic wood.

After allowing sufficient time for the putty to harden, sand all surfaces (sides, top, and bottom) as in Fig. 6. Brush away all sawdust. Cut a piece of "Contact" self-sticking vinyl veneer to 9" by 33". (This material is available in many patterns, textures, and colors. The richest among them is the wood "veneer"

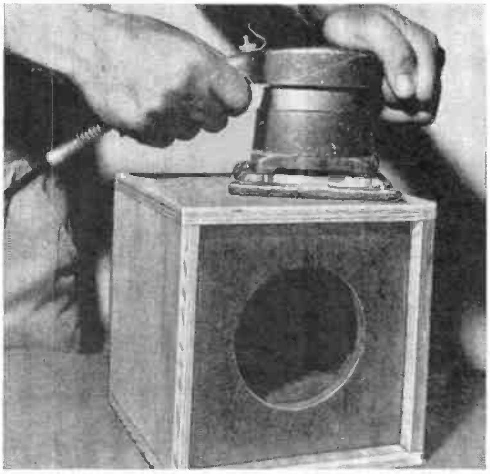


Fig. 6. Power sander is fast way of smoothing surfaces, but you can use wood block and sandpaper.

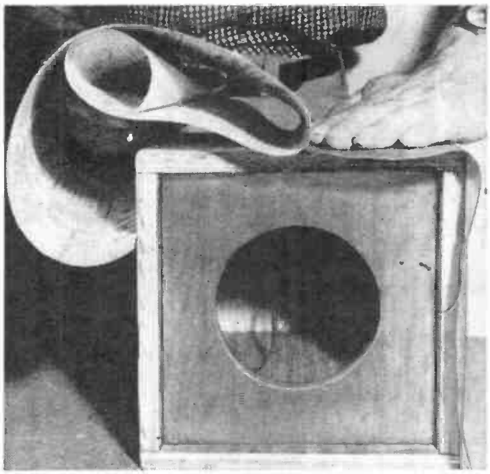


Fig. 7. Thoroughly clean off wood dust before you carefully apply adhesive-backed vinyl to cabinet.

pattern, of which there are several shades and wood grains.) Carefully following the instructions printed on the peel-away paper, stick the veneer to the enclosure sides, starting at a bottom corner so that the seam will not be visible. Apply the veneer so that it is flush with the rear edges of the enclosure and overlaps the front edges (see Fig. 7).

After pressing the Contact into place and removing all wrinkles and air bubbles, make a 90° slit at all four corners. Fold the side strips over the front edge of each side. Then cut the top and bottom strips at 45° angles so that when you fold them over, the effect will be a miter cut.

Cut a piece of acoustical fiberglass to 6" × 24". Roll it up and insert it through the speaker cutout into the enclosure. Now carefully unroll it, and press it into place around the interior walls. Then press into place against the rear wall another piece of fiberglass.

Route the zip cord out of the enclosure through the speaker cutout. Then fill the interior of the enclosure with small pieces of the fiberglass, and cement a ⅛"-thick ring of polyfoam around the speaker cutout to form a gasket for the speaker.

Connect and solder the free ends of the zip cord to the speaker lugs (see Fig. 8). Set the speaker into its cutout

Fig. 8. Fill cabinet with cut-up pieces of fiberglass wool, cement on gasket, and wire up speaker.

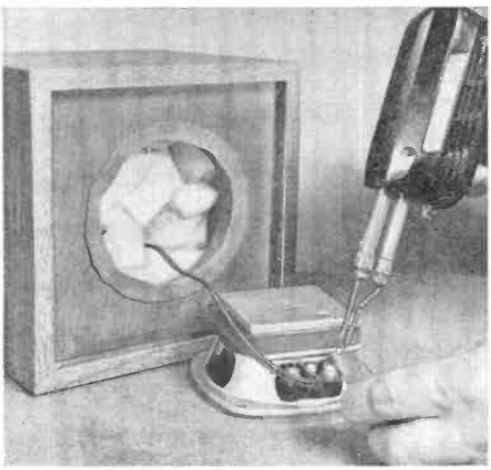
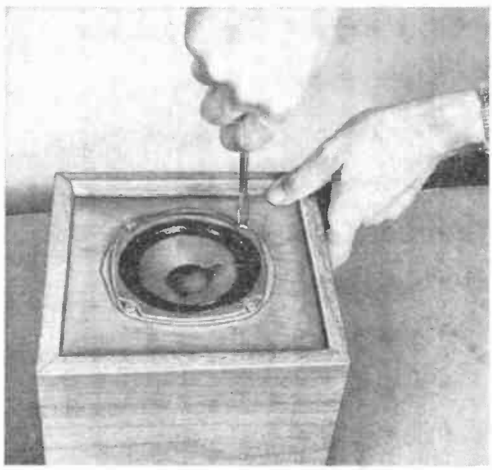


Fig. 9. Speaker front mounts to speaker board. Be careful to avoid cone damage in mounting speaker.



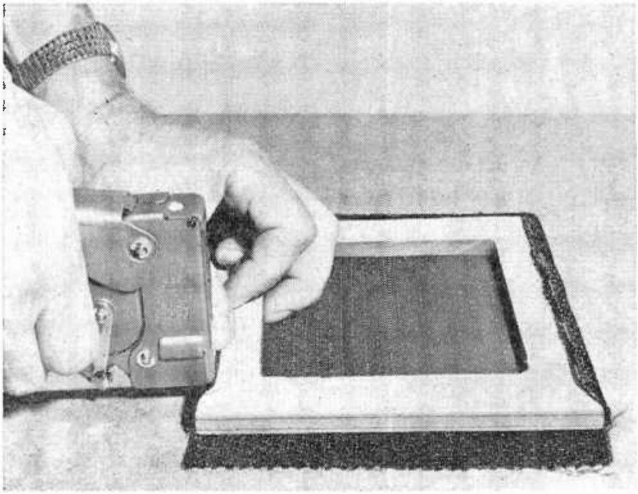


Fig. 10. To provide proper fit, the corners of the grille cloth must be notched to remove excess material before cloth is stapled to frame.

and use #8 × ½″ panhead sheet metal screws to fasten it down as shown in Fig. 9.

Now determine the polarity of the speaker by momentarily touching a 1.5-volt battery to the screw contacts on the terminal strip and observing cone movement. Place a red dot or other identifying mark on or near the screw contact that is the positive end of the battery when the cone moves outward.

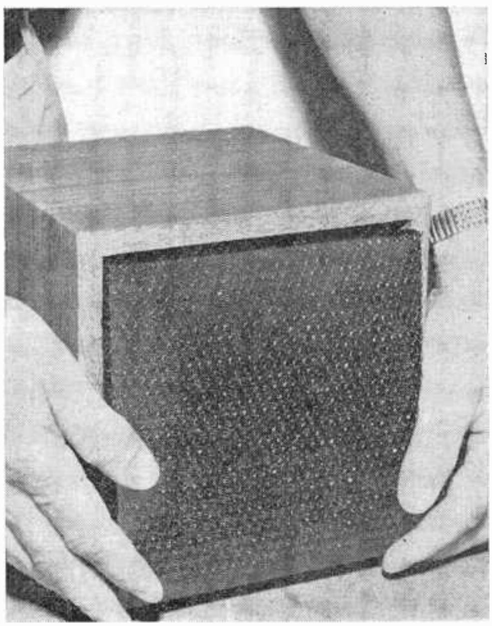
Center the grille frame over the 9″ × 9″ grille cloth, and cut a square notch at each corner of the grille cloth to obviate a thick overlapping at the corners. Tack or staple the grille cloth to the frame as in Fig. 10. The grille assembly can now be press-fitted into the front of the enclosure (Fig. 11). If you selected a very thin grille cloth that produces a loose fit, simply drive a thin wire brad through each corner of the enclosure into the frame.

Finally, cement a 7½″-square by ⅛″-thick sheet of polyfoam plastic to the bottom of the enclosure to provide protection to the furniture on which the speaker is placed and to increase surface friction between the enclosure and a shelf or table.

Connect your speaker or stereo pair to an amplifier or receiver, taking care to connect the identified screw terminal to the "hot" 8-ohm output. Better yet, try switching the leads to one speaker (if you use a stereo pair) to check for proper phasing. When properly connected, the bass response of the system will be markedly better.

Whether you use the Dice speakers as main speakers or as extensions in remote locations, you will be delighted by their appearance and clean sound reproduction. In fact, these easy-to-build boxes might prove so appealing that you will make several pairs to provide stereo listening throughout your home. —30—

Fig. 11. Grille assembly wedge fits into front of cabinet. If fit is too loose, drive thin finishing nails through cabinet corners and into frame.



COVER STORY

# A REAL BOSS SOUND

## THE WAA-WAA

*Be first with a new vibration*

BY JOHN S. SIMONTON, JR.

IF YOU'RE an avid admirer, and a participant in, the rock music scene, you may have noticed that really "new" sounds are coming out of a few recording studios and even fewer groups. Fuzz, reverb, tremolo, and vibrato are being overworked.

The groups that have something new have been keeping it under wraps; but now the secret is out—it's the "Waa-Waa" sound.

You don't need fancy gear to create your own Waa-Waa sound. This story tells how to build a foot-operated self-contained Waa-Waa unit that is simply plugged into the circuit (using ordinary shielded phone cables) between your guitar and amplifier.

Unless you press the Waa-Waa pedal, the sound from your guitar remains unchanged. Pressing the pedal (and releasing it according to the effect you want to create) introduces a totally new sound experience. It's pretty difficult to describe in print. Some groups think it sounds like a "wow" or "whoop"; others use the Waa-Waa to create an effect as if the music were being modulated by the gentle spring breeze. You can do all sorts of tricks with the Waa-Waa and the difference is that this is practically a musical instrument itself. It's not just an idiot box that you turn on and forget. You actually play the Waa-Waa to add a new dimension to any sound signal that is rich in harmonics.

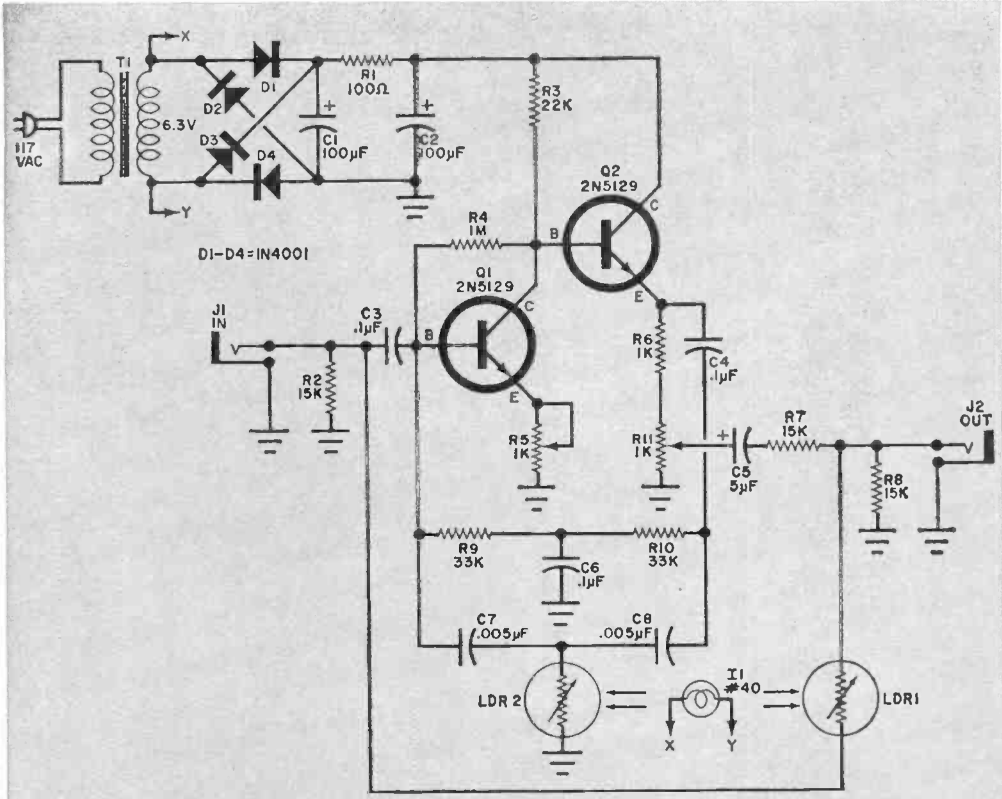



Fig. 1. The circuit is a variable-frequency, narrow-band amplifier whose gain and center frequency are determined by the amount of light on the LDR's.

## PARTS LIST

*C1,C2—100-µF, 10-volt electrolytic capacitor*
*C3,C4,C6—0.1-µF disc capacitor*
*C5—5-µF, 6-volt electrolytic capacitor*
*C7,C8—0.005-µF disc capacitor*
*D1-D4—1N4001 diode*
*I1—#40 pilot lamp*
*J1, J2—Open-circuit phone jack*
*LDR1—Light dependent resistor (Clairex 703L)*
*LDR2—Light dependent resistor (Clairex 703)*
*Q1,Q2—2N5129 transistor*
*R1—100-ohm*
*R2,R7,R8—15,000-ohm*
*R3—22,000-ohm*
*R4—1-megohm*
*R6—1000-ohm*
*R9,R10—33,000-ohm*
*(All resistors ½-watt)*
*R5,R11—1000-ohm, printed circuit type trimmer potentiometer*
*T1—Transformer, secondary: 6.3 volts at 300 mA*
*Misc.—Chassis, wooden foot pedal, mounting bracket for light dependent resistors and light, light mask, spring, dust cover, terminal strips, rubber feet (4), line cord, strain relief, flat black paint, shielded, cable, wire, etc.*
*Note—The following are available from PAIA Electronics, P.O. Box 14359, Oklahoma City, Oklahoma, 73114: etched and drilled PC board #7690. $3.00, postpaid in continental U.S.; prepunched case including all brackets, spring, etc., unpainted, #7690C, $5.10, plus postage for 2 pounds; complete kit including case, circuit board, and all parts, #7690K, $18.75, plus postage for 3 pounds. Oklahoma residents, add 3% sales tax.*

**Construction.** The electronic portion of the Waa-Waa is straightforward and follows the schematic shown in Fig. 1. Component layout is not critical and any method of assembly may be used. Use of a printed circuit board lends a professional touch and guarantees correct wiring. You can make your own board using the foil pattern shown in Fig. 2 or you can buy one as described in the Parts List. Install the components as shown in Fig. 3.

Mechanical construction of the Waa-Waa can be done in one of a number of ways. Basically, what is needed is a U-shaped, sloping top chassis, large enough and strong enough to support the user's foot. A wooden pedal forms the

## HOW IT WORKS

The circuit is basically a bandpass amplifier composed of a common-emitter gain stage *(Q1)* and an emitter-follower stage *(Q2)*, with feedback through a parallel-T filter *(C6, R9, R10* and *C7, C8, LDR2)*. The width and center frequency of the pass band are controlled by the resistance of LDR2, a value proportional to the amount of light falling on the photoresistor's surface.

When the foot pedal is up, *LDR1* is exposed to the light from *I1*. The light striking *LDR1* causes its resistance to be so low that it provides a direct, low-resistance path from the input jack to the output, bypassing the amplifier.

As the foot pedal is depressed, it first blocks the light falling on *LDR1*, thereby raising its resistance so that the signal goes through the amplifier. As the pedal is depressed further, the section of the mask which is in front of *LDR2* gradually begins to expose the surface of this photocell. Its resistance is thus decreased, raising the center frequency of the amplifier's pass band.

Potentiometer *R5* is used to adjust the gain around the feedback loop and is set so that the circuit is held just below the point of oscillation. Potentiometer *R11* is used to adjust the gain at the output and is set so that there is no noticeable change in the volume of the instrument as the Waa-Waa is switched in and out.

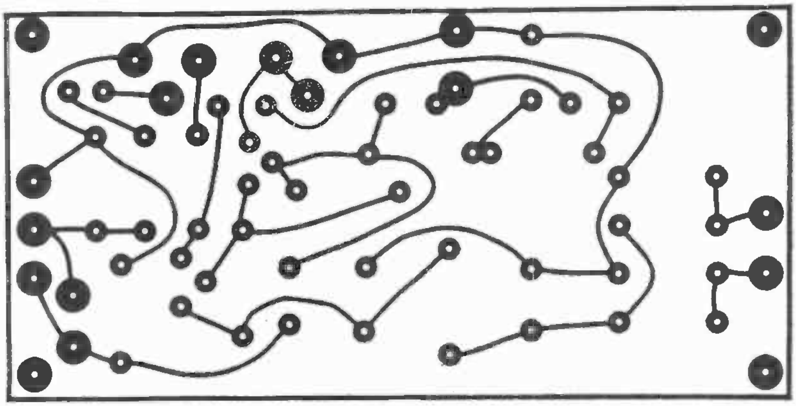


Fig. 2. Actual-size foil pattern can be used to make your own circuit board.

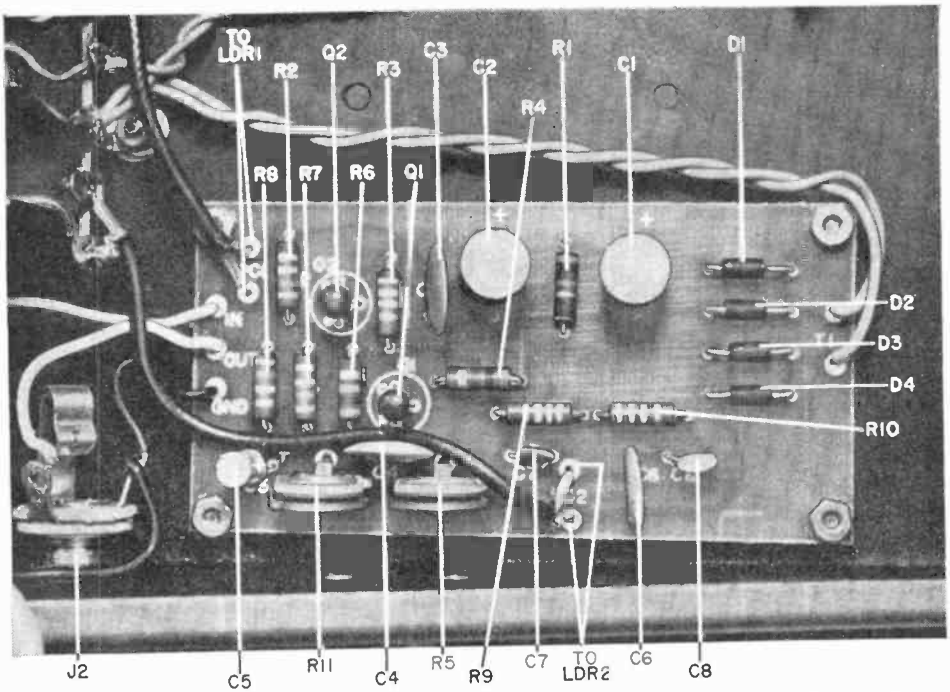


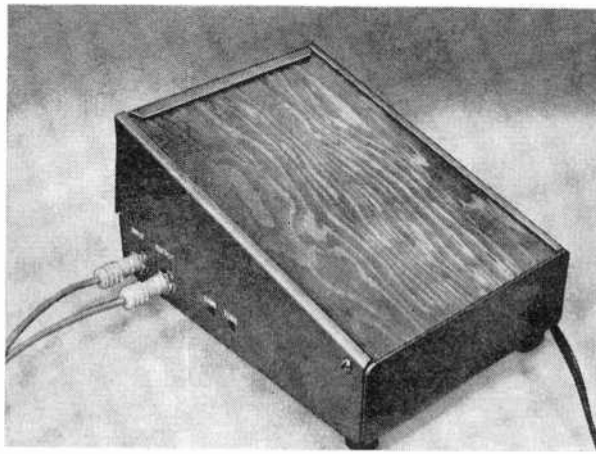

Fig. 3. After installing all components on board, make sure both trimmer potentiometers are accessible through holes drilled in side of chassis. This view also shows connections to other elements.

top of the assembly. The pedal is hinged at the heel (lower) end by a pair of long wood screws. A mild-spring steel spring supports the pedal and returns it to the top position when the foot is relaxed or removed.

On the underside of the wooden pedal, is a specially shaped light mask which, as the pedal goes up and down, passes between a light source and a pair of photoresistors or light dependent resistors.

If you have the metalworking facilities, you can duplicate the prototype chassis, using 16-gauge steel or aluminum and following the layout shown in Fig. 4. Once the chassis is made, fabricate the wooden pedal out of ¾" plywood with the dimensions given in Fig. 5. This illustration also shows the spring that is fabricated from 16-gauge mild-spring steel. The dimensions of the support bracket for the photoresistors and the light mask are shown in Fig. 6.

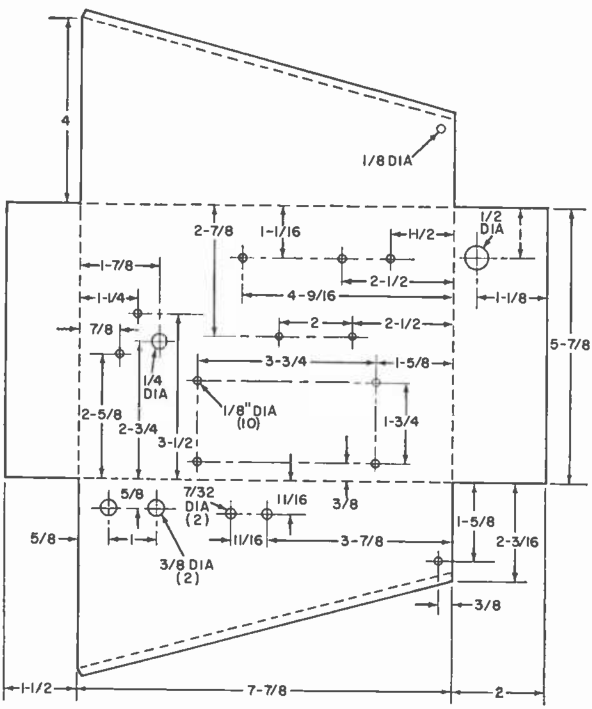
The entire interior of the Waa-Waa, including the mask and photoresistor bracket, must be finished in flat black to



The completed Waa-Waa. Two audio leads, one input and one output, plug into the appropriate jacks. Two holes alongside are for trimmer adjustments.

minimize internal reflections from the light. After the photoresistor bracket has dried, mount it on the chassis as shown in the photos. The two photoresistors are glued in place as shown in Fig. 6.

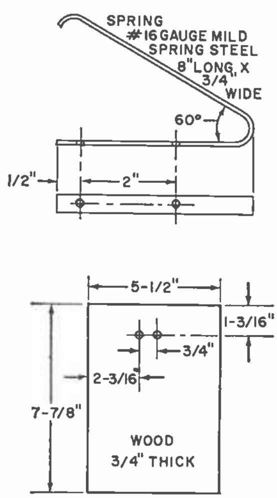
Attach the PC board, temporarily, to




ALL MEASUREMENTS ARE IN INCHES

Fig. 4. If you want to fabricate chassis similar to the one shown in the photos, follow construction details shown here.

Fig. 5. Fabrication details for the wooden pedal and spring. Two holes in the pedal support the shadow mask. Spring serves to return the pedal to the top of its travel when the foot is removed from the top.




PEDAL SIZE AND MASK PLACEMENT

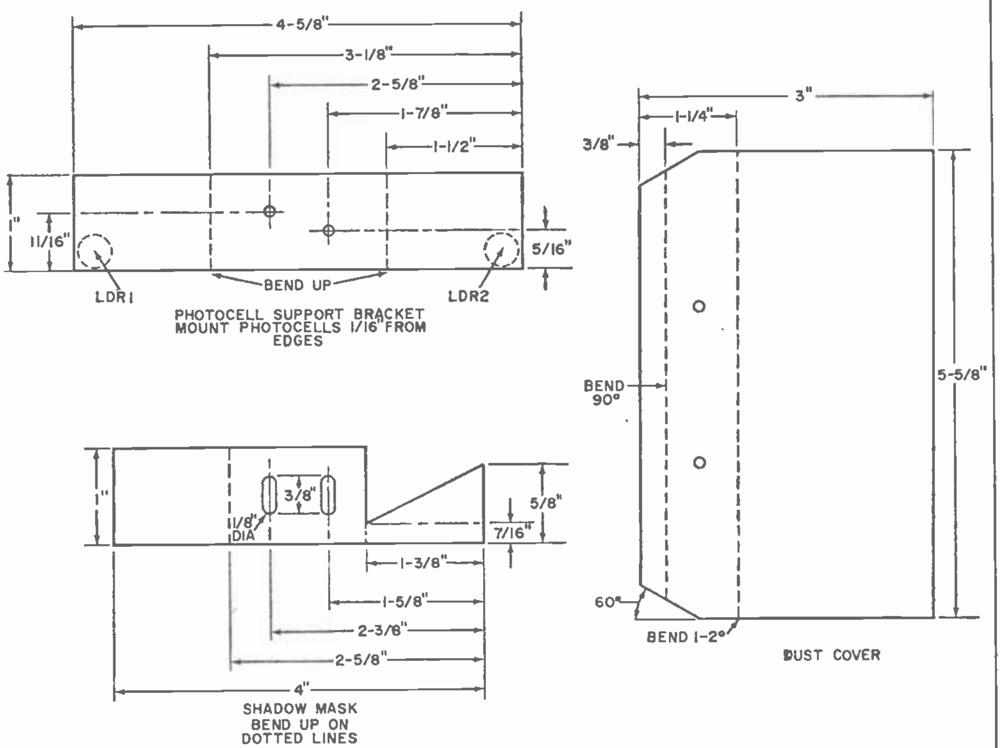
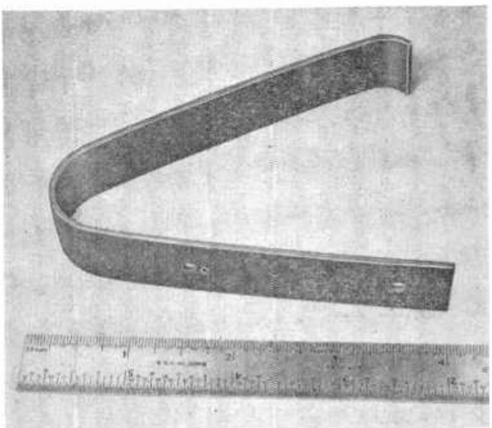



Fig. 6. Construction details for the photocell support bracket, the shadow mask, and the dust cover. These can be made from thin sheet metal and painted flat black to remove reflections.

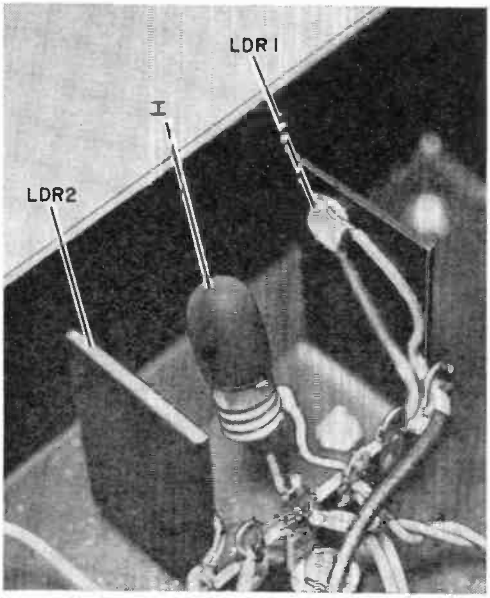
the chassis, using four small standoffs. Note and mark the chassis for both trimmer potentiometers. Remove the PC board and drill holes in the chassis so that the trimmers can be adjusted from outside with a screwdriver.

Using suitable hardware, mount the transformer on the bottom of the chassis. Mount the input and output phone jacks. After soldering appropriately long leads on the PC board terminals, attach the board (on its spacers) to the chassis. Make sure that the two trimmers face the holes for adjustment. Mount a six-lug terminal strip (one lug grounded) close to the photoresistor support as shown in the photos. Lamp *L1* can be installed in a socket or it can be attached to heavy leads soldered to its base connectors. Connect one side of the lamp to the grounded lug on the terminal strip and the other to the adjacent ungrounded lug. Position the lamp midway between the two photoresistors. Coat the lamp with flat black paint. After the paint dries, scratch a small clear spot on each side of the lamp so that, when it is lit, a small beam of light falls on the sensitive face of each photoresistor.

Insulate the leads on the photoresistors and connect them to the outside terminals on the terminal strip. Using shielded cable to minimize hum, connect



The spring has a small curve at the top to slide along the wooden foot pedal as it is depressed.

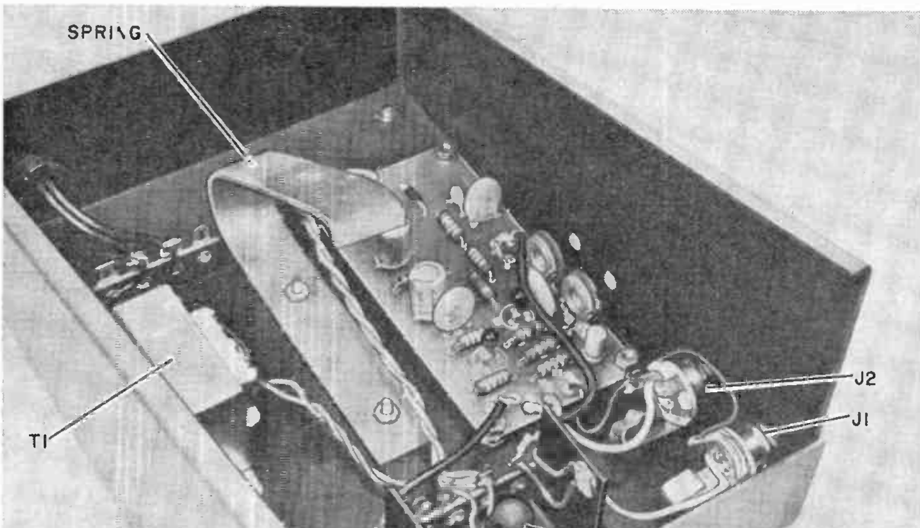


Lamp I1 is painted flat black and small dots of paint are removed on each side to shine on LDR's. Dot where paint was removed appears black here.

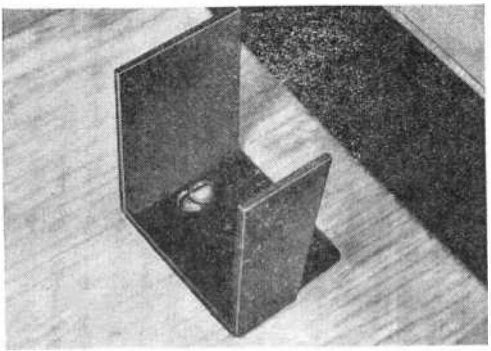
these terminals to the appropriate terminals on the PC board. Use a two-lug (non-grounded) terminal strip to connect the primary leads of the transformer to the line cord. Pass the cord through a hole with a grommet in it in the lower end of the chassis.

Wire the system according to Fig. 1, making sure that the photoresistors are properly installed. Install the wooden foot pedal temporarily, using the hinge screws to hold it. Hold the light mask against the bottom surface of the pedal with the angled portion covering *LDR2*. When the pedal is depressed, the mask must slide cleanly between the lamp and the photoresistors. Put screws through the slotted holes in the light mask to position it laterally but leave it able to move up and down on the pedal.

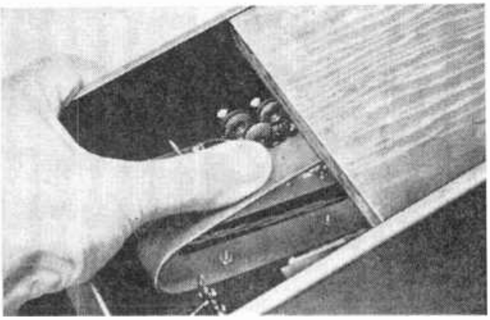
Remove the wood pedal. Attach the spring, using suitable hardware, so that the top of the spring is slightly higher than the chassis walls. Re-install the pedal and secure it with the hinge screws. Check that, as the pedal is depressed, the light mask slides clean. With the pedal all the way up, the uppermost surface of *LDR1* may be in shadow but the majority of its surface must be fully lit by the beam from *I1*. Adjust the final position of the mask so that both photoresistors are completely in shadow when the foot pedal is lightly depressed and *LDR2* is fully lit when the pedal is pressed all the way down. Provide some form of mechanical stop to arrest the pedal at the bottom of its travel. (In the phototype, this stop is provided by the



Interior view of the Waa-Waa showing the location of all parts. Note the two holes for the trimmer potentiometers. The lips on the chassis top limit the wooden foot pedal at the top of its travel.



Shadow mask is secured to underside of foot pedal. The flat black paint removes all reflections.



The spring must be slightly depressed to allow foot pedal to slide under the chassis upper lips.

hitting of the mask against the frame that holds the photoresistors).

Fabricate the light and dust cover as shown in Fig. 6 and mount it on the top end of the foot pedal. The inside of this cover must be painted flat black.

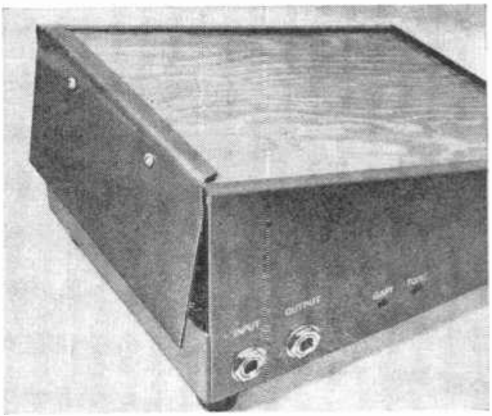
**Operation and Use.** Plug the output from the instrument you are going to use into the input jack, *J1*, of the Waa-Waa and run an audio cable from the output jack, *J2*, to the amplifier. Supply power to the Waa-Waa, set the amplifier volume to a reasonable level, and use a small screwdriver to turn the potentiometers, *R5* and *R11*, fully clockwise. At this point, a squeal may be heard from the amplifier as the Waa-Waa breaks into oscillation. Adjust *R5* until there is no oscillation at any setting of the foot pedal.

Now strike a chord on the instrument and press the pedal. The effect of the Waa-Waa should be obvious; however, there will also be a noticeable increase in volume as the pedal is depressed. Adjust *R11* so that the volume change is minimized.

As you learn to use the Waa-Waa, you may feel that only a slight motion of the pedal produces too great a change in the tone of the instrument. This can be changed by reducing the size of the hole in the paint on the side of *I1* which illuminates *LDR2*. You may eventually find that just a pinhole produces the proper results.

There may be an annoying squeak as the pedal rubs against the sides of the case and the spring. This can be eliminated by coating the offending areas with one of the silicone lubricants.

For maximum effect, the Waa-Waa should be used with instruments producing a tone rich in harmonics, such as a guitar or harmonica. The effect on a guitar is most noticeable when the strings are plucked next to the bridge but this is really a gimmick on top of a gimmick. In general the effect of the Waa-Waa is less noticeable on bass instruments (unless they generate good harmonics as does a bass harmonica). The pedal may be pressed and released rapidly to get a distinctive "wow" or it may be moved slowly to produce a weird "wind in the willows" effect.

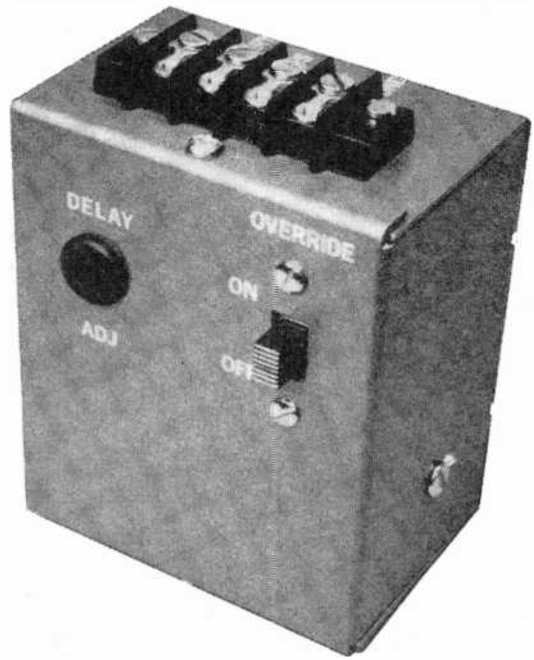


Dust cover keeps the ambient room light from affecting LDR's. A pair of long wood screws form a hinge at the heel (lower) end of wood foot pedal.

The thing to do is experiment. The effect is so unusual that a beginner is as expert as anyone else so no one can say you're doing it wrong.

One word, however! A little Waa-Waa goes a long way. The listener should get the impression of having heard something new, but he shouldn't be able to say exactly what it was. -30-

# BUILD THE Time Out




TURNS OFF CAR LIGHTS WHEN YOU'RE SAFELY INSIDE

BY JOHN STAYTON

THERE ARE FEW things more aggravating to the motorist than pulling into the driveway at night and having to stumble around in the dark driveway to find the key for the garage or front door. Not only is it inconvenient; it's unsafe if there is snow on the ground, or roller skates or bicycles lying around.

Wouldn't it be helpful if you could leave the headlights on for a while after getting out and not have to go back to turn them off? With a "Time Out" you can do just that. When you have this device installed in your car, the headlights stay on after the ignition is turned off and then go off automatically after a predetermined period of time—from a few seconds to a couple of minutes. If you always park in well-lighted areas at night, the Time Out comes in handy should you forget to turn off your lights.

The Time Out is easily constructed using readily obtainable parts and it is easy to install in your car.

**Construction.** There is nothing critical about the circuitry of the Time Out (see Fig. 1) and any method of construction may be used. A printed circuit board like the one used in the prototype helps to produce a sturdy compact unit and may be duplicated using Fig. 2 as a guide. When installing the semiconductors be sure you observe the proper polarities and heat sink their leads while soldering.

In the prototype, the circuit board and relay are housed in a 3¾" × 3" × 2⅛" metal utility box. A barrier-type terminal strip mounted on one end of the box is used to make connections to the automobile wiring. The circuit board is mounted on short spacers and is in such a position that the delay adjusting potentiometer (*R9*) is accessible through a hole drilled in the case. Line this hole with a rubber grommet to prevent short circuits when making adjustments with a metal screwdriver.

When selecting a relay, don't scrimp on the current rating of the contacts. In the prototype, both sets of 10-ampere contacts were wired in parallel just to be on the safe side. The same principle applies to the wire used to connect the

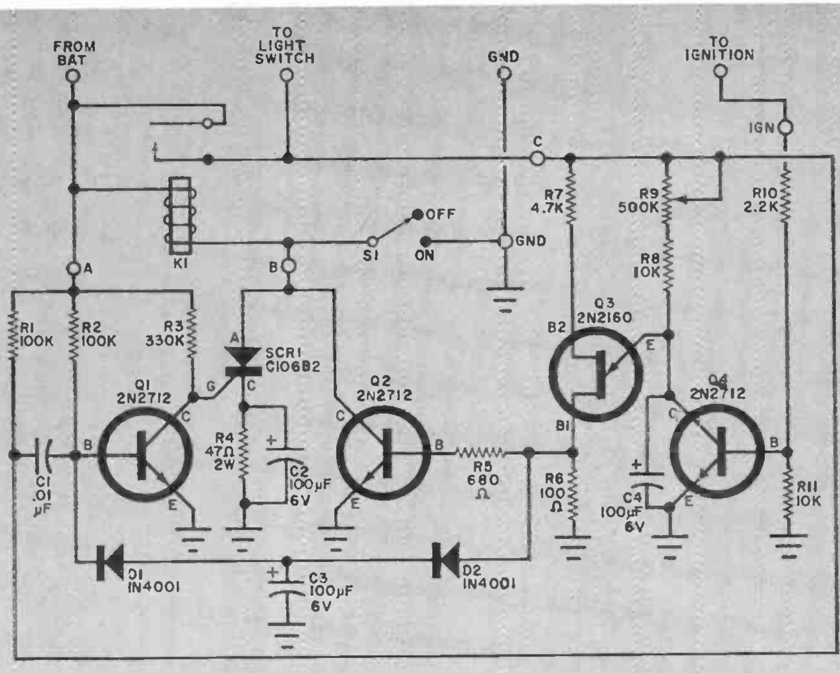



Fig. 1. The UJT turns off the lights by making Q2 appear as a momentary short circuit across SCR1. This causes the relay to open, removing power from lights and timer.

## PARTS LIST

*C1—0.01-µF capacitor*
*C2,C3,C4—100-µF, 6-volt electrolytic capacitor*
*D1,D2—1N4001 diode*
*K1—6-volt d.p.d.t., d.c. relay, 10-ampere contacts (see text)*
*Q1,Q2,Q4—2N2712 bipolar transistor*
*Q3—2N2160 unijunction transistor*
*R1,R2—100,000-ohm*
*R3—330,000-ohm*
*R5—680-ohm*
*R6—100-ohm*
*R7—4700-ohm*
*R8,R11—10,000-ohm*
*R10—2200-ohm*
(*All resistors ½-watt, 10%*)
*R4—47-ohm, 2-watt resistor*
*R9—500,000-ohm potentiometer (printed circuit board type)*
*S1—S.p.s.t. slide switch*
*SCR1—Silicon controlled rectifier (GE C106B2)*
*Misc.—Four-contact barrier strip, 3¼" x 3" x 2⅛" metal utility box, rubber grommet, spacers, mounting hardware, chassis lettering, mounting hardware, etc.*
*Note—An etched and drilled PC board for $1.65 and a complete kit of parts including case, PC board, and hardware, for $12.95 are available from PAIA Electronics Inc., P.O. Box 14359, Oklahoma City, OK 73114. Oklahoma residents add state sales tax.*

## HOW IT WORKS

When the circuit is in its normal, inoperative state, relay *K1* is not energized and no power is applied to either the timing circuit or the headlights. Transistor *Q1* conducts because of the forward bias through *R2*. This holds the gate of *SCR1* near ground potential.

When the vehicle's headlight switch is closed the junction of *R1* and *C1* is grounded through the lights and the charge stored on *C1* creates a negative pulse to turn off *Q1* momentarily. With *Q1* off, a voltage is applied to the gate of *SCR1* turning it on and energizing the relay. Power is thus applied to the headlights and the rest of the timer circuit.

When the ignition switch is closed, the positive potential at the junction of *R10* and *R11* causes *Q4* to conduct and disables the timing circuit by shorting to ground the emitter of uni-junction transistor *Q3*. This condition exists as long as the ignition switch is turned on. When it is turned off, *Q4* stops conducting and a charge builds up on *C4* through *R8* and *R9*. When the charge on *C4* is sufficiently high, *Q3* starts to conduct and a pulse is created on the base of *Q2*, turning it on. With *Q2* conducting, the anode of *SCR1* is shorted to ground. Due to the charge built up on *C2*, *SCR1* is then reverse biased and turns off. The relay is thus de-energized and the headlights are turned off.

When the relay's contacts open, the junction of *R1* and *C1* is once again grounded through the lights and a pulse is created which would begin the turn-on sequence again if it were not for the charge stored on *C3* when *Q3* was conducting. This charge neutralizes the pulse and keeps *Q1* from turning off. Diodes *D1* and *D2* serve to keep the proper polarities in the circuit.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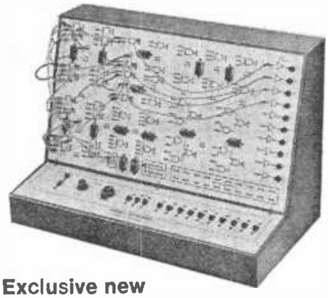

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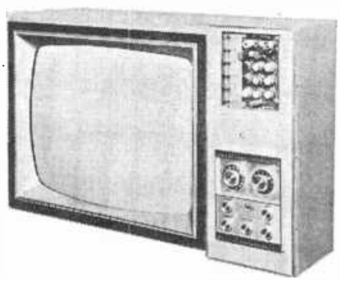

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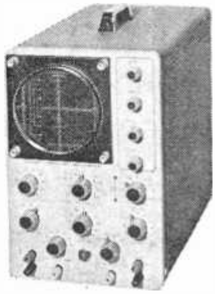

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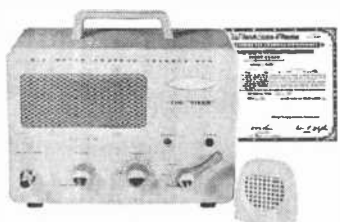

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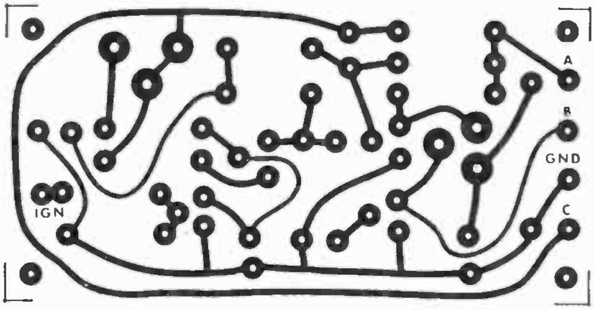
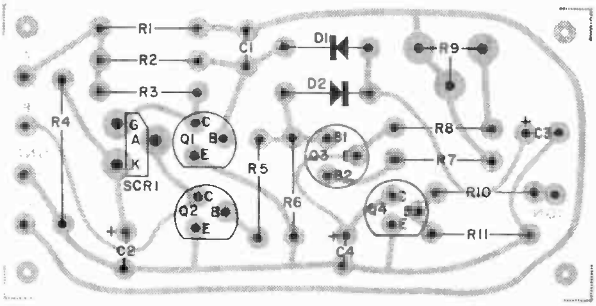


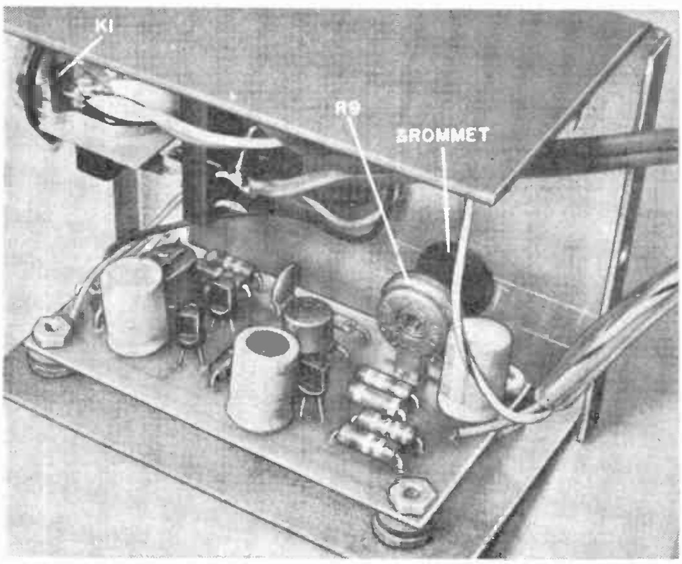

Fig. 2. Actual size foil pattern (above) and component installation (right) for the printed circuit board. Note polarities of semiconductors and capacitors.




relay contacts to the terminal strip—don't use anything smaller than #18 lamp cord or equivalent. The rest of the wiring can be standard #22 hook-up wire. Be sure to leave enough slack in the wires between the circuit and the terminal strip to remove the case.

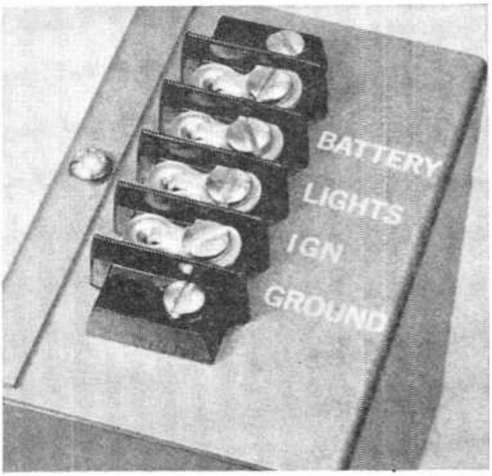
**Installation.** In selecting a location for the Time Out in your car, bear in mind that you may want to be able to reach the override switch (*S1*) from time to time and that the time delay will have to be adjusted when you first set up the system.

Electrical connections to the car are shown in Fig. 3. Locate the lead from the car's light switch to the battery and cut it. After splicing lengths of lamp cord long enough to reach the Time Out, connect the line which goes to the light switch to the terminal marked LIGHTS on




Relay K1 and override switch S1 are mounted on the metal chassis while the grommetted hole allows screwdriver adjustment of R9. Mount the PC board on four rubber shock absorbers to reduce vibrations.

the timer. The wire that goes to the battery should be connected to the BATTERY terminal on the timer. The GROUND terminal of the Time Out is connected to any convenient ground point such as under the head of an existing screw in the firewall or dashboard. The IGN terminal of the timer is connected to any convenient point which is live only when the ignition is on—such as the radio or heater fan motor. In most cases, the Time Out can be electrically connected at the vehicle fuse block.



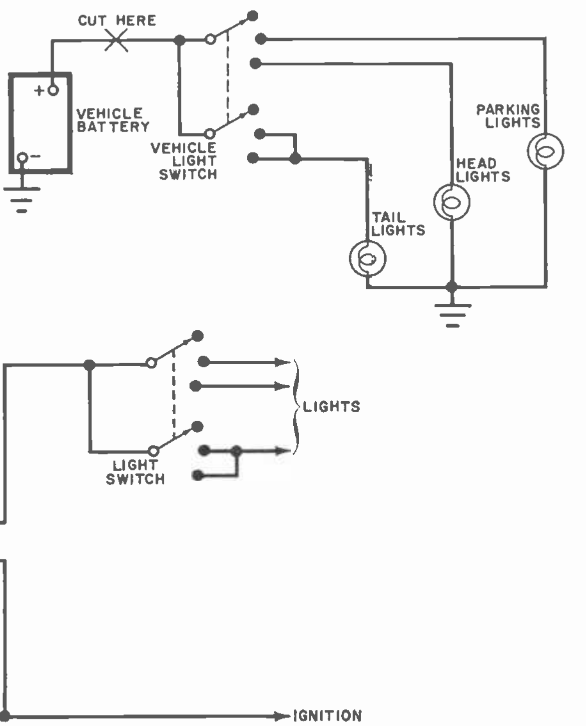
Connections to the vehicle wiring are made via a four-terminal barrier strip. Clearly identify the terminals to avoid wiring errors in installation.

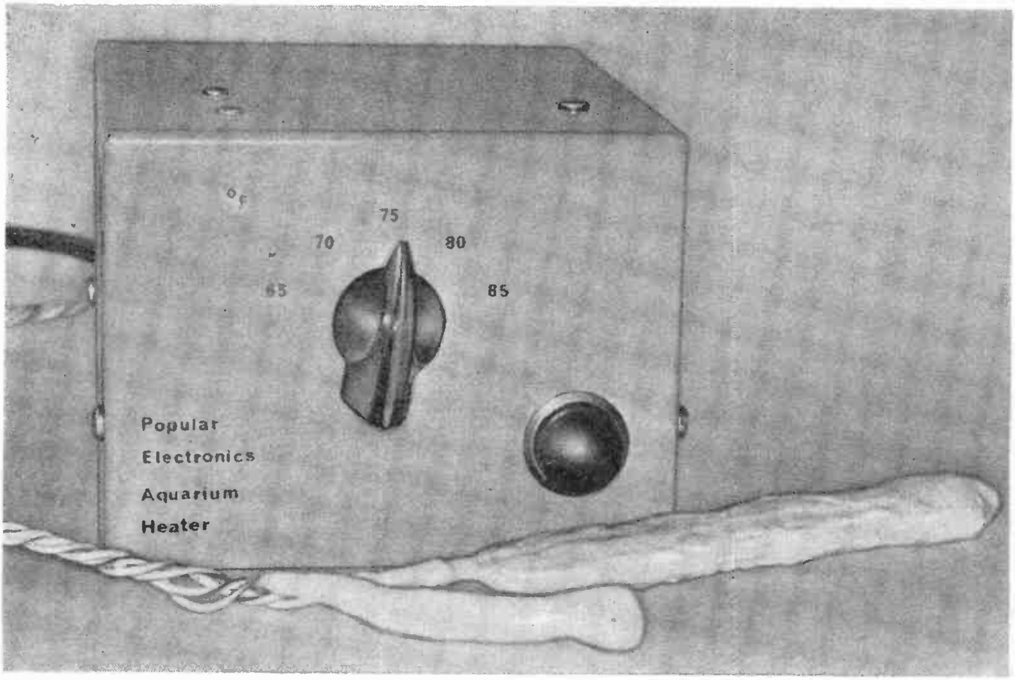
**Operation.** The Time Out does not interfere with the vehicle's conventional lighting and ignition systems. The lights should work normally except that, when the light switch is left on and the ignition is turned off, the timer will hold the lights on for a length of time depending on the setting of the timer and then turn them off. Clockwise rotation of the timer control (*R9*) increases the time that the lights stay on.

When installed as shown in Fig. 4, the Time Out will control both parking and headlights but will not have any effect on the brake lights, turn signals, or emergency blinkers. For emergencies, turn *S1* on so that the headlights will remain lit indefinitely when the ignition is off. Be sure to turn *S1* off when override control is no longer needed. —30—

Fig. 3. Electrical connections for a typical car are shown at the right.

Fig. 4. When installed as shown in diagram below, Time Out has no effect on brake lights or turn indicators.






# Electronic Aquarium Heater

FOR CHILLY FISH FINS

BY STACEY JARVIN

MOST AQUARIUM heaters available on the market today are unsightly, bulky, potentially unsafe, and often not reliable. They operate directly from the a.c. power line, employ an inaccurate bimetallic strip temperature sensor, and are enclosed in a glass test-tube affair, the top of which must be above the surface of the tank water. And, unless you are willing to shell out a lot of money, you cannot buy an aquarium heater that has a calibrated range of temperature settings.

The electronic aquarium heater described here overcomes the major disadvantages of commercial heaters. It is completely safe to operate, is capable of sensing temperature changes on the order of 0.1° F, can be hidden under the gravel or sand in your aquarium, and costs little more than a good commercial heater.

**Construction.** The heater element, *R7*, is a simple affair made up of twenty-four (24) 300-ohm resistors connected in parallel as shown in Fig. 1. To provide rigidity to the assembly, it is suggested that you "ladder" assemble the resistors between two heavy-duty wire busses.

Although the heater arrangement is rated at only 12 watts in free air, it will safely dissipate 50 watts of "heating" power when submerged in water.

Since the heater element is to be operated completely submerged, it must be water-tight. So, after assembling the element, carefully check the heavy wires you plan to use between it and the control/power circuitry for nicks and holes in the insulation. When you are satisfied the wire is safe to use, solder a 5′-10′ length to each of the heater element busses.

Now, coat the entire assembly and 2″ or 3″ of the wire with epoxy potting compound. (Use only a true epoxy, one that must be prepared from separate resin and hardener compounds immediately prior to use.) Do not make the

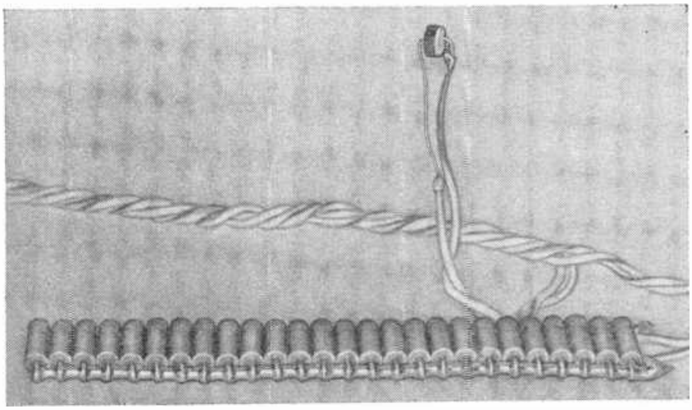


Fig. 1. Heater element (bottom) is assembled ladder fashion between two heavy-duty bus bars. Four-conductor cable is soldered to element and heat sensor.

coating too thick, but make certain that the entire assembly and the attached ends of the wires are completely sealed. A water leak from improper sealing will cause the heater to fail, and copper in solution from the wires will harm your fish.

After the first application of epoxy has set (wait at least 48 hours), put on a second coat and wait for it to set. If the outer coat is not completely set, it will allow volatile solvents to enter the aquarium water—obviously also harmful to your fish.

The temperature sensor, *TDR1*, is also operated while submerged in water. Consequently, the same steps must be taken in selecting interconnecting wires and epoxy potting it as above. When both assemblies are finished, they should appear as shown in Fig. 2.

The layout of the power supply/control circuit (see Fig. 3) components is not critical, permitting any type of chassis wiring you prefer. For your convenience, an actual-size printed circuit board foil pattern and component layout guide are provided in Fig. 4.

When mounting transistors *Q1* and *Q2*, locate them close together, but not touching, to minimize thermal differences in their base-to-emitter junctions. A small heat sink might be needed for *SCR1*; hence, its tab is shown bolted to the angle bracket. (If you substitute another type of SCR for the one specified in the Parts List, check its specifications to make sure that less than 500 microamperes at the gate will drive it into conduction.)

When all components are mounted on the circuit board, mount the board, transformer, fuse holder, potentiometer, and pilot lamp inside the utility box as shown in Fig. 5. The center-tap lead of the transformer can be cut short and the stub taped.

Twist the sensor and heater element wires together and route them and the line cord through rubber-grommet-lined holes in the rear of the utility box. Tie strain relief knots in both cables inside the box, and interconnect all components and assemblies. Assemble the box.

**Calibration and Use.** Immerse the heat-

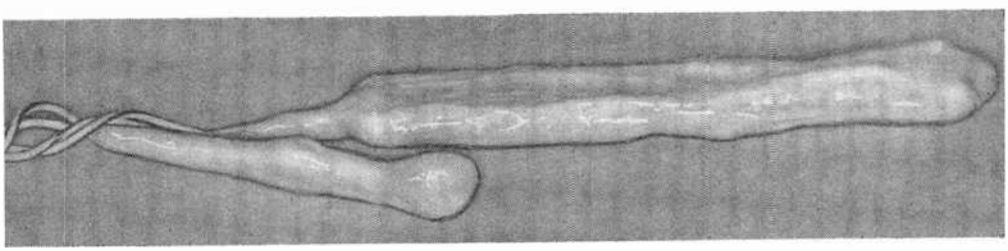


Fig. 2. Entire length of heater element and sensor, plus about 2" of connecting cables, must be thoroughly coated with epoxy potting compound to provide an airtight seal for the immersion elements.

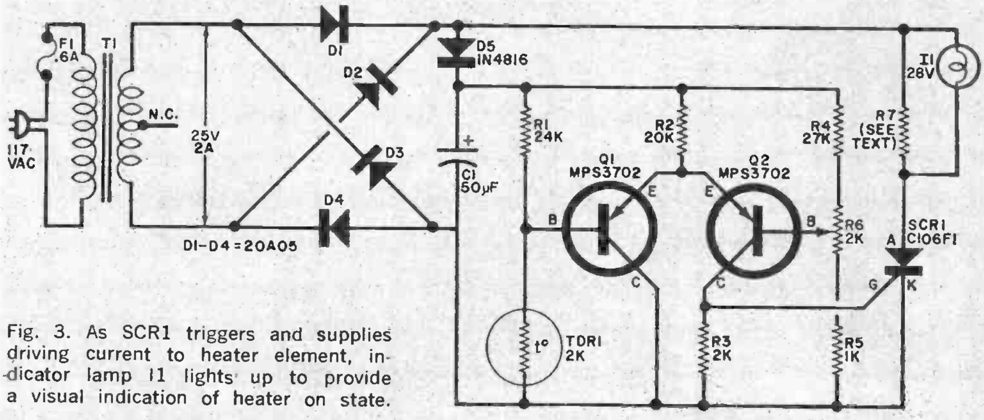



Fig. 3. As SCR1 triggers and supplies driving current to heater element, indicator lamp I1 lights up to provide a visual indication of heater on state.

## PARTS LIST

*C1—50-µF, 50-volt electrolytic capacitor*
*D1-D4—2-ampere, 50-volt diode (International Rectifier 20A05 or similar)*
*D5—1.5-ampere, 50-volt diode (1N4816 or similar)*
*F1—0.6-ampere fuse*
*I1—General Electric #GE 1819 28-volt lamp*
*Q1, Q2—MPS3702 transistor*
*R1—24,000-ohm*
*R2—20,000-ohm*
*R3—2000-ohm*
*R4—27,000-ohm*
*R5—1000-ohm*
(R1–R5: *All resistors ¼-watt*)
*R7—24 300-ohm, ½-watt resistors connected in parallel (see text)*
*R6—2000-ohm linear-taper potentiometer*
*SCR1—C106F1 silicon controlled rectifier*
*T1—2-ampere, 25.2-volt filament transformer (Allied Radio No. 54A4140)*
*TDR1—2000-ohm temperature-dependent resistor (Fenwall No. LP32J2)*
*1—5" x 4" x 3" metal utility box*
*Misc.—Control knob; a.c. line cord; rubber grommets; epoxy potting compound; hardware; hookup wire; solder; etc.*

er element sensor in a glass of cool water. NEVER operate the system unless the heater is immersed in water, preferably with the sensor in the same water. Plug in the line cord; the pilot lamp should immediately come on, indicating that the system is operating. In a few minutes, when the water heats up, the light should extinguish. Rotating the control knob clockwise should cause the light to come on again, counterclockwise to extinguish it. If the reverse happens, unplug the line cord and reverse the connections to the outer lugs of the potentiometer.

A thermometer of known accuracy is needed to properly calibrate the system. First immerse the sensor and heater in about a pint of cold water. Set the control fully counterclockwise, and plug in the line cord. Now stir the water constantly with the thermometer. As soon as the lamp extinguishes, remove the thermometer from the water and note the temperature indicated. Record your reading on the front of the utility box, in line with the index of the control knob.

Return the thermometer to the water and advance the control until the lamp just comes on again. Stir the water with the thermometer until the light again extinguishes. Record your reading. Continue this process until you have enough calibration marks. Then disconnect power from the system, and use a decal or

### ABOUT THE CIRCUIT

The voltage produced by *R1* and temperature-dependent resistor *TDR1* at the base of *Q1* is dependent on the resistance of *TDR1* (see Fig. 3). This voltage is then compared to a reference potential present at the wiper of temperature control *R6*, through the differential amplifier formed by the *Q1/Q2* circuit.

When, due to the cooling of *TDR1*, the voltage at the base of *Q1* changes by about 0.005 volt—corresponding to a temperature displacement of about 0.1° F with the components listed in the Parts List—*SCR1* fires and delivers 50 watts of power to heater element *R7*.

Transformer *T1* isolates the circuit from the a.c. power line and steps down the line voltage to a safe 25-volt level, eliminating the danger of electrical shock. Diodes *D1-D4* form a bridge rectifier circuit that supplies pulsating d.c. to *SCR1*, while *D5* and *C1* form a d.c. power supply for the differential amplifier circuit.

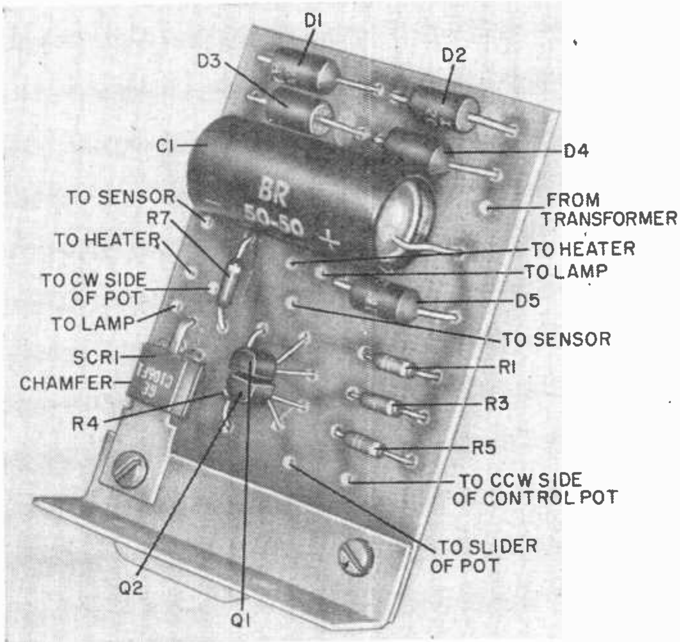
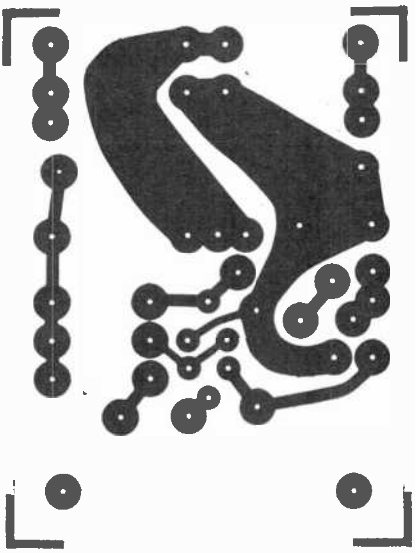



Fig. 4. Actual-size printed circuit board etching guide is given at lower left. Component locations and orientations on circuit board are shown in photo. For proper heat sinking of SCR1, bolt its tab to mounting bracket used for circuit board as shown.



dry-transfer lettering kit to finish the front panel.

In use, the heater element should be buried just under the surface of the gravel and/or sand in the bottom of your aquarium, in a location where the circulator can feed the water over it. Leave the sensor suspended in the water 2" or 3" "upstream" of the heater element. If desired, the sensor element can be camouflaged by the tank plants. Then plug in the line cord and set the temperature control.

The electronic aquarium heater has more than sufficient power for the standard 15-gallon aqarium. It will also serve a much larger aquarium if the water temperature is not to be too much greater than the ambient room temperature. -30-

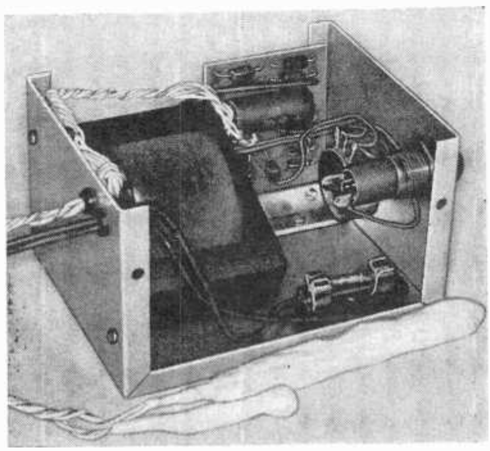
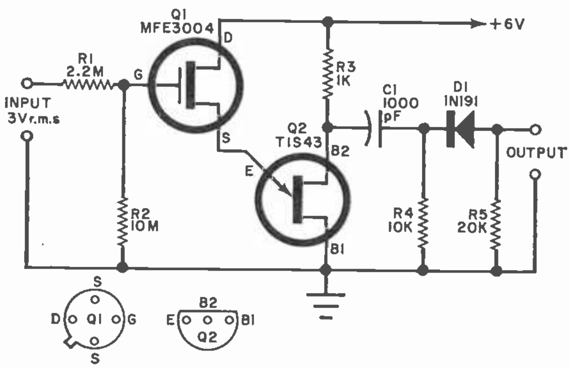


Fig. 5. Route a.c. line cord and heater element/sensor cable through rubber grommet lined holes.

# Micro-Sensitive Schmitt Trigger

BY FRANK H. TOOKER




The very high input impedance of the MOSFET, and the high values of the input resistors, enable this Schmitt trigger to have a negligible loading effect on the input signal source.

**PARTS LIST**

*C1—1000-pF capacitor*
*D1—Diode 1N191 (optional, see text)*
*Q1—MOSFET (Motorola MFE3004*)*
*Q2—UJT (Texas Instruments TIS43)*
*R1—2.2-megohm resistor*
*R2—10-megohm resistor*
*R3—1000-ohm resistor*
*R4—10,000-ohm resistor*
*R5—20,000-ohm resistor (optional, see text)*
**Available from Robert A. Glassman, 20 Hampton Road, Massapequa, N.Y. 11758. Price $1.30 each, postpaid.*

A SCHMITT trigger is a pulse-generating circuit that converts an a.c. input signal into a constant-level output pulse train of the same frequency. The trigger should not be confused with a flip-flop multivibrator, which is similar except that the output is at a frequency half that of the input.

A typical semiconductor Schmitt trigger has a fairly low input resistance and requires a certain amount of power from the input to drive it. Described here is a new approach to a Schmitt trigger in which a MOSFET drives a UJT. The result is a circuit with a very high input resistance (to prevent loading) and a very steep output pulse which can be used in most any triggering application. A prototype of the circuit shown in the schematic was checked at 60 Hz and found to have an input resistance equal to *R1* and *R2* in series, or 12 megohms.

The input signal level required to trigger this circuit is about 3 volts r.m.s. The input current is thus 3/(*R1* + *R2*) or about 0.20 microampere and the required driving power is less than ¾ microwatt! Unlike the more conventional Schmitt, the performance of this circuit is largely independent of the impedance of the driving source.

**How It Works.** The load resistance on the source of MOSFET *Q1* is the emitter-to-base-1 of the UJT *Q2*. Since this junction is reverse biased at voltages below the UJT firing level, the effective resistance in the *Q1* source circuit is very high.

The signal level at the source of *Q1* follows that of the input on the gate of *Q1*. When the positive-going excursion of the sine-wave input is sufficient to cause the source potential to reach the firing level of the UJT, *Q2* conducts. Its emitter-to-base-1 resistance then drops very rapidly and the drain-to-source current of *Q1* increases rapidly. This drives *Q2* hard into conduction. All of this happens very rapidly, of course, and when it does, it produces a very sharp negative-going transition in the potential at base-2 of *Q2*. When the signal input level (at the gate of *Q1*) drops below the hold-on value of the UJT, the latter stops conducting, and remains off until the next positive-going signal is applied to the input.

Capacitor *C1* and resistor *R4* differentiate the negative-going pulse at base-2 of the UJT while diode *D1* and resistor *R5* eliminate the small positive-going spike. In applications where the presence of this spike will do no harm, *D1* and *R5* may be eliminated.

Although the preceding description involves a sine-wave input signal, the circuit performs well with an input of almost any waveform as long as it has a positive-going (with respect to ground) excursion of sufficient amplitude. In circuits where the a.c. signal is superimposed on a d.c. level, the use of a coupling capacitor is suggested.

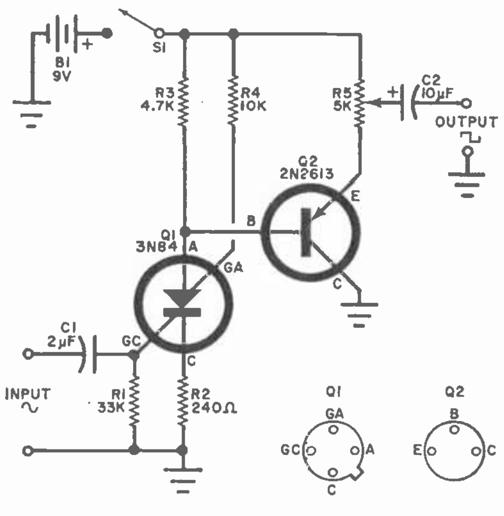
The glass insulator that forms the heart of a MOSFET is extremely fragile electrically and can be easily damaged by the static electricity of the human body or a soldering iron coming in contact with the isolated gate lead. For this reason keep all MOSFET leads in electrical contact with each other until they are fully wired into the circuit. When removing a MOSFET for any reason other than catastrophic failure, take the same precaution. -30-

# SCS Signal-Squaring Adapter

BY FRANK H. TOOKER

### PARTS LIST

*B1—9-volt transistor battery*
*C1—2.0-μF, 100-volt, Mylar capacitor*
*C2—10-μF, 12-volt, electrolytic capacitor*
*Q1—Silicon controlled switch (General Electric 3N84)*
*Q2—2N2613 transistor*
*R1—33,000-ohm*
*R2—240-ohm*
*R3—4700-ohm*
*R4—10,000-ohm*
*(All resistors ½-watt 2% tolerance)*
*R5—5000-ohm potentiometer, linear taper*
*S1—S.p.s.t. slide or toggle switch*




Taking advantage of the unique switching characteristics of the SCS makes for a simple, yet a highly efficient squarer.

TO MAKE square waves, it is customary to start with audio-frequency sine waves, amplify the waveform and then clip off the peaks (negative and positive). Sometimes it takes three or more circuit stages to achieve the desired result—especially if the square-wave output is to have fast rise and fall times and/or if the input sine-wave signal level is low.

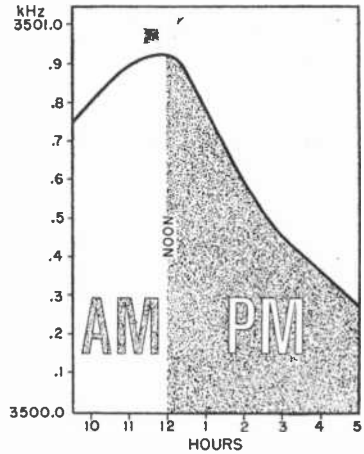
Another approach is to use a Schmitt trigger to square off sine waves. This usually requires two transistors for the trigger and another one as an emitter follower. The circuit can be simplified through the use of a single silicon controlled switch (SCS), which can be triggered by the input sine wave, with a single emitter-follower transistor for current amplification.

As shown in the schematic, *Q1* is the
(*Continued on page* 89)

# An Experiment With GRAVITY

## CHART THESE STRANGE FORCES WITH YOUR RECEIVER

**BY CDR. THOMAS APPLEBY**




Sample graph shows the plot of frequency changes versus time. Note that plotted line peaks out shortly after noon.

We are all familiar with the natural phenomenon known as gravity; but most of us tend to think of gravity on the surface of the earth as being constant. In fact, it is always changing in magnitude, due mainly to the forces exerted on the earth by the sun and the moon. The variations are, of course, so minute that only in the past few years have they been detected by specially designed, highly sensitive instruments. Oddly enough, my years of research into the phenomenon have shown that the average ham radio CW receiver can apparently "detect" changes in gravity.

The effects of gravity on a receiver might account for its drifting off frequency. Even after communications receivers have had time to become thoroughly temperature stabilized, frequency drifting and periodic returning are common occurrences.

**Taking advantage** of the effects the forces of the sun and the moon have on the earth's gravity, you can experiment on your own. All you need is a receiver with an ultra-fine scale on its tuning dial. (One that has 10 divisions for each minor division on the main tuning dial scale.) Remember that gravity variations are on the order of only $10^{-6}$ part of the weight of the mass in which they are produced. Although the effect of the variations is greatly amplified by your receiver, the end result is still minute.

**To perform the experiment,** disconnect the antenna and any other leads that might pick up a signal at either 3500 or 7000 kHz. In the morning, set the tuning dial of your CW receiver to either of the above frequencies and adjust the BFO for zero beat.

Allow the receiver to warm up for several hours. Then reset the BFO for zero beat. Every half hour or so after this, see if it is necessary to retune for zero beat. Record the new dial setting and make up a graph similar to that shown here. The frequency changes you record will be very small so use an expanded scale.

The recorded frequency variations will increase or decrease, depending on whether the magnitude of gravity is increasing or decreasing, respectively. You will notice that after the sun or moon passes the zenith, the curve will begin to bend downward. Also, the curve will change from day to day because of variations in the orbits of the sun and the moon. –30–

> *"A completely new branch of astronomy is opening up with the recent discovery of gravitational waves by Dr. Joseph Weber of the University of Maryland. The force of gravity is the most fundamental and least understood force in the universe; confirmation that gravity waves can be detected may well turn out to be as important as the discovery of radio waves by Heinrich Hertz in 1887."*
>
> —The Industrial Bulletin
> Arthur D. Little, Inc.

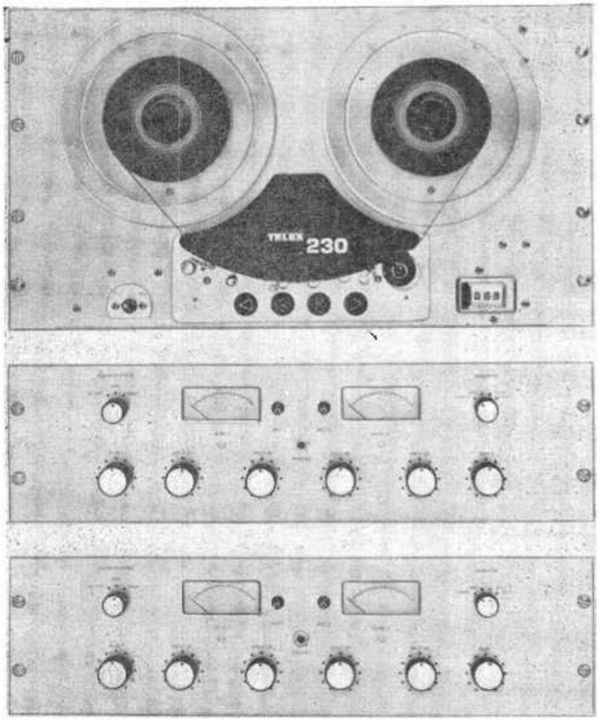
# The Stereo Scene

by Charles Lincoln

## NOW IT'S FOUR CHANNELS

THERE'S A NEW WORD on the stereo scene: "quadrasonic." It pertains to four-channel stereo systems—that's right, four channels! Now, don't start throwing out your two-channel stereo equipment right away, but be advised that quadrasonics is on the way.

The four-channel concept was initiated recently by a relatively small record company, Vanguard Recording Society, noted primarily for classical music offerings. Vanguard calls the system "Surround Stereo," a proprietary name, and they introduced it after several years of experimentation. They—and others involved in promoting quadrasonics—decided that the jaded audio buff needed a lift and that it was time for recorded music to get the kind of treatment that the industry has always talked about, but never managed to achieve—total realism. That last high-sounding term refers, of course, to the re-creation in the living room of aural effects actually experienced in the concert hall. Quadrasonics is another try at reaching the ultimate goal.




Basic "Quad/Sonic" system from Telex uses model 230 tape deck and two preamplifiers for playback only ($670). Setup to record and playback is $1544.

Listening to a quadrasonic system, sacked out in your favorite chair, you have a feeling that you're right in the middle of the orchestra and that you'd better not move or you might nudge one of the players. With popular music, the sound coming from each of the four speaker systems is generally of about the same value or volume. The engineers recorded it that way to create the illusion that the orchestra is all around you.

For classical or symphonic recordings the effect is somewhat different. In front of you, to the right and left, the music pours out just as in two-channel stereo. A little behind you and to the right and left, you hear the reflected or reverberating sounds of the orchestra, just as you would in a concert hall or recording studio. The result is a feeling that *you are there* or, vice versa, that the orchestra is in your living room (and you weren't aware that your room had such good acoustics, with resonances, etc!).

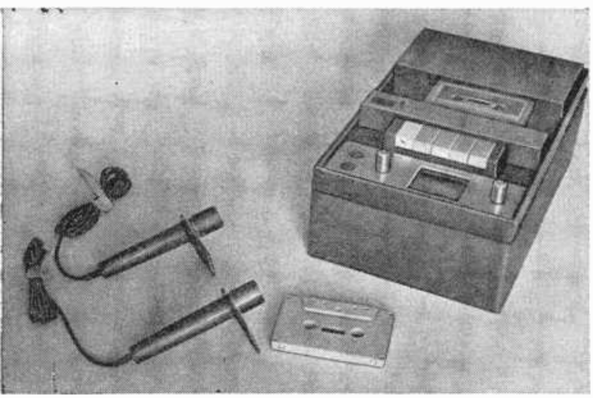
A quadrasonic system is different in another way, also. It enables you to *participate* in reproducing the music. By changing the control settings and/or speaker locations, you can create your own weird effect or overcome some acoustical deficiencies of your room. For example, by fiddling with the volume controls, you can make pop music from the two rear speakers louder than what comes from the front—which gives a real off-beat sound. Actually, the sound level can be changed between the speakers to give any sort of effect you want. The placement of the speakers—close to or distant from a wall—also affect the final sound.

When listening to classical music, you can vary the volume controls to give you the effect of sitting in the front row or in the back of the concert hall. The acoustic effect can be enhanced by raising the volume of the secondary channels to a point that seems just right for you, your mood, and your guests. If the work involves a chorus, you're in for a special treat since you can play the chorus up or down, as you wish.

**Approaches to Recording.** The recording industry has two schools of thought as to the approach that should be used in recording quadrasonic tapes (so far, there are only tapes—no discs). One school says that standards should be set for all recording companies to follow so that the listener doesn't have to fuss with the controls for each recording if he doesn't feel like it. The other school insists that individual companies and their recording engineers should have free rein to gimmick up the sound any way they see fit so that each recording has a "personality," with unique sound results.

The second group suggests that, not only will this approach in itself revolutionize the industry, it will further stimulate matters by making four-channel stereo a medium for which composers will create specific music.

**How Much Does It Cost?** So far the only quadrasonic recordings you can buy are reel tapes from Vanguard and, be prepared, they are $14.95 each. They have a playing time about the same as a long-playing disc. But you need a special deck to play them. At this time, the least expensive is a complete new play-back only deck from 3M/Wollensak for about $500. (The unit also records and plays back regular two-channel stereo tapes.) However, if you have a top-notch two-channel deck, it can be converted with heads from Nortronics or Michigan Magnetics. The heads will cost you about $100. Unless you're a good do-it-yourselfer, the conversion work will run between $25 and $50 additional. If all of this doesn't sound too good, stick around—Telex is coming out with a deck for under $300 and it should be on store shelves soon.



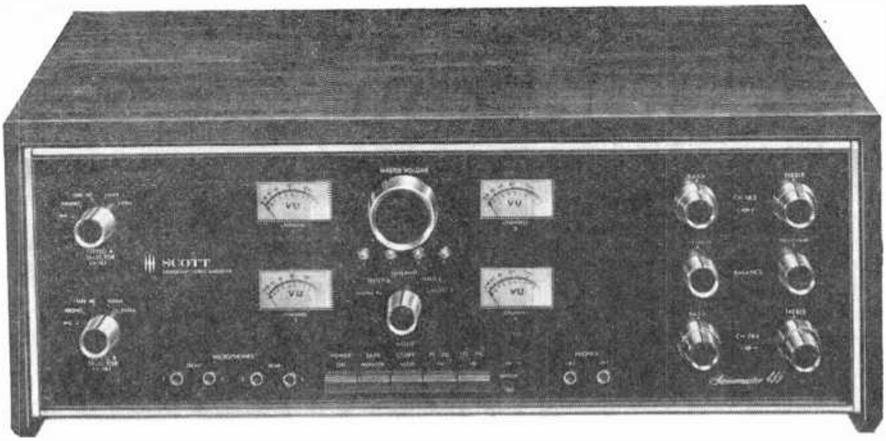
Lumistor model LP-1 cassette stereo tape deck is convertible to play and record 4-channel cassettes.

You will also need an amplifier with tape head inputs to accommodate the tape deck. You can use an existing stereo amplifier (or receiver) and buy another amplifier with similar capabilities for the second pair of channels. Or you might plunk down $600 and buy an H. H. Scott "Quadrant" amplifier, the first four-channel amplifier on the scene.

Another requirement is the second set of speakers. Again there are two schools of thought. One insists that the new speakers must be of the same calibre (hopefully high) as the ones you already have to get the best results. The other school contends that lower quality or smaller size units will do since they will handle "secondary" sound information. Since there are no standards for the recording process, we'd suggest you take the former approach for the long haul, and be prepared for whatever happens.

However, there is the matter of space. If you are in a space bind, you may have to take the second approach and buy smaller speakers. If this is the case, by all means choose top quality units. A new two-in-one speaker system from Jensen might be worth considering. Called "Stereo One," it is, in effect, two speaker systems in a single housing. In fact, using one of these in conjunction with an existing pair of speaker systems might be a space-saving way for you to enjoy four-channel stereo.

**What About FM Stereo?** Will quadrasonics be limited to tape? No. It is possible to broadcast four-channel stereo, and it is being done in Boston by two stations on a tandem basis. The programs—by the Boston Symphony Orchestra—are broadcast by WGBH-FM and WCRB-FM, with each generating two different channels. (The broadcasts can be heard in two-channel stereo also, with traditional equipment, with no degradation of signal.) Two complete stereo reception systems are required. If you have such equipment and want to hear these broadcasts, here's what you do. Set up one system so that you hear WGBH on your front left (right channel) and rear left (left channel). Set up the other system so that the left



H. H. Scott's "Quadrant" amplifier has 35 watts per channel rms output power at 8 ohms. At $600, it has integrated circuit preamps, non-capacitive direct-coupled complementary outputs.

channel of WCRB emanates from the right front and the right channel from the right rear. Make sure all speakers are in phase. If your setup is OK you should hear the voice of the commentator on the left channel only of each station or from your front right and rear left speakers. (As we go to press, two New York stations are planning similar broadcasts. Watch your FM schedules for the details.)

Can you expect quadrasonics in cassettes or continuous-loop tape cartridges? Again, there are rumors that they will be available eventually. How soon? Your guess is as good as ours.

And what about four-channel broadcasts from a single FM radio station? It can be done easily. In fact the Federal Communications Commission is already checking out proposed approaches to the matter. William Halsted and Murray Crosby, two pioneers of FM radio, are understood to be developing FM stereo multiplex systems that would enable a single station to broadcast quadrasonic programs by utilizing subcarriers now used for SCA services (background music, etc.) provided for commercial consumption by some FM stations.

As for the economics of quadrasonics—don't let the initial prices mentioned above scare you too much. In fact, sticking our neck out, we'd say that the economics will take care of themselves. When two-channel stereo came on the scene in record form in 1958, there was a big fuss about equipment costs. "A two-channel amplifier would cost nearly twice as much as a mono unit," was the cry! That turned out to be a lot of hot air. Allowing for the rise in the cost of living, today's stereo amplifier is no more expensive than a mono set of equal quality back in 1957—and in many ways it is better. Further, the industry took a hard look at the mono speaker system of 1957 and decided something should be done about all that bulk. Hence, the bookshelf concept, with top-grade sound coming from small boxes, in a broad range of prices.

As for recorded tapes, that $14.95 price won't hold for long. Once tape duplicators put their minds to it, they'll work out mass production techniques for four-channel tapes and prices will drop to a level close to two-channel tapes. Actually, the manufacturing costs are less of a problem than they might appear to be. Most of the high initial costs will be to offset research and development.

As for program material, there's plenty of it waiting to be worked into four-channel form. Record companies for several years have been recording in 8, 12, up to 24 channels, and these recordings can easily be remastered into four-channel form. It's actually a matter of public demand. If enough people bang on the table for quadrasonics, the recording people will come up with a deluge of tapes in no time.

Audio equipment manufacturers are a highly competitive bunch. Manufacturer A will not let Manufacturer B beat him to the market with a quadrasonic amplifier without offering him a run for the money with the lowest possible price. Tape recorder manufacturers are not going to stand by and let 3M/Wollensak, Teac, Telex and Crown have the four-channel field to themselves for very long. They're cooking up all sorts of sensibly priced equipment that the average guy on the Stereo Scene can afford. And this equipment will be able to handle "old-fashioned" four-track, two-channel stereo tapes as well as quadrasonic tapes.

Receiver manufacturers may have a long wait before they get the results of the FCC deliberations regarding quadrasonic broadcasting. The manufacturers might have to make relatively inexpensive adapters to use with existing stereo receivers, instead of a whole new breed. If they do have to come up with new receiver designs, you can bet they won't be priced at twice the cost of current sets.

**An Important Note!** Manufacturers are going to insure the reality of quadrasonics. It's money in their pockets to do so. In the beginning, their profits may be a bit less as they get the concept off the ground, but they'll make up for it with a bigger sales volume later. The facts of life are that four-channel stereo adds a big dimension to music reproduction and a lot of people are going to want that dimension. Audio equipment makers are going to make it relatively easy for them to get it.

One way of doing so might be through industry adoption of a new recording technique that was announced just as we were going to press. Called the Scheiber system after its inventor, Peter Scheiber, the technique permits the recording of "compatible" records and tapes that could be played as regular two-channel discs or tapes on existing stereo equipment, or as four-channel discs or tapes through a rig consisting of a two-channel preamp, a Scheiber *decoder*, a four-channel amplifier and four speaker systems.

The system takes multi-channel sound information and translates it into two/four-channel compatible information via a Scheiber *encoder*. This information is recorded on standard disc-cutting equipment or existing tape master instruments into a master disc or tape, to be used for making compatible LP's or tapes. The records can be played on a regular two-channel system with the same results you get from any good stereo record. With the aid of a two-channel preamp, Scheiber decoder, four-channel amplifier and four speaker systems, you could hear the record as quadrasonics. A compatible tape would play as a regular tape on your current two-channel recorder system; and, with the proper four-channel reproducing outfit and decoder, would play quadrasonically.

Stereo FM broadcasting stations could use the compatible material for playback as regular stereo or quadrasonically. You could also tape such program material in two-channel form on an existing recorder and play it on two channels or on quadrasonic equipment.

Basically, the Scheiber system would make the transition to quadrasonics a somewhat less expensive matter because it permits the use of disc and tape equipment that you now own. The concept is up for grabs to licensees who might want to make the encoding equipment for recording studios and the decoding circuitry for the folks at home. —30—

## LOOKS LIKE WOOD, BUT IT'S NOT

The General Electric Company has announced the development of a new process that completely eliminates the use of wood in the manufacture of furniture cabinetry while maintaining the appearance and texture of fine-quality hardwood. Their first product to use the new process is a stereo console in the Mediterranean style (model G915) which is finished on all four sides. (Servicing is accomplished by lifting the electronics portion out from the top.)

The process is called Acoustiform (a registered trademark) and it utilizes a combination of injection-molded polystyrene and pressure-foamed polyurethane resins. The cabinet is completely sealed except for the bottom, and no acoustical padding is required in the speaker chambers. The G915 has six front-mounted speakers and a solid-state stereo amplifier which provides up to 30 watts of peak music power. The unit also incorporates an FM/AM/FM-stereo tuner and a four-speed changer with repeat-play option, automatic shut-off and a mass-balanced tone arm with diamond retractable stylus. The suggested retail price of this first model is $299.95.

General Electric expects that eventually the use of the Acoustiform process will permit price reduction well below comparable models with wooden cabinets. In addition, they are working on designs in keeping with the latest modern furniture.

# the product gallery

REVIEWS AND COMMENTARY ON ELECTRONIC GEAR AND COMPONENTS

## PC BOARD KIT
## (D.S. Co. BI Cir-Kit)

WHEN YOU SEE a useful project in POPULAR ELECTRONICS, it's nice to note that an actual size printed-circuit foil pattern is included in the article. In many cases, a finished PC board is available at a modest cost; but if you have the time to spare, it's convenient to make your own—that is if you have the patience for all of that work with a fine brush and liquid resist. Now, with a Cir-Kit (F. Huddleston Assoc., Inc., 408 S. Rosemead Blvd., Pasadena, CA 91107; $6.95) making a PC board quickly is a snap!

The kit contains two pre-sensitized, copper-coated glass boards (one 3″ × 3″ and the other 6″ × 8″), a sheet of Mylar-backed ruby masking, a container of developer, a container of etchant, six rubber finger cots, and complete instructions.

To make a board, the first step is to lay the sheet of red masking material over the foil pattern in the magazine. Then using a sharp instrument, gently cut away all the red material where the foil is to be. When you are through, the actual foil pattern is transparent, while the remainder of the pattern is red.

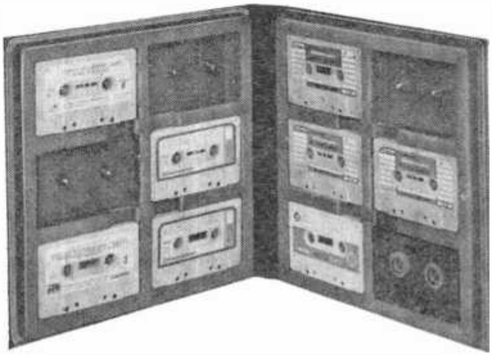
Now, in a darkroom, remove the appropriately sized sensitized board from its light-tight package. Place the transparent foil pattern over the sensitized surface of the board and expose to a strong white or ultraviolet light for a few minutes.

Pour the developer into a glass dish and immerse the exposed board. After a few minutes, remove the board and allow it to dry. Then place it in another glass dish containing the etchant. After etching and washing, dry the board, drill the necessary holes and install the components.

It's as simple as that. Depending on the type of exposure light available and how good you are at cutting the plastic pattern, a complete board can be made in an hour. —30—

Circle No. 87 on Reader Service Page 15 or 97

## "STOR-A-TAPE" CARRY-PAC
## (Modern Album & Finishing Co., Inc.)



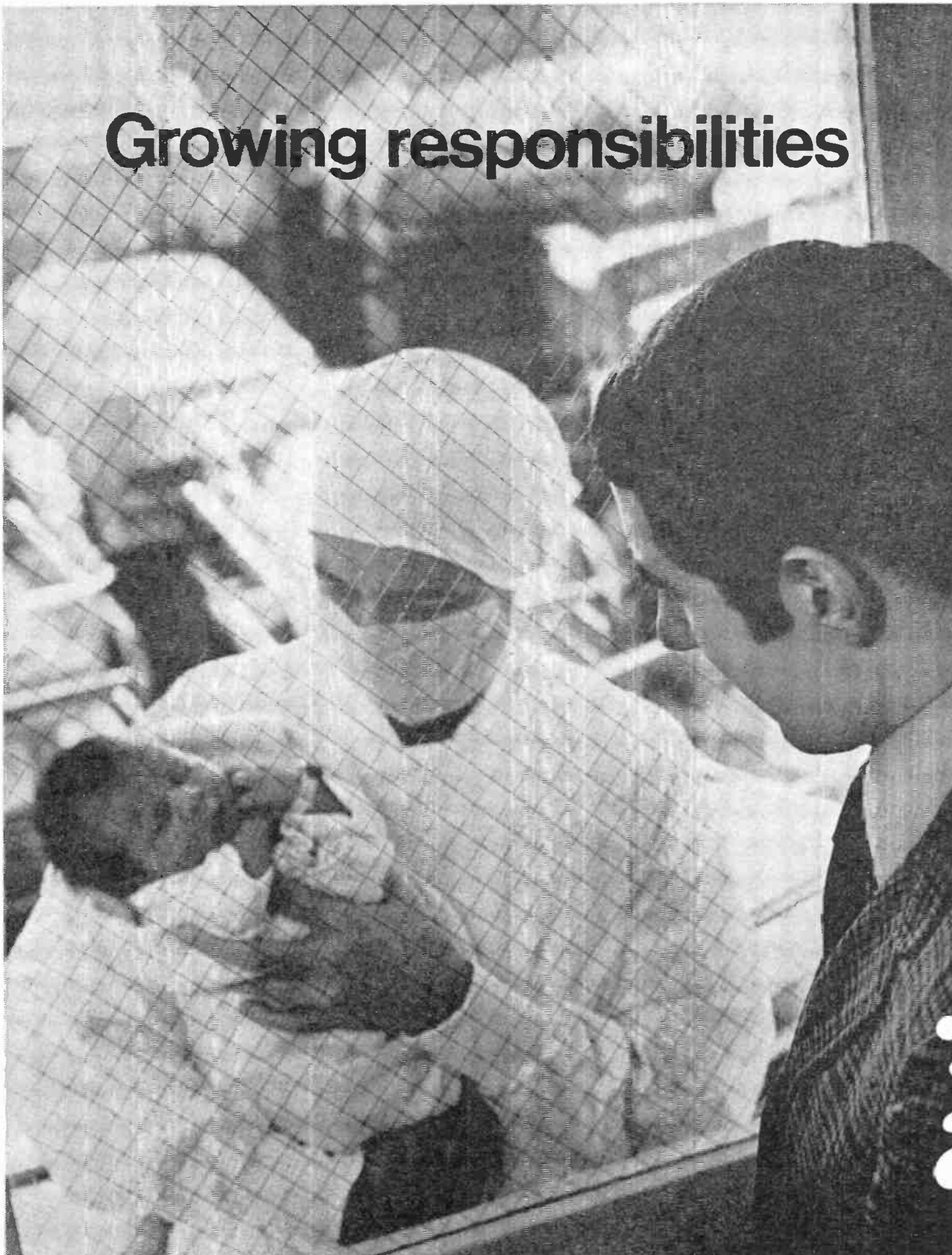
CASSETTES and cartridge tapes, unlike record albums and reel-to-reel tapes, look unsightly when just stacked on a shelf. Pigeon-hole modules are nice, but expensive, since they have to be made to order. What you really need, if you have a cassette or cartridge library, are the attractive booklike "Stor-A-Tape" Carry-Pacs made by the Modern Album and Finishing Co., Inc., 119-01 22 Ave., College Point, N.Y. 11356.

The Carry-Pacs are available in several different models for storage of six, eight, or twelve cassettes, or eight cartridges. Each Carry-Pac has a rigid bookbinder jacket, one or two plastic holders for the tapes, and an indexing strip or chart, depending on the model selected. The jackets are finished in either gold-embossed black leatherette, high-gloss blue, red, or psychedelic colors.

Four separate models are available: the CA-6, measuring 10½″ × 10¼″ × ¾″ and capable of storing six blank cassettes, sells for $3.49. The CA-8, measuring 10⅜″ × 7½″ × 1⅞″ and storing eight recorded cassettes, sells for $3.98. The CA-12, 10½″ square × 1½″ thick, sells for $3.98 and stores 12 blank cassettes. The 8T-8, 12½″ × 11⅝″ × 2¼″, stores eight cartridges and is $3.98.

Circle No. 88 on Reader Service Page 15 or 97

# Growing responsibilities



# ENGLISH LANGUAGE NEWS BROADCASTS FOR THE MONTH OF JANUARY

**Prepared by ROGER LEGGE**

## TO EASTERN AND CENTRAL NORTH AMERICA

| TIME-EST | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|
| 7:00 a.m. | Peking, China | 11.685, 15.095 |
| 7:15 a.m. | Montreal, Canada | 9.625, 11.72 |
| 7:30 a.m. | Melbourne, Australia | 9.58, 11.71 |
| 7:45 a.m. | Copenhagen, Denmark | 15.165 |
| 9:00 a.m. | Stockholm, Sweden | 21.585 |
| 6:00 p.m. | Montreal, Canada | 9.625, 11.945, 15,19 |
| 6:30 p.m. | Quito, Ecuador | 15.115, 17.88 |
| 6:45 p.m. | Tokyo, Japan | 15.445, 17.825 |
| 7:00 p.m. | London, England | 6.11, 9.58, 11.78 |
| | Moscow, U.S.S.R. | 7.15, 9.665, 9.685 |
| | Peking, China | 15.06, 17.673 |
| | Sofia, Bulgaria | 9.70 |
| 7:30 p.m. | Stockholm, Sweden | 5.99 |
| | Tirana, Albania | 6.20, 7.30 |
| 7:50 p.m. | Brussels, Belgium | 6.125 |
| | Vatican City | 6.145, 9.615, 11.725 |
| 8:00 p.m. | Berlin, Germany | 5.955, 9.73 |
| | Budapest, Hungary | 6.234, 9.833, 11.91 |
| | Havana, Cuba | 9.525 |
| | Madrid, Spain | 6.14, 9.76 |
| | Prague, Czechoslovakia | 5.93, 7.345, 9.54, 9.63 |
| | Rome, Italy | 6.01, 9.575 |
| 8:30 p.m. | Berne, Switzerland | 6.12, 9.535, 11.715 |
| | Cologne, Germany | 6.075, 9.735 |
| | Johannesburg, South Africa | 9.705, 11.875, 15.22 |
| | Melbourne, Australia | 15.17, 17.775 |
| 9:00 p.m. | Hilversum, Holland (via Bonaire) | 11.73 |
| | Lisbon, Portugal | 6.025, 9.68, 11.935 |
| | Peking, China | 15.06, 17.715 |
| 10:00 p.m. | London, England | 6.11, 9.51, 9.58 |
| | Moscow, U.S.S.R. | 7.15, 9.685, 9.70 |

## TO WESTERN NORTH AMERICA

| TIME-PST | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|
| 8:00 a.m. | Stockholm, Sweden | 15.315 |
| | Tokyo, Japan | 9.505 |
| 5:30 p.m. | Melbourne, Australia | 15.17, 17.775, 21.74 |
| | Tokyo, Japan | 15.235, 17.825, 21.64 |
| 6:30 p.m. | Johannesburg, South Africa | 9.705, 11.875, 15.22 |
| 7:00 p.m. | Madrid, Spain | 6.14, 9.76 |
| | Peking, China | 15.095, 17.673, 21.735 |
| | Prague, Czechoslovakia | 5.93, 7.345, 9.54, 9.63 |
| | Seoul, Korea | 15.43 |
| | Tokyo, Japan | 15.105 |
| 7:30 p.m. | Berlin, Germany | 5.955, 6.08 |
| | Stockholm, Sweden | 5.99 |
| | Tirana, Albania | 6.20, 7.30 |
| 8:00 p.m. | Budapest, Hungary | 6.234, 9.833, 11.91 |
| | Havana, Cuba | 9.525, 11.76 |
| | Lisbon, Portugal | 6.025, 9.68, 11.935 |
| | London, England | 6.11, 9.51, 9.58 |
| | Moscow, USSR (via Khabarovsk) | 11.85, 15.18, 17.88 |
| | Sofia, Bulgaria | 9.70 |
| 8:30 p.m. | Kiev, USSR (Mon., Thu., Sat.) | 7.15, 9.665 |
| 8:45 p.m. | Berne, Switzerland | 6.12, 9.72 |
| | Cologne, Germany | 6.145, 9.545 |
| 9:00 p.m. | Havana, Cuba | 11.76 |
| | Hilversum, Holland (via Bonaire) | 9.715, 11.73 |
| 10:00 p.m. | Moscow, USSR (via Khabarovsk) | 9.735, 11.85, 15.18 |
| | Tokyo, Japan | 9.505 |
| 10:30 p.m. | Havana, Cuba | 11.93 |

# SHORT-WAVE LISTENING

By **HANK BENNETT**, W2PNA/WPE2FT
Short-Wave Editor

## THE BOOTLEGGERS ARE ACTIVE

WE'VE HAD several reports of stations that would seem to be unauthorized broadcasters, more commonly known as pirates, bootleggers, or clandestine stations. On some occasions these stations broadcast for a short period of time, fearful, we assume,that they will be caught in the act, while others broadcast as though they were completely legal. The following four reports are of interest. Have you heard any of them?

A broadcast of short duration was monitored on the medium-wave frequency of 1580 kHz. It went like this: "This is Radio Jolly Rodger, Cincinnati, Ohio. It is twenty-seven minutes before two o'clock. (Logging time was 0533 GMT). If you hear this test please call collect area code 513 762 59—." This was repeated three times. The monitor logging this broadcast learned that there are no telephone numbers beginning with the digits "59" in the "762" exchange. QRM on the frequency prevented reception of the last two digits.

Another station was found on about 7320 kHz at 1955-2058 announcing as WJMS or WJNS with a location of Free State, U. S. Many Beatle records were played with announcements being made by a boy.

WGHP, "With God's Help Peace", was reported by one of the club bulletins as operating "regularly" on 7285 kHz at 0300-0400. Mutual network news is given at 0330 with the balance of the format being pop music, religious announcements and denouncements of "The Establishment". It claims to be a 50-kW broadcaster! No hint as to a location was given.

Some months back we had numerous reports of WBBH, New Brunswick, N. J., operating on frequencies between 7265 and 7400 kHz. This station was said to have been apprehended and operations terminated. However, new reports indicate a resumption of broadcasts on 7345 kHz at 2130-2230. Identifications include the callsign WBBH and the slogan "Crystal Ship". One program was called "The Bert Nazareth Show". There are no commercials and the turntable is said to run several r.p.m. too fast.

The above four stations were heard by DX'ers in Pennsylvania, New York, New York, and Maryland, respectively.

**Sunrise-Sunset Maps.** Don Erickson of the International Radio Club of America

This is the impressive transmitter building of "Radio Vaticano," Vatican City.

writes that he has local sunrise-sunset maps available for distribution on a first-come basis. The set of 12 maps permits determination of average sunrise and sunset for any location in the U. S. and Canada for any month of the year. Map corrections are within 10 miles of true average time. There is no charge for this set of maps other than 18¢ in U. S. or Canadian stamps for one set per person. For information on additional quantities, as well as for ordering your own set, please write directly to Mr. Erickson, 6059 Essex Street, Riverside, California 92504.

The "Sweden Calling DX'ers" Bulletin, published by *Radio Sweden*, terminated a few months ago for financial reasons, is again available. In mimeographed form, the bulletin is now issued fortnightly rather than weekly as before. We're glad to see this bulletin back on the scene.

Luxembourg anticipates placing a new 500-kW transmitter into service on 6090 kHz sometime this month. Keep your monitoring ears open for it.

An overseas bulletin confirms our information given last month of *Radio Andorra*. There is still no indication of any resumption of service on 5995 kHz. The medium-wave outlet has English at 0000-0100 Saturdays on 701 kHz.

With the coming of the New Year, *Radio Nederland* will institute a new series of programs about short-wave antennas to be broadcast on Thursdays in the English juke-box program. Printed text material will be available at no charge. Write to the station at Post Box 222, Hilversum, Holland.

## CURRENT STATION REPORTS

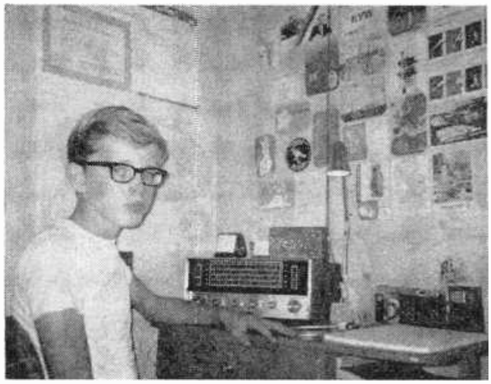
The following is a resume of current reports. At time of compilation all reports were as accurate as possible, but stations change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to Short-Wave Listening, P. O. Box 333, Cherry Hill, N. J. 08034, in time to reach us by the fifth of each month; be sure to include your WPE identification and the make and model number of your receiver.

**Afghanistan**—*R. Afghanistan*, Kabul, has English to Europe daily at 1800-1830 on 11.790 kHz (50 kW) and 15,265 kHz (100 kW) and to neighboring countries at 1400-1430 on 4775 kHz (100 kW).

**Albania**—*R. Tirana* was noted on 9495 kHz at 1530 with their IS, anthem, and s/on in Arabic; news continued to past 1536.

**Angola**—A logging, listed as tentative, is that of *R. Moxico*, Luso, on 5126 kHz (listed for 5137 kHz) at 2330-0100 s/off with native and U. S. pop tunes and Portuguese anmt's. S/off is with "A Portuguesa".

**Australia**—*R. Australia*, Melbourne, operates to N.A. at 0100-0300 on 15,170 kHz (new), 17,775 kHz (replacing 17,840 kHz) and 21,740 kHz (unchanged). English is also heard on 9550 kHz at 1500 to past 1634 with a newscast at 1500. Domestic stations VLM4 (Brisbane) and VLT4 (Port Moresby, Papua) have been heard on 4920 and 4890 kHz respectively until 1400 s/off. . . . The Australian



Chuck Kuchta, WPE3HYY, Pittsburgh, Pa., uses a Heathkit GR-64 receiver, a Realistic Patrolman for VHF listening and a Westinghouse tape recorder. He has 33 countries and 12 states logged.

Post Office time station, VNG, 12,000 kHz, is often good at 0500 and 0900. Other frequencies in use include 5500, 7500, 20,500 and 25,500 kHz. The ID is given five times on the hour. Reports go to Radio Section, Post Master General's Office, 57 Bourke Street, Melbourne.

**Biafra**—*R. Biafra*, Enugu, was heard good but with poor modulation from 0500 s/on in English on 7301 kHz. This home service was not found on 6145 kHz at this time.

**Brazil**—PRF7, *R. Cultura de Campos*, Campos, 4950 kHz (listed 4955 kHz) recently moved to this frequency to avoid QRM from *R. Nacional de Colombia*. It is heard in Portuguese daily to past 0100. . . . ZYE2, *R. Difusora do Macapa*, Amapa, 4910 kHz (listed 4915 kHz) is noted occasionally in Portuguese from 0900 s/on. . . . Others being heard include ZYB22, *R. Rio Mar*, Manaus, 9695 kHz, from 0045 with a soccer game, and *R. Clube de Varginha*, Varginha, 4823 kHz, from 0024-0057 s/off with music and ID's.

**Brunei**—*R. Brunei* was monitored on 4863 kHz at 1330-1430 s/off in all Malay with a lengthy reading of a religious (?) nature, and on 7215 kHz at 1410-1432 s/off with classical and light music and an English ID at s/off. They want reports for 7215 kHz.

**Cameroon**—*R. Buea*, Buea, 3971 kHz, now s/on at 0430; it was noted at 0453 in French with some music.

**Colombia**—A new outlet on 5943 kHz is causing some confusion among the reporters; ID's of *Emisora Colombia* (or *Colombiana*) are reported by some while others claim it is *R. Horizonte* moved from 5970 kHz. We noted one time when both ID's were given together. It's being heard from 0215-0500 with news at 0230-0240 and all Spanish programming of music and commercials for the balance of listening time. . . . *Emissora Atlantico*, Barranquilla, is active on 4906 kHz as noted in Spanish to 0500 s/off. . . . *R. Sutatenza*, Bogota, was heard on 5060 kHz from 0150 in Spanish music and comments.

**Costa Rica**—*R. Reloj*, San Jose, is again moving around in frequency, its latest stop being on 6055 kHz as logged at 0037 with some commercials and ID's.

**Ecuador**—A frequency change for *R. Canal Manabita*; it is now on 4823 kHz and heard 0345-0433 with L.A. music, many ads, news, and a time check after each news item. Given location is Portoviejo. . . . *R. El Progresso* is up to 4730 kHz; music and ID's heard from 0330. . . . HCMB5, *R. Popular Independiente*, Cuenca, 4807 kHz, is often good at 0500-0515 with all-Spanish music and ads.

*(Continued on page 94)*

# TWO WAY REACTIONS

BY G. H. REESE, KCN6990

## BIG YEAR FOR CB

AT THE BEGINNING of a new year, it is appropriate to take a look backward and another one forward to see where we have been and where we are going. Last year was the eleventh for Citizens Two-Way Radio. The FCC granted about 160,000 CB licenses in 1969, bringing the total issued since 1958 to 1,525,000.

There were many interesting "happenings" in CB in 1969. We're sure a record number of jamborees and other mass meetings were held. But of more importance, thousands of CB'ers performed outstanding services in the wake of Hurricane Camille and other less-publicized disasters were dealt with with equal efficiency throughout the year.

Although it wasn't a disaster (depending on your point of view), the Woodstock Music and Art Festival, in Sullivan County, N.Y., was certainly a newsworthy event, and CB'ers were there too. When the expected crowd of 50,000 turned out to be 450,000 and help in the form of food, water, and medical aid was needed, CB'ers volunteered. Nearly 40 mobile units composed of Civil Defense workers relayed information on traffic and dispatched ambulances. A steady communications link was maintained for three full days in this unusual event.

**Chicago Area WARN.** Citizens Radio operators are cooperating with the Chicago office of the U.S. Weather Bureau in observing and reporting weather phenomena. Loosely organized into what is called WARN (Weather Auxiliary Reporting Network), this league of CB clubs, REACT teams and interested individuals covers all of Chicago plus some of the suburbs including Elgin and Waukegan, Illinois.

Made up of about 30 base stations and 200 mobiles, the WARN system goes into operation when severe weather (such as a tornado) is threatening. Any mobile unit spotting something worthy of reporting transmits the information to its assigned base station. The information is then dispatched by telephone to the Weather Bureau radar center where it is evaluated in relation to other reports and the radar scanning. WARN members use a restricted Weather Bureau telephone number to communicate with the radar center. If the radar center detects something that requires field verification, it contacts one of the base stations closest to the scene by telephone so that an on-the-spot report can be obtained from a mobile unit.

Bill Bishoff is probably the key man in the WARN operations. He is a Science Teacher at Glenbrook South High School in suburban Glenview, Ill., and is keenly interested in meteorology. Monthly meetings of the group are usually held at the high school. Training in weather observation and reporting is given to all participants by Bill and members of the Chicago Weather Bureau. Weather Bureau films and literature are very helpful to all.

Citizens Radio groups interested in cooperating in this program, which falls under the Weather Bureau program known as "Operation Skywarn," should direct inquiries to the nearest U.S. Weather Bureau. This is a very worthwhile and educational activity for your CB club.


Insignia, in form of embroidered patch, is available to official teams from National Headquarters.

**License Plates!** California has adopted a program whereby you can get your CB call-letters on your auto license plates. There is an extra cost, but many CB operators will be happy to pay it. Many groups have been campaigning to get this service in other states. We'd like to get a report from readers in states where the service is available and from those who are campaigning to get it in their state. We will publish a roundup in an early spring issue.

**Channel 9 Approval Around Corner.** By the time you read this, the FCC will be reviewing comments on its decision to modify the CB Rules and set aside channel 9 for use only for emergency communications involving the safety of life, the protection of property, or assistance to motorists.

Channel 9 is now designated for emergency communications by REACT, and many other groups, and it is expected that the new proposal to modify the CB Rules will win instant approval. Also under consideration will be the substitution of either channel 8 or 15 to replace the interstation communications now conducted on channel 9.

The FCC, in making this not-too-surprising late October announcement pointed out that use of channel 9 does not preclude emergency communications on any other CB channel. And, the FCC stressed that the success of the plan to use channel 9 depended on self-policing by CB'ers.

**CURRENT REACT NEWS**

**Norfolk, Va.** . . . Base station for Norfolk REACT is located in the police station of the 4th Precinct in Ocean View. The team also uses the station for a meeting place. This close cooperation with the local police has resulted in benefits to both parties.

**Dover, Del.** . . . Central Delaware REACT and MaryDel REACT members were called upon to provide security for a downed private aircraft. The plane had crashed in a farmer's field about 50 miles from Dover. The REACT'ers guarded it from 1:30 a.m. until the removal crew came at 1:30 p.m. the next day.

**Mexico, N.Y.** . . . Oswego County REACT is organized for full cooperation with local law enforcement agencies for emergency communications. Its rescue unit is equipped with snowmobiles, boats, and four-wheel drive vehicles, all owned by team members. They have conducted a Courtesy Patrol on Interstate Highway 81 on weekends and holidays.

**Terre Haute, Ind.** . . . Wabash Valley REACT has been busy assisting in searches for lost persons, fires, a fairground accident and a train derailment. The latter, at Lewis, Ind., included seven cars loaded with bombs! The team provided 35 units, and they worked for two days.

**Toledo, Ohio.** . . . Lucas & Wood County REACT conducted a Labor Day Courtesy Patrol on a 17-mile section of the Detroit-Toledo Expressway. The 60 team members cooperated with local police and the Ohio State Highway Patrol to render assistance to any motorist who needed it. The patrol was in effect from 6:00 p.m. Friday to 1:00 a.m. Saturday and from noon to midnight Saturday, Sunday, and Monday. REACT member Frank Grant stated, "We perform a number of services. If a motorist is out of gas, we give him enough to reach a gas station. We also change tires, work traffic details to assist police when an accident ties up traffic, and some of our members who are trained in first aid help out at accidents."

**Ottumwa, Iowa.** . . . Examination of the log of

*(Continued on page 96)*


Members of Lower Pinellas REACT Team serve coffee during "Bring 'Em Back Alive" safety program conducted in St. Petersburg, Fla. area. Seven such stations were manned by other area teams and clubs.

# AMATEUR RADIO

By **HERB S. BRIER,** W9EGQ
Amateur Radio Editor

## AN OSCAR FROM RUSSIA?

WILL THE NEXT OSCAR (Orbiting Satellite Carrying Amateur Radio) be launched from Russia? It is a possibility. At the 1969 meeting of the Region 1 (European) branch of the International Amateur Radio Union, the delegates voted to approach the Russian government through the Amateur Radio Section of the Russian Sports Federation. The action was prompted by the long delay in American launching of the European OSCAR unit built by DJ4ZC. Part of this delay has been occasioned by U.S. space technicians' questioning whether the European bird was rugged enough to function.

At present, the U.S. Amateur Satellite group is completing tests on the Australian "Australis" transponder for a probable early-1970 launch as OSCAR-V. In a speech reported in *Break-in* (New Zealand) Michael J. Owen, VK3KI, Federal President of the Wireless Institute of Australia, stated that the "Australis" was designed and built by Australian university students and is the second space vehicle built in Australia. The first one was built by professionals using imported parts almost exclusively, while the "Australis" is built of components the constructors made themselves or obtained locally.

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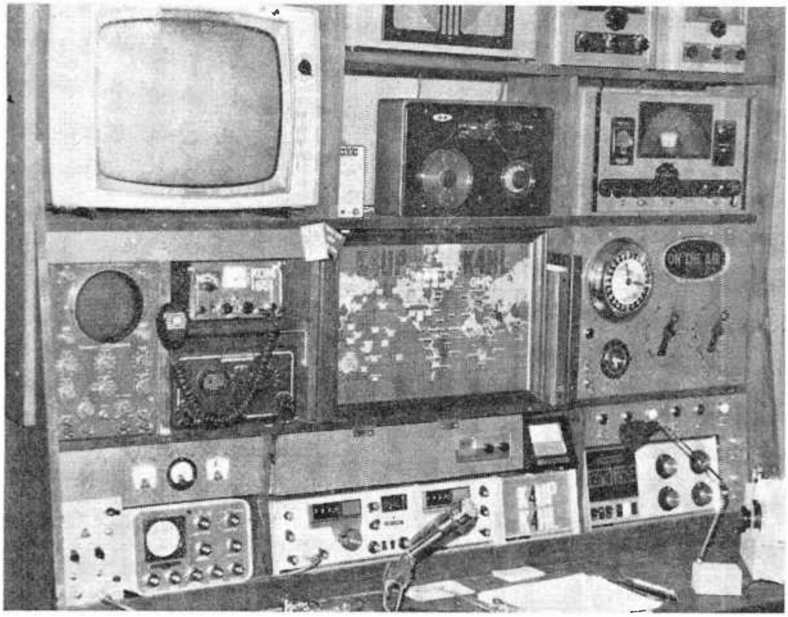
AMATEUR STATION OF THE MONTH


David Selkowitz, WAØQYS, 2904 Greenway Dr., Bettendorf, Iowa 52722, earned his Novice license at 14 and is now studying for Extra class. He usually works 15-meter CW with a Drake T-4XB transmitter and R-4B receiver and a Hy-Gain 14-AVQ vertical. He has logged 30 countries and 49 states and is firmly convinced that Vermont doesn't exist. He gets a 1-year subscription to POPULAR ELECTRONICS for winning this month's Amateur Station Photo Contest. You can enter the contest by sending a picture (preferably black and white) of yourself at the controls of your station with some details about your amateur career to: Amateur Contest, Herb S. Brier, P.O. Box 678, Gary, IN 46401.



This is the station of Dr. Shailer Peterson, W5PJ, K4HL, Associate Dean of the School of Dentistry, U. of Tennessee, San Antonio branch. When not operating the National NCX-5/NCL-2000 shown here, he is probably mobile on a Drake TR-4.

**More on Hurricane Camille.** As soon as they realized the seriousness of the situation on the Gulf Coast, K4VFY, WA4IMC, WA4LBM, and W9CTA/4 loaded their equipment into a van (lent to them by an automobile dealer) and headed for the Gulfport, Mississippi, disaster headquarters. They were dispatched to Pass Christian, the hardest hit of all the Mississippi communities, to a schoolhouse where they supplied communications to the outside world. They set up two stations, one on CW and one on phone and sent out over 500 messages. Their operations continued for 48 hours until the authorities ordered the evacuation of Pass Christian.

Meanwhile, back in Florida, the West Florida Phone Net was in continuous session for 96 hours, before, during, and after the hurricane. Club members kept WA4ECY, station of the Pensacola Amateur Radio Club, on the air 24 hours a day to handle emergency and priority messages. Incidentally, anyone who doubts the value of amateur emergency and traffic nets could have gotten an education from listening to the efficient way messages were handled on the West Florida Phone Net (and other nets composed of experienced traffic handlers) compared to the haphazard procedures used by amateurs who were long on enthusiasm and short on message-handling experience. (Via "Florida Skip")

**News From Here and There.** H. R. "Duke" Ellington, W6OZD, reports in the *WCAR-Sentinel,* Carson City, Nevada, that effective January 1, all Mexican amateur radio licenses are to be cancelled until each licensee passes a 10-WPM code test. Mexico will not issue any temporary amateur operating permits (the means through which foreign amateurs have been permitted to operate in Mexico) until the new program is completed. A reciprocal operating agreement between Mexico and the United States is expected to be signed soon, however. We understand that Mexican objection to some legal mumbo-jumbo required by U.S. regulations has held up completing the agreement.

Latest English amateur license figures (June, 1969) show that there are now just under 15,000 amateurs in Great Britain. Also in "G-Land." an additional license is required for mobile operation. Three thousand hams have the mobile endorsement. English amateurs really use their mobiles and the number of attendees at rallies rival those at the largest U.S. hamfests.

Both English amateur magazines, *Short Wave Magazine* and *Radio Communications,* have commented on the increasing number of English amateurs interested in the VHF/UHF amateur bands. This contrasts with the drop in the number of Tech-

(*Continued on page* 91)

# SOLID STATE

By **LOU GARNER,** Semiconductor Editor

## WHAT'S IN STORE FOR 1970?

HERE IT IS January, 1970 and time for us to face up to the predictions made in our January, 1969 column. These were our predictions for 1969 and how we scored on them:

*Development of an r.f. power transistor capable of handling well over 100 watts.* Home run! Several high-power r.f. transistors are now on the market and RCA has announced the development of an experimental transistor capable of generating 800 watts at 1 MHz. Fairchild's 2N5008, a typical unit, has a 100-watt power dissipation rating and a minimum $f_T$ of 40 MHz. Used as an efficient class B or C amplifier, the 2N5008 can deliver considerably more than 100 watts. A British manufacturer, Redifon Ltd. (Broomhill Road, London S.W.18, England), has utilized several high-power r.f. devices in the design of a new fully transistorized, wide-band r.f. amplifier that can deliver 100 watts over the 1.5- to 12-MHz frequency range when driven with as little as 100 mW.

*A solid-state oscilloscope (either kit or factory-built) for approximately $100.* Strike out! Although solid-state scope prices have dropped somewhat, inflation has taken its toll and we haven't heard of any unit offered in the $100 range.

*IC's at over-the-counter prices of $1 (or less) each.* Home run! Motorola's MC715P and MC718P dual 3-input gate IC's are offered at catalog prices of $1.00 each in unit quantities, while RCA's CA3053 differential cascode amplifier IC goes for a little over 80 cents. If you prefer kits, Motorola's HEK-1 kit contains five digital IC's for less than four dollars, while RCA's KD2117 includes five linear IC's at under $5.00.

*Another major firm introducing a line of experimenter/hobbyist semiconductor devices.* Home run! Both Sylvania and GC Electronics' Calectro Division are now offering broad lines of blister-packaged semiconductor devices intended for experimenter applications.

*Expanded use of solid-state equipment in the war against crime, including the use of radios by foot-patrol officers.* Home run! Space limitations prohibit a detailed discussion of the many, many ways electronic equipment is now being used by our law enforcement agencies, but a number of cities are now equipping foot patrolmen with two-way walkie-talkies when assigned to critical areas. A closed-circuit TV surveillance system operated by the police to monitor the main business district is being used in Olean, N. Y., while some Los Angeles buses are equipped with two-way radio systems incorporating a "silent alarm" feature to signal police in the event of a hold-up or other emergency.

*Lower prices for semiconductor lasers, making them suitable for some experimenter applications.* Home run! In case you missed the item in our March (1969) column, Laser Diode Laboratories, Inc. (205 Forrest St., Metuchen, N. J. 08840) offers a gallium-arsenide infrared injection diode laser for only $18.00. Identified as their model LD11, the device has a peak power rating of 5 watts in pulsed applications.

*Higher manufacturing efficiencies, resulting in lower prices for FET's as well as high-voltage diodes and bipolar transistors.* Home run! As predicted, FET prices dropped appreciably during the year with, today, several types available for under one dollar—a few for as little as 75¢. Among the bipolars, prices have continued to nosedive and one manufacturer (Motorola) quotes prices for only 19¢ each in quantities of 100 for certain plastic encapsulated silicon units. High-voltage silicon rectifiers, once relatively expensive, are now cheaper than many comparable vacuum tubes. A 10,000-volt Varo type VF5-10, for example, is priced at under $2.00 in Allied Radio's current catalog.

*Development of new microwave semiconductor devices which can challenge even the more exotic vacuum tubes.* Home run! New specialized types of transistors, varactors, and related devices have performance capabilities comparable to those of traveling-wave (TWT's) and other exotic vacuum tubes. United Aircraft's type S-1050 *npn* planar transistor, a typical unit, can deliver 10 watts at 1 GHz with 5 dB gain. A solid-state multiplier developed by Applied Research, Inc. uses a combination of transistors and varactors to deliver 250 mW, at 16 GHz, while TRW Semiconductors, Inc. is now offering a series of microwave amplifiers with outputs up to 10 watts at frequencies as high as 2.3 GHz. In fact, microwave devices are even within the reach of the average hobbyist. See William F. Hoisington's "Microwaves For The Beginner," (POPULAR ELECTRONICS, November 1969).

So we scored 7 home runs and 1 strikeout in eight times at bat. Mets, move over!

**Things to Come.** During 1970, watch for: *Light-emitter diodes (LED's) at prices comparable to those of long-life incandescent lamps.* . . . linear IC's with built-in special input devices, such as sensors or pick-ups. . . . *moderate power (5 to 10 watts, or more) amplifiers at prices competitive with discrete component designs.* . . . a virtually complete switch-over to solid state circuitry in consumer products. . . . *the introduction of r.f. IC's with integral, rather than external, inductance elements.* . . . the formation of a new corporation offering a broad range of specialized semiconductor-operated products at the consumer level. . . . *the use of lasers as production tools in the manufacture of solid-state devices.* . . . the introduction of an unusual new solid-state device—perhaps an IC opto-coupler or monolithic microwave circuit. . . . *the production of "all-IC" consumer items with few, if any, discrete components, except for electro-mechanical devices, such as loudspeakers and controls, or physically large units, such as transformers.* . . . the development of a new solid-state memory system suitable either for a computer or, possibly, an "electronic" camera.

**Manufacturer's Circuit.** The 3-transistor regenerative receiver circuit illustrated in Fig. 1 is one of some ten projects suggested in the booklet furnished with the "S-DeC" breadboard kit marketed by the Intratec Division of the British Aircraft Corp. (399 Jefferson Davis Highway, Arlington, Va. 22202). Although intended for the AM broadcast band, the basic circuit can be used at other frequencies simply by changing the front-end tuning coils. Other projects described in the booklet include an electronic flasher, a binary counter, an audio amplifier, a CPO, a wireless microphone, a light-operated switch, and a Wien-bridge oscillator. The "S-DeC" kit itself was described in detail in the July 1969 "Product Gallery."

Referring to Fig. 1, the design features an r.f. detector/amplifier and a two-stage audio section with loudspeaker output. In operation, r.f. signals picked up by the antenna coil assembly are selected by tuned circuit *L1-Ct* and detected by diode *D1* in conjunction with *Q1*. The first stage is interesting in that *Q1* has a *dual* collector load, an r.f. choke, *RFC*, shunted by *R1*, and a fixed series load resistor, *R3*. Thus, *Q1* serves both as an r.f. amplifier (furnishing a regenerative feedback signal through *C2* to *L1*) and as a detector-audio amplifier. Base bias is established through *R2*. The audio signal developed across *R3* is coupled through *C4* to gain control *R4* and from there through d.c. blocking capacitor *C5* to *Q2*'s base electrode. Base bias for *Q2* is supplied through *R6* while *R7* serves as the collector load. The amplified audio signal appearing across *R7* is applied through coupling capacitor *C6* to the power amplifier, *Q3*, which, in turn, is direct-coupled to

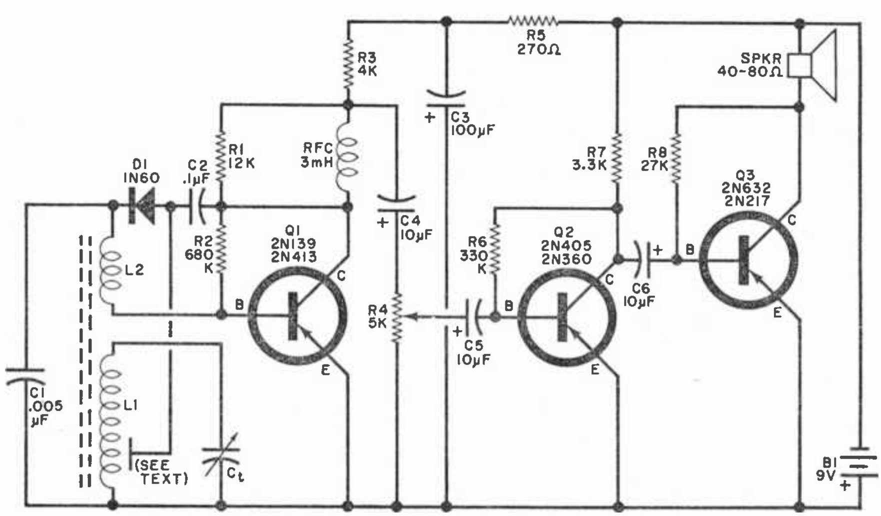



Fig. 1. Simple regenerative receiver can be used on AM or modified for other frequencies.

a PM loudspeaker. Base bias for *Q3* is furnished through *R8*. Circuit operating power is supplied by *B1*, while *C3* and *R5* form a simple L-type decoupling filter for the first stage.

The ferrite core antenna coil, *L1-L2*, is a standard commercial unit similar to the Calectro type D1-848, while tuning capacitor *Ct* is chosen to match *L1* (typically, Calectro type A1-232). The feedback loop is a single turn of insulated hook-up wire wrapped loosely around *L1* and connected *only* to the junction of *D1* and *C2*. Except for gain control *R4*, which should have a log taper, all resistors are half-watt types, while *C3*, *C4*, *C5* and *C6* are 12-volt electrolytics.

After circuit assembly is completed and checked for possible errors, the feedback loop should be adjusted for maximum performance. This is accomplished by shifting the feedback coil's position along *L1* while tuned to a weak station.

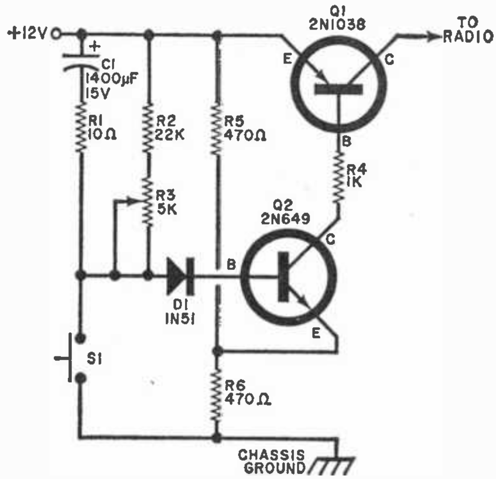



Fig. 2. A series transistor is used to cut off d.c. supply to car radio and kill unwanted commercials.

**Reader's Circuit.** Suitable for use with transistorized automobile receivers, the interesting circuit in Fig. 2 was submitted by E. M. McCormick, 8720 Ewing Drive, Bethesda, Maryland 20034. Mack devised the circuit to serve as a "commercial killer" when he found some of the longer radio commercials not only bothersome, but dangerously distracting when driving in heavy traffic. When activated, the unit shuts off the car radio for periods of up to one minute.

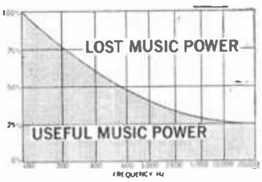
Referring to the schematic diagram, series *pnp* power transistor *Q1* controls the receiver's d.c. power source. This transistor, in turn, is controlled by *npn* transistor *Q2*. Under normal conditions, *Q2*'s base bias, furnished through *R2*, *R3* and *D1*, holds this transistor in a conducting state, permitting the application of a saturation bias to *Q1*'s base through *R4*. With *Q1* saturated, virtually full power is furnished to the receiver, except for a small drop across *Q1*. When *S1* is closed momentarily *C1* is charged rapidly to full battery voltage through surge limiting resistor *R1* and, thereafter, furnishes a reverse bias which switches *Q2* to a nonconducting state. This removes *Q1*'s base bias. Thus, the receiver's power source is opened until *C1* discharges through *R1*, *R2* and *R3*, permitting normal biasing to be reestablished and power restored to the radio. Diode *D1* is included to minimize transient current surges which might otherwise damage *Q2*.

Neither layout nor lead dress is critical and the unit may be assembled using any standard construction technique, provided all d.c. polarities are observed and care is taken to avoid overheating the semiconductor devices. Mack assembled his unit in a commercial 2" x 4" x 1½" metal case and suggests that heat-sink mounting be provided for *Q1*.

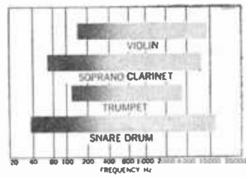
In use, the circuit is connected in series with the car radio's "hot" power lead and to ground, as shown, if the auto has a standard *negative ground* electrical system. A

(*Continued on page* 98)

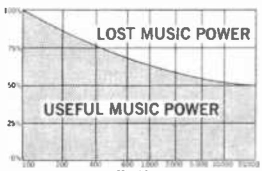
*A new concept* **100% MUSIC POWER®**



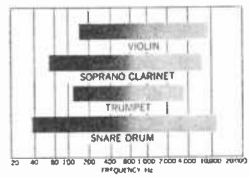

CARTRIDGE "C"
at 25% Music Power



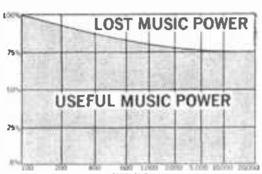

. . . a serious loss of definition occurs: because cartridge "C" has completely lost 75% of the Music Power at the higher frequencies.



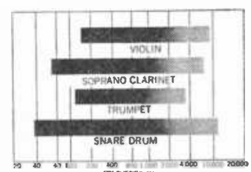

CARTRIDGE "B"
at 50% Music Power



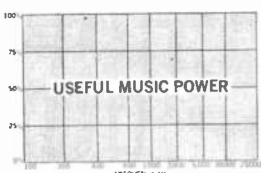

. . . in this case you lose definition of tone and instruments: because cartridge "B" loses as much as 50% at higher frequencies.



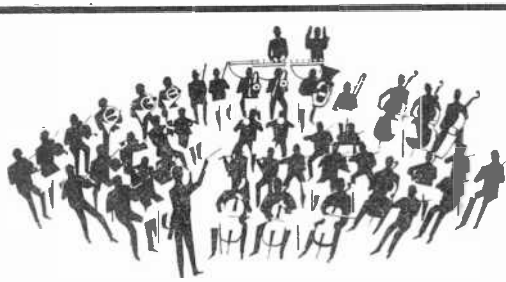

CARTRIDGE "A"
at 75% Music Power

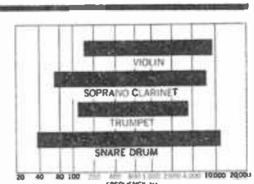



. . . the instruments seem a little faded in the upper frequencies: because cartridge "A" attenuates higher frequencies as much as 25%.




XV-15
at 100% Music Power






. . . the instruments, all of them, are distinct and clear throughout the entire fundamental frequency range.

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**CIRCLE NO. 22 ON READER SERVICE PAGE**

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION (Act of October 23, 1962; Section 4369, Title 39, United States Code).

1. Date of filing: October 1, 1969.
2. Title of publication: Popular Electronics.
3. Frequency of issue: Monthly.
4. Location of known office of publication: 307 N. Michigan Avenue, Chicago, Illinois 60601.
5. Location of the headquarters or general business offices of the publishers: One Park Avenue, New York, New York 10016.
6. Names and addresses of publisher, editor, and managing editor: Publisher, Phillip T. Heffernan, One Park Avenue, New York, New York 10016; Editor, Oliver P. Ferrell, One Park Avenue, New York, New York 10016; Managing Editor, John R. Riggs, One Park Avenue, New York, New York 10016.
7. Owner: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given.) Ziff-Davis Publishing Company, One Park Avenue, New York, New York 10016; William B. Ziff, One Park Avenue, New York, New York.
8. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities: None.

10. Extent and nature of circulation

| | Average No. Copies Each Issue During Preceding 12 Months | Actual Number of Copies of Single Issue Published Nearest to Filing Date |
|---|---|---|
| A. Total No. Copies printed (Net Press Run) | 478,319 | 467,904 |
| B. Paid circulation | | |
| 1. Sales through dealers and carriers, street vendors and counter sales | 74,167 | 79,200 |
| 2. Mail subscriptions | 303,167 | 303,673 |
| C. Total paid circulation | 377,334 | 382,873 |
| D. Free distribution (including samples) by mail, carrier or other means | 5,796 | 5,800 |
| E. Total distribution (Sum of C and D) | 383,130 | 388,673 |
| F. Office use, left-over, unaccounted, spoiled after printing | 95,189 | 79,231 |
| G. Total (Sum of E and F—should equal net press run shown in A) | 478,319 | 467,904 |

I certify that the statements made by me above are correct and complete.

WILLIAM PHILLIPS, Assistant Treasurer

## SCS ADAPTER

(*Continued from page* 65)

SCS and *Q2* is the transistor connected as an emitter follower. (See "Getting to Know the SCS," POPULAR ELECTRONICS, Sept. 1969, p 75 for a description of how the SCS works.) Potentiometer *R5* provides output-level control. Capacitors *C1* and *C2* provide d.c. isolation at the input and output, respectively.

Using this circuit and an input sine wave of approximately 1 volt r.m.s., you can obtain an output square wave with a 7-volt overall swing within the range 40 Hz to 20 kHz. Rise and fall times of the square wave are excellent, while the horizontal portions are quite flat. Maximum power required is 18 mW from a 9-volt transistor battery.

The circuit is not critical as far as layout is concerned and any neat, clean arrangement can be used. Just make sure you don't damage the semiconductors when soldering them into the circuit.

To test and use, obtain a sine-wave input signal from an audio generator and couple the square-wave output to an oscilloscope. Set *R5* for maximum output. When the output level of the audio generator is about 1 volt, the square-wave adapter will go into operation with a square wave displayed on the oscilloscope. Adjust the audio-generator output level until the square wave is symmetrical. Other than adjusting the gain via *R5*, there are no other adjustments and the signal squarer is ready to use.

A lower cost, but not as good, circuit can be made by changing the values of *R1* to 15,000 ohms and *C1* to 0.5 $\mu$F, eliminating *R2* and *R4* (ground C and make no connection to $G_A$), and reducing the battery voltage to 3 volts. In this version, the input signal requirement is 0.5 volts r.m.s. and the output square wave is 2 volts, while the frequency range is 20 Hz to 15 kHz. Since power drain is only 4.5 mW, a pair of 1½-volt flashlight cells in series can be used as a power source. —30—

## HOLOGRAPHY

(*Continued from page* 35)

correct interval. (4) Film resolution may be lost due to poor developing techniques or uneven temperatures in the chemical developers.

**Refining the Hologram.** Since holography is a new technology, perfection is not easy. However, there are a few things that can be done to improve the results a great deal and the serious experimenter will want to try them.

The first refinement is to "clean up" the laser beam where it leaves the housing. You will notice that no matter how you clean the optics, the laser beam is still inclined to be "blotchy." The blotches can be cleaned up by the use of a spatial filter. The latter is easy to make: two convex lenses of short focal length (10 to 30 mm) and a pinhole in a piece of aluminum foil are all you need. The arrangement is shown in Fig. 6. Place the assembly between the laser beam exit hole and the beam splitter.

Multi-mode lasers of the type used here cannot be completely "cleaned up" by this process. There may still be "holes" in the hologram—portions of the target that are not illuminated. To remedy this, you can try a single-mode laser ($69.95) in place of the multi-mode, low-cost laser.

Another refinement in holograms is to make them of larger objects. The optics described in this article are suitable for making larger holograms if you use a larger film holder and bigger film and lengthen the exposure time. However, if you lengthen the exposure time, the stability of the optical system becomes much more critical.

Finally, a really advanced refinement is to put two holograms of different targets on one piece of film. To do this, take one exposure (timed a little short), rotate the film 180 degrees, still with the emulsion side toward the target, change the target, and make another exposure (also timed short). When viewing a dual hologram, remember to rotate the film to see both images. -30-

## AMATEUR RADIO

(*Continued from page* 82)

nician licenses issued in the United States. It is difficult, however, to determine how much of the drop in Technician licenses indicates a decrease in interest in the frequencies above 50 MHz and how much of it is the result of the 1967 change in FCC regulations. Before that time, one could hold a Novice and a Technician license simultaneously. As a result, many Novices took the Technician exam just to determine if they could pass the Technician/General written examination, with nothing to lose—except the $4.00 license fee—whether they passed or failed. Today, however, many Novices bypass the Technician license and aim for the General or Advanced license as the next step up the license ladder.

In Eire (Ireland), beginning amateurs receive an "Experimenter's License." It authorizes CW (code) operation between 7 and 7.1 MHz (the entire European 40-meter band) and 14 to 14.35 MHz with a transmitter power input of 25 watts.

Alan Winzenried, WN9ZCO, Green Bay, Wis., started out with a 15-watt, home-built transmitter before graduating to a Heathkit HW-16 CW transceiver. So far he has worked a total of 19 states.

Fifth Annual Louisiana QSO Party starts 1800 GMT, Saturday, January 17 and ends at 2200 GMT, Sunday, January 18, 1970. Suggested frequencies, 3.6, 3.91, 7.075, 7.26, 14.075, 14.3, 21.075, 21.4, 28.1, and 28.7 MHz. Same station may be worked once per band or mode (CW-phone). Louisiana stations send QSO number, signal report, and the name of their parish; and receive QSO number, signal report, and the name of the state, province, or country for a complete contest exchange. Vice versa for contestants outside of Louisiana. Each exchange counts one point. Louisiana stations multiply number of contacts by the number of states, provinces, and countries worked; others multiply their contacts by the number of Louisiana parishes worked. Certificates awarded to high scores in each state, province, country, and Louisiana parish. Louisiana stations are also competing for the W5PM trophy. A minimum of 50 points (25 for DX) is required to qualify for a certificate. Mail scores to: Danny Griffith, K5ARH, QSO Party Chairman, Lafayette Amateur Radio Club, 123 Normandy Rd., Lafayette, La. 70501. Include a stamped return envelope for a list of the winners.

## NEWS AND VIEWS

**Paul Gilbert, WA7KIY,** Cedar City, Utah. knocked the "N" out of his call letters and operated in the last ARRL Field Day as a single-operator station. He made 440 contacts on 40 meters. using a pair of crystals. His station was built by Mid, W7ZC/W5CA, and was described in *CQ Magazine* for October, 1946. The receiver uses a regenerative 6K7 detector and a 605 audio amplifier. The transmitter uses a 605 crystal oscillator to drive a 6L6 amplifier. Tube filaments were heated by four #6 dry cells in series, and 180 volts of B battery supplied plate power. The antenna was a dipole made of lamp cord, 30 feet high. You just can't beat this modern equipment! Don't be too surprised to hear that Paul worked all states on 40 meters as a Novice . . .

Steve Gordon, WA6MDR, Salinas, Calif., claims his 10-, 15-, 20-meter Quad antenna also works on 80 meters. He uses a dipole on 40 with a Swan 350 SSB/CW/AM transceiver doing all the inside work.

**A. D. "Mid" Middleton, W7ZC,** Box 303, Springdale, Utah, 84767, is celebrating his 50th year as a radio amateur. He holds DXCC. A1 Operator, and 35-WPM code certificates—among many others—and he will work prearranged schedules on 15 through 160 meters, SSB phone or CW with anyone needing a Utah contact/QSL. Tell him when you want the sked with a stamped return envelope to set up the contact. By the way, Mid is the custodian for Utah

All County Award, issued to amateurs who have worked all 29 Utah counties, a total of seven issued to date . . . **Paul Leuck, WAØWUW,** 2512 Pierce St., Minneapolis, Minn. 55418, operates a Knight-Kit T-60 transmitter at 60 watts to feed a 40-meter dipole, eight feet high. He receives on a Heathkit HR-10B and has 19 states, Canada, and Mexico in his log. Paul also reports a new traffic net on 7060 kHz on Mon., Wed., Fri., at 1700, EST.

**R. Bruce Hibbert, WN6BPH,** 559 Oriole Lane, Corona, Calif. 91720, is waiting to see if his General call letters will start with WA or WB and trying to pry cards out of the stations he has worked who have not QSL'ed. Bruce transmits with a Globe Master feeding an inverted Vee antenna and receives on a Hallicrafters S-20R . . . **Orlin D. Jenkins, WAØWYP,** 2101 5th St., Greeley, Colo. 80631, worked 35 states and four Canadian provinces in his five months as a Novice. He then failed the General class code test but returned to the Denver FCC office a month later to pass the code test and the Advanced class written exam for good measure. A Heathkit HR-10B receiver and SB-400 transmitter, and a Hy-Gain 18-AVQ vertical antenna process the electrons at WØWYP . . . **Jim Pruitt, WA7DUY/AFB7DUY,** 111 Hershbeck Heights, Aberdeen, Wash. 98520, just moved from Idaho, where he spent his Novice career. He worked 38 states and five countries as a Novice, although it took him five months to work his home state! He kept chipping away at the states as a General and Advanced licensee. The GSL card for state number 50 (Maine) arrived the day before he left Idaho. All this was done with an EICO-720 transmitter, Mosley CM-1 receiver and Hy-Gain 18-AVQ vertical antenna . . . **Alan Cowan, WN5ZKO,** P. O. Box 568, Saginaw, Tex. 76079, says "You certainly do meet a lot of friendly people in amateur radio." In two months as a Novice, Alan has collected 180 QSL cards from 43 states and 10 countries. A Globe Chief transmitter and a Hallicrafters S-108 receiver, plus vertical and inverted-Vee antennas are his tools.

**Max Galloway, K9OXA,** has been chosen "Male Volunteer of the Year" over 2000 volunteers by the Indianapolis chapter of the American Red Cross. Max, Chairman of Emergency Communications for the chapter, designed and supervised the installation of WA9LGQ, the chapter amateur station, as well as other chapter communications equipment, including converting a truck into a mobile communications center . . . **Al Gritzmacher, WN2KJT,** 155 Waterman St., Lockport, N.Y. 14094, thanks the Lockport Amateur Radio Association's annual Novice course for his ticket. Al says that when he put up his antenna, he discovered there wasn't room for a 40-meter dipole. So, upon the advice of his father (who doesn't know any more about antennas than Al does), he put up a horizontal Vee, its center is fastened to the side of the house, one end to a tree, and the other end to a 15-foot pole. Although no good radiating to the east, Al has worked 27 states, all on 40 meters. A Heathkit DX-35 transmitter and a Lafayette HE-30 receiver decorate the WN2JKT operating table . . . **Rick Davis, WN4LWY,** 3518 Indian Lane, Doraville, Ga. 30340, takes the saying, "You can't work 'em, if you can't hear 'em," to heart. He receives on a Collins 75S-3B and transmits on a Knight-Kit T-60 through either a "trap" dipole or a 15-meter inverted-Vee. He has 20 states and four countries logged.

Will we read your "News and Views" and see your picture in your column soon? The first step is for you to write that letter. If you hold a General class or higher license, are over 21, and are willing to act as a volunteer examiner for Novice and Technician examinations, please let us know. Also, we appreciate being on the mailing list to receive your club bulletin. The address is: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P. O. Box 678, Gary, IN 46401.

Happy New Year.
73, Herb, W9EGQ.

# SHORT-WAVE LISTENING

*(Continued from page 78)*

**Egypt**—Cairo has been testing to N.A. in English and asking for reports at 0135 on 11,725 kHz. Other channels heard include 9475 kHz at 0200-0330 in English with news at 0225, and 9630 at 2200 in Arabic.

**England**—At press time, London was using 11,845 kHz for its Asian Service at 2300-2330 in English to 2315 and Indonesian for the remainder.

**Ethiopia**—*V. of Ethiopia*, Addis Ababa, is good on 9610 kHz daily at 0330 s/on until at least 0415 with beautiful native music, and on 15,170 kHz from 0438-0456 with ID's in English, French and possibly Amharic.

**France**—Paris has English news daily at 1915-1930 on 15,295 kHz. The address they are giving on the air is *ORTF*, English Service, Room 4664, Paris, France.

**Germany (West)**—*Deutsche Welle*, Cologne, was found on a new frequency of 17,800 kHz at 2326 with German language and commentary and, at 0000, news in German.

**Honduras**—HRVK, Tegucigalpa, shows on 4847 kHz frequently between 0130-0200 with some na-

### SHORT-WAVE CONTRIBUTORS

David Larrabee *(WPE1HRB)*, Brunswick, Maine
John Banta *(WPE2PHU)*, Bay Shore, N. Y.
John Herkimer *(WPE2PIL)*, Caledonia, N. Y.
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Dan Ferguson *(WPE4AUL)*, Coral Gables, Fla.
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Robert Moser *(WPE9ASH)*, Chicago, Ill.
Gerry Dexter *(WPE9HDB)*, Lake Geneva, Wis.
Richard Pistek *(WPE9HOA)*, Chicago, Ill.
Bill Vogt *(WPE9IND)*, Tinley Park, Ill.
Richard Coddington *(WPE9JNB)*, Lockport, Ill.
John Patterson *(WPE9JOL)*, Oswego, Ill.
Charles Wehking *(WPE9JTF)*, St. Louis, Mo.
A. R. Niblack *(WPE9KM)*, Vincennes, Ind.
John Beaver *(WPEØAE)*, Pueblo, Colo.
Gary Bowers *(WPEØFNV)*, Kirksville, Mo.
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Paul Cau *(VE3PE2OZ)*, St. Catharines, Ont.
Robert Boulle, Middletown, N. J.
Ed Curran, Chicago, Ill.
Bill Grant, Worcester, Mass.
John Hurwitz, Shawnee Mission, Kan.
Michael Mayo, St. Louis, Mo.
Japanese Short Wave Club, Sendai, Japan
North American Short Wave Association, Altoona, Pa.
Sweden Calling DX'ers Bulletin, Stockholm, Sweden

tive, some U.S. pops and periodic ID's. At times they give the slogan of *Radio San Isidro* rather than the listed *Radio Catolica.*

**India**—*All India Radio,* Delhi, 15,080 kHz, was noted at 1924-1940 with poetry in English in their General Overseas Service to East Africa.

**Indonesia**—*R. Indonesia,* Bandjarmasin, was heard on 5972 kHz at 1202-1211 with news in Indonesian followed by Far East music.

**International Waters**—An overseas source lists *The Voice of Peace* as being in the Mediterranean and beamed to the Middle East. An Israeli bar-owner reportedly bought a ship for $45,000 and has installed an American xmtr. Broadcasts are in Arabic, English, French and Hebrew; the signature tune is "Give Peace A Chance" as recorded by the Plastic One band. No frequencies were listed. It is said to be on the air now.

**Italy**—Rome is on 9575 kHz in Italian at 2230-2300 to N.A. Italian is also found on 15,340 kHz at 1831-1905 s/off and on the same channel at 0305 in Spanish.

**Kashmir**—*R. Kashmir,* Srinigar, 3277 kHz, has English news at 1700-1705 and s/off at 1733. This should be virtually impossible to hear in N.A. at this time.

**Kuwait**—A new frequency for *R. Kuwait* is 15,345 kHz as heard at 1600-1900 in English with news, talks, pop music and frequent ID's. Also heard: 21,685 kHz at 1645-1700 in Arabic with news at 1700.

**Lebanon**—*R. Lebanon,* Beirut, is beamed to N.A. on 15,170 kHz at 0130-0200 in French, 0200-0230 and 0300-0330 in Arabic, 0230-0300 in English and 0330-0400 in Spanish. English to Africa is at 1830-1900 on 15,350 kHz.

**Liberia**—ELWA, Monrovia, has moved from 15,155 kHz to 15,098 kHz for French to N. Africa and W. Europe at 2000-2100; Arabic is also here at 2130.

**Mexico**—The new Mexican station, XERMX, 11,718 kHz, is requesting reception reports to P. O. Box 20100, Mexico City. Reports from 0100-0205 indicate considerable English anmt's, some Spanish ID's and mostly L.A. instrumental music. ID's are also given in French and German. . . . XEQM, Merida, is good around 0100 with bell and ID, L.A. music, commercials, and ID's for XECM.

**New Hebrides**—*R. Vila,* 3905 kHz, has music and French at 0638; news in English or Pidgin at 0700; s/off 0710.

**Nicaragua**—*R. Zelaya,* Bluefields, fair to good with pop and classical music, few ID's, until 0400 s/off on 5950 kHz.

**Pakistan**—*R. Pakistan,* Karachi, has English news at 2000 and a letter-box, request-music show at 2015 to 2030 s/off on 15,240 kHz, beamed to Europe. English news is also given at 1340-1350 on 17,945 kHz.

**Peru**—OBZ40, *R. Union,* Lima, is heard well on 6115 kHz with pop music, frequent ID's and ads at 0415-0430. Despite many reports, the station on 5061 kHz continues to give an ID for OAX8E, *R. Loreto,* Iquitos. Repeated ID's were copied at 0430 during a period of typical Andean music and Spanish anmt's.

**Portugal**—A new frequency from Lisbon is 15,394 kHz, found with an ID in Portuguese at 2205.

**Rhodesia**—*R. Gwelo* is on 4828 kHz at 0401-0410 with English news, then into vernaculars with music to past 0415. This is dual to 5012 kHz.

**Romania**—*R. Bucharest* is now on 11,770 kHz, an unlisted channel, in English to Western Europe with news at 2100-2109, commentary to 2114, instrumental music and talks to 2124, closing anmt's and s/off at 2126.

**Saudi Arabia**—Jeddah is often good on 11,855 kHz with English at 1700-2000, then into French.

**South Africa**—*R. RSA,* Johannesburg, is on 9705 and 9715 kHz to N.A. in English at 0030. Reports show, as we too have noticed, that 9715 kHz is often a far better channel. A Portuguese xmsn from this station has been logged on 15,175 kHz at 2115.

**Sudan**—Omdurman was noted with a definite ID at 0445 in Arabic on the new frequency of 11,835 kHz.

**Sweden**—At press time, *R. Sweden,* Stockholm, was using 5990 kHz in English to N.A. at 0300-0100 and 0200-0230.

**USA**—WWV, Fort Collins, Colorado, was found on 30,000 kHz at 2230-2350; reception made on an HQ-180A.

**USSR**—*R. Magadan,* 4040 kHz, heard with home service in Russian at 1155 with classical music; 1200 time signals and into a newscast. . . . Petropavlovsk-Kamchatka, 4485 kHz, noted at 0730-0900 with organ music, anmt's in Russian, old American pop tunes, a speech, and what seemed to be news. . . . Khabarovsk heard on 4610 kHz in home service at 1150 with an opera in Russian and news at 1200 after time signal. . . . Tashkent, 5970 kHz, good at times with Russian music and anmt's from 0810-0903, dual to 5900, 7305 and 9375 kHz. . . . Time station RID has been heard on 15,004 kHz with time ticks and morse ID every 15 minutes. At times it covered WWV and was unusually strong.

**Vatican City**—New frequencies in use by *R. Vatican* include 11,725 kHz, dual to 9615 kHz at 0110 in French and on the latter frequency at 0030-0045 in Spanish and 0050-0100 abrupt s/off in English.

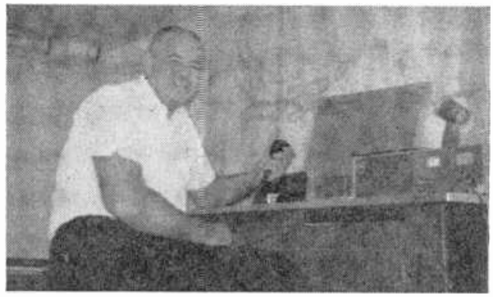
**Windward Islands**—*Windward Islands B/C Corp.,* St. Georges, Grenada, has been heard on 3280 kHz at 0115-0215 s/off with pop music, religious programming, news and a program schedule preview, and on 11,970 kHz at 0130 in English to Jamaica. A QSL sent upon receipt of a reception report took three months from postmark date to travel from Grenada to California!

## TWO-WAY REACTIONS

*(Continued from page 80)*

Wapello County REACT discloses these routine calls: mobile requesting directions to Post Office; report of motorist swerving across bridge; request for ambulance; report of school bus accident to police; report of stalled semi-trailer on highway; request for State Police to direct traffic; report of presence of prowler to sheriff; car full of boys shouting foul language; several small auto wrecks; requests for road information; relay of messages to Red Cross at scene of drowning; request for help in searching for small boat.

**St. John, N.B.** . . . Cooperation between various



George W. Arthur, above, of Hernando County (Fla.) REACT was at post during hurricane watch. Below, Wabash (Ind.) REACT put out 10 roadside signs.

### WHAT'S A REACT CLUB OR TEAM?

It has come to the attention of REACT National Headquarters that there is some confusion over the use of the name REACT in connection with some local organizations of Citizens Radio operators. The name REACT is a registered trade name and cannot be used by groups not officially recognized by REACT National Headquarters. If any organization using this designation has not received a certificate of recognition at some time from REACT National Headquarters, it is subject to legal action, which is required to protect the trademark registration. If you are in doubt about your group's status, please write for clarification to:

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| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
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1 b

## CB CODE OF COURTESY

- Extend the courtesy of channel priority for base-to-mobile communications from 6 to 8 a.m. and 4 to 6 p.m. local time when people are traveling to and from home and work.
- Pause a few seconds before keying your mike so that you can hear a "breaker" or see if you missed hearing a transmission that was already in progress.
- Try not to tie up the channel.
- Use discretion in "breaking." If it is important that you reach another station, break, but make your call as short as possible or ask party you are calling to move to another channel.
- When you turn on your transceiver or move to another channel, wait a few seconds to be sure the channel is clear before starting your transmission.
- If it is necessary to transmit a test (matching the antenna, checking SWR, etc.), wait for, or go to, a clear channel.
- Avoid discussing your transceiver's performance. If there are irregularities in your transmissions, someone will let you know about them soon enough.
- Give a clear channel to an emergency call. Give your full cooperation during an emergency situation.
- Use good taste in what you say on the air.
- Don't give names, addresses, or phone numbers on the air.

local agencies has been achieved by St. John REACT Emergency Team through a series of meetings with the Red Cross, local radio stations, Chief of Police, City Manager and various businesses. In this way, the team has received official recognition so that it is included in the disaster plan being formulated by the city authorities. Demonstrating its ability to be of service, the team provided radio communications during a local forest fire. Four days were spent in relaying messages from portable units in the field to mobile units and then to base control in the city. The team cooperated with police, fire departments, and the forestry service in this effort. The St. John team has posted REACT signs announcing it is monitoring channel 9 on the four highway approaches to the city. —30—

## SOLID STATE

(*Continued from page* 86)

similar connection technique may be used if the car has a positive ground system, but the circuit should be modified by replacing *Q1* and *Q2* with their complementary equivalent types and reversing *D1* and *C1* polarities. Potentiometer *R3* permits a fine adjustment of off time from about 55 to 65 seconds. If a different range is preferred, *C1* can be replaced with a smaller (for shorter time intervals) or larger valued capacitor.

**Transitips.** Add a dash of creative imagination and virtually any basic circuit can be used in a variety of applications. Often, the only modification needed is a minor change in a component value.

Consider the basic blocking oscillator circuit illustrated in Fig. 3. Here, center-tapped transformer *T1* serves both to provide the feedback signal needed to start and maintain oscillation and to furnish a drive signal to a PM loudspeaker. The circuit's "natural" frequency is determined primarily by the transformer characteristics, while its blocking rate is determined by feedback coupling capacitor *C1* in conjunction with base resistor *R1* and series current limiting resistor *R2*. Operating power is supplied by *B1*, controlled by *S1*.

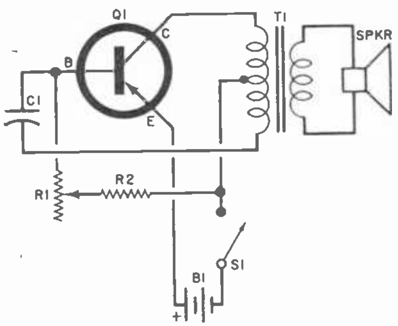


Fig. 3. Blocking oscillator has many variations.

As shown, such a circuit can supply a harmonic-rich tone—suitable, perhaps, for checking microphone placement.

Let's add our dash of imagination and see what happens . . .

Change *C1*'s value to provide a higher pitched tone (smaller C here) and replace *S1* with a handkey. Presto, a *code practice oscillator.*

Remove the handkey and substitute a pair of test jacks or leads, and we have a *continuity tester.*

Change *C1* to a fairly large value, and we have a *metronome.*

Return *C1* to its original value and replace the loudspeaker with a 10-ohm potentiometer, and there is a simple *audio test signal* source.

Return to our original circuit and substitute a photo relay's contacts for *S1*, and, now, an *alarm signal.*

Add additional feedback capacitors, each of a different value, and each switched into the circuit by a normally open push-button switch. Behold, a basic *electronic organ.*

Easy, isn't it? —*Lou.*

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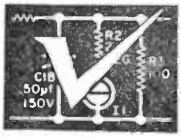

# OPERATION ASSIST

*Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information, write him directly—he'll appreciate it. If you need help, send a postcard to Operation Assist,* POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name and model number of the unit. If you don't know both the maker's name and the model number, give year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Do not send an individual postcard for each request; list all requests on one postcard. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

**Hallmark** Model CB2-12. Schematic needed. (Joseph Scanny, 2540 S. 67 St., Phila., Pa. 19042)

**National** Model NC-109 receiver. Schematic and alignment data needed. (Earl Lolley, 407 Mock St., Andalusia, AL 36420)

**AK** Breadboard receiver needed. (A.J. Luber, 1628 Rouse Ave., Modesto, CA 95351)

**EMC** Model 107A V.T.V.M. and Capacitance Checker. Schematic needed. (Hugh S. McKay, Hilbre, Manitoba, Canada)

**Wilcox-Gay** Model 772 "Recordio" tape recorder. Source for parts needed. (L. Herzog, 916 W. 9 St., Dixon, IL 61021)

**Atwater Kent** Model 60C. Schematic and source for parts needed. (Wm. Visser, 34 Church St., Norwell, MA 02061)

**Polytronics** Model Polycomm Pro. Schematic and operating manual needed. (Larry Riffle, 10 Summit Ave., Thurmont, MD 21788)

**Hallicrafters** Model S-107 SW receiver. Manual, schematic and calibration instructions needed. (W.E. Lloyd, 1 Eccleston Dr., Apt. 212, Toronto 16, Ontario, Canada)

**Weston** Model 665 Type 1 selective analyzer. Info on types of battery required and operating manual needed. (Charles Fleckenstein, 65-31 80 Ave., Glendale, NY 11227)

**Hallicrafters** Model RE-1 receiver. Alignment info, parts list, operating manual and schematic needed. (Robert Jordan, 1410 Mt. Stanley Way, San Jose, CA 95127)

**Truvox of London** Model PD 96 Stereo tape recorder. Tube numbers, tube locations and schematic needed. (Len Scott, 160 McDiarmid Dr., Brandon, Manitoba, Canada)

**Philco** 3" "IF/MF" oscilloscope. Schematic and any additional technical info needed. (Robert J. Patterson, AF16847163, 26 AMS CMR 4183, APO NY 09009)

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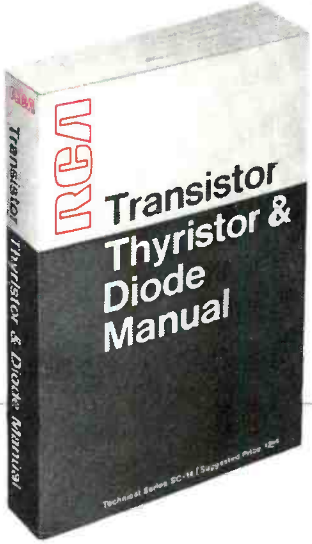


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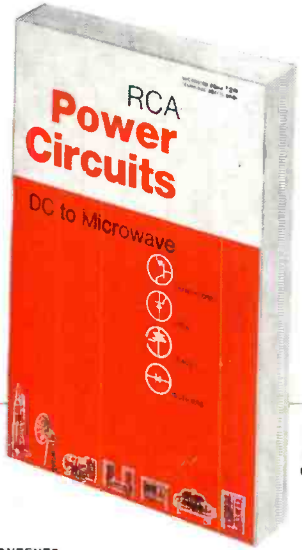


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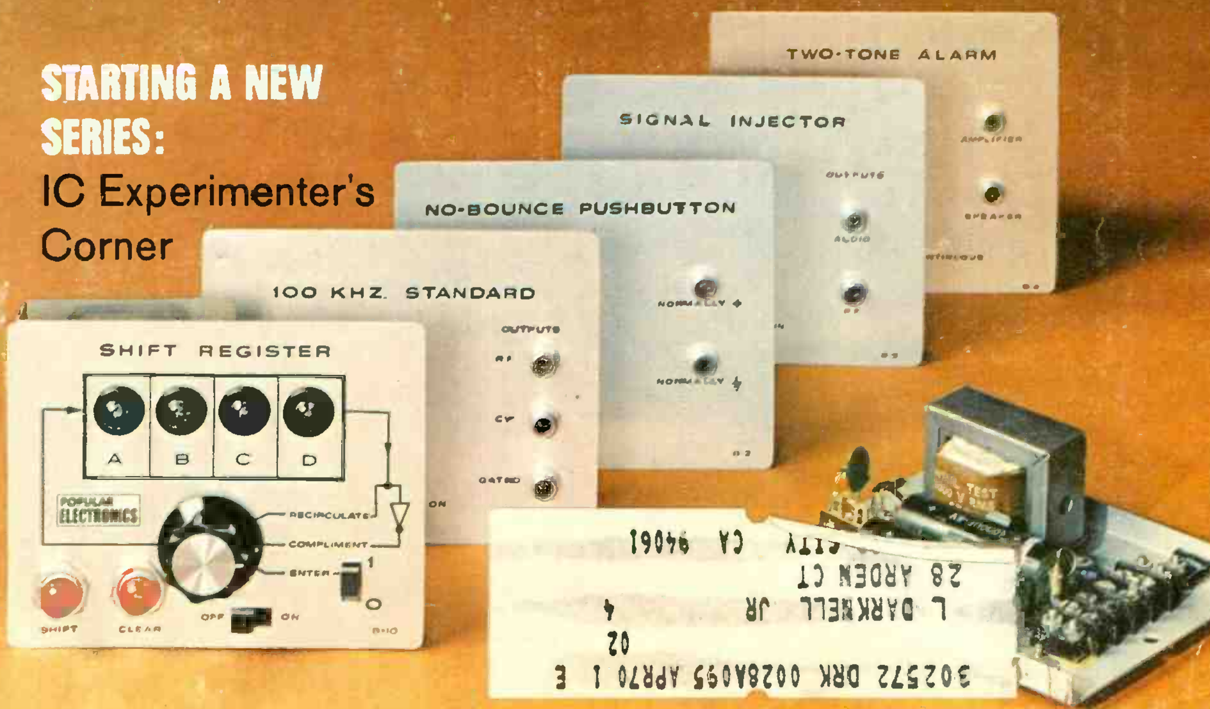


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# letters

## FROM OUR READERS

### LASERS AND SAFETY—AGAIN!

—Send me any information on where I can obtain plans for a high-power, small-beam divergence, pulse or continuous laser—

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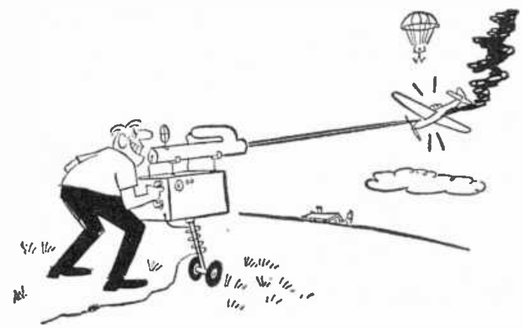

send information for this type of tube, the maximum power without getting overheated—

—I would greatly appreciate . . . a medium-priced laser of mild burning capabilities (say through a piece of cardboard) and a visible range of several miles—

*The extracts above are from only three of the many letters we have received requesting information on how to obtain or build a high-power laser, or how to boost the power of the one described in the article "Experimenters' Laser" in our December 1969 issue.*

*The dangers involved in working with high-power lasers were mentioned several times in the December issue, but apparently many readers choose to ignore them.*

*If a laser is to be capable of burning or producing physical damage to a target, it must be capable of producing many watts of beam power. Unfortunately, when you reach the vicinity of about 3 milliwatts, the eyes of any observer, either directly in the laser beam or receiving a reflection of the beam from a shiny surface are endangered. Even at this relatively low power, permanent blindness is a real possibility—and only a fraction of a second of exposure is necessary to produce this total and irreparable damage.*

*The output of the laser described in our December article cannot be made to exceed 0.5 milliwatt—far below the danger point. (Though a beam of this intensity should not*


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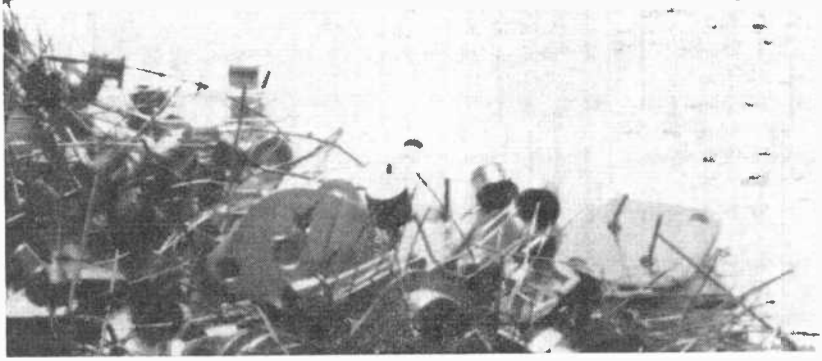

## LETTERS *(Continued from page 8)*

*be looked into directly.) This cannot be said of the semiconductor or gas lasers that are available for use in research laboratories under controlled conditions.*

*We would like to repeat also that dark glasses, unless they are specifically made for the laser involved, are of no help. Do not depend on them for protection.*

*Out of responsibility and concern for our readers, POPULAR ELECTRONICS cannot suggest or recommend a laser of any higher strength than the one described in the article.*

### SKY KING IDENTIFIED

To answer your questions: SKY KING, is an unclassified collective callsign used for all airborne SAC aircraft; SKY BIRD, is an unclassified collective callsign used for all SAC ground radio stations; LOOKING GLASS is the unclassified name of the SAC airborne command post.

LT. COL. G.F. HENNRIKUS, JR.
Offutt AFB, Nebraska

### UN-MUDDYING THE WATERS

There is no doubt that laser light has and will continue to play a significant role in the field of ophthalmology. It has been used to seal retinal holes, treat very small retinal detachments and in some instances has played a role in the treatment of diabetic retinopathy and other retinal problems. Xenon light has also been used for photocoagulation and many ophthalmologists prefer its use over laser light.

However, your statement that "one pulse from a laser and the retina is a 'spot welded' back in place" ("The Lively Laser," December 1969) is not only misleading, but adds to the confusion about complex medical problems in an already overexpectant lay public. By far the great majority of retinal detachments, unfortunately, cannot respond to photocoagulation alone. And even now, detached retinas require "complex surgery and a long recuperative period." Retinal detachment surgeons already have a difficult time explaining to patients that the "magic light" will not perform miracles in their eyes.

Now to further "muddy the water" you state that "micro-surgical treatment of glaucoma using a laser to remove a portion of the iris of the eye is showing great promise." You forgot to add, however, that this is a highly experimental procedure performed, as far as I know, only in animals. There are still some problems to iron out before this can become a safe procedure to perform in humans.

M. M. COHEN, M.D.
Resident in Ophthalmology
Univ. of Mich. Medical Center

*Many thanks for straightening us out on these highly technical and important aspects of the subject.*

## FREE BOOKLET AVAILABLE

I'm positive that we were unintentionally "dropped" from Dave Weems' fine December issue article on bass reflex enclosures. Please tell your readers to write me for a free copy of our bass reflex design handbook.

BILL SUTHERLAND
Electro-Voice
Buchanan, MI 49107

## APPRECIATION APPRECIATED

Please keep coming out with your excellent projects such as "Microwaves For The Beginner" (November issue) and that great "Experimenter's Laser" (December).

KEN REID
Independence, Kansas

## STATION ADDRESSES

As a brand-new short-wave listener I'm perplexed about writing to the various hams and broadcasters. Should I report that I heard them? If so, how do I find their addresses?

R. J. MILLER
Montvale, N.J.

*Most radio stations still appreciate receiving accurate reception reports. The addresses of ham stations are contained in two separate Radio Amateur Callbooks available at most radio stores. International broadcasters are listed in the "SWL Address Book" ($2.95) mail-order from Gilfer Associates, P.O. Box 239, Park Ridge, NJ 07656.*

# OUT OF TUNE

"Experimenters' Laser" (December 1969). Many readers see what appears to be a discrepancy between Figs. 1(B) and 6 where none actually exists. Four resistors are shown in Fig. 6 for *R22-R24*, while only three are shown in Fig. 1; and the location of the junction between resistors to which *C12* is to be connected is in question. The difference between the two figures is explained on page 110 under the heading "Troubleshooting." The figures are correct.

"Psychedelia I" (September 1969). In Fig. 3 on page 30, change *R8* to *R9*. Then, in the upper right of Fig. 4 on page 32, the 6.3-volt, center-tapped secondary of *T2* should read to "PCU"—not "QFU." In Fig. 6 on page 35, change *C15* to *C16*; *R10* to *R40*; *Q3* to *Q5*; and *R22* to *R27*.


# ELECTRONICS library

QUIET

## FUNK & WAGNALLS DICTIONARY OF ELECTRONICS

This book, more of a desk-top encyclopedia than a simple dictionary, will appeal to a wide variety of people. Particular attention has been paid to the interests of the non-electronics professional (such as physicians, biologists, and psychologists) who find it necessary to deal with electronic equipment and concepts. The dictionary defines in sophisticated yet clear and precise language the basic terminology of electronics, aided by formulas, graphs, and component and schematic diagrams. Mathematical descriptions, which can be skipped at the reader's discretion, are given where they help to clarify concepts. In addition, an entire section in the back of the book is devoted to tables of logarithms, trigonometric function, and other useful information.

*Published by Funk & Wagnalls, 380 Madison Ave., New York, N.Y. 10017. Hard Cover. 230 pages. $6.95.*

## HANDBOOK OF TRANSDUCERS FOR ELECTRONIC MEASURING SYSTEMS

*by Harry N. Norton*

This is the first applications book ever written about transducers and their use in measuring systems. The first three chapters provide background in telemetry and measuring systems, transducer basics, calibration, and testing. The remaining 14 chapters cover all physically measurable quantities, from acceleration and attitude to pressure and temperature. The information given with each group of devices covers design, operation, specifications, applications, calibration, and testing—all preceded by basic definitions and explanations of physical laws. Numerous sectional and exploded illustrations show the internal construction and elements of transducers.

*Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Hard Cover. 704 pages. $26.*

## ELECTRONIC CIRCUITS FOR THE BEHAVIORAL AND BIOMEDICAL SCIENCES

*by Mitchell H. Zucker*

Even readers with little prior experience in electronics can read and understand this

# POPULAR ELECTRONICS READER SERVICE PAGE

## free information service:

Here's an easy and convenient way for you to get additional information about products advertised or mentioned editorially (if it has a "Reader Service Number") in this issue. Just follow the directions below...and the material will be sent to you promptly and free of charge.

**1.** On coupon below, circle the number(s) that corresponds to the key number(s) at the bottom or next to the advertisement or editorial mention that is of interest to you. (Key numbers for advertised products also appear in the Advertisers' Index.) Print or type your name and address on the lines indicated.

**2.** Cut out the coupon and mail it to: POPULAR ELECTRONICS, P.O. Box 8391, Philadelphia, PA 19101.

**note:** If you want to write to the editors of POPULAR ELECTRONICS about an article on any subject that does not have a key number, write to POPULAR ELECTRONICS, One Park Avenue, New York, N.Y. 10016. Inquiries concerning circulation and subscriptions should be sent to POPULAR ELECTRONICS, Portland Place, Boulder, Colo. 80302.

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## LIBRARY *(Continued from page 14)*

book, the first of its kind to explain how to build and repair solid-state circuits for use in the behavioral and biomedical sciences. The first four chapters discuss the basic principles of circuit design and explain how to understand circuit diagrams. The major portion of the book consists of diagrams of circuits that have applications in typical laboratory experiments—including a few that were picked up from POPULAR ELECTRONICS. Each schematic diagram is accompanied by a parts list and construction tips. Principally a reference work for those possessing limited knowledge of electronics, this book can also be used as a text for courses in circuit design and construction.

*Published by W.H. Freeman and Co., 660 Market St., San Francisco, Cal. 94104. Hard cover. 241 pages. $9.75.*

### FUNDAMENTALS OF ANALOG COMPUTERS

*by Robert C. Weyrick*

This book is an up-to-date introduction to both the theory and equipment associated with electronic analog computers and their application. The first chapter describes the evolution of computers, their uses and limitations, and relates analog computers to digital and hybrid systems. Subsequent chapters cover linear computing circuits, operational amplifiers, computing servomechanisms, function generators and multipliers, control and auxiliary devices, differential equations, programming, and simulation examples.

*Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. Hard cover. 289 pages. $10.50.*

### INTEGRATED CIRCUITS
### (A Basic Course for Engineers and Technicians)

*by Robert G. Hibberd*

This sequel to the author's previous book, *Solid-State Electronics*, will provide anyone who has a high school education with an understanding of the structures of various integrated circuits—digital, linear, bipolar, MOS, MSI and LSI—and how they are used. The ten clearly illustrated lessons of which the book is comprised include titles such as Solid-State Technology, Digital Logic Circuits, Digital Integrated Circuits, Standard Catalog IC's, and Use of Integrated Circuits in Electronic Control. Each lesson ends with a glossary to terms and review questions.

*Published by McGraw-Hill Book Co., 330 West 42 St., New York, N.Y. 10036. Hard cover. 177 pages. $9.95.*

# TRUE-FALSE QUIZ ANSWERS

(*Quiz appears on page* 32)

1. False. LSI stands for Large Scale Integration.

2. False. The third band on a resistor always designates a multiplier. When the third band is silver, the multiplier is 0.01; gold is 0.1. For instance, a red-red-gold-silver resistor would be 2.2 ohms with 10% tolerance.

3. True. Increasing the distance between the plates on any air-spaced capacitor decreases its capacitance.

4. True. The Seebeck and the thermoelectric effects are the same.

5. False. A dynamically balanced tone arm will not correct skating force. A slight opposing force, proportional to stylus pressure, is normally used to counter the skating force.

6. True. Magnetostrictive materials (nickel, stainless steel, iron) are used as transducers in ultrasonic equipment.

7. True. Just as a magnetic field causes a change in size, so can a change in size of the cone cause a magnetic field. The field, of course, generates a voltage in the coil.

8. False. The Curie Point is the temperature above which a ferromagnetic material becomes practically non-magnetic.

9. False. Tungsten's resistance is directly proportional to temperature but carbon is inversely proportional.

10. True. Each resistor in a series circuit absorbs half the total power. Either configuration will have the same power rating.

11. False. Most infrared missile systems are test-fired on desert ranges. These systems operate on a temperature differential, not ambient temperature.

12. True. In both cases, the power must be removed from the device so that it "unlatches" and a pulse is all that is required to energize them.

13. False. Radio communication with submerged submarines is carried on in the VLF band.

14. True. Most rare earths are not now considered rare.

15. False. A 50-ohm coaxial cable is now available measuring only 0.0104 inches in diameter. Losses are increased with the reduction in size, however.

15. False. An anisotropic magnet has an axis with preferred characteristics over other axes. An isotropic magnet has no preferred axis.

17. True. After the flyback, the damper tube charges the boost capacitor which forms the first half of the sweep.

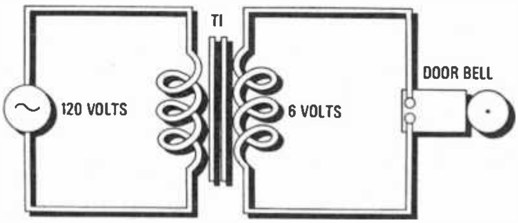
*Second in a series...*

# Can you solve these problems in electronics?

## They're a cinch after you've taken RCA Institutes' new communications electronics program.

It includes new preparation for the FCC license plus the assurance of your money back if you fail to get it.

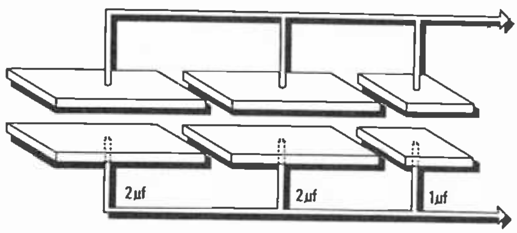
This one is quite elementary.




**In this door bell circuit, which kind of transformer is $T_1$—step-up or step-down?**

Note: if you had completed only the first lesson of *any* of the RCA Institutes Home Study programs, you'd easily solve this problem.

This one is more advanced.




**What is the total capacitance in the above circuit?**

Note: you'd know the solution to the problem if you'd taken only the first two lessons in RCA's new Communications Electronics Program.

These are the lessons that prepare you step-by-step for an FCC License.

This license is a requirement for servicing all types of transmitting equipment and can help open doors to jobs commanding high income in communications, radio and broadcasting, aerospace, industrial automation and many others.

**For a rewarding career with good pay, take that first step now. Send for complete information—mail the attached card.**

Answers: Step-down.
5 μf

# NEW PRODUCTS

*Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15 or 115.*

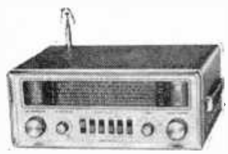
## REFLECTIVE SPEAKER SYSTEM

A reflective speaker system, the Model W80, utilizing a dramatic new concept in sound dispersion and stereo fidelity, was recently introduced by the Wharfdale division of *British Industries Co.* The W80 differs from other reflective and omnidirectional speaker systems on the market in that the sound dispersion is fully controlled by means of a unique moveable variplanar reflector. The sound can be adjusted specifically for the acoustical characteristics of the listening room and decorating layout. Technical specifications: 20 Hz to beyond audibility frequency range; 15 IHF watts minimum, 50 IHF watts maximum power input; 4-8 ohm impedance; 1000-Hz midrange, 3500-Hz sub-treble tweeter, and 5000-Hz ultra-treble tweeter electrical crossovers; 12½" woofer with 9½-lb magnet assembly, 5" midrange, 3" sub-treble tweeter, and 1" domed ultra-tweeter speaker complement; 85-lb sand-filled cabinet.

Circle No. 75 on Reader Service Page 15 or 115

## SOLID-STATE GENERAL-COVERAGE RECEIVER

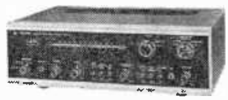
The GR-78 receiver recently introduced by the *Heath Company* provides AM, CW, and SSB coverage from 190 kHz to 30 MHz in six switch-selected bands. The all solid-state circuit employs FET's in the r.f. section and four ceramic i.f. filters for excellent sensitivity and selectivity. The built-in bandspread tuning can be calibrated for either the shortwave broadcast or amateur radio bands, and a switchable 500-kHz crystal calibrator insures accurate dial calibration. The receiver has a rechargeable nickel-cadmium battery pack and built-in charging circuit. An automatic noise limiter cuts down ignition and static interference, and the automatic volume control keeps the volume level constant under changing signal conditions. Additional features of the GR-78 include a headphone jack, built-in speaker, external antenna terminals, receiver muting for use with a transmitter, and S meter.



Circle No. 76 on Reader Service Page 15 or 115

## STEREO RECEIVER EMPHASIZES "NEW LOOK"

A high-cut filter, tape monitor, loudness control, and FM muting are a few of the features available with the *Pioneer Electronics U.S.A. Corp.* Model SX-770 AM/stereo FM receiver. In addition, the receiver features a black front panel with illuminated blue tuning scale, the "new look" favored by interior decorators. A FET front end and IC i.f. strip provide a 1.8-$\mu$V sensitivity, 60 dB at 98 MHz image rejection, and 70 dB IHF signal-to-noise ratio. For stereo reception, the multiplex section employs a time-switching demodulator. Output audio power is 70 watts IHF into a 4-ohm load, while harmonic distortion is less than 0.8% at full rated output. The use of low-noise silicon transistors throughout ensures complete stability and absolutely quiet operation. And monolithic construction of the multiplex section results in stable wide-channel separation over a broad frequency range.



Circle No. 77 on Reader Service Page 15 or 115

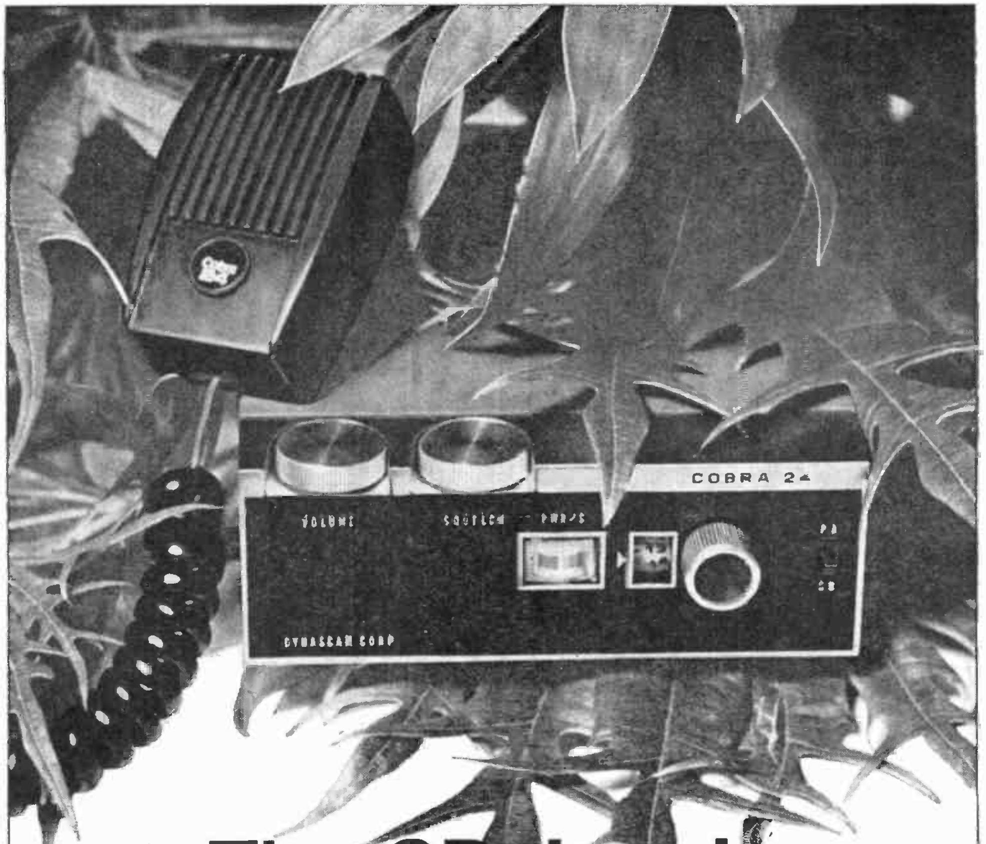
## ELECTRONIC PROJECTS KIT

Two transistors and a solid-state diode are included in the more than 40 electronic parts that make up *Radio Shack's* Science Fair "50-in-1 Project Kit." This safe kit is designed for the beginning experimenter to put together 50 or more battery-powered projects. Provided with the kit is a manual that describes how to put together the circuits and how the circuits operate. The beginner's problem of reading schematic diagrams is given special attention, and parts connections on the board are numbered for easy location. A chart comes with each circuit diagram, indicating which numbers should be connected together. The 50 projects described in the manual include radio receivers and transmitters, test instruments, rain and burglar alarms, and a tachometer circuit.

Circle No. 78 on Reader Service Page 15 or 115

## MONITOR RECEIVER FOR EVERYONE

Foresters, doctors, and movie makers are just some of the possible users of the Model PRO-2 business and emergency communications receiver made by *Radio Shack*. In fact, just about everyone interested in communications—even if it is just listening to the weather forecasts on 162.55 MHz—will find use for this re-




# The CB Jungle is suddenly still...

## There's a new Cobra Lurking!

*The new Cobra 24:* with more power, intelligence, and beauty than any of the others in its class!

The Cobra 24 preys on the others' weaknesses. With *more talk power*—a full, legal-limit 5-watt input and exclusive Dynascan DYNA-BOOST Speech Compression. And a selective dual-conversion superhet receiver with ceramic filter to give outstanding selectivity and gain.

And *more intelligence*—it always gets the message through crisp and sharp, even when others are garbled and unclear. Crystal-controlled transmit and receive on all 23 channels. (No extra crystals to buy!)

And *more beauty*—a striking, no-nonsense exterior. Designed for attack...with a push-to-talk mike, automatic noise limiter, and positive or negative ground operation without internal wiring changes, featuring reverse polarity protection. There's a PA/CB switch with adjustable volume. And the illuminated channel selector and "S" meter makes even night transmission easy. Beautiful, with all silicon transistor, F.E.T. and integrated circuit. It uses 12 volt DC; AC adapter available. Meets FCC requirements. It even comes with its own mounting bracket.

See your dealer or write us for full details.

**Cobra 24 Net $169.95.**

Product of DYNASCAN CORPORATION
1801 W. Belle Plaine, Chicago, Illinois 60613

**CIRCLE NO. 2 ON READER SERVICE PAGE**

## PRODUCTS (*Continued from page* 22)

ceiver, considering that the receiver tunes the 30-50-MHz and 152-174-MHz bands. The PRO-2 is a specially designed high-frequency FM receiver, containing a complete tuning system with a color-coded scale for each band. Sensitivity of the receiver is better than 0.5 $\mu$V, and output power to the built-in speaker or 8-ohm external phones or speaker is 2 watts of audio. A squelch control limits noise nuisance, and an audio signal for tape recording or external audio system is available on the rear panel. The receiver can be a.c. line powered or operated from a 12-15-volt d.c. source.

Circle No. 79 on Reader Service Page 15 or 115

### STEREO/HI-FI MUSIC CENTER

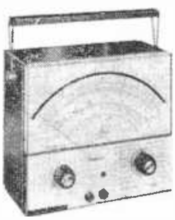
The most recent advances in electronics for listening pleasure are said to have been combined in the *Allied Radio Corp.* Model 1450 stereo hi/fi music center. It contains a solid-state receiver, automatic turntable, cassette recorder, and walnut base. The 55-watt ±1 dB (into 4 ohms) stereo amplifier has separate bass and treble controls, mono-

stereo switch, and loudness control. Microphone inputs and a stereo headphone jack, as well as tape and auxiliary inputs are provided. Frequency response is 20-30,000 Hz ±1 dB. The stereo FM/AM tuner employs FET's in the front end, IC's, and a.f.c. for finest reception. The dial has a unique point-of-light tuning indicator. The four-speed automatic turntable and stereo cassette recorder have all of the features needed for maximum versatility.

Circle No. 80 on Reader Service Page 15 or 115

### MAXIMUM-ACCURACY VOM

*Simpson Electric*'s Model 202 "Accu-Log" VOM eliminates the need to keep reading at the high end of the scale or to worry about "percent-of-full-scale" accuracy ratings. The 202's quasi-logarithmic scale gives consistent percent-of-*reading* accuracy to within 2% for d.c. and 3% for a.c. values. The instrument has six d.c. and four a.c. voltage, five d.c. current, and five resistance ranges. Two of the resistance ranges are for low-power testing. The 7" antiparallax mirror scale reduces reading error; and the taut-band movement is over-



load protected, shock resistant, and self-shielding.

Circle No. 81 on Reader Service Page 15 or 115

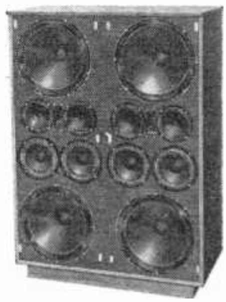
### SOLID-STATE METAL LOCATOR

An all-solid-state metal locator capable of detecting buried metal objects down to a depth of 6′ was recently introduced by *Heath Co.* Called the Heathkit Model GD-48, the new metal locator employs the induction-balance method of detection. As the sensing head of the instrument comes near a metal object, a loud tone is heard, from a built-in speaker or through headphones. For more accurate indications, a meter monitors relative imbalance between the two induction coils. The on-off/sensitivity control can be adjusted to detect an object as small as a dime buried at a 6" depth. The search head is supplied with both coils already accurately aligned and cemented in place; everything else is in kit form.

Circle No. 82 on Reader Service Page 15 or 115

### FOUR-WAY SPEAKER SYSTEM

The LWE IV, a new 14-speaker, high-efficiency four-way, non-resonance speaker system is being introduced by LWE Division of *Acoustron Corp.* The system is designed and engineered with inverse feedback electronic suspension and room gain control for improving sound reproduction in large listening rooms. The transducer complement of the LWE IV consists of four 15" woofers, four each 8" and 6" midrange speakers, and two 5" horn-type tweeters. Frequency response of the system is 20-20,000 Hz ±3 dB with crossover points at 150, 1000, and 4000 Hz. Nominal impedance is 4 ohms. Power handling capacity is 200 watts rms with 100 watts minimum power required to drive the system. The control panel contains high-frequency, high-midfrequency, low-midfrequency controls; phase switch; auxiliary amp jack; main input connector; and exclusive gain control.



Circle No. 83 on Reader Service Page 15 or 115

### FOUR-TRACE OSCILLOSCOPE PREAMP

A four-trace oscilloscope preamplifier, the first in a new line of kits, has been announced by the *Phase Corp.* The preamp is designed for use with any a.c. or d.c. oscillo-

(*Continued on page* 26)

## NEW PRODUCTS

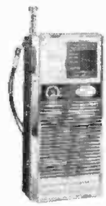
(*Continued from page 24*)

scope, providing the capability of observing as many as four waveforms simultaneously. Individual centering control is provided for each of the four inputs to the preamp. With an input impedance of 1 megohm/channel, the sensitivity of the preamp is limited only by the sensitivity of the scope with which it is used. The preamp is compact, facilitating mounting inside the scope housing or in an optional case. The circuit of the preamplifier employs four FET's and nine silicon transistors. Included in the kit is a printed circuit board that comes etched and drilled.

Circle No. 84 on Reader Service Page 15 or 115

### EMERGENCY/PSB MONITOR RECEIVERS

A new line of police/fire monitor receivers available from *Courier Communications, Inc.*, includes the Model COP-20H (148-175 MHz) and Model COP-30L (20-50 MHz).

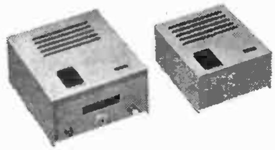


Both models are three-channel, pocket-size receivers that tune the bands indicated plus the AM broadcast band. An adjustable squelch control is incorporated to minimize hum and noise. An exclusive feature of these receivers is that the three crystal-controlled channels can be monitored with no coil changes. A built-in battery-level indicator, earphone and carrying strap, and built-in telescoping antenna are standard items with the receivers.

Circle No. 85 on Reader Service Page 15 or 115

### WIRELESS SMOKE AND FIRE ALARM

The *Olson Electronics, Inc.*, Model SW-440 smoke and fire alarm features solid-state circuitry for reliable and economical home and business protection.



The alarm is equipped with sensitive smoke and heat detectors, with provisions for adding an external heat sensor, emergency pull chain, and an extra a.c. outlet for additional signal devices. The detector can be located in the probable fire area and the alarm anywhere in the same building (on the same electrical system to provide a closed path for the wireless system, of course). The heat sensor activates the alarm at 135° F, sounding a loud buzzer.

Circle No. 86 on Reader Service Page 15 or 115

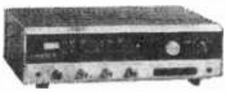
### DUAL POLARIZATION ANTENNA

The *Mosley Electronics Inc.* Model DMS-3D is a deluxe 12-element "Saser Beam," a combination of two MS-3D beams stacked. It has the sturdy construction of a beam plus a choice of polarization usually found only in the quad design. Each of the six horizontal and six vertical elements has two deluxe high-Q coils that are so powerful they can be used on a 10-meter ham antenna. A double-T matching system provides balanced feed horizontally and vertically; and a polarization switching control, located at the transceiver, permits selection of polarization at the turn of a dial. Technical specifications—10.5-dB compared to reference dipole, 12.6-dB over isotropic source forward gain; 25-dB front-to-back ratio; 30-dB polarization isolation; 1.5/1 or better SWR; 52-ohm feed impedance; 166-lb EIA standard 80 mi/h wind load.

Circle No. 87 on Reader Service Page 15 or 115

### 100-WATT AM/STEREO FM RECEIVER

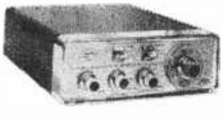
Solid-state design, with four FET's, is used in *Lafayette Radio Electronics'* recently introduced Model LR-775 100-watt solid-state AM/stereo FM receiver. The LR-775 has automatic stereo FM switching and stereo indicator light; an illuminated tuning meter; main and remote speaker switching; front- and rear-panel jacks for tape output; and rear-panel stereo inputs for magnetic and ceramic phono, auxiliary, and tape play. Other standard items include switched and unswitched a.c. outlets. Technical specifications: 50 watts/channel dynamic power into 4 ohms; less than 1% at rated output, 0.07% at 1 watt harmonic distortion; 20-20,000 Hz ±1 dB frequency response; 15-30,000 Hz power bandwidth; 1.7-$\mu$V IHF usable sensitivity; 1.5 dB capture ratio; 40 dB at 400 Hz stereo multiplex separation.



Circle No. 88 on Reader Service Page 15 or 115

### TWO MONITOR RECEIVERS IN ONE

The brand new *Courier Communications, Inc.*, Model COP-5OHL is a deluxe 12-channel, crystal-controlled high- and low-band monitor that is actually two receivers in one. Six high-band and six low-band channels can be monitored with crystal-clear reception with an exclusive r.f. peaking control that provides greater receiver sensitivity for each channel than was possible before. An exclusive tone control in the COP-50HL emphasizes highs or lows at the listener's discretion, and greater efficiency is obtained through the use of an IC in the audio section. Technical specifications: 25-50 MHz FM low-band, 150-175 MHz FM high-band frequency ranges; 10.7 MHz and 455 kHz i.f.; 0.5-$\mu$V sensitivity for 50 mW output on both bands; 0.5-$\mu$V and 0.3-$\mu$V sensitivity for 20 dB signal-to-noise ratio on high- and low-band, respectively; 46 dB minimum image rejection; 6 dB ±12 kHz and 60 dB ±20 kHz selectivity; 117-volt a.c./12-volt d.c. operation.



Circle No. 89 on Reader Service Page 15 or 115


New RCA WV-500B VoltOhmyst®
only $88.00*

# It measures AC volts, DC volts, resistance, current! It's portable, stable, accurate! It's all solid state!

RCA's new WV-500B VoltOhmyst is a completely portable voltmeter that's just right for the shack. It's battery-operated (no AC line to stretch to that unreachable outlet). No more warm-up time! No more "zero-shifting" (which sometimes happens with vacuum-tube voltmeters). WV-500B measures: DC voltages from 0.01 to 1500 volts; DC current from 2$\mu$A to 1500mA; AC voltages (RMS) 0.1 to 1500 volts; AC peak-to-peak voltages from 0.5 to 4200 volts; resistances from 0.2 ohm to 1000 megohms.

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**RCA**

CIRCLE NO. 23 ON READER SERVICE PAGE

**COVER STORY**


BUILD THE

# TWO-TONE "WAVERLY" ALARM

AUDIBLE WARNING OF MANY USES

BY DON LANCASTER

HAVE YOU EVER needed an audio tone source that was really loud, absolutely distinctive, or even downright annoying? If so, the Two-Tone Alarm is for you.

The circuit of the Alarm automatically switches the audible output from 500 to 1000 Hz five times a second, producing a *"twee-dell, twee-dell"* sound that can't be missed anywhere and positively can't be ignored. By adding an optional potentiometer to the circuit, the sound level can be changed from a high tweet to a low growl.

The Alarm can be set to run continuously or it can be turned on with a local switch or a remotely operated contactor. There are two outputs; a low-level one which can be amplified in any audio amplifier and a high-level one that can be used to drive a conventional speaker directly.

You can use the Alarm as a panic button, a novelty audio device, an electronic doorbell, a selective call, a Science Fair multivibrator demonstrator, a burglar alarm, or as a signalling device for high-noise industrial environments.

**IC EXPERIMENTER'S CORNER**

**Construction.** A schematic diagram of the Alarm is shown in Fig. 1. While it is not essential, a printed circuit board greatly simplifies the assembly. If you want to make your own, use the foil pattern and drilling details shown in Fig. 2. Mount the parts as shown in Fig. 3. The integrated circuit polarity is identified by a notch (between pins 1 and 14) and a dot. In the illustrations it is shown

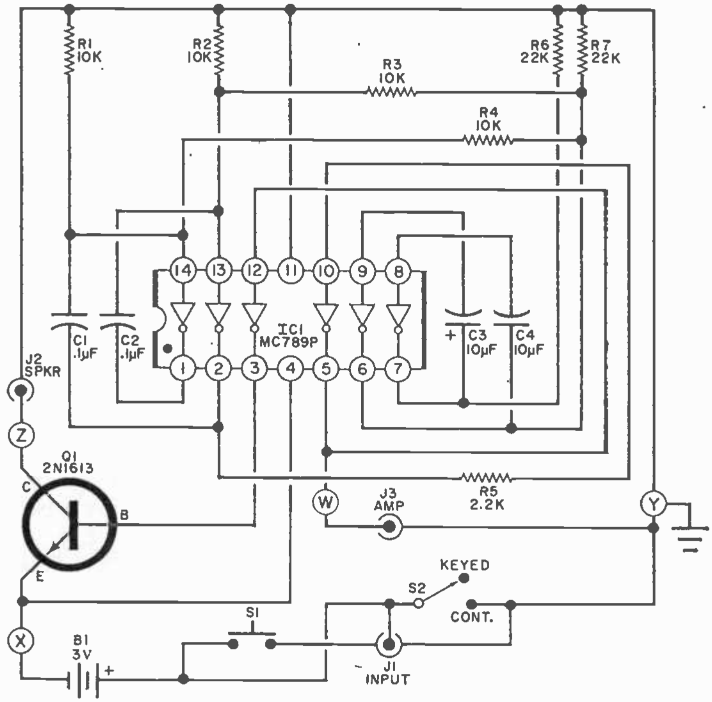



Fig. 1. The circuit is essentially a pair of audio oscillators that interact with each other to produce the strange sound. Note that the positive side of the battery is grounded to the chassis to ease the wiring.

## PARTS LIST

*B1—D cell (2)*
*C1,C2—0.1-μF, 10-volt disc ceramic capacitor*
*C3,C4—10-μF, 10-volt electrolytic capacitor*
*IC1—MRTL hex inverter (Motorola MC789P)*
*J1-J3—Phono jack*
*Q1—2N1613 npn medium-power transistor (or similar)*
*R1-R4—10,000-ohm, ¼-watt resistor*
*R5—2200-ohm, ¼-watt resistor*
*R6,R7—22,000-ohm, ¼-watt resistor*
*S1—S.p.s.t. normally open pushbutton switch*
*S2—S.p.s.t. slide switch*
*Misc.—PC terminals (4), 3" x 4" x 5" case, mounting hardware, battery holder (Keystone 176), PM speaker and enclosure (optional), wire, solder, etc.*
*Note—The following are available from Southwest Technical Products, Box 16297, San Antonio, Texas, 78216: etched and drilled circuit board, $1.50; complete kit of all parts including prepunched, vinyl-clad case, but less batteries and speaker, $6.90, postpaid in U.S.A.*

### HOW IT WORKS

The integrated circuit used here is called a hex inverter and contains six separate inverting amplifier stages. Two of these stages are combined with *R6*, *R7*, *C3*, and *C4* to form a 5-Hz astable multivibrator (square-wave oscillator). Two more inverters are combined with *R1* through *R4* and *C1* and *C2* to form a second astable multivibrator that can operate at either 500 or 1000 Hz, depending on the state of the 5-Hz multivibrator and feedback through *R3* and *R4*.

The remaining inverters provide load isolation, while transistor *Q1* provides enough drive to handle a permanent-magnet speaker.

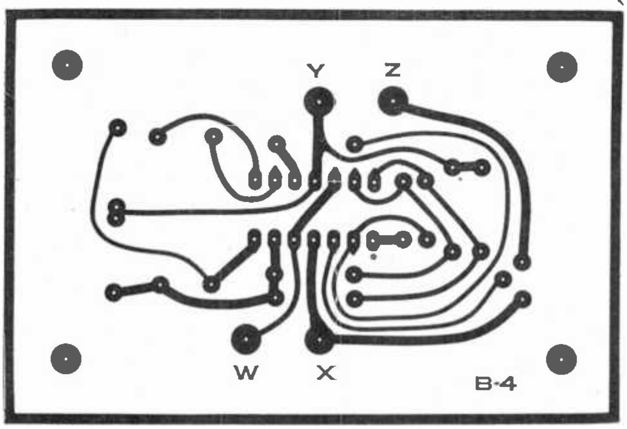
Power for the Alarm is obtained from two D cells. Any other medium-current d.c. supply with a voltage from 1.5 to 6 volts can be used. Switches *S1* and *S2* and jack *J1* are all in parallel to energize the Alarm. To simplify the assembly, the case is connected to the keyed positive supply level (PC terminal Y).

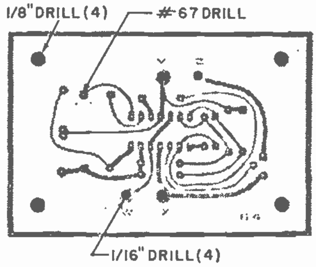
from the top. Be sure to orient it properly and use a small soldering iron and fine solder when installing it. Also, be careful about the polarities of electrolytic capacitors *C3* and *C4*.

Assemble the Alarm in a 3" × 4" × 5" metal box. The battery holder is mounted on the bottom with pop rivets or #6 hardware, while the PC board goes on the top with suitable spacers or #6 hardware.

**Operation:** To test the Alarm, either connect the amplifier output (*J3*) to a suitable amplification system or attach

Fig. 2. Actual-size foil pattern for the Two-Tone Generator. The IC is oriented so that pin 1 is adjacent to the small dot on the foil pattern. After fabrication, the board can be drilled as shown below, and PC terminals can be used at the four lettered locations. The board is supported by spacers at each corner location. Component location is shown in Fig. 3.




a low-impedance (4-, 8-, or 16-ohm) speaker to the speaker jack (*J2*). The Alarm should operate immediately.

To vary the output sound, add a 500- or 1000-ohm potentiometer in series with *S1*.

Capacitors *C1* and *C2* determine the frequency of the lowest note, while *C3* and *C4* determine the switching rate. The difference between the highest and lowest notes is determined by *R3* and *R4*. You can experiment with any of these values to get different audio results.

Volume should be more than enough for most applications. If you want more, however, try using a higher supply voltage (up to 6 volts). You can also use an output matching transformer or a high-efficiency horn-type speaker. -30-

### COVER FEATURE

This is the first in a series of simplified integrated circuit projects. In addition to the Two-Tone Alarm, the series includes a Signal Injector, a Bounceless Pushbutton, a Shift Register, and a 100-kHz Standard. The last four will appear in future issues of POPULAR ELECTRONICS. In these articles, the author demonstrates a variety of uses of commonly available integrated circuits. The projects themselves may be used for classroom or Science Fair demonstrations, or they may be repackaged and put to more constructive uses. Each project will be complete and will include details on circuit operation.

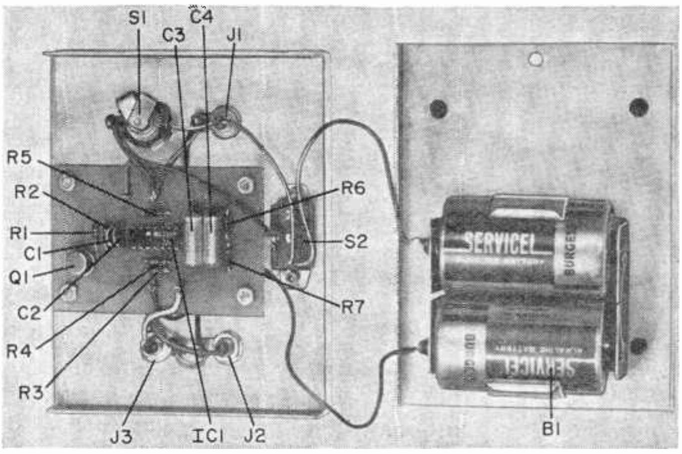



Fig. 3. Although the alarm can be built in almost any type of case, the prototype was built within a small metal enclosure. Install the components on the PC board as shown at left and mount batteries on other side.

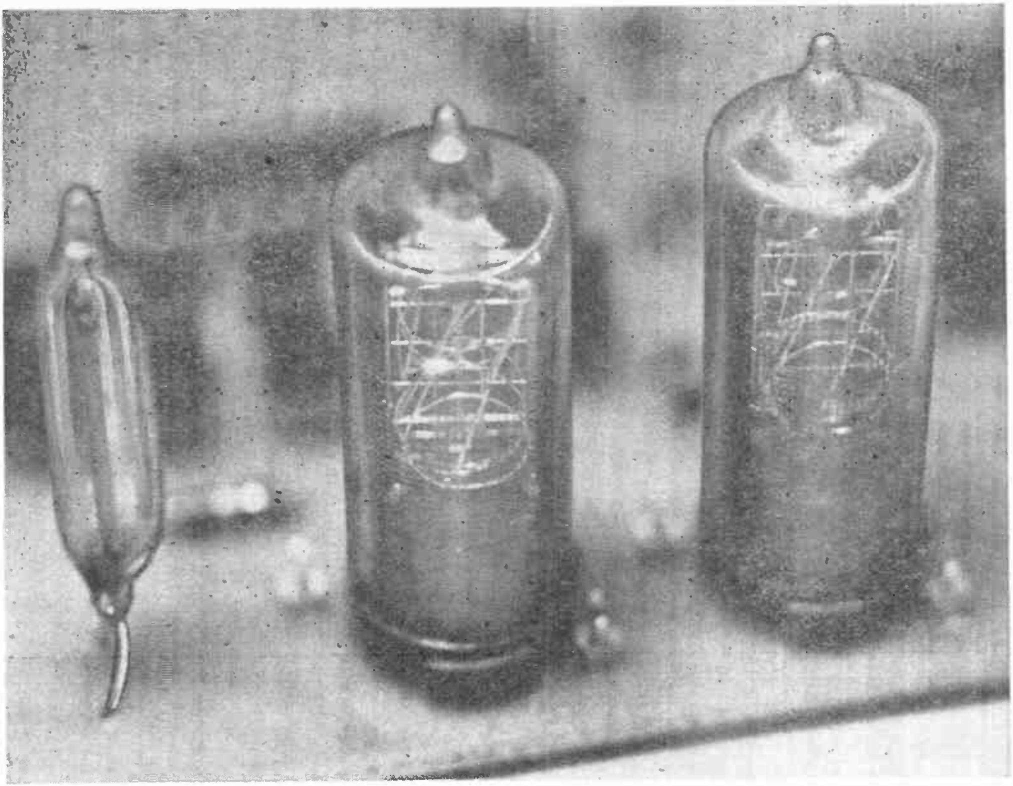
# LSI Gives Semiconductors a "Trip"

A TRUE-FALSE QUIZ THAT COVERS THE ELECTRONICS WATERFRONT

(*Answers on page* 17)

BY VIC BELL

1. LSI is being used to "dope" many new types of semiconductor materials. TRUE____ FALSE____
2. If the third color band on a resistor is silver or gold, the resistor is either a 10% or a 5% unit and is less than 100 ohms. TRUE____ FALSE____
3. Spreading the outside plates on a variable air capacitor decreases its maximum capacitance. TRUE____ FALSE____
4. When two dissimilar metals are joined and heated, a voltage is developed across their junction. This is known as the Seebeck effect. TRUE____ FALSE____
5. "Skating force" is the side pressure exerted on a phonograph tone arm by the record groove spiral. It can be eliminated by using a dynamically balanced tone arm. TRUE____ FALSE____
6. A magnetostrictive material is one that changes its physical dimensions when magnetized. TRUE____ FALSE____
7. When a coil is wound around a magnetostrictive material core, a voltage is developed across the coil if a pressure is applied to the core. TRUE____ FALSE____
8. The Curie Point of a material is the temperature where it becomes radioactive. TRUE____ FALSE____
9. The resistances of both tungsten and carbon are inversely proportional to temperature. TRUE____ FALSE____
10. The combination of two 10-ohm, ½-watt resistors in series will have the same power rating as the combination of two 40-ohm, ½-watt resistors in parallel. TRUE____ FALSE____
11. Infrared detection systems are of little use in desert areas because of the high sand temperature. TRUE____ FALSE____
12. The SCR is the solid-state equivalent of the d.c. latching relay. TRUE____ FALSE____
13. Submarines are capable of radio communications while submerged by using the SHF band. TRUE____ FALSE____
14. Rare earths now being used in color picture tubes are not really rare compared to many other elements. TRUE____ FALSE____
15. Coaxial cable cannot be made substantially smaller because frequency response dictates its size. TRUE____ FALSE____
16. An anisotropic magnet is one which has the same magnetic characteristics along any axis or direction. TRUE____ FALSE____
17. The first half of the horizontal sweep in a normal TV receiver (left side of the screen) is formed by the damper circuit. TRUE____ FALSE____



# Build Numeric Glow Tube DCU

## *Nixie Readout at $15 per Decade*

BY DON LANCASTER

NOW IT IS possible to build a high-speed, decimal counter module (complete with logic and Nixie® tube readout) at a cost of $14.90 per decade. This counter, with speeds from d.c. to either 8 or 12 MHz (depending on the type of logic used), can be built with 2½ decades (0-199), 3½ decades (0-1999), or 4½ decades (0-19999) using a single printed circuit board. No mounting or front brackets are needed and there is a minimum of interconnections to be made.

The design provides an overflow indicator and latch which operate when full scale is exceeded. This function is useful for overrange indication or as a "turn-around" command on dual-slope DVM designs. Display blanking, in which the readout can be turned off or on by an external 0-2-volt d.c. control signal is also available. This feature eliminates display bobble or blur and back-and-forth numeral motion during rapid counting.

There is also a self-contained "gate" input that permits turning the counters on and off and is useful for period or frequency measurements. This feature eliminates quite a bit of external circuitry.

You have a choice of the type of logic you use in building the DCU. If RTL is used, the unit is fully compatible with previous POPULAR ELECTRONICS projects. Or you can use Utilogic® (Signetics Corp.), a faster type of logic with a higher voltage swing that is compatible with industrial TTL and DTL circuits. Both types of logic cost the same.

The IC counters are "weighted" in the industrial 1-2-4-8 manner to provide electrical as well as visual outputs if de-

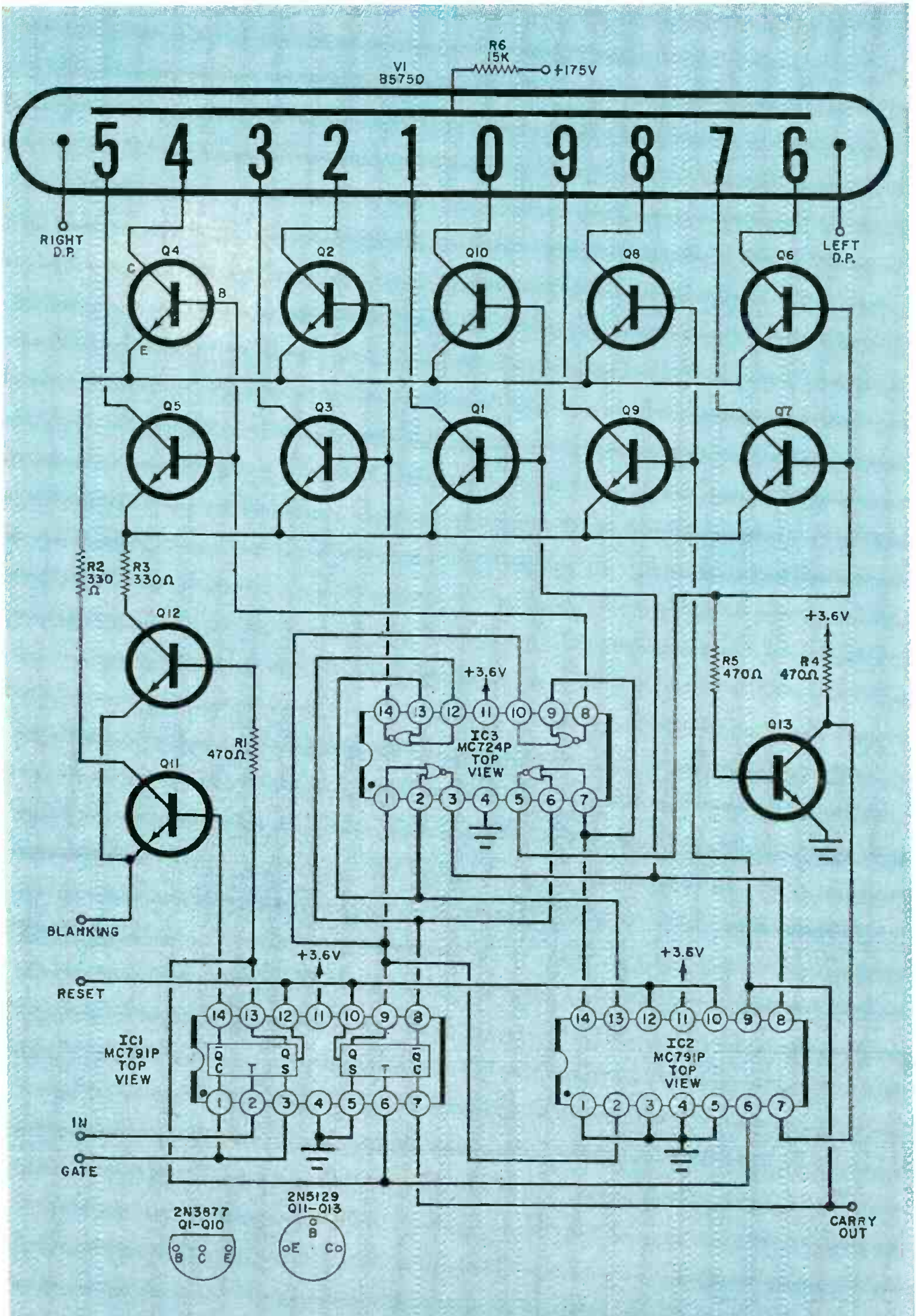
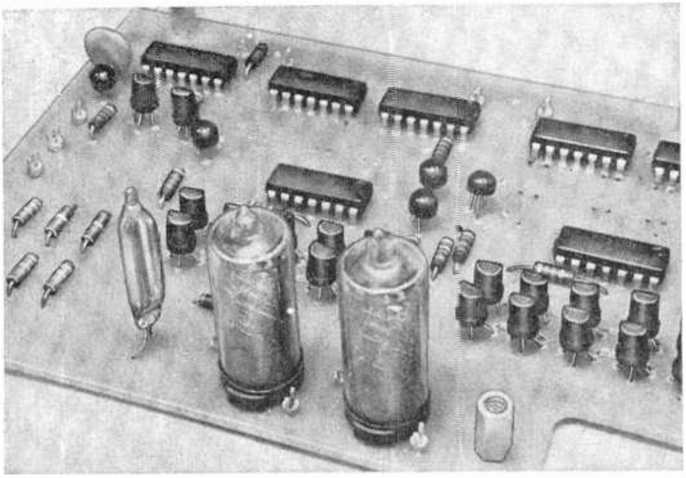



Fig. 1. The schematic for one decade counter. As many decades as desired can be built using this same schematic. The readout is a conventional Nixie tube with a glowing numerical-shaped display.

The 2½-decade board. Each Nixie indicates up to 9, and at the 100th count, both Nixies indicate zero while the special "1" neon lamp comes on. The combination indicates to 199. At 200th count, a special over-range neon lamp (not shown) glows indicating that counter has progressed beyond its limits.



sired. A simple modification and an external adapter can be used to convert the RTL version of the DCU into an "add-subtract" counter which operates in either direction. The units are useful in computers, calculators, and positional controls.

When RTL is used in this new DCU, the unit can be used in POPULAR ELECTRONICS projects such as the "Digital Voltohmmeter," the "Universal Frequency Counter," the "Sports Timer," and the "Electronic Stopwatch." In fact, with a few mechanical changes, the new 2½-digit assembly can be dropped into the "Digital Voltohmmeter" without adding any new parts. This makes a DVM that looks like the industrial models that cost many times as much.

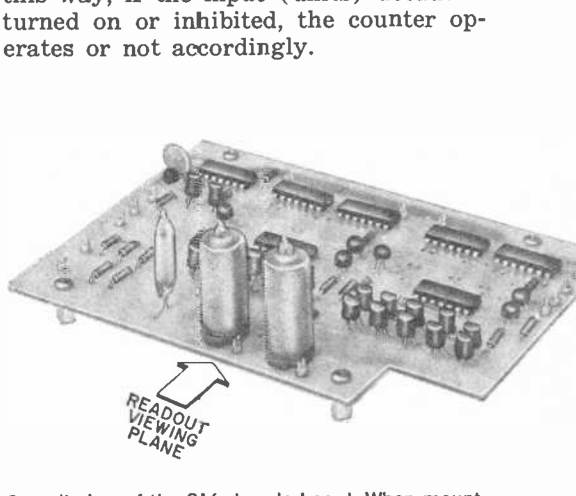
## PARTS LIST
## DECADE COUNTER

*IC1,IC2—MRTL dual JK flip-flop (Motorola MC791P)*
*IC3—MRTL quad two-input gate (Motorola MC724P)*
*Q1-Q10—2N3877 transistor (Allied Electronics 49D30 2N3877 SPR, no substitute)*
*Q11-Q13—Transistor (National Semiconductor 2N5129)*
*R1,R4,R5—470-ohm, ¼-watt resistor*
*R2,R3—330-ohm, ¼-watt resistor*
*R6—15,000-ohm, ¼-watt resistor*
*V1—Nixie tube (Burroughs B5750)*
*Misc.—#24 wire jumpers, insulated sleeving, solder, spacers, mounting hardware, etc.*
*Note—The following are available from Southwest Technical Products, Box 16297, San Antonio, Texas 78216: Etched and drilled PC boards—2½-digit, $4.00; 3½-digit, $5.75; 4½-digit, $7.50. Complete kit of all parts—2½-digit, $43.50; 3½-digit, $59.50; 4½-digit, $75.00. Write for a complete list of related circuits, kits, and instruments. All prices postpaid in U.S.A.*

Because of space limitations, construction details are given here for the RTL counter only. Complete information, including PC layouts, for the Utilogic version is available without cost from the source given in the box.

In deciding whether you want to use RTL or Utilogic in your DCU, consult the Table.

The circuit for one decade of the DCU is shown in Fig. 1 and that of the overflow counter is shown in Fig. 2. Although these are shown as separate circuits, in practice, one overflow counter and as many decades as are necessary are mounted on one PC board. Interconnections for the units are shown in Fig. 3. Note that the Gate connections of all decades except the first are grounded. In this way, if the input (units) decade is turned on or inhibited, the counter operates or not accordingly.




Overall view of the 2½-decade board. When mounted in enclosure, only the readouts will be visible.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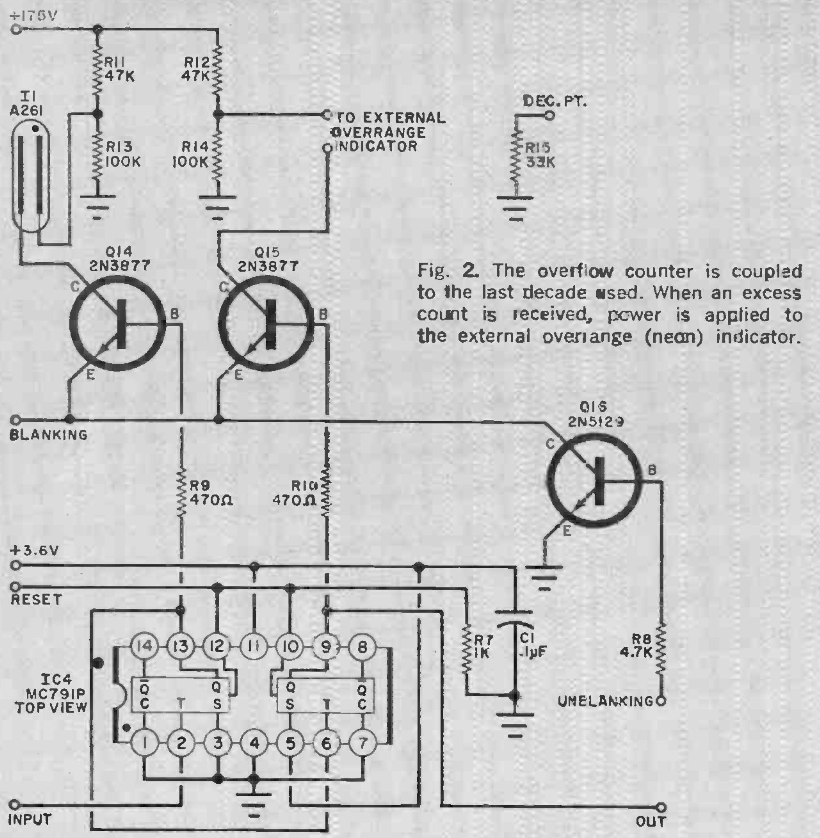


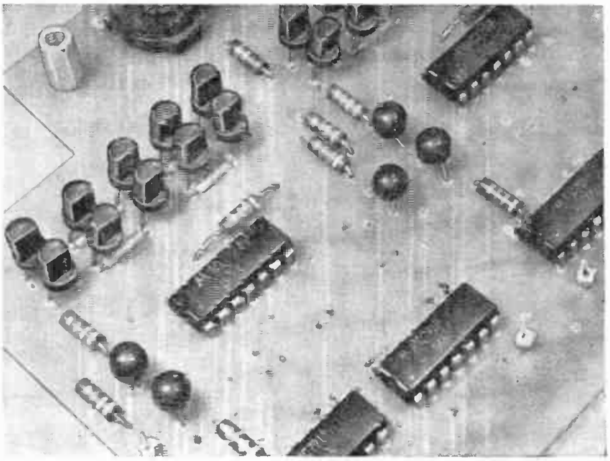

Fig. 2. The overflow counter is coupled to the last decade used. When an excess count is received, power is applied to the external overrange (neon) indicator.

## PARTS LIST OVERFLOW COUNTER

*C1—0.1-μF, 10-volt disc ceramic capacitor*
*IC4—MRTL dual JK flip-flop (Motorola MC 791P)*
*Q14,Q15—2N3877 transistor (no substitute)*
*Q16—Transistor (National Semiconductor 2N5129)*
*R7—1000-ohm,*
*R8—4700-ohm*
*R9,R10—470-ohm*
*R11,R12—47,000-ohm*
*R13,R14—100,000-ohm*
*R15—33,000-ohm*
*All resistors 1/4-watt*
*I1—Numeral "1" neon readout (Signalite A-261)*

**Construction.** Decimal counting units can be built in a number of configurations: 1½ (counting to 19), 2½ (to 199), 3½ (to 1999), 4½ (to 19999), etc. In each case the ½ stands for the "1" of the overflow counter, while the whole number stands for the number of decade counters (each counting to 9).

Construction details are given here for the popular 2½-digit assembly. Because of the complexity of the circuit, a printed board is mandatory. A board is shown actual-size in Fig. 4. A commer-



General view of a portion of a 2½-decade board. This view shows the correct way to install the ten switching transistors for the Nixie drive.

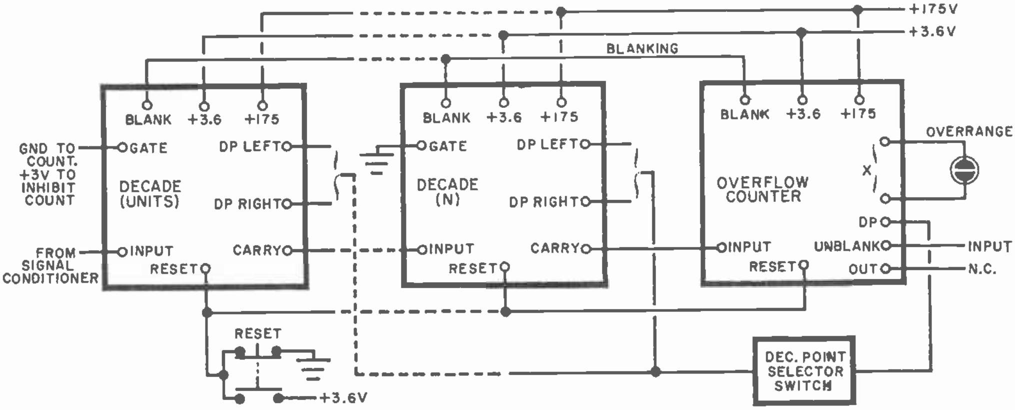



Fig. 3. Interconnection of decades, overflow, overrange indicator and decimal-point selector. Note that all decade gate inputs, other than the first one, are grounded. First gate is used to start and stop counting.

cially made board is available (see Parts List for Fig. 1). If you prefer to make your own, it is recommended that you use the better-grade, G-10 fiberglass.

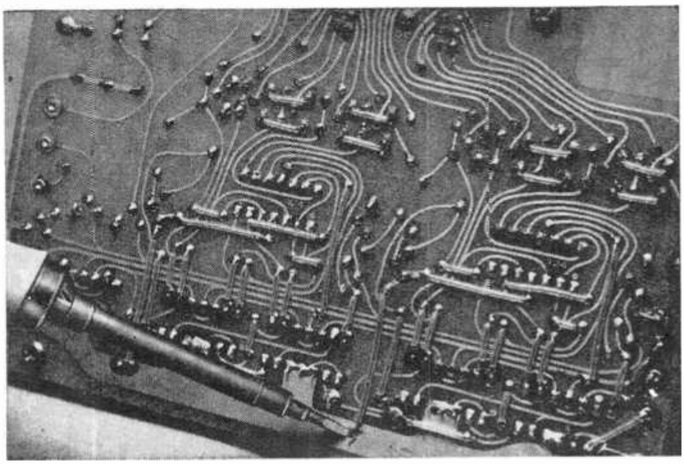
Besides drilling details, Fig. 5 shows the location of the 32 jumpers located on the component side of the board. In addition, there are four jumpers that are "sewn" through the board, so that they alternate from one side to the other and pick up five connections each. Details of this are also shown in Fig. 5. The long bare jumper is soldered at one end and then threaded through the holes in the board. Use insulated sleeving over the exposed parts to prevent shorts to the transistor leads.

Once the various jumpers have been installed, the components are inserted in accordance with the layout shown in Fig. 6. Use a low-power (40-watt) soldering iron and thin solder to make all connections. The IC's are identified by a notch and dot code for positioning. To insert the 20 driver transistors, hold them with the flat facing away from the readout tubes. Then bend the center lead back toward the tubes and insert as shown.

In inserting the Nixie tubes, put the leads in two at a time. Before soldering, make sure that all leads are tight, none are doubled over or shorted to each other and the viewing face of the tube is aimed in the correct direction. Also be certain the tube is vertical.

Mount the neon lamp (for numeral 1) so that the metal rods within the tall narrow bulb are at the same height as the numerals in the Nixie tubes.

Underside view of the PC board showing how some jumpers are connected. These below-board jumpers must all be insulated.



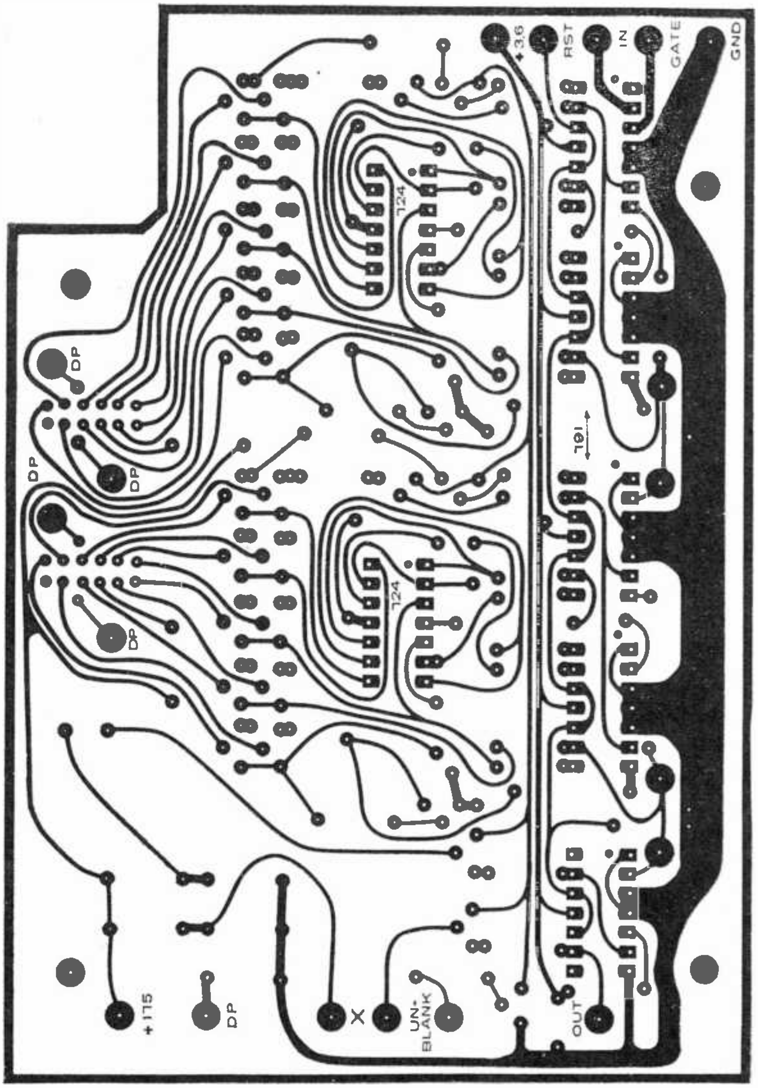
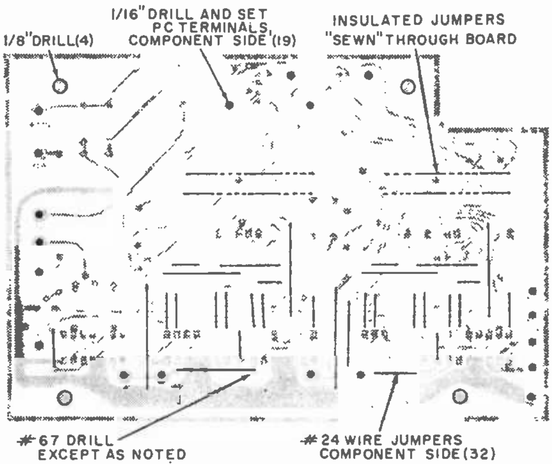



Fig. 4. Actual-size foil pattern for the 2½-decade board, with associated overflow counter. By judicious re-arrangement of the foil pattern the number of decades used can be extended. Boards for multi-decade readout can also be purchased.



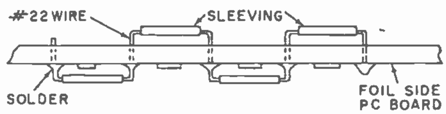




Fig. 5. Board drilling and jumper installation. Some jumpers are "sewn" through the board as illustrated above. Start at one end, and pass the wire through the respective holes, inserting the insulation at the required places.

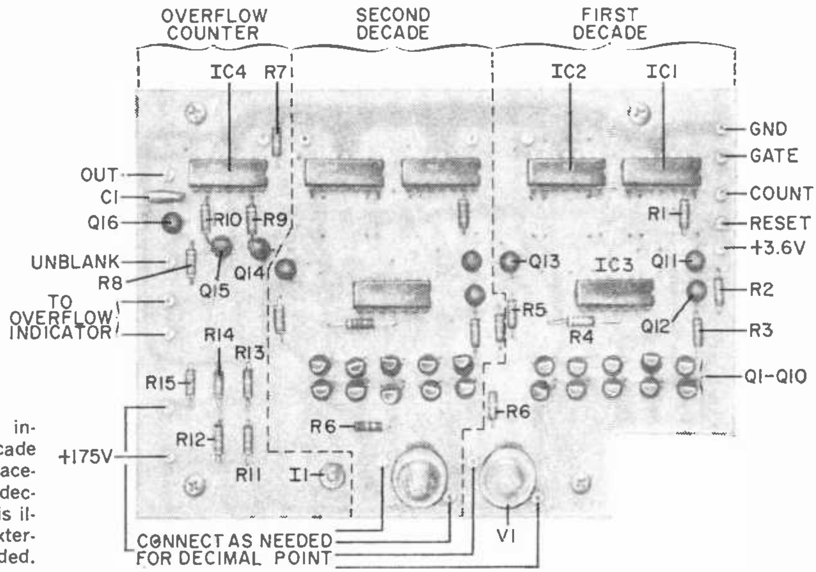



Fig. 6. Component installation of 2½-decade board. Other than placement of R6, both decades are similar. This illustration shows external connections needed.

**Use.** The 2½-digit module can be used in any one of a variety of chassis styles—as long as it has a rectangular front-panel cutout for the two Nixie readout tubes and the neon light. A special polarized optical filter is available (see Parts List for Fig. 1) to improve readout visibility. This filter should be oriented to produce the blackest instrument interior when viewed and illuminated through the filter. Once the correct orientation has been found, glue the filter in place behind the front-panel cutout.

External connections to the module are shown in Fig. 6. The 2½-digit module requires +175 volts at 5 mA for the readouts, and +3.6 volts at 340 mA for the remainder of the circuit. A power supply (such as the one shown in Fig. 7) is required. It has low ripple with high-frequency bypassing—an essential.

Ground leads should be short and of

## PARTS LIST
## POWER SUPPLY

*C1—100-µF, 250-volt electrolytic capacitor*
*C2—6000-µF, 10-volt electrolytic capacitor*
*C3—200-µF, 6-volt electrolytic capacitor*
*C4—0.1-µF, 10-volt disc ceramic capacitor*
*D1,D2—1-ampere, 600-volt silicon diode (1N4005 or similar)*
*D3—1-ampere, 50-volt silicon diode (1N4001 or similar)*
*D4—4.2-volt (RTL) or 5.6-volt (Utilogic) 1-watt zener diode*
*F1—0.5-ampere fuse and fuse holder*
*Q1—2N5190 transistor and suitable heatsink*
*S1—Power switch (usually a part of other instrument or circuit switching)*
*T1—Power transformer; secondary 135-0-135 V at 50 mA, 6.3 VCT at 1 A (Southwest Technical #TR-DVM or similar)**
*Misc.—Mounting spacers, hardware, wire, solder, terminals, line cord and strain relief.*
**Available at $6.50 plus 4 lb postage from Southwest Technical Products, Box 16297, San Antonio, Texas 78216.*

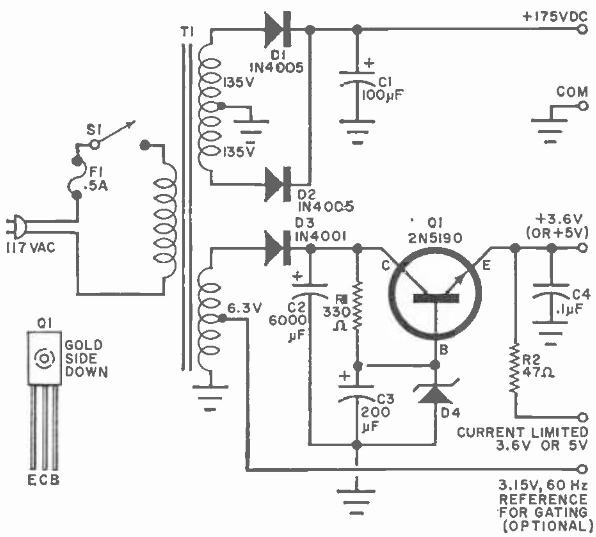



Fig. 7. Low-ripple power supply for the 2½-decade board. By changing D4, the supply can be used for either RTL or Utilogic circuits.

## FOR UTILOGIC DCU DETAILS

Complete construction information, including full-size PC layout replicas and all other details, is available free upon request from:
Alvin R. Smith, Section Head
Digital Design Group
Southwest Technical Products, Inc.
Box 16297
San Antonio, Texas 78216
Please limit free requests to single copies.

heavy gauge wire (at least #16). The "Out" terminal on the board is used only in some special DVM circuits and is normally left unconnected. The terminals along the rear of the board are for use in the future with an add-subtract adapter and are also left unconnected for routine applications.

The "Gate" input, if used, goes to an RTL-derived signal that is positive when the counter is to be inhibited and ground when the counter is to count. If you are not going to gate the assembly, the Gate terminal should be connected to the ground terminal.

To provide a blanking feature, connect the "Unblank" terminal to an RTL-derived signal that is positive when you want the display to light and ground when you want it off. Remember that the Unblank input does not stop the

**CHOOSING THE RIGHT LOGIC FAMILY**

| RTL | UTILOGIC |
|---|---|
| Supply: 3.6 volts. | Supply: 5 volts. |
| Compatible with all previous POPULAR ELECTRONICS projects. | Compatible with industrial DTL and TTL circuits. |
| Typical maximum speed: 8 MHz. | Typical maximum speed: 12 MHz. |
| Grounding and supply leads relatively critical. | Grounding and supply leads less critical. |
| May be converted to an add-subtract counter assembly. | Conversion difficult. |
| Input toggle must be bounceless and fall faster than 200 nanoseconds. | Input toggle must be bounceless, but may have considerably longer fall time. |
| External monostables, astables, crystal oscillators using RTL easy and cheap. | External circuitry often much more complex and expensive. |
| Recommended for student and home experimenter. | Recommended for industrial technician or engineer. |

## HOW IT WORKS
## DECADE COUNTER

One decade counter can be divided into four sections: the actual counter, the decoder, the readout driver, and the readout.

The counting portion (at bottom of diagram) consists of four JK flip-flops arranged to count to 9 before reverting back to zero and simultaneously delivering a "Carry" output to the next decade. To force the counter to count only to 9, an inverter in a feedback loop is used. The voltage levels, which are unique for each count, are taken from the Q and $\overline{Q}$ outputs of each flip-flop for use in the decoder. The flip-flop outputs are in the common 1-2-4-8 code. If more than one module is to be used in an instrument, the "Gate" input terminal of the counter is connected to ground in all but the first counter. When the gate is grounded, the counter operates normally. When it is made positive, the counter is inhibited. In this way, an externally generated signal can be used to determine when the counter is to operate.

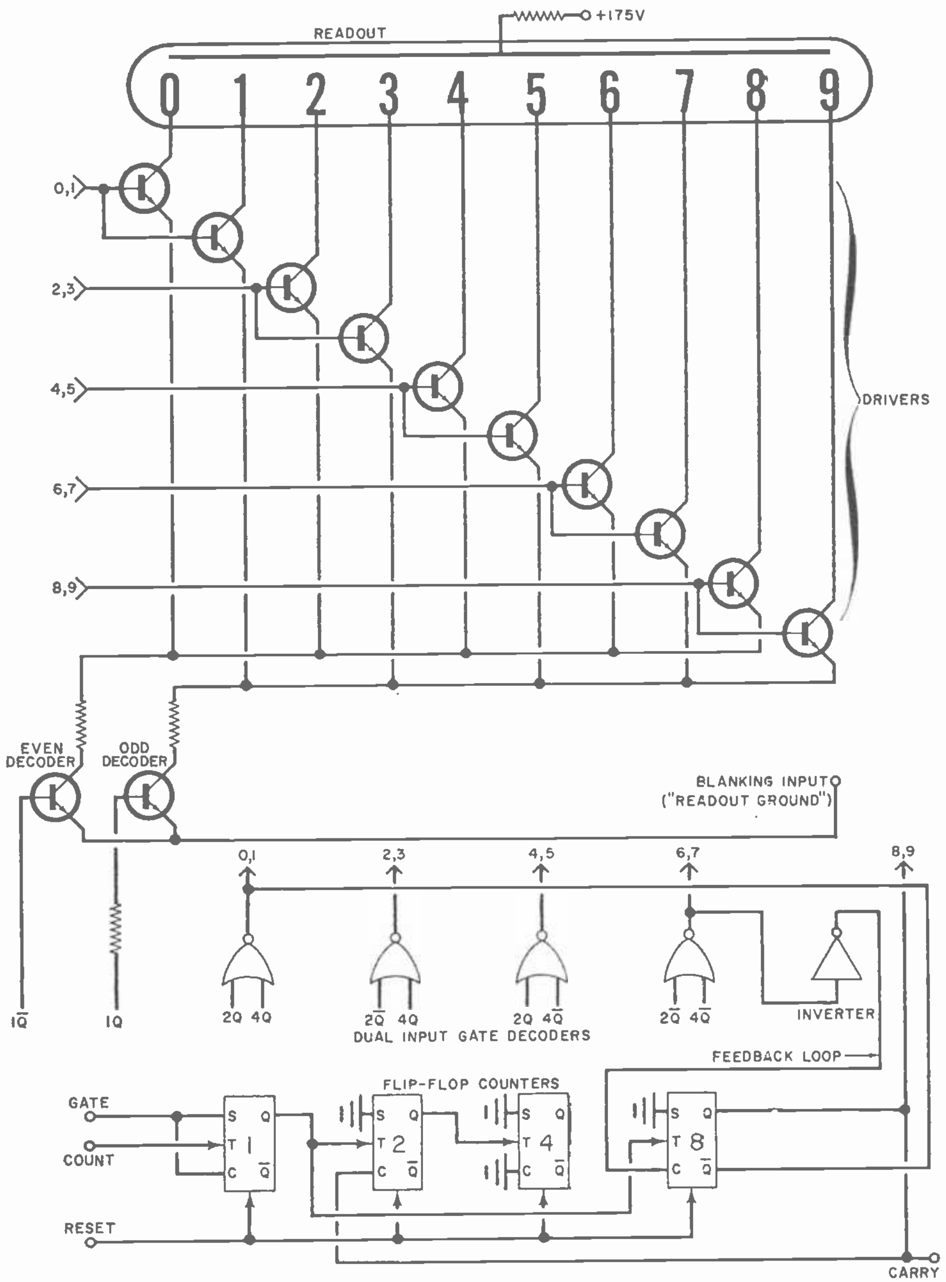
In the decoder, consisting of four gates and two discrete transistors, the 1-2-4-8 output of the counter is converted into a *biquinary* (divide by 2, then by 5) code. It has seven outputs: even, odd, 0 and 1, 2 and 3, 4 and 5, 6 and 7, 8 and 9. These form the input to the readout drivers.

The readout (Nixie tube) is a gas filled tube with one common anode and 10 discrete metal cathodes, each formed into the shape of a number (from 0 to 9). When B+ is applied to the common anode and any of the cathodes is grounded, the gas around that particular piece of shaped metal glows causing a number to appear in the viewing plane.

The readout drive consists of 10 high voltage transistors, driven in pairs by the decoder outputs. The transistor collectors are connected to the 10 cathodes of the Nixie tube. The emitters of all of the odd-numbered transistors are connected together and to the "odd" buss, while the even-numbered transistors have their common emitters connected to the "even" buss. The even and odd busses are driven by the two transistors in the decoder.

The system can be considered to operate like a switching network. When, for example, the even transistor in the decoder is saturated (with its emitter grounded), the even buss is essentially at ground. Then, if a signal is applied to the bases of one pair of driver transistors, only the one whose emitter is connected to the even buss saturates and acts as a switch to close the circuit to the appropriate cathode on the readout. Suppose, for instance, that the count is 7. Since 7 is an odd number, the odd decoder transistor is saturated and the odd buss is grounded. Simultaneously, the 6 and 7 output of the decoder applies signals to the 6 and 7 driver transistors. Because only the 7 transistor is connected to the grounded odd buss, only the 7 transistor saturates, causing the number 7 to glow in the readout.

Note that we said previously that the odd or even buss must be grounded for the decoder transistors to work. The grounding is made external to the counter through a connection to the "Blanking Input" terminal. A circuit in the overflow counter determines when this terminal is grounded for display viewing. In this way, rather than have a blur of numbers while the counter is counting, the blanking input keeps the display off until the counting is complete. Then a steady display is shown.


+175V
READOUT
0 1 2 3 4 5 6 7 8 9
0,1
2,3
4,5
6,7
8,9
DRIVERS
EVEN DECODER
ODD DECODER
BLANKING INPUT
("READOUT GROUND")
0,1
2,3
4,5
6,7
8,9
1Q̄
1Q
2Q 4Q
2Q̄ 4Q
2Q 4Q̄
2Q̄ 4Q̄
DUAL INPUT GATE DECODERS
INVERTER
FEEDBACK LOOP
FLIP-FLOP COUNTERS
GATE
COUNT
RESET
CARRY
S Q T 1 C Q̄
S Q T 2 C Q̄
S Q T 4 C Q̄
S Q T 8 C Q̄

## HOW IT WORKS
## OVERFLOW COUNTER

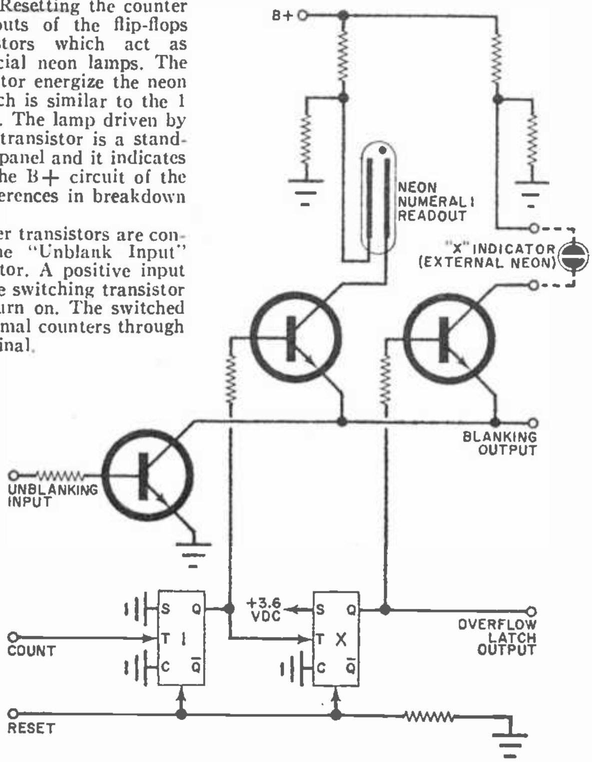
The overflow counter consists of a counting section, a display driver, and a display.

The counter contains two JK flip-flops the first of which is a divide-by-two and the second a latch. The latch flips positive and stays positive when there is an overflow. Resetting the counter resets the latch. The outputs of the flip-flops drive high-voltage transistors which act as switches in series with special neon lamps. The first flip-flop and its transistor energize the neon lamp that displays a 1 which is similar to the 1 displayed by the Nixie tube. The lamp driven by the second flip-flop and its transistor is a standard neon lamp on the front panel and it indicates "Overrange." Resistors in the B+ circuit of the neon lamps provide for differences in breakdown voltages.

The emitters of both driver transistors are connected together and to the "Unblank Input" through a switching transistor. A positive input to this terminal saturates the switching transistor and causes the display to turn on. The switched signal is supplied to the decimal counters through the "Blanking Output" terminal.

Remember that counting continues whether or not the display is lit. The blanking merely controls whether or not the display is on.

The overflow counter also contains a bypass capacitor for the supply, resistive loading for the reset buss, and a decimal point resistor. These elements are connected to their respective circuits through the instrument wiring.

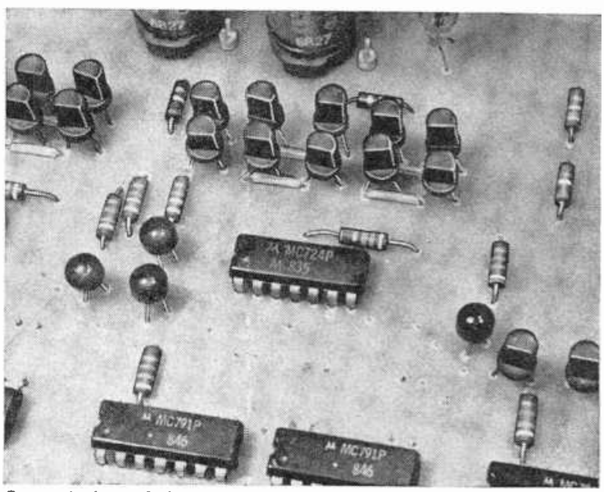



counter from working—it just determines whether or not the display can be seen. If you do not want to turn the display off, connect the Unblank terminal to the +3.6-volt source.

The two terminals marked "X" are connected to a neon overrange indicator (usually mounted in a red holder). If you don't want the overrange indication, leave these two terminals unconnected.

Decimal points are activated by connecting the selected decimal point terminal beside each Nixie tube to the "DP" terminal on the overflow counter through an external switch. Decimal point operation is independent of display blanking.

The "Reset" terminal is normally connected to ground through an external switch. Raising the buss to +3.6 volts momentarily resets the assembly to zero.




General view of the second decade of the counter. Even though the three portions extend across the board, the three readouts are very closely spaced.

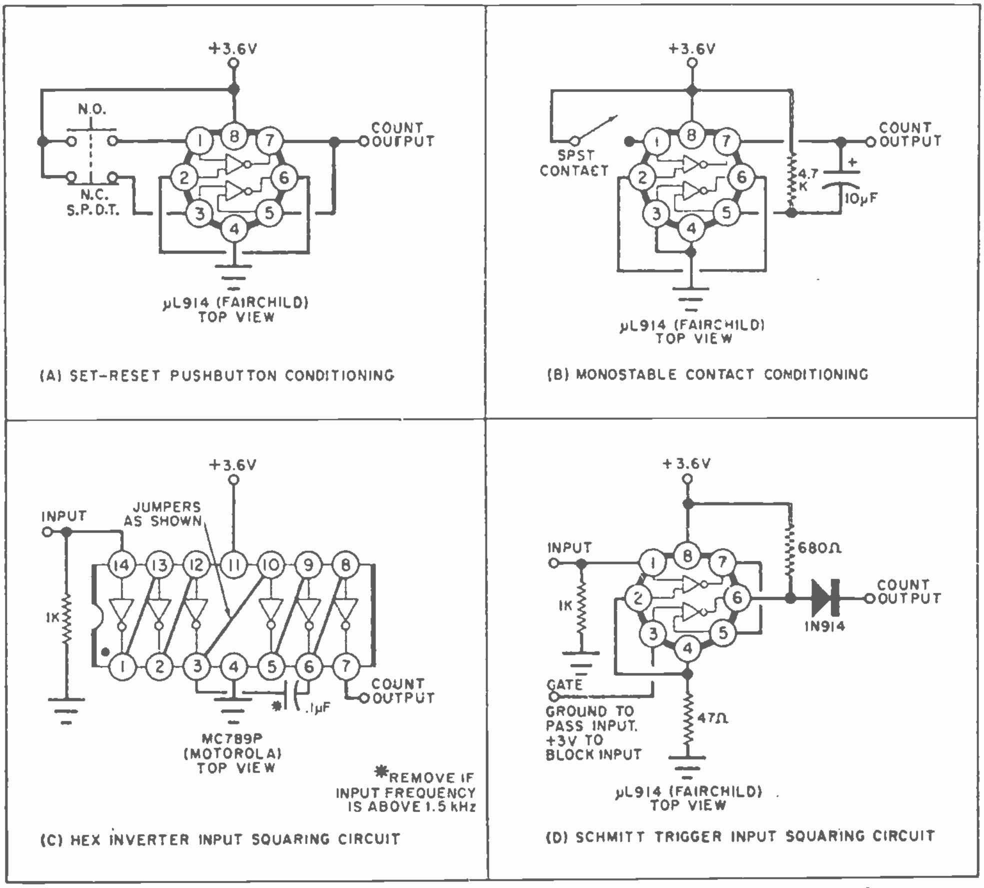



Fig. 8. Four approaches to "bounceless" signal conditioners. Either A or B can be used for mechanical switching, while either C or D can be used if the input signal comes from a conventional audio generator.

The Reset button need not be bounceless. If you use an electronic reset, a 2-microsecond pulse with a fanout of 30 is required.

**Input.** The input must be a waveform that changes abruptly from +3.6 volts to ground each time a count must be registered. For the counter to operate properly, the input must be both noiseless and bounceless and have a fall time less than 0.2 microseconds. Thus it is absolutely mandatory that the input be properly conditioned. Four possible signal conditioners are shown in Fig. 8. Circuits (A) and (B) are used for mechanical-contact inputs, while (C) and (D) are for electronic inputs. Circuit (C) is used for input levels of about 2 volts r.m.s. If the input frequency is below 1500 Hz, the capacitor must be included. For higher frequencies, omit the capacitor. Circuit (D) is a Schmitt squaring circuit.

Any of the circuits used in previous POPULAR ELECTRONICS DCU projects have the proper conditioning circuits built in. Thus, if you have built or are considering building the Digital Volt-ohmmeter (December 1968), besides making the mechanical modifications that are necessary to use this new counter module, connect the "Unblank" input to the existing "Gate" terminal on the V/F module in the Voltmeter. Should the brightness of the display be inadequate, the original DVM transformer should be replaced with the one called for in Fig. 7.

**Power Supply.** A recommended power supply with sufficient regulation is shown in Fig. 7. This supply is wired point-to-point after all parts have been mounted in a suitable chassis. -30-

# THE GREAT ELECTRON-PEDANTIC PROJECT

BY CARL KOHLER

I ALMOST made it.

Sneaking from the car to the workshack, my arms loaded with stacks of books borrowed from the public library, I was doing just fine until one of the larger, heavier tomes toppled—hitting the pavement with an echoing smack.

Friend Wife, Peggy, immediately peered out the back door, hearing the sound and spotting me going tippytoe lugging the books. She came through that doorway and was upon me before I could stagger another step. So I stood stockstill, deciding to play it totally cool.

"What's with all the books?" she demanded.

"Going to do a little reading," I murmured from behind the wavering stacks I was balancing. "Just going to do a little reading, that's all."

Her face appeared around one of the unstable stacks, sheer disbelief gleaming in her eyes, complete suspicion quirking her mouth. I stared back with what I hoped was the most innocent and appealing expression this side of that overweight infant on the babyfood tins.

"You always do your reading in the house," she said flatly. "How come you aren't bringing them into the house?"

"Uh . . . not *this* time."

"What are they—dirty novels?"

*"Certainly not!"* My voice trembled with indignation. "Why, these represent some of the most profound concepts that the finest minds of mankind ever sustained long enough to put on paper!"

"Oh, yeah?" Her eyes roved over several titles. "Hmmmm. They *look* dull enough to be as high-brow as you claim. *First Principles—"* she read aloud, *"Abstract Mathematics—History Of Philosophy—Grey's Anatomy—The Natural Sciences—Profiles Of Classical Artists."* She glanced at me with a tight little smirk. "Isn't all this stuff slightly over your head? I always figured you were more a 'MAD' magazine buff!"

I sighed. A long, shuddering sigh of defeat.

"All right," I muttered dully. "Tote some coffee out to the workshack and I'll wire you in to the whole plan. You'll find out sooner or later, anyway."

While she went sprinting away to bring the requested brew, I carried the teetering towers of books into the workshack. letting them spill to the floor. Restacking them neatly alongside all the other books earlier sorties had produced, I bitterly meditated upon my fond and chronic illusion of secrecy. Sometimes I actually managed to bring a project pretty well along before she chanced upon it. Once, I even came within twenty minutes of completing a project in delicious secrecy. But a malicious fate sent her blundering into the workshack while I was still bolting a chassis into its casing.

"Ah, well," I sighed again. "At least I'm gifted with a glorious verbal-defensive ability. Things *could* be worse. I could be slow-spoken. Or have the handicap of a stammer."

She waltzed into the workshack, holding the tray skillfully aloft. It bore a pot of coffee and two cups. She lowered it with a flourish, not spilling a drop.

"Exhibitionist!" I sneered.

"Now," she chirped brightly, "tell me all about what's going on! Why you're suddenly bringing books in here by the ton."

I gestured at the books. "Those gems of knowledge," as I gestured again at the nearby object covered with a dust-sheet, "are to be fed painstakingly and efficiently into *that* veritable jewelbox of scintillating information."

Her face followed my gestures, swinging back and forth with an expression of immense bewilderment.

"Let's have that again?" she giggled.

I inhaled deeply enough to get slightly dizzy with the intake of oxygen. "Here we go again," I thought tensely, "all my defensive resources gathering against the onslaught I knew was coming. If she doesn't recognize the instrument immediately, one of us is slipping."

I yanked the dust-sheet from the computer.

"I'm going to feed the contents of those books and more into the memory banks of this sensitive, superbly conceived and constructed instrument." My chin went a trifle higher. "In short, sister, I intend to transfer all known facts and theories and reasoning into this newly modified digital computer."

Recognition oozed over her face as she stared transfixed with happy derision at the bulk of the computer which had been disconnected and hidden from the world for a long, long time. But not long enough for her to forget what it *had* been when I originally built it.

"Ooh, *I* know *that* crazy gismo!" she trilled. "Sure! *That's* the nutty *thingamuhcallit* you were so positive was going to make us wealthy beyond our wildest dreams because it would be able to *analyze* the *future!* Or *something* like that!"

I nodded grimly, pouring scalding-hot coffee down a throat constricted with humiliation. *"Go ahead,"* I thought glumly. "Go ahead and get every last grain of salt into the wound! Really squeeze it for all it's worth. Have a ball!"

She spewed merry laughter all over me, the books, and the computer. "Oh, I never thought you'd *ever* have the gall to bring that costly flop out of hiding!"

"It's not the same instrument," I murmured softly. "Not the *same* at all. Been modified. Brought up to date. Completely redesigned, except for the housing, to do something entirely different. Something practical. Functional. *Patriotic* even."

"Oh, *go ahead* and make it clack out that wonderful 'Cross my palm with silver line!' Please make it do that again! The last time I laughed until I thought I'd split! All that hokey science talk—about a gadget that turned out to be nothing more than a greedy, metal Gypsy fortune-teller!"

Bile rose to meet the descending scorch of the coffee. I swallowed with difficulty. "It simply can't *do* that again!" I desperately assured her. "The whole computer has been revamped and rewired. Wholly new circuits. Integrated circuits that give it a brand new purpose. A *splendid* function that—scoff if you like—could just very well make me a most wealthy man, at least, and possibly even save the country from a generation of imbeciles, cretins and savages!"

"Huh?"

I patted the dully gleaming casing of the computer fondly. "UNIversity, here, will replace all archaic notions of formal education."

"Uni-what?"

"UNIversity. That's its name and its purpose! To be a complete university! Why, the impact of this advance in the

"What are they—dirty novels?" she asked, as the stack began to waver.

educational field will probably be felt around the globe!"

"Eh?"

"Certainly! By merely replacing the old fashioned college campus—that has proved to be so terribly vulnerable to student violence—UNIversity will enable serious, ambitious students to achieve a full and enriched formal education without being subjected to the vagaries and disruptions currently found on university campuses everywhere!"

"Wait a minute!" she protested, jerking a thumb at the computer. "Are you trying to tell me that this reformed gypsy is going to dispense education?"

Head held high, nostrils flared with pride, I looked down my nose at her, but smilingly, and I accorded her a brief nod. A firm, confident nod.

*"How?"* she demanded.

"Simplicity itself! Once I demonstrate this prototype model to colleges and universities—showing how the best minds of all eras have been locked within its memory banks, how every possible subject is completely recorded, how the arts, the sciences, business, the humanities and even theoretical research in every imaginable field have been captured, needing only selective operation to deliver as fine an education as has ever been available anywhere—those higher institutions of learning will *beg* to buy them in carload lots. Educational history will be made! The serious students will be assigned one instrument to an individual or perhaps even a small class. No longer will there be a need for huge campuses, expensive buildings and the fantastic overhead necessary to maintaining a full university!"

"You gonna give 'em away?"

A sly smile played about my mouth which had gone thin-lipped with resolution. "Absolutely not. I'll *lease* hundreds of thousands of UNIversities. Oh, the jolly profits will flood in! I'll be a multimillionaire many times over!" I tweaked her cheek roguishly. "I may even spend a few dollars on you!"

"Where's all these millions coming from?"

I shook my head sadly at her. "Don't you know that almost every university in the country receives Federal aid as well as state and private funds? No need to worry about the *money!* It'll pour into the coffers of UNIversities, Unlimited in torrents of fat, lovely sums. I may even have to buy one of the smaller foreign countries for a tax write-off!" I yawned elaborately. "Why, there will probably be millions in gratitude gifts from the parents of UNIversity-taught pupils who have saved considerable sums of money by not having their children write asking for money from distant campuses!"

"How do you figure that?"

"Easy. UNIversity can be installed and operated just as efficiently in the home as anywhere else." I assumed a humble posture. "Think of all the innocent youth who will be spared the riotous living and sinful ways of dwelling far from their native hearths. Yes, I can see a definite moral fiber in this plan. The world will eventually get around to bestowing its honors upon UNIversity and me for bringing back a stout moral tenor to its precious younger generations."

She stared hard at me. "You really believe all this guff you been handing me?"

I cleared my throat, ignoring the jibe. "You'll have to excuse me now. I must contact all of the electronics schools and institutes, and the trade schools, of course. Mustn't delete *any* form of knowledge once I begin programming it into the instrument. I may even include some frivolities for comic relief. Just for *balance,* you understand!"

"Yeah," she yawped, heading for the doorway. "I *knew* you'd dream up an excuse to read a few issues of "MAD" into that screwy machine!"

"Not a bit," I retorted, drawing myself up with frosty dignity. "Actually, I was thinking of something with *more* humor—such as the *Congressional Record* or the minutes from a few meetings of the D.A.R. This is a *class* operation, y'know!"

"Puns yet!" she wailed, departing swiftly.

The months that followed were exhausting ones as I proceeded to work my way methodically through subject after subject—basing my programming upon standard college texts—until I'd concisely read hundreds of books, pamphlets, essays and technical papers aloud into UNIversity who smoothly filed all the material away into its memory banks, diverting it according to classification with my help at the master control panel.

Finally, I realized this was a somewhat larger task than I had originally estimated. Even so, I figured it was about time to make a demanding test of UNIversity—to find out if it could indeed give information—both literally and analytically—when selected playbacks were delved from its memory banks. This being a rather awesome moment, I felt the need for company, graciously inviting Friend Wife to be a witness at the first lectures and seminars delivered by my brainchild.

"Well, this is it!" I announced in a voice hoarse and thickened from hours of reading educational facts into the computer aloud. "How would you like the honor of selecting a test subject?"

"It ain't gonna *work* anyways," she stated sourly. "None of your gadgets *do* what they're *supposed* to do. So I guess it don't matter what I pick, huh?"

I favored her with a tired, condescending smile that made a shambles of her jibe.

"Just choose a subject—*any* subject," I suggested patiently. "Never mind all the sunshiny thoughts and utterly blind faith in my meager genius."

She thought intensely, her face working with the effort of her mental straining. "Okay, have it tell me all about Mars!"

"The mythological god or the planet?"

"Huh?"

"Let it pass. I assume you mean the planet Mars."

"That's what I said!"

I sighed. "So you did, and that's what you shall have—a comprehensive lecture upon every known aspect of that red and mysterious planet!" Deftly making a few simple adjustments upon the Master Control Panel, UNIversity glowed into activity—muted bleepings, minor clickings and sequences of flashing lights indicating that the instrument was ready to function.

"How come it ain't going *clack-clack-clack* and popping out those little pieces of paper?" she asked, nervously stepping back from the light patterns now sparkling madly across the computer's traceboard. "It looks like it's gonna blow-up!"

"Relax. This baby is a far cry indeed from that admittedly crude and ineffectual item that preceded it." I peered intently at the Control Panel, making several more corrections with the cold mien of the true scientist, murmuring incoherently to myself for added dramatic impact. "Actually, UNIversity not only absorbs facts but has been designed to draw *meaningful conclusions* from all programmed data. Additionally, UNIversity can recognize human voice patterns."

"Why?"

"Well, each of the kids has a differing mental capacity. I figured if UNIversity could instantly recognize each kid by his

"Listen!" I roared. "I demand that you select college level delivery of data pertaining to Mars!"

or her voice, it could immediately channel a vocabulary understandable to each child's mental-level—and I had the foresight to program all data in various age-range vocabularies which was a chore mildly comparable to inscribing a decade of income tax information on the head of a very small pin."

"Gee!" she said in an awed tone. "Then, this thingie is really pretty *smart*, huh?"

"Not really but almost."

"I AM READY," announced UNIversity in a cultured tone with undeniably refined accents. "KINDLY GIVE YOUR CHRONOLOGICAL AGE AND PRESENT GRADE IN SCHOOL."

*"Holy Solid State!"* whispered Friend Wife. "It talks real *classy* yet!"

"Odd," I muttered. "Doesn't *sound* like me but I distinctly recall—oh, well, perhaps I'm too tired to recognize my own recorded voice. Possibly some of that economy priced tape accounts for the tonal difference."

"Go ahead—talk *back* to it!" she urged delightedly.

"My age is forty-five. I no longer attend any institution of learning, having completed—"

"SUBJECT DESIRED?" invited UNIversity smoothly.

"Uh—the planet Mars," I stated.

"MARS IS A PLANET. MARS IS IN SPACE. SEE THE PRETTY RED PLANET IN SPACE. SEE THE PRETTY RED PLANET IN ORBIT! ORBIT, MARS, ORBIT!"

There was a terrible moment of silence.

"What the old hell is *happening* here?" I croaked, frantically checking everything and finding nothing wrong. "I just cannot understand—"

*"I knew it!"* she howled merrily. "I just *knew* that crazy pile of blabbermouthy parts would *hassle* you! Oh, this is marvy! Your brain of a machine reading primer-level facts to you!"

"MARS IS FAR, FAR AWAY," droned UNIversity in clipped precision. "MARS IS TOO FAR, FAR—"

I snapped a recycling-switch, cutting into the taped dissertation and bringing the instrument back to "Initial Communication."

"KINDLY GIVE YOUR CHRONOLOGICAL AGE AND—"

"Listen!" I roared. "I demand that you select college level delivery of data pertaining to Mars! I may be only a high school graduate but I read a lot and I've programmed enough material into—"

"YOU DO NOT QUALIFY FOR COLLEGE-LEVEL DATA," it informed me flatly. "HOWEVER, A SUGGESTED ALTERNATIVE IS OBTAINING A MINIMUM OF FOUR YEARS AT ANY ACCREDITED—"

*That's* when I pulled the plug.

"Can't understand it!" I stared dazedly at my happily smirking wife. "I was so *careful!* Why, I even included each of the kids' voice-patterns and a plethora of essential statistics that should have prevented anything like *this* from—"

"I was sure *wrong* about this thingamajig!" she yawped joyously.

"Wrong? In *what* way?"

"It can't be *all* bad," she gasped, between disgusting fits of vulgar laughter, "if it's *smarter* than *you*—and it *is!"*

She was still shrieking with nauseating hilarity when I sulked away to consult a dictionary. I doubted that I would find the word 'overteach' in it, having just contributed that nefarious term to the English language in the form of an academically snobbish computer. But I thought I'd look anyway. —30—

## NASA TO LAUNCH AUSTRALIS-OSCAR 5

The National Aeronautics and Space Administration (NASA), in a letter to the Radio Amateur Satellite Corporation (AMSAT), has agreed to launch the Australis OSCAR-A satellite as a secondary payload on the TIROS-M mission scheduled for January 9, 1970. The amateur satellite will be ejected into orbit from the second-stage engine compartment of the Thor-Delta launch vehicle in the same manner as previous Delta secondary payloads have been launched.

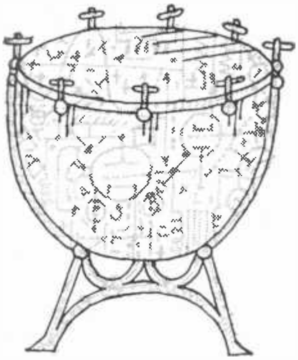
The planned orbit will be nearly polar at an inclination of 101.56 degrees to the earth's equator, at an altitude of approximately 790 nautical miles (910 statute miles). This will result in an orbital period of about 114 minutes.

Australis OSCAR-A, which is to be known as Australis-OSCAR 5 once it is in orbit, is a 12" × 17" × 6", 39-pound spacecraft constructed by a group of amateur radio operators at Melbourne University in Australia.

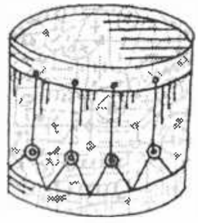
This will be the first launch for AMSAT, which was formed in March 1969 to foster radio amateur participation in space search projects. AMSAT is preparing the satellite for launch, performing the necessary tests for proper functioning, conducting liaison with NASA and assisting in the collection of data.

Australis-OSCAR 5 will transmit at 29.45 MHz in the 10-meter band and at 144.05 MHz in the two-meter band. A transmitting life of about 2 months is expected from the 20 pounds of batteries which the satellite carries. This lifetime is based on continuous operation of the 2-meter transmitter and weekend operation of the somewhat higher power 10-meter transmitter. The latter can be turned on and off by commands from the earth.

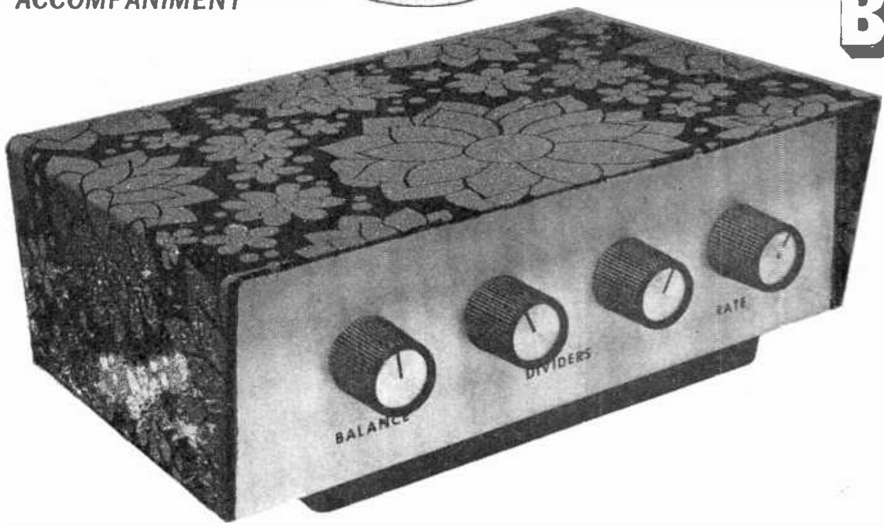
*JOHN S. SIMONTON, JR.*



# THE THUMPA-THUMPA BOX



*RHYTHM DRUM ACCOMPANIMENT*




THE ELECTRIC GUITAR sounds best when accompanied by a tempo-setting, rhythm drum. Unfortunately, few amateur guitarists are lucky enough to find drummers who are willing to accompany them day and night. There are, however, electronic drummers that fill the bill nicely. If the $200-up price tags on commercially made electronic drummers do not appeal to you, try building the "Thumpa-Thumpa Box" for about $17.

The Thumpa-Thumpa Box, or TTB, employs low-cost UJT pulse-generator, divider and simplified "drum" circuits to produce a wide variety of percussion sounds. In fact, the TTB can duplicate most of the tricks of the expensive commercial electronic drummers—and a few that commercial units can't produce.

Just set the TTB's divider and rate controls, and you have automatic bass and wood-block accompaniment. If you are the adventurous type, you can even adjust the circuits so it sounds as if you are being accompanied by anything from a pot lid to J. Arthur Rank's gong!

**Construction.** Layout of the TTB circuit (see Fig. 1) is not critical; but, while any method of assembly will give acceptable results, a printed circuit board will go a long way toward guaranteeing a successful project. The printed circuit board can be obtained commercially (see Parts List), or you can etch and drill

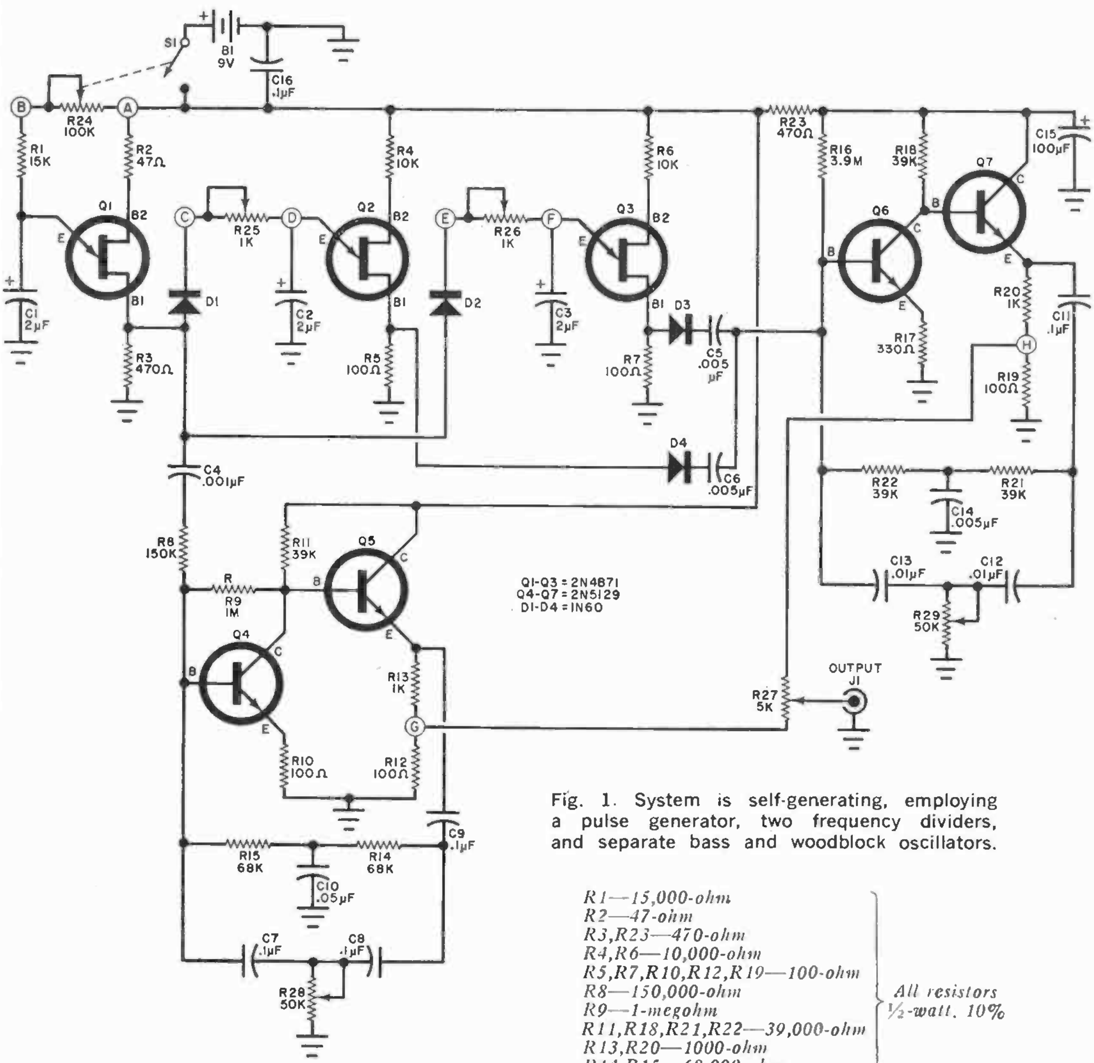
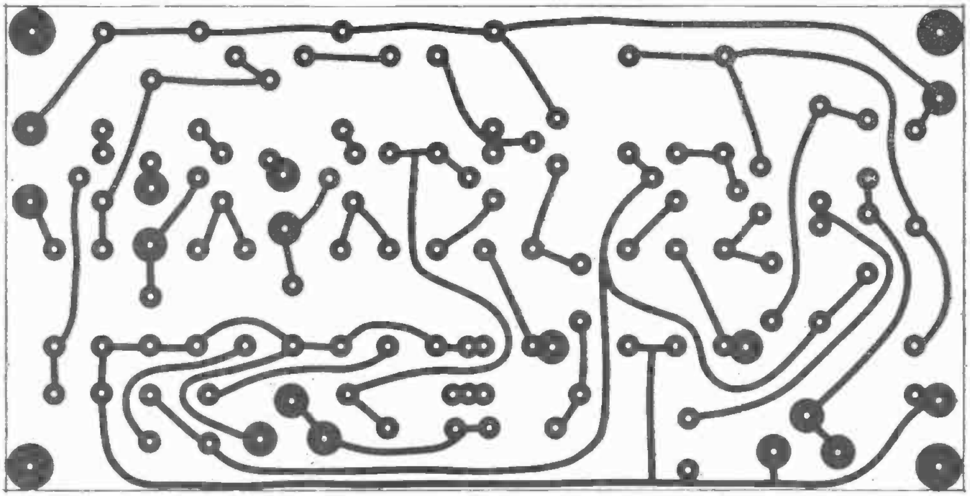



Fig. 1. System is self-generating, employing a pulse generator, two frequency dividers, and separate bass and woodblock oscillators.

## PARTS LIST

*B1—9-volt transistor battery*
*C1,C3—2-µF, 6-volt electrolytic capacitor*
*C4—0.001-µF ceramic disc capacitor*
*C5,C6,C14—0.005-µF ceramic disc capacitor*
*C7,C8,C9,C11,C16—0.1-µF ceramic disc capacitor*
*C10—0.05-µF ceramic disc capacitor*
*C12, C13—0.01-µF ceramic disc capacitor*
*C15—100-µF, 10-volt electrolytic capacitor*
*D1-D4—1N60 diode*
*J1—Miniature phone or standard phono jack*
*Q1-Q3—2N4871 unijunction transistor*
*Q4-Q7—2N5129 bipolar transistor*
*R1—15,000-ohm*
*R2—47-ohm*
*R3,R23—470-ohm*
*R4,R6—10,000-ohm*
*R5,R7,R10,R12,R19—100-ohm*
*R8—150,000-ohm*
*R9—1-megohm*
*R11,R18,R21,R22—39,000-ohm*
*R13,R20—1000-ohm*
*R14,R15—68,000-ohm*
*R16—3.9-megohm*
*R17—330-ohm*
*(All resistors ½-watt, 10%)*
*R24—100,000-ohm, linear-taper potentiometer*
*R25, R26—1000-ohm, linear-taper potentiometer*
*R27—5000-ohm, linear-taper potentiometer*
*R28, R29—50,000-ohm, linear-taper "trim-pot"*
*S1—S.p.s.t. switch (part of R24)*
*Misc.—Metal chassis case; printed circuit board; battery holder; battery connector; control knobs (4); rubber feet; #6 machine hardware; hookup wire; solder; etc.*
*Note—The following items are available from PAIA Electronics, Inc., P.O. Box 14359, Oklahoma City, OK 73114: etched and drilled printed circuit board for $3.50 postpaid (specify #8690); complete kit of parts, including pre-punched, unpainted case, but less battery, hookup wire, and solder for $16.75 plus postage for 2 lb. Oklahoma residents add 3% sales tax.*



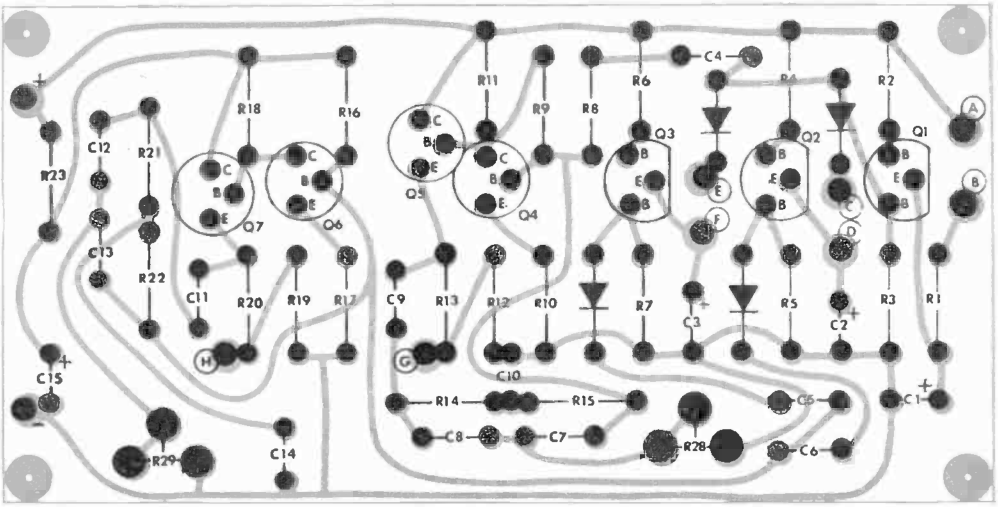



Fig. 2. Actual-size printed circuit board etching guide is shown at top. Directly above are component placement and orientation on circuit board after etching and drilling.


Battery can be conveniently mounted inside chassis with dual AA cell holder; use a conventional snap-on connector. Holes drilled directly in line with R28 and R29 (see top center of photo) provide access for tuning bass and woodblock oscillators. Mount output jack on rear.

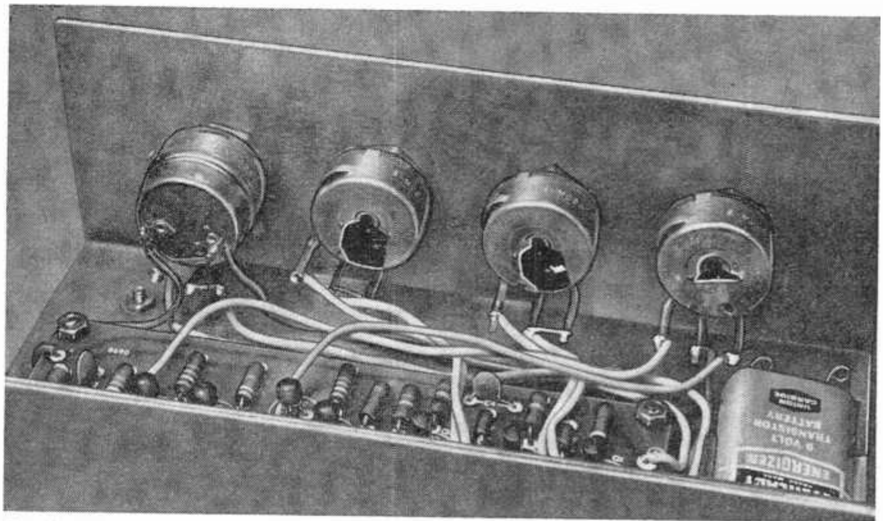


Fig. 3. All controls, except pots R28 and R29, are mounted on front panel. Battery holder and printed circuit board are mounted inside the chassis; use rubber feet on under side.

your own board by following the actual size etching guide shown in Fig. 2. In either case, mount the components on the board as shown, paying particular attention to the polarities of the electrolytic capacitors and lead orientation of the diodes and transistors. Also, when soldering the transistor and diode leads to the foil pattern, use a heat sink and a soldering iron rated at 35 watts or less.

The project can be assembled inside any metal enclosure that will accommodate the circuit board, battery, and controls. It is a good idea to decide on the locations of the components and drill the mounting holes first. Deburr the holes; then spray paint the cover or cover it with self-sticking vinyl, and just spray paint the front and back of the box.

Now mount the dual-AA-cell holder, jack, and potentiometers in their respective locations (see Fig. 3). Then mount four rubber feet to the bottom of the case.

Solder an 8″ length of wire to the circuit board at locations A through H and the hole marked with a + sign. The completed circuit board should be the last item mounted inside the case. Use 4-40 machine hardware and ⅜″-long insulated spacers and make sure the holes in the rear of the case line up with *R28* and *R29*.

Connect and solder the free ends of the circuit board wires to the controls and *S1* as shown in Fig. 4, removing and discarding any excess wire as you go. Then finish wiring together the circuit, referring back to Fig. 1 as needed. Finally, slip the battery into its holder, use a dry-transfer lettering kit to letter the functions of the controls on the front panel, and assemble the case.

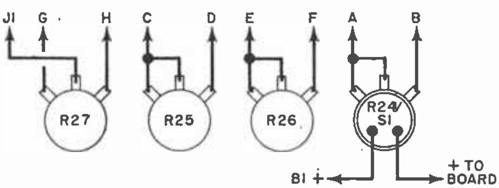



Fig. 4. Diagram shows the connections between pots and S1 lugs to lettered holes on circuit board.

**How to Use.** Connect a cable from the output jack of the TTB to the input of a hi-fi or instrument amplifier. Rotate the BALANCE control fully counter-clockwise, turn on the amplifier and TTB, and adjust the RATE control for a slow-tempo beat. Then rotate both DIVIDER controls fully clockwise.

Adjust the setting of *R28* for the most pleasing sound. Rotate the BALANCE control fully clockwise, and adjust the setting

## HOW IT WORKS

The Thumpa-Thumpa Box consists of five basic sections: a pulse generator, two frequency dividers, and two ringing oscillators. As shown in Fig. 1, unijunction transistor *Q1* and its associated components make up a simple relaxation oscillator that serves as the "clock" generator for the system.

With *S1* closed, *C1* charges up through *R1* and *R24*. When the potential across the capacitor exceeds the threshold of *Q1*, the UJT fires and allows *C1* to discharge rapidly and produce a voltage spike across *R3*. The rate of charge and discharge, or frequency, of the clock generator can be varied by changing the setting of *R24*.

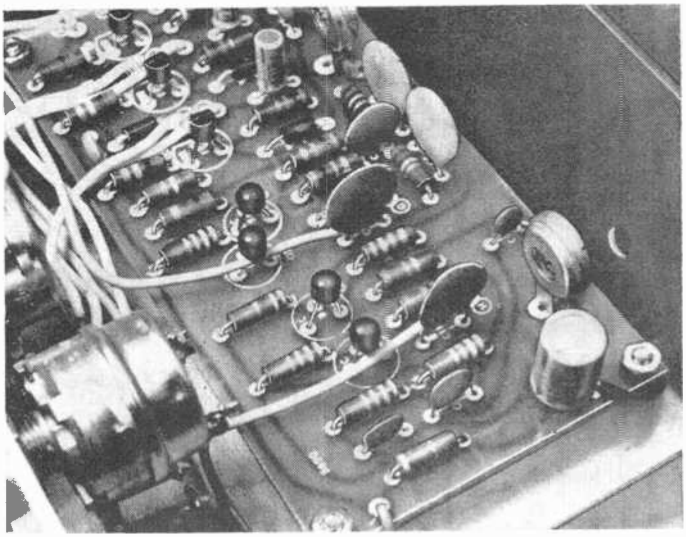
Each clock pulse does several things simultaneously. First, it triggers the ringing oscillator formed by *Q4* and *Q5* to produce a tone similar to that of a bass drum. Second, it is coupled through potentiometers *R25* and *R26* to deposit charges on *C2* and *C3*, respectively. Diodes *D1* and *D2*, normally reverse biased, prevent the charges from leaking off.

The amplitudes of the charges across *C2* and *C3* increase with each successive pulse from the clock generator. At some point during the voltage build-up, *Q2* and *Q3* fire, either simultaneously or independently, and rapidly discharge *C2* and *C3*, respectively. The resulting pulses that appear across *R5* and *R7* are then coupled to the base of transistor *Q6* in the "wood-block" oscillator. (Potentiometers *R25* and *R26* can be varied independently so that frequency dividers *Q2* and *Q3* fire at different rates to produce a wide variety of syncopated rhythms.)

The wood-block (*Q6* and *Q7*) and bass (*Q4* and *Q5*) oscillators are almost identical, each being composed of common-emitter gain and emitter-follower buffer stages. Feedback for the individual oscillators through the parallel-T filters (shown below each pair of transistors) is such that the amplifier is held just below the point of oscillation.

When a pulse is coupled to the input of either of these two oscillators, the circuit immediately breaks into a rapidly decaying oscillation. So, by properly selecting the gain of the amplifier and time constants of the parallel-T networks, the period and decay of the oscillating signals can be made to simulate the sound of practically any percussion instrument.

The output of the Thumpa-Thumpa Box is fed to an external amplifier. And potentiometer *R27* serves as a balance control to provide the desired mixture of bass and wood-block beats.

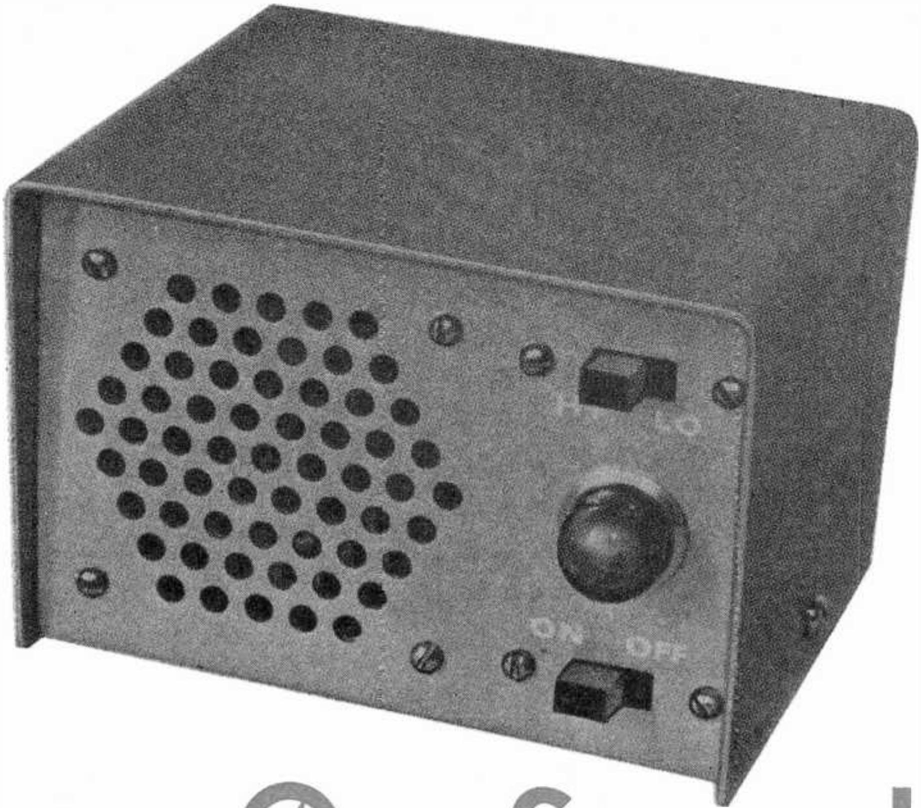


Bolt assembled circuit board to chassis via short spacers and #6 hardware. Note proper method of neatly dressing hookup wires.

of *R29* for the most pleasing sound. Now rotate the BALANCE control back and forth to make sure the mixing, or balancing, action takes place.

In operation, the DIVIDER controls are used to produce the rhythm pattern desired. Tempo can be set by adjusting the RATE control. The BALANCE control is used to accentuate your choice of either bass or wood-block sounds. (Once *R28* and *R29* are set, they do not need to be touched again.)

A final note: the cover of the TTB case is held in place by the pressure of the sides against the front and rear of the box. However, if the TTB is to be subjected to rough handling, it is a good idea to bolt the halves of the case together with the aid of four L brackets. The mounting screws for the rubber feet can be used to anchor the brackets to the bottom of the case, and self-tapping sheet metal screws can be used to bolt the top to the brackets. —30—




# One Second METRONOME TIMER

VISUAL AND AUDIBLE INDICATIONS FOR YOUR DARKROOM

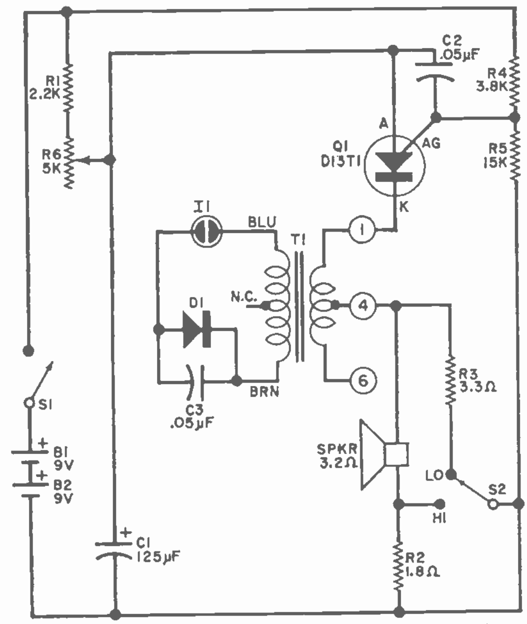
BY A. A. MANGIERI

ONE THOUSAND AND ONE . . . one thousand and two . . . one thousand and three . . . that's the familiar method of counting off the seconds for camera and enlarger exposures when a mechanical or electrical timer is not available. This method is not very accurate. For example, if you are in a big hurry, your count may speed up; or if you are tired, it may slow down. What you really need is a timer that is insensitive to emotions and fatigue.

The photographer's visual/audio One-Second Metronome Timer fills the bill. It paces your second count so that your film and paper exposures can be uniform. To accomplish this, the timer provides an audible "click" and a simultaneous flash of light every second. All you do is count the number of clicks and/or flashes.

**How It Works.** Transistor *Q1*, in Fig. 1, is a General Electric Type D13T1 "programmable" unijunction transistor, a special type of SCR. The anode gate (AG) of *Q1* is at a voltage determined by voltage divider resistors *R4* and *R5*. When *S1* is closed, *Q1* is initially in the non-conducting state.

Voltage at anode A begins to build up as timing capacitor *C1* charges up




## PARTS LIST

*B1,B2—9-volt battery*
*C1—125-μF, 35-volt electrolytic capacitor*
*C2,C3—0.05-μF disc capacitor*
*D1—1-ampere, 200-volt silicon diode (Motorola HEP-156 or similar)*
*I1—NE-51H high-intensity neon lamp*
*Q1—D13T1 programmable unijunction transistor**
*R1—2200-ohm*
*R2—1.8-ohm*
*R3—3.3-ohm*
*R4—3800-ohm*
*R5—15,000-ohm* (*All resistors ½-watt*)
*R6—5000-ohm potentiometer (Clarostat Type U39, or similar)*
*S1—S.p.s.t. slide or toggle switch*
*S2—S.p.d.t. slide or toggle switch*
*SPKR—3.2-ohm, 2½"-square speaker*
*T1—8-watt universal speaker transformer; do not substitute (Allied Radio No. 54C2021)*
*Misc.—Dialco No. 95-9110 lamp socket with red dome, less resistor for I1; 4½" x 3¼" x 3" aluminum chassis box; perforated phenolic board and push-in solder terminals; rubber feet; hardware; hookup wire; solder; etc.*
**Available for 87¢ from Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680. Specify No. 49F3-D13T1-GE.*

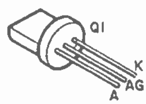



Fig. 1. The circuit is essentially a relaxation oscillator using the latest type of UJT. The turns ratio between the low-impedance winding (connected to the UJT cathode lead) and the high-impedance winding (connected to the neon lamp) of T1 causes the lamp to flash with each audible "tick" of speaker.

through timing resistors *R1* and *R6*. When the voltage at the anode builds up to slightly more than the voltage at AG, *Q1* goes suddenly into conduction and allows *C1* to discharge rapidly through *T1* and the speaker's voice coil.

The sudden discharge of *C1* through *T1* generates a high-voltage spike across the secondary of the transformer, briefly lighting *I1*. Diode *D1* and capacitor *C3* enhance the brightness of the lamp's glow and the duration of the flash. The speaker produces an audible click simultaneously with the flash of *I1*.

As each click and flash occur, the voltage across *C1* drops to a low level and *Q1* ceases to conduct. The cycle then repeats itself as long as *S1* is closed.

Resistors *R4* and *R5* set the *Q1* standoff ratio and valley current for high circuit efficiency. Capacitor *C2* is an r.f. or noise bypass to prevent premature turn-on of *Q1* by nearby electrical interference. Switch *S2* provides HI and LO level audio selection.

**Construction.** It is imperative that a metal case be used to house the timer circuit to shield it thoroughly from electrical noise pickup. A 4½" × 3¼" × 3" aluminum chassis box easily accommodates all parts.

First perforate the front of the box with a ¼" drill (or cut out a 2¼" opening and use a screen grille) for the speaker. Then determine how and where you plan to mount each part and assembly, and machine the box accordingly. A suggested layout is shown in Figs. 2 and 3.

Start assembly by mounting *T1* and the battery clamp on the rear wall of the box. Then mount the components on a 2½" × 2¼" piece of perforated phenolic board with push-in terminals, and bolt the board in place.

Mount the lamp socket, switches, and speaker in their respective locations on the front of the box. Wire together all components, referring to Fig. 1. Make sure that the leads of *C3* and *D1* in the high-voltage secondary side of *T1* do not touch other wires or components. Lengths of plastic tubing slipped over

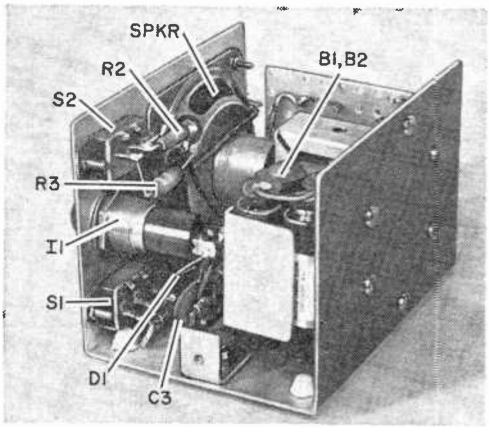



Fig. 2. If you arrange the components properly, they will easily fit within small metal chassis. Metal is used to prevent external noise from false triggering of the UJT, causing timing errors.

these leads will prevent accidental short circuits.

When the circuit is completely assembled, set *R6* for about mid-range. Set *S1* to ON and listen for the click and observe the brightness of the flashes, with *S2* set in the LO position. If the click is too loud or the flash level is too bright, you can omit battery *B2* and operate the circuit on only one 9-volt battery. In either position of *S2*, if the flash level is not bright enough, try reversing the diode. Use the connection that provides the brightest flash. Also, if you prefer an audio-off position, omit *R2*.

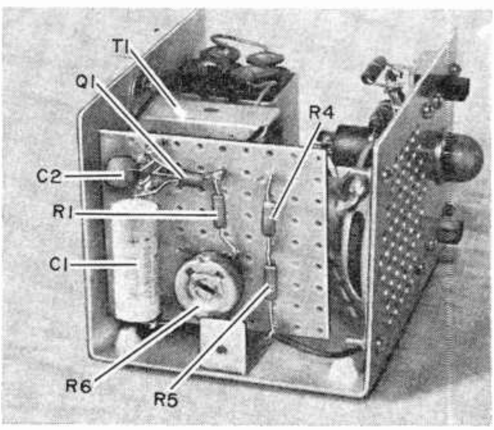


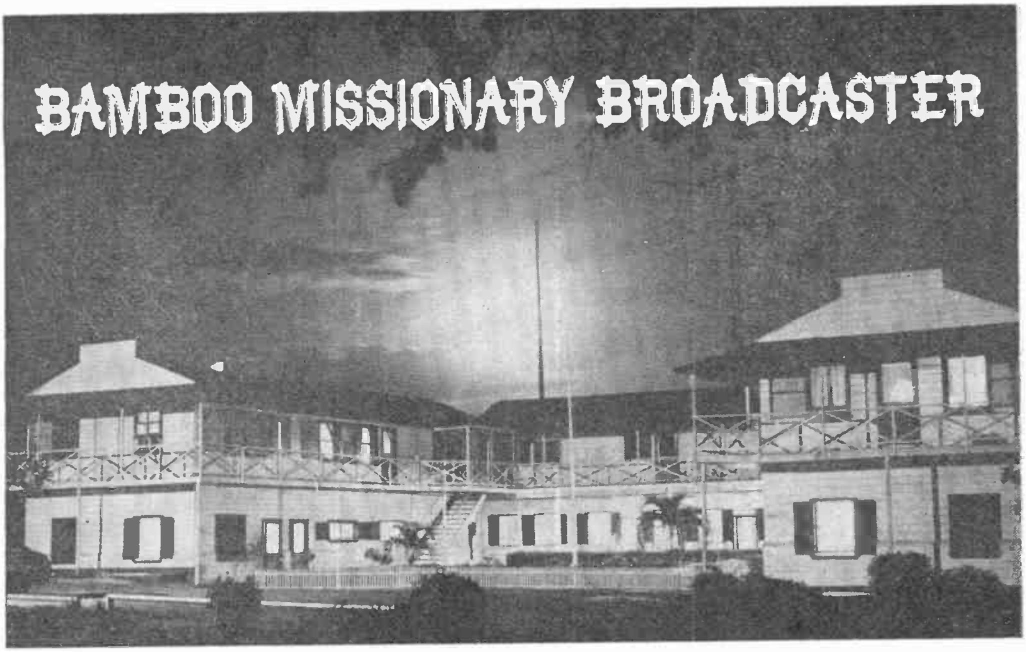

Fig. 3. Most of small electronic components can be directly mounted on piece of perforated board.

**Calibration and Use.** With the circuit operating, use an electric clock with a sweep second hand to adjust *R6* until you hear ten clicks and see ten flashes in exactly ten seconds. This is all there is to calibration, and you can now assemble the metal box.

Use the timer to pace your count for both timed camera and enlarger exposures. With a few practice runs, you will quickly acquire the knack of operating the camera cable release or enlarger switch at exactly the right moment.

If you incorporated the audio-off feature and have the timer set in this position when working in your darkroom, pace your count by lamp flashes, and rely on that pace because you might miss a lamp flash between eye blinks.

You can expect considerable battery life due to the low drain circuit of the metronome timer. As a rule of thumb, replace the batteries when either the audio or light output drops below your preferences; the count rate is affected very little by battery ageing. Also, recheck the count rate occasionally and adjust *R6* if needed to compensate for any long-term change in *C1*. -30-



# BAMBOO MISSIONARY BROADCASTER

## GOSPEL VS CHAIRMAN MAO

BY JOHN KIMBERLEY

THE Far East Broadcasting Company is a name that few in the radio world in the United States have ever heard of. That in itself would not be so unusual were it not for the fact that the FEBC—as the company likes to abbreviate itself—is the largest private international broadcasting operation in the world. It also would not be so strange if that were the only unique thing about the FEBC. But it is not. The FEBC is undoubtedly one of the most, if not *the* most, unusual large-scale broadcasting ventures in the world.

From humble beginnings with a 1,000-watt transmitter more than 20 years ago, the FEBC has grown into a giant with 20 stations using more than a half dozen medium and 15 international broadcasting frequencies. Its transmitters are interspersed half way around the world from San Francisco across the Pacific Ocean to the Seychelles islands in the Indian Ocean near the East Coast of Africa. The FEBC message is broadcast nearly 4,000 hours a month to a potential audience of more than 2 billion persons.

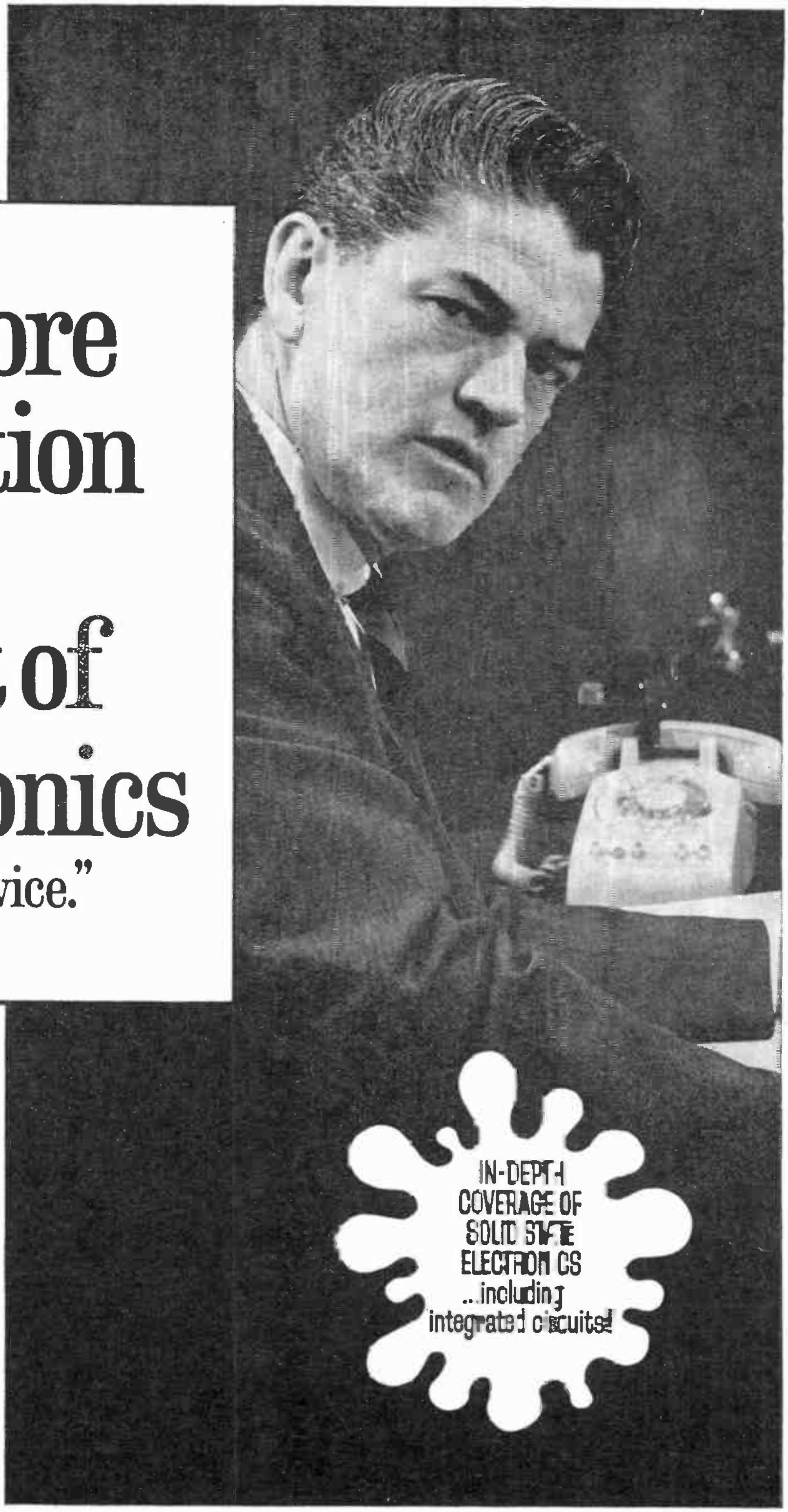
One of the things that makes the FEBC unusual is its message. Unlike the other giants of the international broadcasting world (Radio Moscow, Radio Peking, Voice of America, Radio Cairo, BBC, etc.), the FEBC has no political line or national interest to sell. Nor is it backed by government funds, a truly unique situation in large-scale international short-wave broadcasting. In fact, the FEBC message is a simple, familiar one to Americans: that of the Bible and the Christian faith.

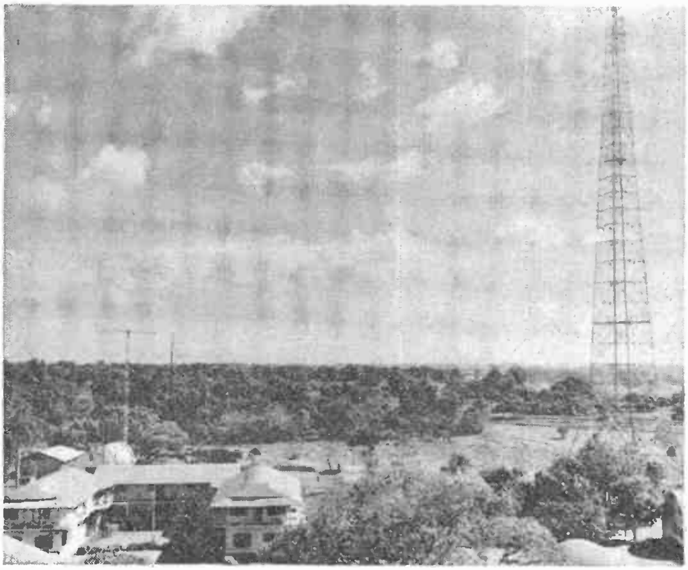
The Far East Broadcasting Company is an entirely private, non-commercial, non-profit organization financed by church groups and interested individuals throughout the world. It serves interdenominational interests, with headquarters in Whittier, California. As its name suggests, the FEBC's principal activities are in the Far East. In fact, an estimated 90% of the company's broadcasting hours are directed to Asian points (the remaining 10% consists of daily broadcasts to South America from the Company's largest—250,000-watt—transmitter located at the old Voice of America site in Belmont, Calif.

The Far East Broadcasting Company got its start back in 1945 as a result of the vision of three men: Robert Bowman, who was formerly connected with the religious "Haven of Rest" radio se-

# "Get more education or get out of electronics

...that's my advice."





Overall view of one of main stations of the Far East Broadcasting Company, located just outside Manila, the Phillipines.

ries; the Rev. William J. Roberts, who was pastor of a large church in Los Angeles and broadcast a daily local program called "The Family Bible Hour"; and John Borger who had just been discharged from the Navy after service in the Far East. Bowman remains actively involved in FEBC today and is president of the company. Roberts is vice-president for public relations. Broger is no longer associated with the company.

**It Started in Manila.** Although FEBC was incorporated on Dec. 20, 1945, it took several years of fund-raising and other preparation before the company's first broadcast went out over the air waves. That long awaited moment came in June 1948 when their first 1,000-watt transmitter hummed into life in Manila, the Philippines, sending out its signal on 680 kHz with the callsign DZAS.

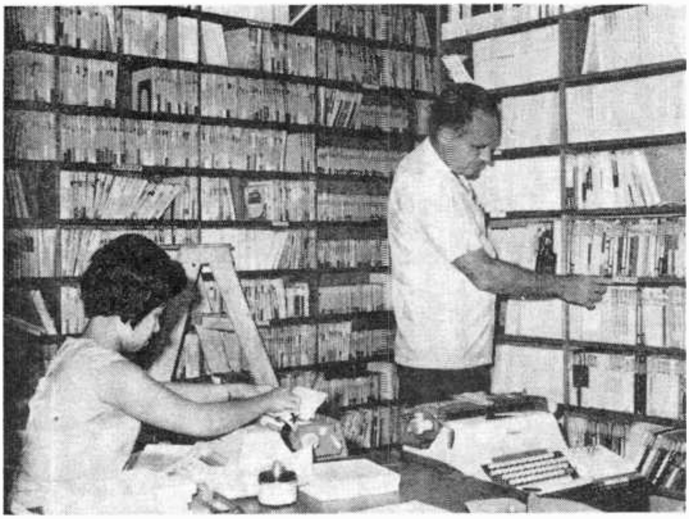
In the years that followed, the activities of the FEBC grew enormously and the transmitter capacity also rocketed. One year after getting DZAS on the air, the company's first "Call of the Orient" short-wave operation—DZH6, on 6.030 MHz—began, also from Manila and also aimed at a Philippines audience. A second short-wave station, DZH7 on 9.730 MHz was started in 1950. The following year saw the addition of DZH8 on 11.885 MHz, DZH2 on 3.345 MHz and DZH9 on 15.300 MHz. By this time the FEBC was broadcasting in 30 languages and dialects and rapidly gaining recognition in international broadcasting. Along with the VOA and the "Voice of Free China," the FEBC broadcasts to Communist China and the Soviet Union were being jammed.

In 1952, the FEBC's sixth short-wave station, DZL6 on 17.805 MHz was added. And in 1954, DXFE medium-wave transmissions on 1030 kHz began in Manila employing a new 10,000-watt Collins transmitter. A second 10,000-watt Collins was put on the air in 1955.

One of the big developments in the history of the FEBC was the acquisition in 1956 of two 50,000-watt giants. These transmitters were purchased in San Francisco and shipped to Asia. The same


Technician at studio for short-wave broadcasting.

Part of FEBC's extensive tape and record library which is used by all system stations.



year, DZI8, FEBC's seventh short-wave "Call of the Orient" station was added. In 1957, the company made its first move outside the Philippines. That year a station with the call letters KSAB began operations on 1020 kHz from Naha, the capital of American-administered Okinawa. This station provided an English and Japanese language service. That same year a 100,000-watt transmitter was shipped to Okinawa and a 50,000-watt transmitter to the Philippines.

Thus when the FEBC celebrated its 10th anniversary of broadcasting in 1958, its list of facilities included nine stations on the air in Manila, and a growing network on Okinawa, plus recording facilities in Hong Kong and Taiwan.

The next 10 years proved no less important, with the constant expansion of services and improvement of equipment and programming. Today, the FEBC has joined the ranks of the broadcasting giants. Measured in terms of the number of weekly hours broadcast to international audiences, the FEBC (with 900 hours weekly) trails only Radio Moscow (1,898 hours weekly), Radio Peking (1,451 hours weekly) and the Voice of America (932 hours weekly). FEBC is now on the air to overseas listeners more hours weekly than Radio Cairo (779 hours) or the BBC (695 hours). Its 20 stations broadcast in 40 languages and dialects. Needless-to-say, the Far East Broadcasting Company is in a completely unchallenged position as a private international broadcaster.

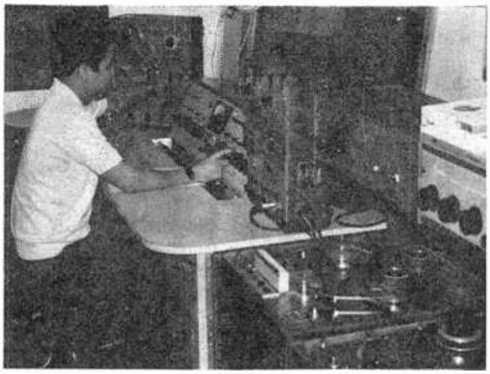
**Review of Facilities.** A review of FEBC's facilities and operations today tells better than anything else the significance and scope of its operations:

*San Francisco:* The FEBC operates one of only three privately operated short-wave stations licensed to broadcast from the United States. It is station KGEI which, using a recently acquired 250,000-watt transmitter, beams its programs to South America. (The FEBC has applied to the FCC for permission to broadcast to the Expo '70 exposition, which starts in Osaka, Japan on March 15, radiating off the back of the KGEI beam.)

*Okinawa:* The main broadcasts to Communist China—some 14 hours daily—are made from the 100,000-watt transmitter located at Okuma, some 50 miles north of Naha, the capital city. This transmitter on 1360 kHz has the call letters KSBU. In Naha itself are two FEBC-operated transmitters, the 1,000-watt KSBA broadcasting in English to American forces on Okinawa and the 5,000-watt KSDX broadcasting in Japanese to the native Okinawans.

*The Philippines:* Without doubt the most important broadcasting and transmission center in the FEBC operation is the Philippines. Currently, FEBC operates 14 stations in the Philippine archipelago, including new stations in Jolo, Sulu islands, and Fuimaras Island in the Southern Philippines. The company has six 50,000-watt transmitters used to beam broadcasts to the rest of South and Southeast Asia as well as the Soviet Union, Australia and New Zealand. The importance of the FEBC operations in the Philippines is reflected in the fact that Philippine President Ferdinand Marcos uses FEBC stations when he wants to broadcast a message to his people.

*The Seychelles:* From these British-administered islands in the Indian Ocean off the East Coast of Africa, the FEBC will soon begin using two 100,000-watt transmitters targeted for India, Pakistan and Ceylon. Later the company also hopes to beam its signal to the East Coast of Africa and the Middle East. The approval for these two transmitters on Seychelles is the first time the British government has allowed a private organization to broadcast short-wave from a British colony. Just another in the list of unique achievements of the FEBC.



Above, another short-wave transmission studio and below, a view of shop where equipment is repaired.

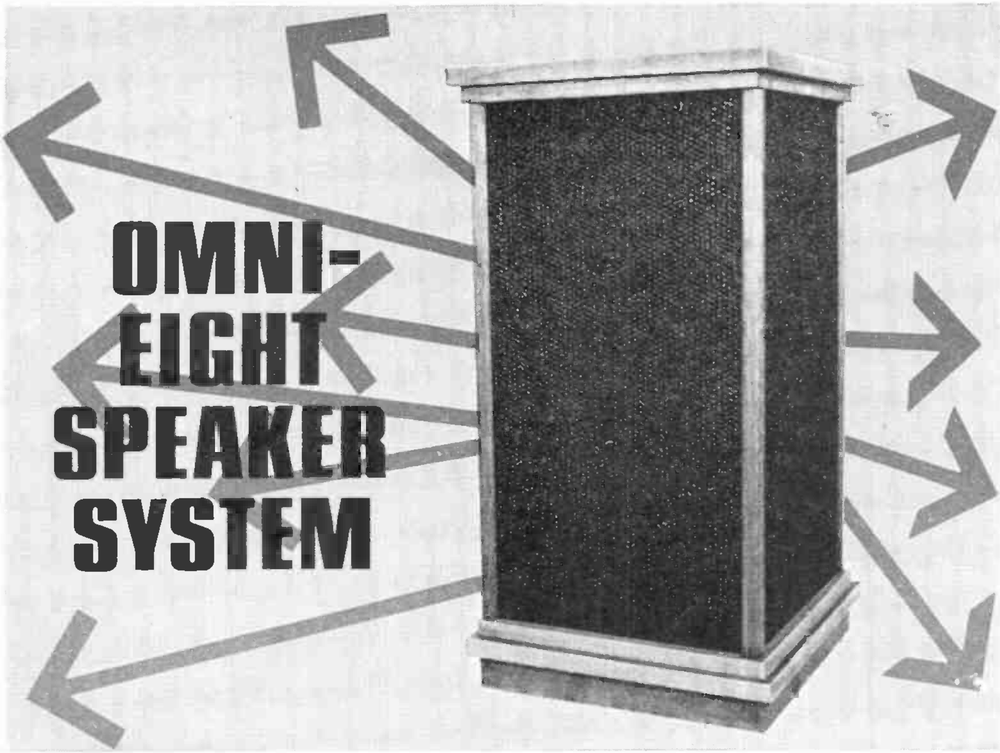
**Widening Scope.** The scope of the FEBC goes much further than that of its broadcasting stations. More than 300 persons are employed in FEBC activities. The company operates seven recording studios to help supply the 4000 hours of programming required each month. These are located in Tokyo, Japan; Bangkok, Thailand (where programs in Thai, Burmese, Laotian, Cambodian and Vietnamese are produced); Bangalore, India; New Delhi, India; Singapore; Manila; and Hong Kong. The Hong Kong office also is involved in preparing communications studies in the FEBC Research Center. In addition, the company has an office in Djakarta, Indonesia. Some 35 other studios in Asia cooperate in making programs for FEBC.

Some indication of FEBC's effectiveness in reaching its potential audience is provided by the mail that pours into FEBC offices. Mail from 58 countries has been received, at an average rate of 12,000 letters a month. The company even receives an occasional letter from Communist China, despite the tight controls slapped on the people living in that country. In fact, last year 58 letters were received from behind the Bamboo Curtain. During the previous 15 years, only 47 letters had been received from China.

All of this activity is underwritten by contributions from church groups and individuals. Those contributions range from one to several thousand dollars. The FEBC solicits contributions in a kind of personalized fashion: "Many are now feeling a closer tie with the broadcasting ministry by personally sponsoring the broadcasts in the language of their choice for $5.00 (U.S.) for a 15-minute broadcast to Asia or Latin America over FEBC's powerful facilities." The choice of languages is indeed large, ranging from Amoy (a Chinese dialect) to Ukranian. As an added inducement to contributors, the FEBC points out that "gifts" are tax deductible.

Thus the Far East Broadcasting Company has grown, quietly but effectively, into one of the giants of international broadcasting. Today, one of the greatest challenges to the FEBC is to get its message into the increasing number of countries that are banning missionaries and missionary activities. It is one of the FEBC's mottoes, in fact, that men may stop the missionary but they cannot stop the message. —30—

# OMNI-EIGHT SPEAKER SYSTEM



## MULTI-DIRECTIONAL LOW-COST SOUND

BY DAVID B. WEEMS

THE GENERATION GAP has reached stereo speaker systems. Last year, a floor-standing speaker was invariably placed near a wall or in the corner of a room. Those positions gave better "loading" at the important bass frequencies. Now, suddenly, there are free-standing, column-type speaker systems everywhere —even standing in the middle of the room. Old-timers shake their heads and mutter comments about doing things the hard way. But advocates of the new systems counter with talk about "multi-directional sound," "reflection ratios," and the elimination of "standing waves."

Although some of the current approaches are new, the history of hi-fi is littered with memories of multi-directional speaker systems. One early example was the Columbia "360", a compact monaural phonograph with two opposing 6″ speakers. The name was derived from the idea of a full 360° of sound dispersion, realized mainly in the low frequencies.

Another ploy, recommended by G. A. Briggs, the English authority, was to face the speaker upward, directing the sound onto a diffusing cone or spherical reflector. These upturned speakers were usually located at the top of a 4′ ported column. They produced true omnidirectional sound, but the low frequencies from the bottom port and the treble notes from the high reflector were sometimes noticeably divided.

The first of a new breed of column-shaped enclosures (still with us) puts the woofer at the base, facing downward. The mid-range speaker and the tweeter are more conventionally located on one side. The moderate height of this enclosure makes it more acceptable to the lady of the house, and the sound is better integrated than that possible from the tall columns. However, only the bass range is completely omnidirectional.

The latest development in the "sound-all-around" game places multiple speakers facing outward in several directions.

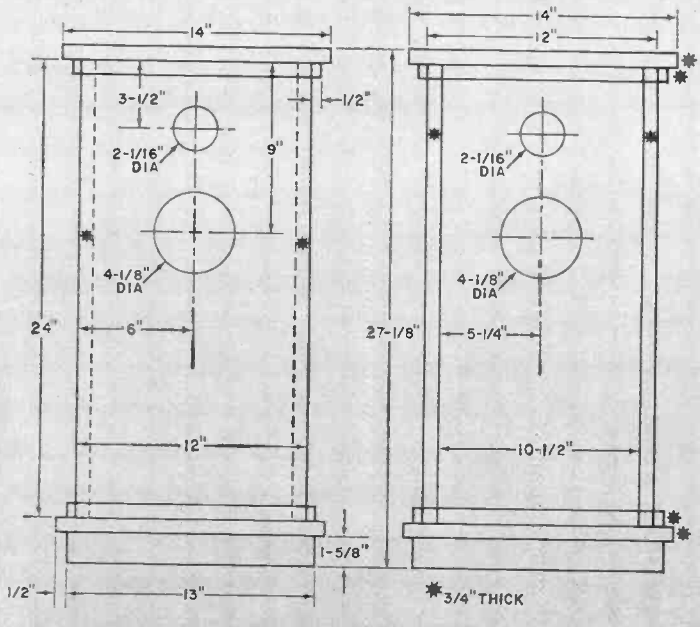



Fig. 1. While only front and one side are shown in drawings, opposite sides are identical in dimensions; ¾"-thick plywood is used for sides.

These systems produce multi-directional, full-range sound that reaches the listener largely by sound waves reflected from room surfaces. These new speaker systems appear to have some distinct advantages over conventional systems—enlargement of the optimum listening area for stereo effect, for example, and a feeling of "depth" imparted by the reflected sound.

There are several possible ways of producing an omnidirectional speaker system. One is to use a collection of full-range speakers; another is to couple an omnidirectional woofer to multiple mid-range speakers and tweeters. Or several small woofers can be used in conjunction with the multiple high-frequency speakers. The choice depends on such factors as cost and the amount of space that is available. For a relatively low-price system—and one that takes up very little floor space—you will want to try the "Omni-Eight."

**About the System.** The Omni-Eight speaker system uses the multiple-woofer approach to multi-directional sound. It

### BILL OF MATERIALS

*4—5" woofers (Olson No. S-845)**
*4—2 ⅜" horn tweeters (Olson No. S-846)**
*1—Two-way crossover network (Olson No. HF-102)**
*1 pkg.—Acoustical fiberglass (Olson No. HF-17)**
*2—24" x 12" pieces of ¾" fir plywood for sides*
*2—24" x 10½" pieces of ¾" fir plywood for sides*
*2—14" x 14" pieces of ¾" hardwood plywood for top and bottom*
*4—13" x 1 ⅝" pieces of ¾" hardwood plywood for foot pieces (miter cut ends to 45°)*
*1—9' length of ¼" x ½" trim for top and bottom (see text)*
*1—8' length of ½" outside corner hardwood molding for corner trim*
*1—144" length of ¾" x 1/48" wood veneer (Shurwood wood tape or similar) for plywood edges*
*4—10½" length of 1" x 2" pine for top and bottom cleats*
*4—7¼" lengths of 1" x 2" pine for top and bottom cleats*
*Six-penny finishing nails for attaching sides*
*Three-penny finishing nails for attaching trim*
*32—#8 x ¾" panhead sheet metal screws for mounting speakers*
*8—#8 x 1½" flathead wood screws for attaching top*
*8—#10 x 2" flathead wood screws for attaching foot pieces*
*Misc.—Grille cloth (see text); wood glue; flat black paint; stain; sandpaper; wire; solder; etc.*
**Olson Electronics, Inc., 260 S. Forge St., Akron, Ohio 44308*

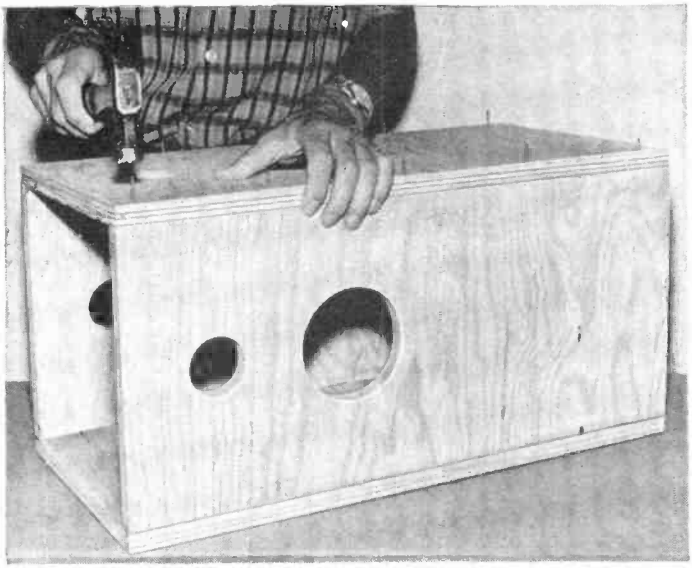


Fig. 2. Start construction of column by gluing and nailing together front, sides and rear. Note that speaker cutouts must all be in a common direction.

has four woofer-midrange speakers connected through a 3000-Hz crossover to four horn-type tweeters. Thus a woofer-tweeter pair faces each of the four walls or the corners if desired. The use of four small woofers results in an enclosure of modest dimensions that occupies only about 1⅓ sq ft of floor space. A control on the bottom-mounted crossover network balances the tweeter output to that of the woofers.

The bass response of the Omni-Eight is clean and true, due to the 50-Hz free-air resonance of the woofers. It isn't the same kind of bass response you get from a 12" woofer, but you will find a degree of naturalness not present in many large speaker systems. The sound quality of the Omni-Eight can be described simply as "refined."

The total effect of the system is one of diffused sound, due to the multi-direc-

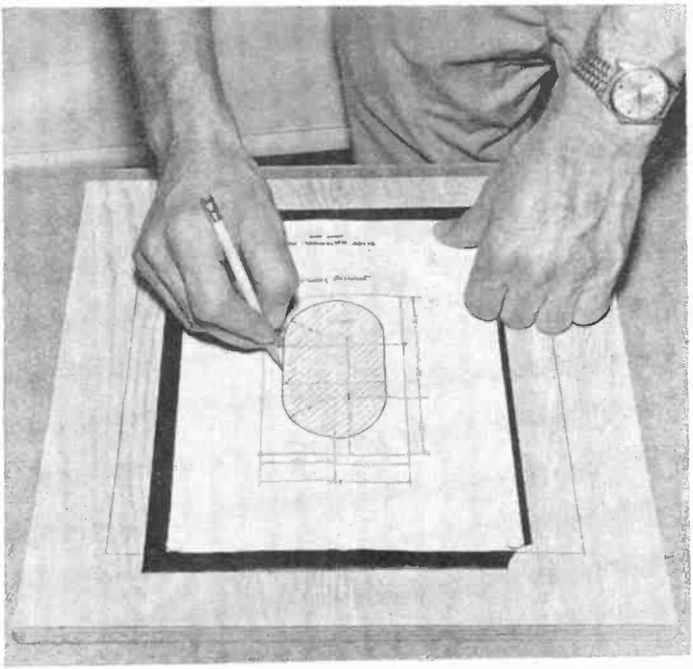


Fig. 3. Provided with crossover network is template that determines dimensions of cutout on bottom of enclosure. Use carbon paper to transfer dimensions to bottom plate.

tionality. The ear can still identify the location of a multi-directional speaker due to the fact that direct sound reaches the ear before the reflected sound; but the placement of the column is less critical than that of conventional systems.

The music power rating of the Omni-Eight is on the order of 30 watts, but it can be driven to good room volume by a 10-watt amplifier.

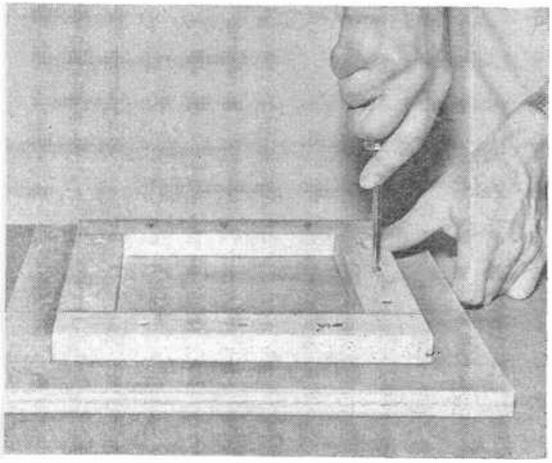


Fig. 4. Prior to mounting top plate on column, attach 1⅝" x ¾" pine cleats as shown in photo.

**Construction.** The enclosure can be built with common hand tools, though 45° miter cuts for the "foot" pieces and trim will improve the appearance. Cut out the parts to the dimensions shown in Fig. 1. In addition to the speaker cutouts, drill two guide holes for screws through each side piece about ⅜" from the top edge and 5" apart. Glue and nail together the sides to form the column as in Fig. 2. Then coat the exterior surfaces of the column with a flat black paint.

Prepare the 14" square top and bottom pieces. Use the template supplied with the crossover network and a piece of carbon paper to make the cutout for the crossover on the bottom (see Fig. 3). Remove the cutout with a sabre or keyhole saw. Center the top and bottom on the open-ended column and outline the position of the sides against the end plates with a pencil.

Attach 1" × 2" cleats with glue and #8 × 1¼" flathead wood screws on the interior surfaces of the top and bottom plates as shown in Fig. 4. The cleats should fit within the space outlined by the pencil marks to allow screws to be driven through the enclosure sides into the cleats.

Next, cover the plywood edges of the top and the bottom with wood veneer edging to match the veneer on the plywood. Use a razor blade to cut a piece of ribbon veneer slightly longer than the panel. Coat the plywood edge and the rear surface of the veneer with contact cement. Allow the cement to dry for 10 to 20 minutes until it is tacky but does not stick to your finger. Then apply the veneer, but don't let the surfaces touch until the veneer is in exact position. The cement will adhere on contact; but to make sure the entire surface is tightly bonded, place a small block of wood against the veneer and tap with a hammer. Move the block and tap it along the entire length of the veneer. With a razor blade, trim the ends of the veneer to the proper length. Then sand the edges, using a small wood block covered with fine (4/0) sandpaper, slightly rolling the top edge to blend the grain of the veneer with that of the plywood.

Coat all matching surfaces between the bottom cleats, the bottom plate, and the bottom edges of the column with wood glue. Attach the bottom by driving

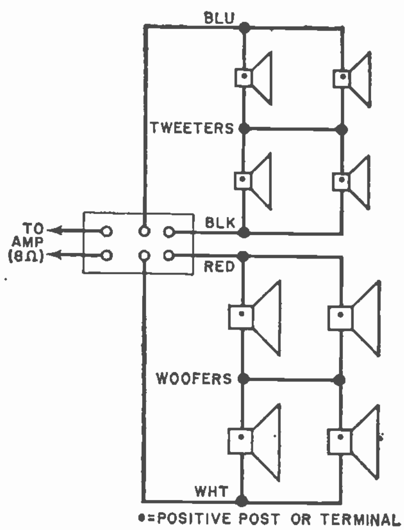



Fig. 5. Tweeters and woofers are wired in series-parallel to present 8-ohm impedance to amplifier.

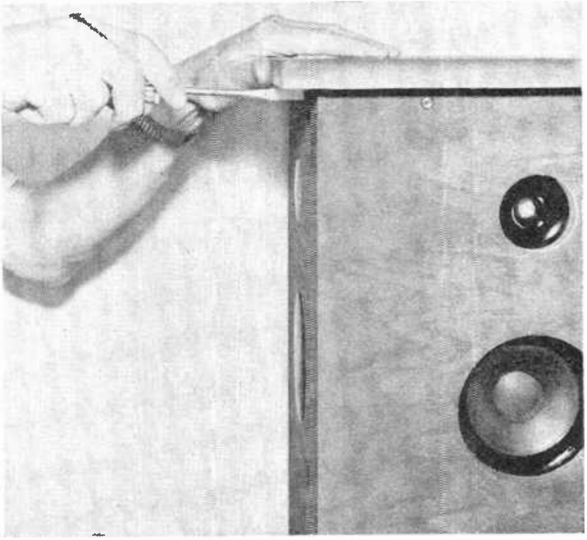


Fig. 6. Screws driven through column walls and into cleats secure top plate in place on enclosure.

nails through it into the lower edges of the four sides. If you have a good fit between the parts, the glue will be sufficient for proper sealing. If not, add screws through the sides into the cleats. Then check for air leaks and caulk the corner joints if necessary.

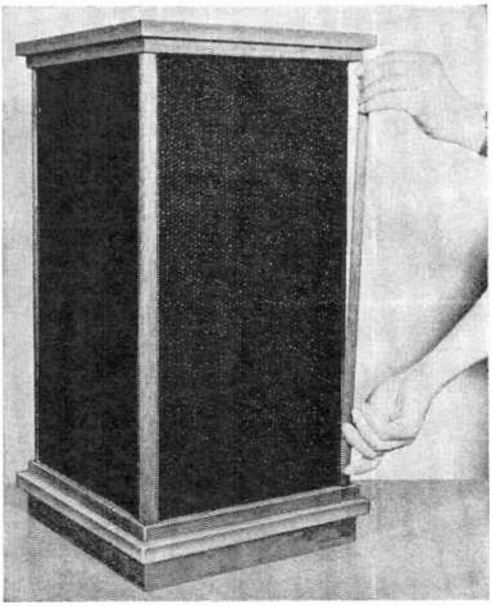


Fig. 7. Staples or tacks securing grille cloth at corners of column are hidden by corner molding.

Install the four miter-edged foot pieces on the bottom plate with glue and eight #8 × 2″ flathead wood screws. Feed the wires from the crossover network into the enclosure and install the network on the bottom, using the ten screws supplied with it.

Now mount the woofers with #8 × ¾″ panhead screws. Locate the positive terminal of each woofer (may be identified by a red insulating washer between the terminal and the speaker frame; negative terminal has white washer). Wire the woofers according to Fig. 5. Then check the polarity of the system by connecting a flashlight battery to the crossover terminals. For proper phasing, all woofer cones should move together in one direction, either outward or inward.

Next, mount the tweeters with panhead screws; wire them according to Fig. 5; and follow the instructions supplied with the network to complete the speaker hookup. Connect the system to an amplifier and check the operation of the tweeter control; clockwise rotation should increase the sound level of the tweeters.

Fill the enclosure with loose fiberglass. One 72″ × 18″ sheet of Olson fiberglass is the minimum amount that should be used. Cut the batting into pieces about 18″ × 10½″, and insert them through the openings at the corners of the enclosure to fill the lower part up to the woofers. Then cut smaller pieces, about 3″ × 10″, to fit in the space between the woofers. The level of the fiberglass should extend to the level of the tweeters.

Set the top in position, and mark the correct positions for screws on the inside cleats. Remove the top and drill ⅛″ guide holes in the cleats. Cement a thin gasket of polyfoam or felt along the top edges of the sides. Then replace the top and anchor it with screws driven through the sides and into the cleats as in Fig. 6. The screws will be in the proper position to draw downward on the top, compressing the gasket. If necessary, weight the top to bring the guide holes in line with the screws.

A piece of grille cloth 2′ × 4′ will fit the enclosure column, wrap-around style. However, if the grille cloth you select does not have a strong vertical or horizontal pattern, you might be able to

(*Continued on page* 113)

# FIRST PERSON DX'ing

MR. SWL—

ARTHUR CUSHEN—CIRCLES THE GLOBE VISITING BROADCASTERS

First of the ten international broadcasting stations visited by my wife, Ralda, and me was the VOA 250,000-watt installation at Dixon, Calif. We were interviewed for a VOA broadcast to Asia. The antenna site occupies 800 acres.


Radio Canada maintains an active club and our second interview was conducted by Elaine McMaster (club secretary) and Duncan Nicholson (club vice president). These interviews gave me an opportunity to tell listeners what it was like to DX on the shortwaves from New Zealand.


Arriving in England we were cordially greeted by the staff of the BBC. While in London I gave a first-hand report of New Zealand DX'ing to Henry Hatch, who moderates many of the World Radio Club programs. Since I am blind I did a program for "Radio 4" for blind listeners.

On to Denmark, only to be greeted by the sad news that Radio Denmark was considering cessation of its English-language programs. Christion Flagstad is addressing Ralda and me with Luise Berald and Dick Platt of Radio Denmark, right, joining the conversation.

At Halmstad, Sweden, the European DX Council held an International Parliament to discuss matters of common interest. At left is J. Vastenhoud of Radio Nederland; at right, renowned Radio Sweden Editor, Arne Skoog.

On our way home, we stopped at Radio RSA, Johannesburg, South Africa. We were interviewed again(!) by Dorianne Berry and Arthur Hanna, two more well known announcers. Unfortunately, these few photos cannot possibly show all the wonderful people we met nor express our deep thanks to all who were so cordial to us.

—*Ralda and Arthur Cushen*

# Engineering Level Opportunities

# FOR YOU

## HOME STUDY IS THE ANSWER

BY ALEXANDER W. BURAWA, Associate Editor

THE PHENOMENAL PACE at which electronics has developed in the last few years—and the ever-increasing complexity of the technology—have precipitated an unprecedented demand for engineering level electronics technicians. In the aerospace and communications industries, in sophisticated computer centers, and in scientific and medical electronics—all areas where the most lucrative job opportunities exist—training on the level of the radio-TV repairman is no longer sufficient. Technicians in these job situations are actually associate or assistant engineers; and it takes engineering training on the college level to get these jobs—something you can now do with home study.

If you can't take the time or haven't the money to spend for two to four years of college what do you do? Do you know that four nationally accredited *home study schools* are now offering engineering courses on the college level? If you have the prerequisites, two years or less of leisure-time home study could put you well on your way toward one of these engineering technician positions.

The college-level courses offered by home-study schools have gained wide-spread approval in industrial and educational circles. In most cases, the student receives an industry recognized diploma upon completion of one of the courses. One home study school offers the opportunity of earning a degree.

**Home study courses** in electronics actually started in the 1920's. The earliest courses were highly specialized, tending to focus on certain areas in a technology which was then only in its infancy. Gradually, coverage was expanded and today's home study engineering courses are as up-to-date and cover as much ground (in the technology) as those offered in many technical colleges.

Schools accredited by the National Home Study Council* and offering engineering programs are: Capitol Radio Engineering Institute (CREI), 3224 Sixteenth St., NW, Washington, D.C. 20010; Cleveland Institute of Electronics (CIE), 1776 East 17 St., Cleveland, Ohio 44114; Grantham School of Engineering (GSE), 1505 North Western Ave., Hollywood, Calif. 90027; and National Technical Schools (NTS), 4000 S. Figueroa St., Los Angeles, Calif. 90037.

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**The Accrediting Commission of the National Home Study Council has been approved by the U.S. Office of Education as a "nationally recognized accrediting agency." Its purpose is to establish educational, ethical, and business standards; examine and evaluate private home study schools in terms of these standards; and accredit (only) those schools which qualify.*

"General acceptance of correspondence study as a legitimate technique has been developing for years. Recently, however, the growth of that acceptance has been phenomenal. Hundreds of private companies are using home study to enable their employees to do a better job. Colleges and universities are becoming more willing to give formal credit on the basis of personal interviews and qualifying examinations.

"No study of correspondence education has shown it to be appreciably inferior to classroom instruction, while a number of studies have shown correspondence students do measurably better on examinations."

*L. M. Upchurch, Jr.*
*President, CREI*

**Prerequisites** for engineering level home study courses are obviously high. The applicant must be a high school graduate (or possess a high school equivalency certificate) and have studied, or had previous job experience in, the electronics industry. Applicants without the electronics prerequisite but who have a firm grasp of theoretical and practical physics and intermediate mathematics are good potential candidates.

There are very practical reasons for setting these high prerequisites. The courses provide studies only in electronics theory; there are no gimmicky training kits or home-built TV receivers. The schools sense that no engineering level home study course can possibly provide the exposure to all the test equipment, circuits, and systems required for a full resident laboratory course. Since home study programs feature low cost, this is a sound principle and the study programs have been adjusted accordingly.

Thus, even though home study engineering courses have no costly kits and training aids, nothing has been sacrificed in the quality of educational materials provided. Such items as tube and transistor manuals, special textbooks, and slide rules are included in the basic tuition.

### WHAT IS AN ENGINEERING TECHNICIAN?

The entire technical work force in electronics can be divided into two broad, but not necessarily well defined, categories: technicians and engineers. Technician in this sense refers to the person who operates, maintains, troubleshoots, and repairs electronic gear. Engineer refers to the designer of new devices, circuits, and systems. Between the two categories lies a growing force of engineering technicians (sometimes referred to as associate engineers). The engineering technician's duties and responsibilities overlap both categories.

Engineering technicians usually work directly with scientists and engineers with degrees. They analyze and solve engineering problems and occasionally prepare technical reports. Consequently, the engineering technician must have a thorough grasp of the scientific principles of his particular field and a good understanding of mathematics and physics. Generally, to be entitled to the title of associate engineer, the person is expected to be a graduate of a two-year college. However, the growing recognition of home study by the industry does entitle the home study graduate to apply to his name the title of engineering technician.

**The home study concept** of education is geared for individual attention. Each lesson is written to provide maximum clarity. But even the clearest written text might confuse some students. So, all of the schools maintain a full-time consultation service, staffed with engineers and educators who are experts in home study problems, to which the student can turn for help. This service is available even after graduation.

Textbooks are broken up into bite-size lessons for easy assimilation and to allow the student to pace his progress. Within each lesson are answer-keyed questions that are designed quickly and immediately to check the student's comprehension of the material covered. At the end of each lesson is an exam which must be completed and sent to the school. All questions asked are of the thought-provoking essay type.

At the school, the student's exams are reviewed and graded by professionals. In grading the exams, several things are looked for: The correct answer, of course, is one, but more important are the techniques used in answering math questions and the method of presentation. If an incorrect method or answer is given, the person grading the exam will supply corrective hints that show where the student went wrong, and refer him to the

"Many people are now realizing that everyone can't go to college; and, more important, many individuals should definitely not seek a college education. Home study is an ideal alternative—not a substitute but an excellent opportunity to obtain specialized education quickly, effectively, and economically.

"At CIE, we have some 775 industrial and commercial clients, and this roster is growing daily."

*Ralph J. Schmotzer*
*CIE*

Angelo Vaccaro came to the U.S. from Italy 15 years ago and went to work as a machinist. When he enrolled in CREI in 1953, he could hardly speak English, and he gives the lessons credit for helping him learn the language. Today he is Vice President of Columbia Controls Research Corporation in Glen Cove, N.Y. He holds in his name or in the name of the company 15 patents for devices such as an electronic scanner, an electronic tensioning control device, and a reader for a computer system. Some of these devices have been sold or licensed, and negotiations are under way for others.

# ON THESE PAGES

*An interesting item that appeared in the August 1969 Supplement of the "National Home Study Council News" under the heading "Recent Research Developments in Correspondence" cites a further example of the effectiveness of home study training: "In representative examples of correspondence students at the University of Minnesota, every twentieth card in the current student card file was selected to give a 5% sample . . . In terms of grade points, students in correspondence study rated higher than those in day school, evening school, or in summer sessions. Only in the Graduate School was the average higher."*

Although David J. Chestnut is not a "typical" graduate of home study electronics engineering, his story does show how far a person with initiative can go. Mr. Chestnut began his CREI studies in 1932 and is now Managing Editor of Technical Communications of Raytheon Company's Wayland Laboratories in Massachusetts. In his ten years with Raytheon, he has supervised many areas of technical communications, including cinematography and in-plant engineering writing seminars. Since his CREI studies, Mr., or rather, Dr. Chestnut has added B. Mus., M. Ed., and Ph. D. titles to his name, has had several papers published, and has been a prominent speaker on the subject of technical publications in this country and abroad—an impressive number of achievements by any yardstick.

Joseph W. Pieczynski enrolled at CREI in 1963 and is currently manager of the EPC Division of Artisan Electronics Corporation in Parsippany, N.J. The EPC Division was formed by the acquisition of Electronics Products Corporation, of which Mr. Pieczynski was founder and president. Among his achievements is the patent he holds for a self-powered timer. He also received honorable mention in the 1963 Gustav Johanson Awards for his contribution to timer technology.

# SOME SUCCESSFUL STUDENTS

Maurice T. Swinnen graduated from CREI in 1962 shortly after he arrived in the U.S. from Belgium. Not long after graduation, he joined the Division of Neuropsychiatry at Walter Reed Army Medical Center in Washington, D.C. Starting at Walter Reed as an equipment repairman, Mr. Swinnen rapidly rose to electronics technician and, finally, to supervisor of the electronics shop facility of the Division of Neuropsychiatry. He is in charge of seven technical support personnel, two of whom are graduate electronics engineers. He has contributed well over 100 technical reports about the instruments he has devised during the past seven years and more than 20 publications have appeared under his name in both medical research and electronics journals. He is often called upon to attend the various technical and medical conventions around the country—to learn as well as to teach.

"Our home study degree program is relatively new, but already quite a few firms and agencies are paying tuition in this program for their employees. And many others are reimbursing their employees who complete correspondence 'semesters.' Some of the firms and agencies who have paid tuition directly to the School are: Naval Ordnance Station of Indian Head, Md.; the WDL, E&TS, and C&TS Divisions of Philco-Ford; Sprague Electric Co.; Consolidated-Bathurst, Ltd., of Canada; ESSA Research Labs; and NASA Flight Research Center, Edwards, Calif."

*D. J. Grantham*
*President, GSE*

page or section in the lesson that should be reviewed.

When the student is through with his course, he must complete a comprehensive examination that touches on every area studied. The end-of-course exams are usually proctored (taken in the presence of a qualified person). Then upon passing the comprehensive exam, a diploma, which is the school's statement of the student's competence, is awarded.

**Although basically similar,** the exact content of the home study engineering courses offered by the various schools varies.

At CREI, the master, or principal, course on the college-engineering level is the Electronic Engineering Technology Base Program with Major Electives. It has two objectives: to provide a broad basic foundation in electronics and to equip you with specialized knowledge in a particular field of your choice. The Base Program covers the theory and application of advanced electronics in relation to circuits, components, and systems. The electives in which you can specialize include: Communications; Aeronautics and Navigation; Television; Computers; Nuclear Instrumentation and Control; Automatic Control; Missile and Spacecraft Guidance; Radar and Sonar; and Digital Communications.

CIE and NTS also offer master courses in electronics engineering. No electives are available as such, but the courses are designed to prepare the student for a career in one of a wide variety of specialties in the electronics industry. Typical basic subjects include steady-state and transient network theory, solid-state physics, magnetics, etc.

GSE's program consists of five sections and includes an "incidental" preparation program for an FCC First Class Radiotelephone License with Radar Endorsement. Emphasis is on mathematics and physics (as it is in all home study courses). The course sections are: Basic Electronics with Mathematics; Communications Circuits and Systems; Engineering Mathematics and Computers; Classical and Modern Physics, and Technical Writing; and Engineering Calculus, Electrical Networks, and Solid-State Circuit Design.

**A very important benefit** of these courses for those students who plan to go on to college to earn their associate and bachelor degrees in electronics engineering is that many colleges allow considerable advance-standing credit for material covered (depending on the college and the results of tests). In addition, Grantham has oriented its program toward the obtaining of a degree. After completing his home studies, the student attends a two-week resident class at the school, for which he earns an Associate in Science in Electronics Engineering (ASEE) degree. —30—

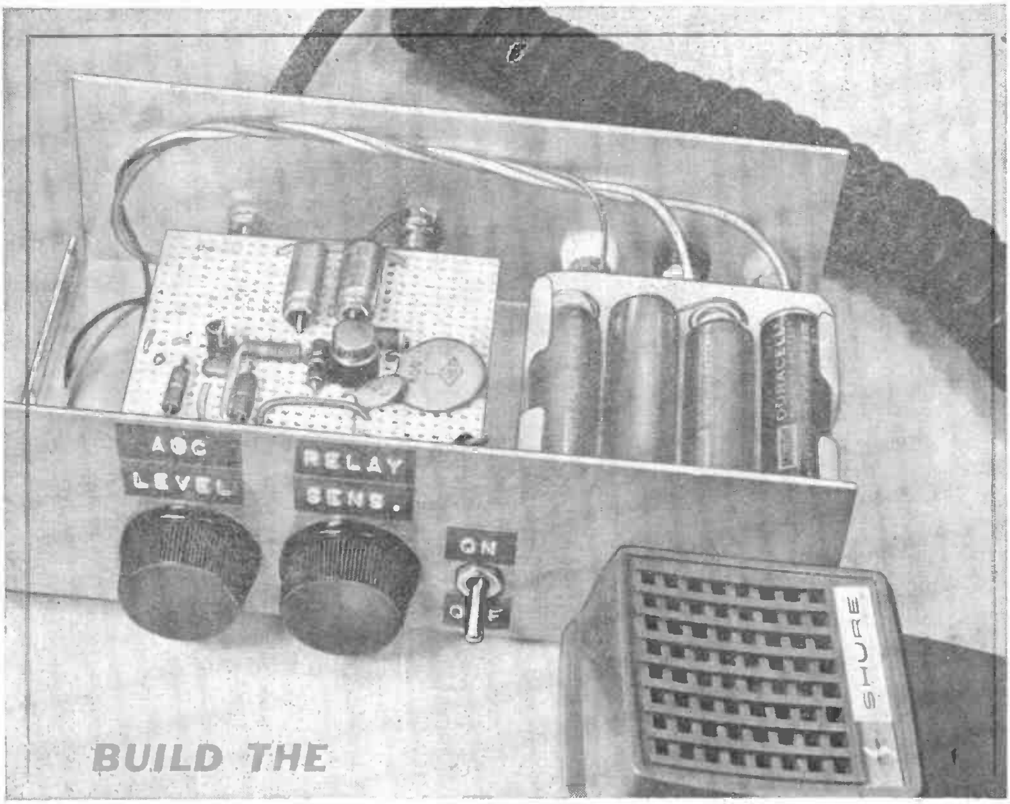
"It has been said that education is the mother of leadership; and by encouraging education, the National Home Study Council helps build leaders to guide America through the tests and trials of this critical and complex time. . . . Never has your mission been more timely or more imperative than now. Your high academic standards promise quality education to all who pursue correspondence study. I commend your distinguished and enduring service to America."

*—Excerpt from a telegram sent by President Nixon to the NHSC at its 1969 Annual Conference.*

"Recognition of home study programs in direct conjunction with college-level education is distinctly on an upward swing. As an indication that industry does accept home study graduates, our own experience has been that major firms throughout the world have sought and value our graduates.

"Data involving motivational research has proven that self-directed independent study is more effective than resident training. One obvious reason for this is that the home study student must research his own material as sent by the school without someone at his side. While he is guided, supplied with accurate and tested study material, and counseled as needed, he is not spoonfed information, nor is he held back in a class of students with a variety of achievement skills."

*Robert Parma*
*Director of NTS*




# VOXOR

## A VOICE-OPERATED MICROPHONE WITH SPEECH COMPRESSION

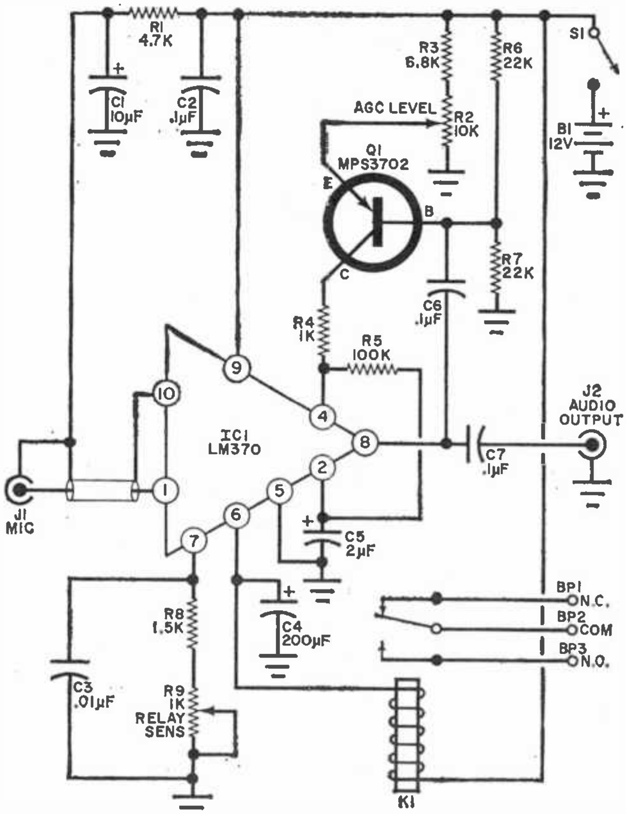
BY ROBERT A. HIRSCHFELD

HOW WOULD YOU like a microphone system that operates without a push-to-talk switch and compensates for differences in voice levels automatically? Whether you are using a tape recorder, ham or CB rig, these are real advantages. You can get both of them by building the "Voxor," a unit that has a voice-operated relay (VOX) and speech compression (audio a.g.c.)—features that are normally found only in expensive military and commercial equipment.

The Voxor uses the new National Semiconductor LM370 integrated circuit and is connected between your microphone and recorder or transceiver. All you do is start to talk and the system turns on immediately. When you stop talking, and if you're using a transceiver, it will switch immediately to the receive mode. In the meantime, while you are talking, the Voxor output will be at a nearly constant, high-modulation level.

**Construction.** The circuit of the Voxor (see Fig. 1) can be built on either perf board or on a printed circuit board. A possible layout is shown in Fig. 2. Components not shown in the figure are below the perf board. To make wiring easier, it is suggested that a 10-pin integrated circuit socket be used for *IC1*. Once the board is complete, it can be mounted on standoffs and connected to the external components.

On the prototype shown in the photos the a.g.c. level potentiometer *R2*, the relay sensitivity potentiometer *R9* and the power on-off switch *S1* are mounted on the front of the chassis. The micro-



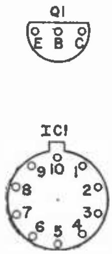




Fig. 1. The circuit is not a speech clipper but a legitimate speech compressor. When connected to a radio telephone transmitter or a tape recorder, the circuit will maintain a high modulation level with the speech clarity of the original input. As a bonus, the circuit will also operate a relay that can be used to switch the transceiver on or start a tape machine when speech does.

## PARTS LIST

*BP1-BP3—Insulated binding post*
*B1—12-volt d.c. battery or power source*
*C1—10µF, 25-volt electrolytic capacitor*
*C2,C6,C7—0.1-µF capacitor*
*C3—0.01-µF capacitor*
*C4—200-µF, 25-volt electrolytic capacitor*
*C5—2-µF, 10-volt electrolytic capacitor*
*IC1—Integrated circuit (National Semiconductor LM 370 or Sylvania ECG370)*
*J1,J2—Phono jack*
*K1—1640-ohm relay, s.p.d.t., 1-ampere contacts (Sigma 65F1A-12DC or similar)*
*Q1—Npn silicon transistor (Motorola MPS3702 or similar)*
*R1—4700-ohm*
*R3—6800-ohm*
*R4—1000-ohm*
*R5—100,000-ohm*
*R6,R7—22,000-ohm*
*R8—1500-ohm*
*(All resistors ½-watt)*
*R2—10,000-ohm linear potentiometer*
*R9—1000-ohm linear potentiometer*
*S1—S.p.s.t. switch*
*Misc.—Metal chassis, perf board, standoffs, microphone (Shure 401A), battery holder, knobs, 10-pin IC socket (Cinch-Jones 10-ICS), mounting hardware, etc.*

phone input *J1*, audio output *J2*, and the three relay contact binding posts are on the rear. As with any high-gain amplifier, leads should be kept short and direct to prevent feedback and high-frequency oscillations.

While almost any dynamic microphone capable of delivering up to five millivolts can be used, the one specified in the Parts List works especially well with this circuit. Certain microphones, including the one used here, have push-to-talk switches that close the circuit when the microphone is in use and also short out the microphone element itself when it is not in use. Such microphones must be rewired so that the element is never shorted.

To use the Voxor with an input other than the signal from a dynamic microphone, rewire the input circuit as shown in Fig. 3. This can be used as long as the maximum input level does not exceed about 50 millivolts. Larger inputs will

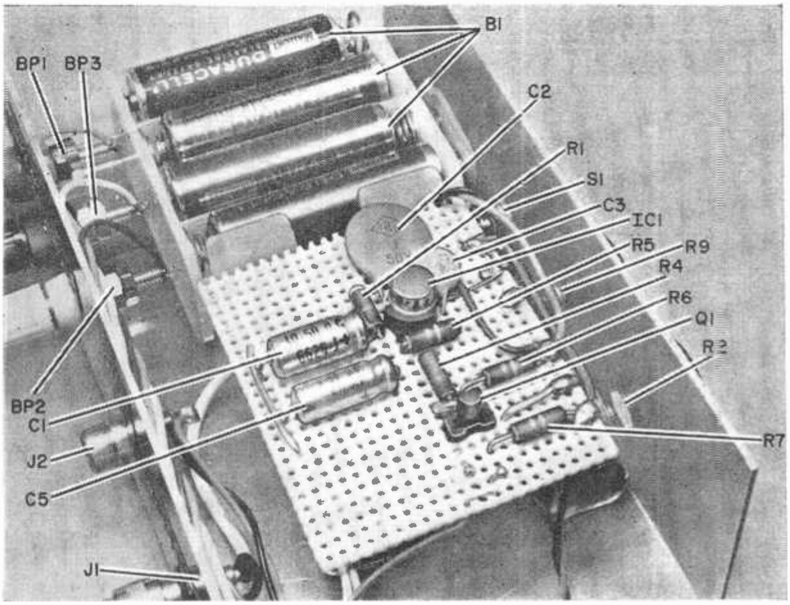



Fig. 2. The author constructed his Voxor on a section of perf board, although any other type of construction may be used. Sockets were used for both IC1 and Q1.

produce distortion. Inputs of less than one millivolt do not give reliable operation of the relay.

While the Voxor can be used with any d.c. supply from 9 to 24 volts, it works best with a 12-volt supply.

The attack and release times of the Voxor are determined by the value of capacitor *C4*. With the value prescribed in the Parts List, the timing is just about right for normal speech. Doubling the capacitance doubles the attack and

## HOW IT WORKS

The integrated circuit—containing a complex combination of 34 transistors, diodes, and zeners, plus 20 resistors—performs two separate functions. The first is preamplification, with gain controlled by an external d.c. voltage (applied to pin 4). When this potential is less than 2 volts, the gain of the preamplifier is a maximum (about 100 with a 12-volt supply). With higher voltages, the gain decreases: until, with 2.6 volts or more, there is an attenuation of 100.

The second function is performed by a very high-gain amplifier-detector that receives the same input as the preamplifier but is otherwise independent. A potentiometer, external to the IC, sets the desired "squelch" threshold at pin 7. The output stage of the amplifier-detector is a medium-current *npn* power transistor. This transistor is normally off when only low-level inputs are present: but when the threshold is exceeded, pin 6 provides nearly a short circuit to ground, and the current is sufficient to operate the relay.

The input from the microphone is applied directly to both sections of the IC with d.c. bias derived from *R1* and *C1*. Sensitivity for the VOX section (the second function of the IC) is set by *R9* and the relay is driven directly by the output at pin 6. Normally, *C4* is charged up to the positive supply voltage through the relay coil. When a microphone input occurs, the relay is energized and *C4* discharges. Thus, the relay remains closed even after the input disappears—until *C4* has had time to recharge. This provides a "fast attack" so that early speech won't be lost, and a "slow release" so that the relay won't cut out between normally spaced words in a sentence. Capacitor *C3* makes the VOX less sensitive to high-frequency noise, so that sensitivity to speech frequencies is retained and false triggering made less likely.

Speech compression is performed by detecting the negative audio peaks at the output of the preamplifier (pin 8) through capacitor *C6*. With no audio present, the potential at the base of *Q1* is half of the supply voltage, as determined by the voltage divider made up of *R6* and *R7*. A negative-going audio peak causes *Q1* to turn on momentarily, which quickly brings the control input (pin 4) above the voltage where the preamplifier begins to turn off. This, in turn, charges *C5*, the a.g.c. smoothing capacitor. The net effect is that the first excessive peak seen by the detector causes the gain to be reduced just enough so that succeeding peaks of the same signal strength no longer activate the detector. A nearly constant amplitude of the output voltage is the result. Capacitor *C5* discharges more slowly than it charges so that the a.g.c. action also has a fast attack and slow release. If the speech level drops below the desired level, the amplifier gain increases as *C5* discharges until the preset level is reached.

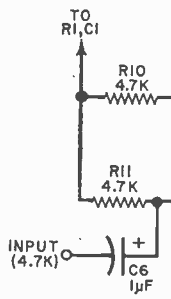



Fig. 3. This optional circuit may be used with an input other than the dynamic microphone specified.

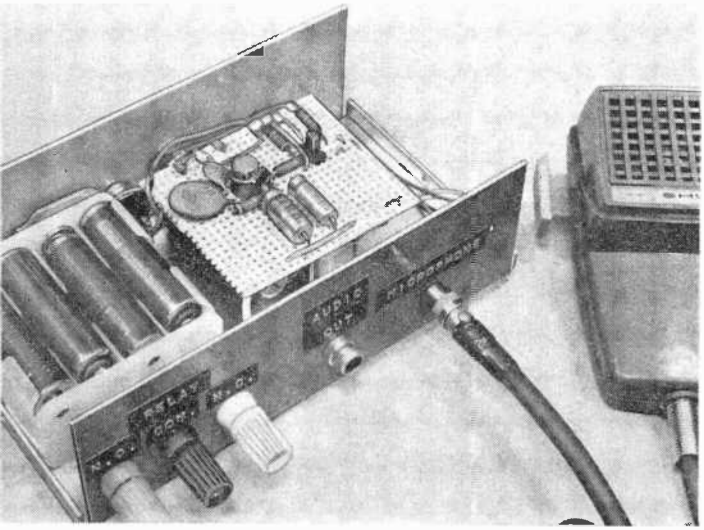
release times; reducing the capacitance, reduces the times.

**Operation.** After checking the circuit, connect the power supply and microphone and set *S1* to ON. Set the RELAY SENS. control for maximum resistance and note that relay *K1* is de-energized. Decrease the resistance of *R9* until the relay picks up and then back off slowly until it drops out again. Speaking into the microphone should cause the relay to be energized rapidly, with dropout occurring about one second after speech has ended. Setting *R9* closer to the "threshold" point increases relay sensitivity, while increasing *R9* resistance makes the relay less sensitive.

Connect the audio output of the Voxor to the input of the equipment with which it is to be used and set the equipment audio gain to the desired level. Set potentiometer *R2* for minimum resistance (rotor to grounded end). Speaking in a normal voice, the correct distance away from the microphone, adjust *R2* until the audio output of the Voxor decreases to the desired level. Note that changing the voice level or moving closer to or farther from the microphone does not change the audio level. In this way, it is possible to modulate fully a radio transmitter or tape recorder without overloading it.

For use with a transceiver, connect the relay common and normally open contacts to the wiring that formerly went to the microphone push-to-talk switch and the audio output of the Voxor to the mike input. Adjust the relay sensitivity so that the Voxor is not activated by the sound from the speaker during the listening interval. To operate the transceiver, just speak into the mike and the switching is done automatically. If the Voxor a.g.c. level and transceiver audio modulation level (if any) controls have been properly set, you will notice an increase in the talk power due to the constant high level of modulation.

The relay in the Voxor can handle most battery or low-voltage tape recorders. Connect the relay common and normally open contacts in series with the recorder motor and associated power supply. Speaking into the Voxor will automatically start the recorder. As with the transceiver, the tape recorder and Voxor controls are set to provide maximum modulation of the tape. —30—




The three relay contacts—normally open, normally closed, and armature are terminated in three binding posts on the rear apron. These are connected as required by the external equipment being controlled, which can be either a tape recorder or transceiver.

# The Stereo Scene

## MAGNETIC TAPE: HANDLE WITH CARE

BY CHARLES H. DODSON, Ampex Corporation

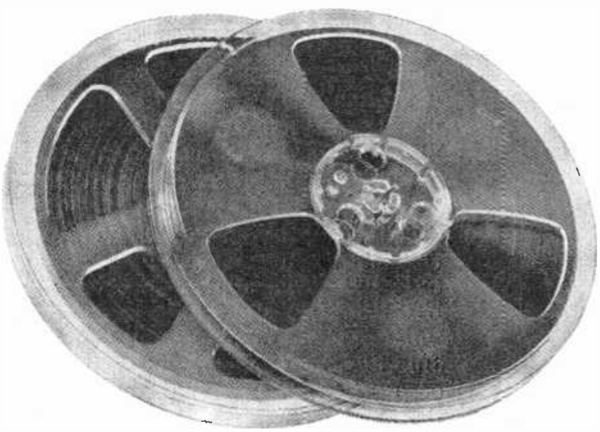
POSSIBLY the most overlooked aspect in the routine of a tape recording hobbyist concerns the tape itself. While he is usually very concerned with the maintenance and operation of recording hardware, not enough serious thought or attention is given to the proper care and handling of the tape that plays such a vital role in all magnetic recording operations.

Proper care is essential to the long life and high quality of tape and is an important preventive step in assuring maximum performance from recorders.

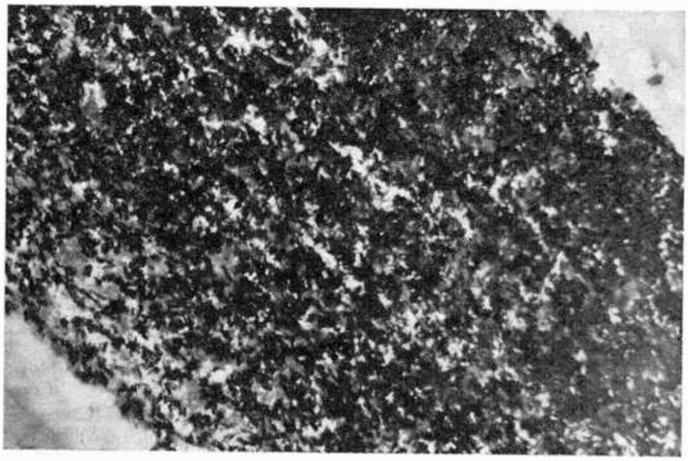
Scores of different types of audio tapes are manufactured for use by home hobbyists, recording companies and broadcasting stations. Tapes are packaged in a variety of ways, including plastic and metal reels, cassettes, cartridges and 11½-inch mats (called cue mats). For the home audiophile who wishes to get the best available recorded sound on a consumer-quality reel-to-reel recorder, the tape he wants is that which is available on 3", 5" and 7" plastic reels. This tape is 0.246 inch wide with a tolerance of ±0.002 inch. Total thickness ranges from less than 0.0007 to 0.0019 inch, the length from 150 feet to 3600 feet.

**Composition of Tape.** Magnetic tape consists of three principal elements—base material, binder, and oxide. The main properties and functions of each are as follows:

*Oxide.* The oxide particle is the heart or working part of all magnetic tape. In virtually all precision tapes, the oxide used is gamma ferric oxide in cigar-shaped particles approximately 0.1 micron thick and 0.7 micron long. These particles are suspended in the binder in much the same manner as almonds are in a chocolate bar. During manufacture of the tape, the oxide particles are ori-



Even after several passes, a high-quality tape reel played on a good machine retains a smooth tape pack. Uneven winding (left) is a result of an imperfect reel or a recorder needing adjustment, or both.



Cross-section of a piece of audio tape magnified 30,000 times shows cluster of oxide particles with tape coating on one side, epoxy on other.

ented on the tape in uniform patterns. Size and distribution of the particles vary with the manufacturer and the type of application for which the tape is made. Some formulations, for instance, use slightly shorter oxide particles in the production of "low noise" tape, a tape which when played through a recorder adapted for the low noise characteristic, provides less unwanted and foreign sounds than standard audio tape. Shorter particles are also used in formulations for slow-speed tape, which yields improved performance over standard tapes at the slower recording and playback speeds (1⅞ in./s and 3¾ in./s).

*Binder.* The binder joins the oxide to the base material. It must provide even dispersion of the oxide particles and confine them within a thin layer. It must provide an efficient adhesion of the oxide coating to the backing material and an effective cohesion of the magnetic particles to each other.

*Base Material.* The base material provides a means of holding the iron oxide and moving it past the head of a recorder in a controlled manner. It must magnetically separate one layer of oxide coating from another to minimize print-through, a condition that occurs when adjoining layers of tape on a reel pick up the magnetic characteristics of their neighbors, causing noise on the affected segments of tape. It also must have enough strength to resist breaking during starting, stopping and high-speed rewinding and yet be pliable enough to provide good tape-to-head contact.

Polyester and cellulose acetate are the most commonly used base materials. Generally, polyester has the best characteristics for high-quality audio applications and for storage of prized recordings. It has strength, long life, and relative stability in varying conditions and environments. Cellulose acetate, frequently used in less demanding audio applications, does not possess the stability and durability required for high-quality recording. It is less expensive, however, and does not stretch as much as polyester. Typically, cellulose acetate tape costs about 15% less than a similar reel of polyester tape.

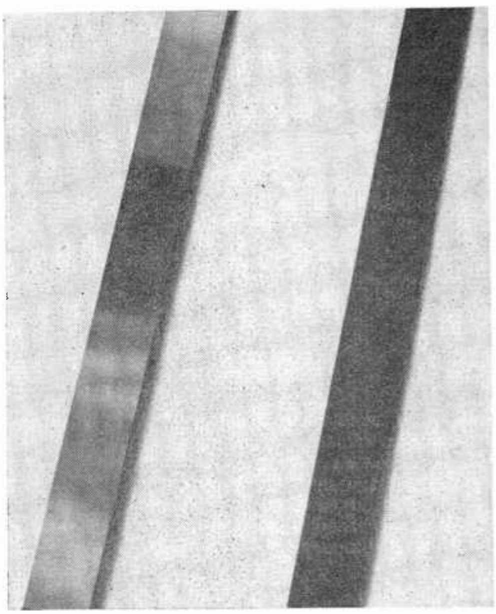
TREAT TAPE GENTLY

**Purchasing Tape.** Since the magnetic characteristics of a reel of tape cannot be "seen" by a prospective buyer, there is no simple way of determining the recording quality of tape. It is recommended, therefore, that the serious audio hobbyist confine his tape purchases to brand name products.

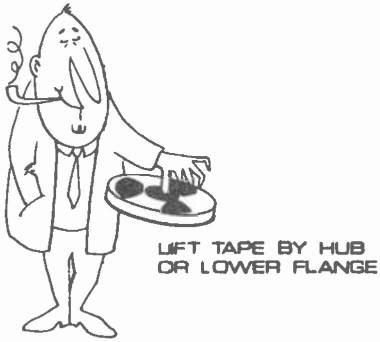
Since most tapes include a lubricant in the formula, the buyer should not be misled by claims of special lubricants contained in the product. A "lubricated" tape, however, is one with a lubricating coating which allows it to move easily within its container. This lubricating is required only in cartridges—where the tape is packaged as a continuous loop. On a reel, lubricated tape tends to leave an oily residue on recording heads and may cause problems with the equipment, requiring frequent cleaning and causing poor performance. So buy lubricated tape only in cartridges where the lubricated coating permits the layers of tape to slide against each other more easily.

The reel itself often reflects the overall quality of a tape. By comparing several tape reels for balance and rigidity of the plastic, it is easy to determine which reels are best. Cheap reels are often made of thin plastic which loses shape easily.

**General Handling and Storage.** When tape is exposed to *excessive* fluctuations of temperature and humidity the base material expands or contracts, causing tremendous internal stress in the tape pack. This stress can induce distortion



Lubricated tape at right can be identified by the dull finish. Non-lubricated tape (left), with a bright surface, is better for reel-to-reel jobs.




beyond the elastic limits of the base material, which in turn can render the tape useless. Generally, it is advisable to store and use tape in an environment where the temperature is between 50 and 90°F and the humidity ranges from 40 to 60 per cent. Under ideal circumstances, temperature should be about 70°F and humidity 50 per cent. If a reel of tape is temporarily exposed to unfavorable temperatures or humidity, it should be stored in the proper environment for at least 24 hours before recording or playing.

Because of the magnetic properties of tape, it should be stored in an area which is not in any stray magnetic fields. It is not necessary for the user to build special protective shelters in his home and attempt to measure magnetic fields. It is simply suggested that he avoid storing tape next to electrical appliances which have motors or transformers (such as refrigerators, air conditioners, amplifiers, television sets, washing machines, and radios).

Reels of tape should be handled gently and by the hub whenever possible. Never pinch the flanges as this squeezes them into the tape pack and can cause tape damage.

When threading audio recorders, the tape should be placed around the recording heads carefully. Leave enough slack to prevent unnecessary pulling or stretching of the tape as it is threaded. The tape should remain completely threaded while on the machine and should be rewound to one reel before being removed.

**Care of Equipment.** Because of the close operating relationship between tape and

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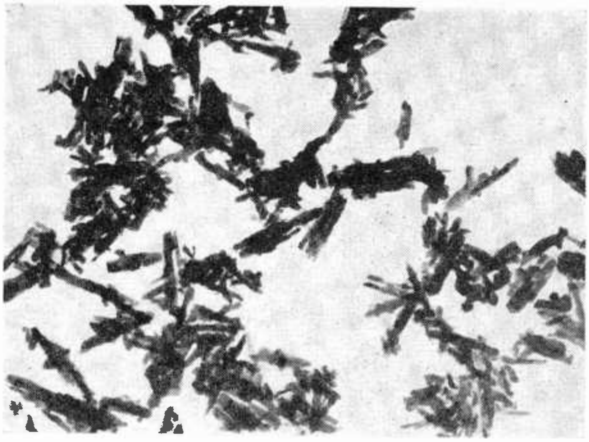


This electron microscope photograph of a piece of audio tape shows the oxide particles; magnification, 60,000 times.

equipment, proper care of tape requires good maintenance of recording hardware. Tape recorders vary in design and there are no set rules for their maintenance. Procedures for cleaning and checking recorders are carefully explained in the manuals that come with new machines.

A poorly functioning recorder may harm the tape used with it. Worn parts with rough edges along the tape path can damage the surface of the tape. Metal parts which come in contact with the tape, including heads, capstans, and guides, have a tendency to become magnetized and cause partial erasure of the tape.

To avoid tape damage, the recorder should be checked visually periodically to make sure that all surfaces that contact tape are smooth. A crease, nick or scratch on a strip of tape usually indicates a worn part along the tape path. When discovered, worn or broken parts should be replaced immediately.

Also, splice out wrinkled and damaged portions of a tape, or duplicate the tape and throw away or shelve the original. Failing to do so may result in still further tape damage.

Loss of quality in high-frequency notes often indicates some demagnetization of the tape. An inexpensive degausser (under $10), available from most consumer audio equipment suppliers, should be used each time the recorder is cleaned to demagnetize its parts.

**Shipping and Storing.** When magnetic tape is shipped by the manufacturer, it is placed in a container designed to protect it from dust and humidity. Usually this shipping case or a special tape mailing case is the best and safest container for storing and mailing tape.

Tapes placed in the mail are at the mercy of postal and shipping clerks and should be packaged in appropriate containers to prevent tape or reel damage due to rough handling. If a valuable tape is to be mailed, it is suggested that a duplicate be made in case the original is lost or subjected to extreme environmental conditions.

One of tape's virtues is its durability. But in order to realize the potential long life of tape (good recording and playback performance for hundreds of passes), it is necessary to take the extra time and effort required for the proper care of tape and recorder. -30-

# the product gallery

## REVIEWS AND COMMENTARY ON ELECTRONIC GEAR AND COMPONENTS

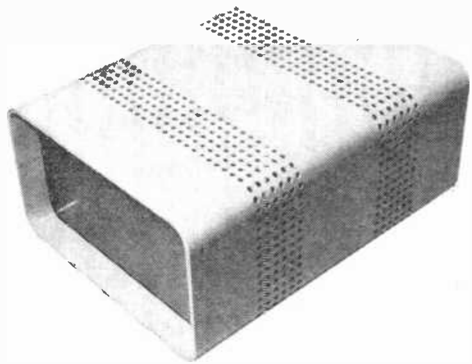
### EQUIPMENT CABINET (LMB)

THE HOME experimenter faced with the dilemma that his pet project is finished and works like a charm soon realizes that the metal working shops and metal box makers have left him out in the cold. There are just too few good looking equipment cabinets available.

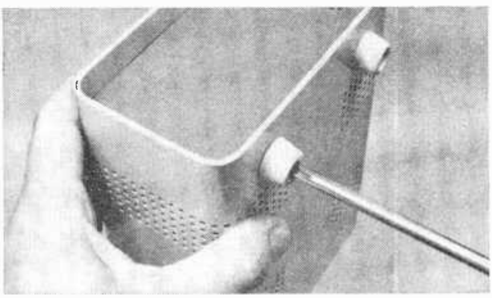
However, there is an exception to the rule and this reviewer believes that one company (LMB, 729 Ceres Ave., Los Angeles, CA 90021) deserves a pat on the back for continuing to offer experimenters several fine looking sturdy equipment cabinets. In fact if you look closely you will probably see that the cabinet in these photos has been used by a dozen different manufacturers.

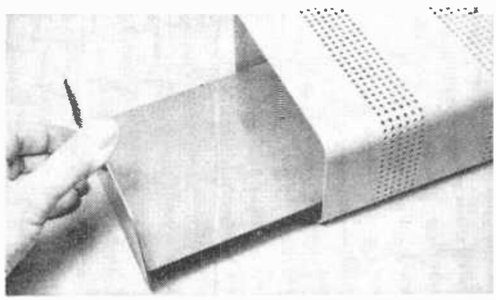
The cabinet pictured is only representative of a whole line—we suggest getting a catalog or seeing them for yourself at your local radio parts dealers.

Circle No. 90 on Reader Service Page 15 or 115



Popular LMB equipment cabinet model CO-3 measures (overall) 7¼" in length, 5½" in width, and 3⅛" in height. It sells for under $6.00. Releasing the four Phillips head screws in the mounting feet frees the interior chassis deck. Rear and front panels are welded to the chassis. The wraparound is very sturdy and painted shipboard Navy gray.





### SCREW-HOLDING SCREWDRIVERS (Kedman Company)

THREE ULTRA-MINIATURE and midget size "Quick-Wedge" screw-holding screwdrivers made by the Kedman Company (762 South Redwood Rd., Salt Lake City, UT 84110) recently underwent revision to make them more efficient. Without removing any strength from the screwdriver blades, the manufacturer has eliminated a surplus portion of the previously thick grind of the split blades of the Models 1253-B Ultra-Miniature and 1253-A and 1258-A Miniature size drivers.

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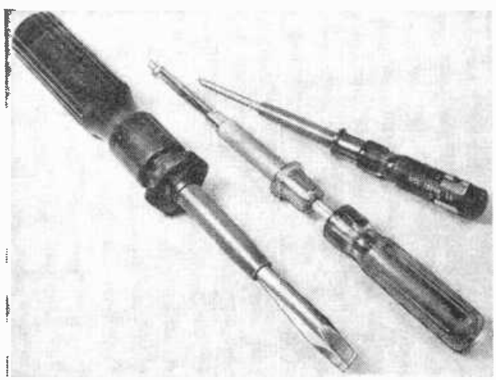


## SHARPENING HEATHKIT COLOR TV

The design of any television receiver involves hundreds of compromises—some to counteract possible wiring and misalignment errors, some just the product of subjective analysis.

In the recent Heathkit color TV receivers (Models GR-25, GR-180, GR-227, GR-295, GR-481, GR-581, and GR-681) certain elements were selected that insured uniform picture quality at a very modest sacrifice of vertical resolution.

Continuing experiments by the Heath Company engineers have shown that three component values can be changed in the video detector stage to improve picture sharpness. These changes are shown in the accompanying wiring diagram. The Heath Company is now making a modification kit available (free) to all color TV set owners—it is labelled the Model GRM-681-1.

We installed a kit in our model GR-681—it took about 15 minutes—and were duly impressed by the noticeable improvement in vertical test pattern resolution and general off-the-air picture sharpness. If you have a Heathkit color TV, we recommend getting one of the kits.

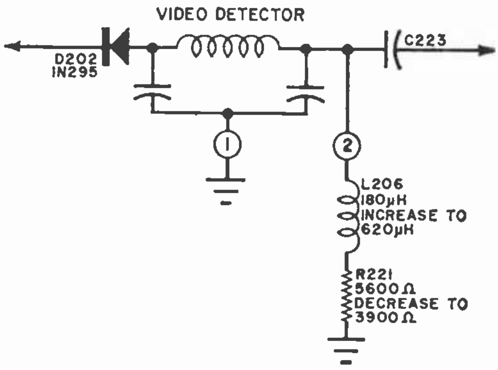
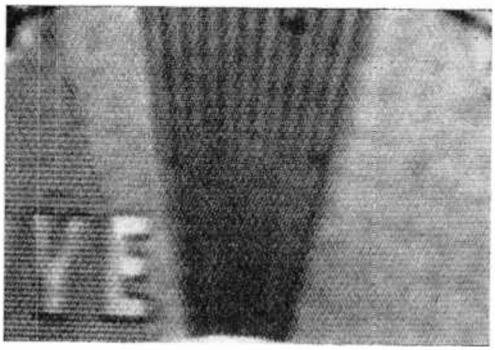
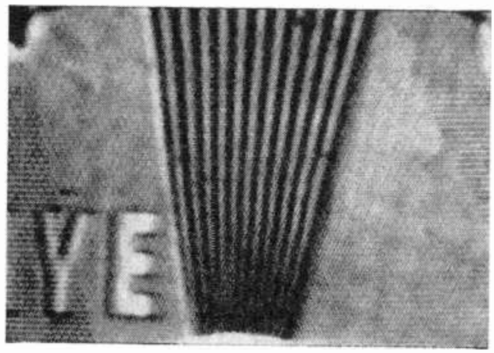



Diagram above shows parts in video detector that are modified to improve color picture resolution. Photos below illustrate improvement—at left is before installation of the kit; at right, after.





## HAM BAND RECEIVER (Allied Radio Co. A-2516)

At TODAY'S prices the radio amateur lacking a dual-conversion high-selectivity receiver is not "really with it". Of course, you can get something selling for around $750.00, or look at it more realistically and shoot for a receiver at about $190.00 complete ($169.95 for the receiver and $19.95 for a matching speaker). The Model A-2516 (Allied Radio Corp.) is a prime example of a fairly decent import—nicely constructed with smooth operation, lacking only the refinements you would expect to get when you pay top dollar.

We used a Model A-2516 for several weeks and found it to be reasonably stable on SSB (we would have preferred some sort of fine-tuning "clarifier" control); very selective with good modulation recovery on AM; very, very good on CW; easy to operate; and with a fairly high order of "resetability."

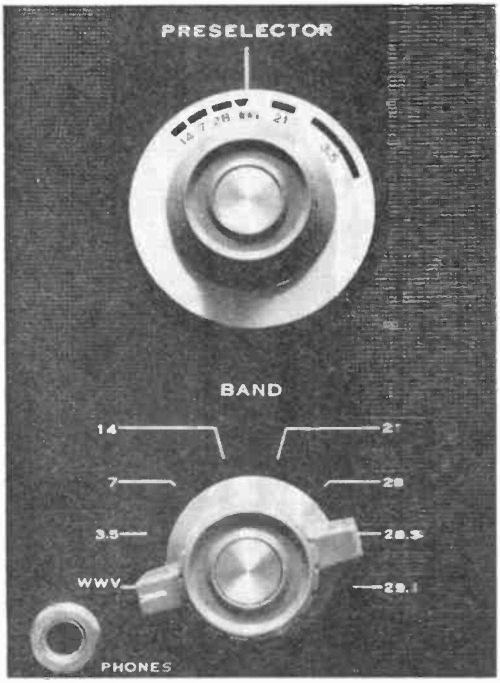
**Circuit.** The A-2515 is a 7-tube receiver with a crystal-controlled first mixer and transistorized tunable second mixer. There are 2 i.f. stages both using mechanical filters to give a selectivity curve that's about 3 kHz wide at the top and 10 to 12 kHz wide at 60 dB down. Sideband selection (upper or lower) is manual and is a little fussy to deal with. Receiver sensitivity appears to be excellent and we had no difficulty holding ON4BT, KZ5BR, etc. on 15 meter SSB over a period of several hours.

**Summary.** The A-2516 is a good receiver at a modest price. It's not the receiver for the avid DX'er, but it will prove worth every cent of its investment for the Novice and General class ham with a limited budget.

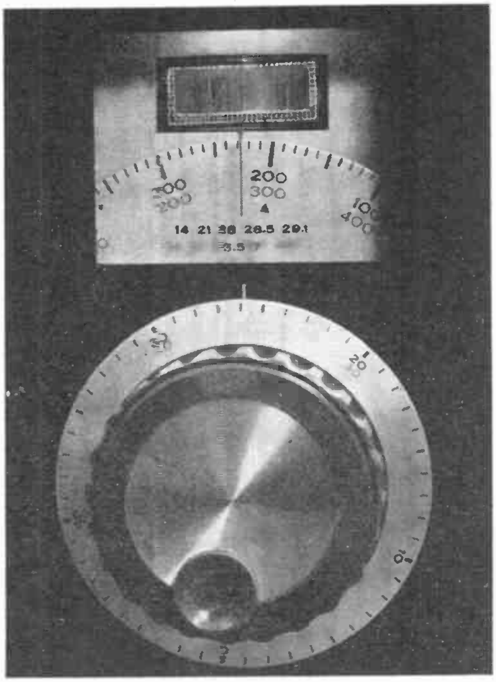
Circle No. 93 on Reader Service Page 15 or 115

Allied Radio model A-2516 is a Japanese import internationally marketed as the Trio JR-500SE. Due to its inherent stability and excellent selectivity, the receiver has won wide acclaim.

Each crystal-switched tuning range is 600 kHz—wide—including the mysterious WWV—permitting tuning outside the edges of ham bands. However, in the model tested, direct frequency readout varied from band to band and sometimes was 5 to 6 kHz out of calibration. The preselector is reasonably broad and requires only minor re-tuning.




Near direct-frequency readout of the A-2516 receiver is accomplished by adding switched crystal frequency to the reading on the rotating wheel (behind escutcheon) and the reading on the dial skirt. Thus frequency here is either XX.226 MHz or XX.244 depending on band The S-meter is poorly illuminated and far too small for easy viewing.



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*A sophisticate who can afford the finest in stereo components and equipment, would select the Pickering XV-15 Cartridge labeled 750E, 400E or 350. They're the proper ones to deliver "100% Music Power."*

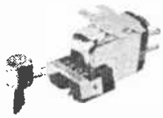
*With the more simple equipment that characterizes today's informal living, the XV-15 with a DCF of 150 or 200 will assure "100% Music Power."*

*A Pickering XV-15 Cartridge with a DCF of 100 or 140 will guarantee "100% Music Power" on the type of set up that the young in your house use for dancing or listening.*

The Dynamic Coupling Factor is an index of maximum stylus performance when the cartridge is related to a particular type of playback equipment. This resultant number is derived from a Dimensional Analysis of all the parameters involved. To select a pickup for a professional manual turntable, with its sophisticated, dynamically balanced tone arm, tracking at an ultra-light force, a higher DCF index would be required than, say, for a pickup to be used in an ordinary record changer. For maximum distortion-free response, this index to application relationship properly determines maximum stylus performance in your playback equipment. 100% music power is assured at all frequencies — linear response from 10 to 20,000 Hz virtually a straight line — due to the extremely low mass of its moving magnetic system — 1/5 to 1/10 of ordinary pickups.

There are seven DCF rated XV—15 models. Each is equipped with the famous patented V-Guard "floating stylus" — the easily replaceable stylus assembly that protects the diamond and record while it plays. In addition each model includes the DUSTAMATIC™ brush that automatically cleans the record groove while it plays.

**PICKERING**



*For those who can [HEAR] the difference*

THE NEW PICKERING XV-15/750E. PREMIER MODEL OF THE XV-15 SERIES. TRACKS AT ½ TO 1 GRAM. DYNAMIC COUPLING FACTOR OF 750 FOR USE IN FINEST TONEARMS. $60.00. OTHER XV-115 CARTRIDGES FROM $29.95. PICKERING & CO., PLAINVIEW, L.I., N.Y.

**CIRCLE NO. 31 ON READER SERVICE PAGE**

# TWO WAY REACTIONS

BY G. H. REESE, KCN6990

## EXCLUSIVE CHANNEL 9

DESIGNATION of channel 9 of the Citizens Radio Service exclusively for emergency communications involving the immediate saving of life, protection of property, or assistance to motorists has been proposed by the Federal Communications Commission. This action is the result of years of effort on behalf of REACT National Headquarters, publishers and other interested Citizens Radio groups. The proposed ruling was announced late in October with favorable or adverse comments and replies to be filed through December 31, 1969. It is anticipated that the Commission will rule that channel 9 be reserved for emergency communications within the next few months. While designating channel 9 for emergency communications, the Commission plans to add one channel now reserved for intrastation communications (among units of same licensee only) to replace channel 9 in the interstation group. This would be either channel 8 or 15. The Commission will determine which of the two channels will be advanced to the interstation category (that is, for calling between licensees) on the basis of the comments received favoring either channel 8 or channel 15.

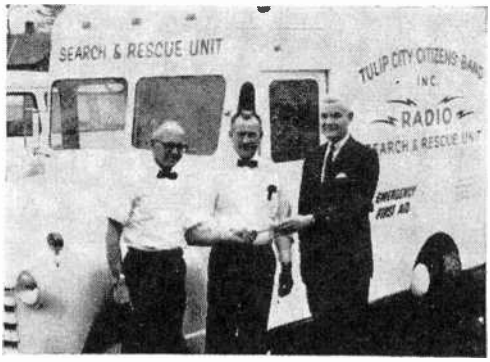
Reservation of channel 9 for emergency communications will mean that CB radio operators must restrict communications on channel 9 to actual emergencies. Any communication that does not fit this requirement should be shifted to some other channel. The absence of all non-emergency traffic will significantly increase the value of the Citizens Radio Service in emergency situations. It will remove the necessity of a caller having to "break" the communications of others to clear the channel for an emergency message.

The official designation of channel 9 will also provide a single channel for all who are interested in serving as emergency communication monitors with a single channel to monitor. In this way, many official agencies such as police, Civil Defense, Coast Guard, etc., will find it more desirable to monitor channel 9 as it will be free of extraneous communications.

**New Dawn for CB Radio!** A new era in CB radio will be forthcoming when the FCC makes channel 9 the official emergency channel. Traveling salesmen, transcontinental truckers, families on vacation, and sportsmen will consider CB a necessary accessory for their automobiles. Should they become stranded on a turnpike, confused by a cloverleaf, or uncertain about where to stay the night, a channel 9 monitor can provide the necessary information. This increase in the value of Citizens Two-Way Radio is recognition of the potential that is inherent in this radio service. It is a fact that there are more two-way radios in the CB category than all others combined. With an effective system of monitors across the country, and a clear channel for emergencies, it may be possible to realize the potentials that two-way radio offers in reducing traffic fatalities and mobilizing communications in case of disasters and emergencies of every kind. The essential ingredient is cooperation. All users of CB radio must cooperate to clear channel 9 for emergency communications. It would be a good idea to start this practice immediately and not wait for the official pronouncement by the FCC.

The Commission has indicated that the success of this program will require consid-

Yuma, Ariz. REACT has posted three of these large signs on highways surrounding the city. Such signs were cited by FCC in proposal to make channel 9 exclusively for use in emergency communications.




Oliver Yonker and Harold Pippel, of Tulip City (Holland, Mich.) search and rescue unit, with P. Barron, president of sponsoring insurance group.

erable self-policing activity. This means that a voluntary compliance with the emergency channel concept is essential to the success of the program. All CB radio users can benefit from this emergency channel ruling only if they divert their normal calling to other channels. Current CB radio users should regard the Commission's action as recognition of the good works they have performed in the past. They may take pride in this further recognition of the potential for the future.

The second essential element is the availability of trained and effective 24-hour monitors. This is the concept of REACT—to provide a voluntary system of 24-hour monitors for emergency communications. It stands to reason that those who are now using channel 9 for routine communications will find it more advantageous to comply with the emergency channel restrictions if they are aware of an effective monitor serving their area. Thus, we are embarking on a concentrated program to expand both the monitoring services of present REACT teams and the number of teams so that 100% coverage of the United States can be achieved. Never before has the opportunity for service through emergency communications groups using the Citizens Radio Service been so great. Never before has the *need* for an effective monitoring service such as REACT been greater! If you or your CB club is interested in learning how they can participate in this program, contact REACT National Headquarters at once. Write to: REACT National Headquarters, 205 West Wacker Drive, Chicago, Illinois 60606. We will send you complete information on how your group can become a REACT team. Organize now so that you will be ready when channel 9 becomes the official emergency channel.

**New Canadian Rules.** It has been learned that Canada's Department of Communications has instituted a new application form and intends to tighten up on present licensees. The Department points out the General Radio Service equipment may not be used for diversionary or recreational purposes. This would appear to mean that almost all GRS Club activities would be stopped. The DOC rules about collecting money are also being examined. They appear to be interpreted that any use of GRS equipment for any function which collects money from the public, for any reason, or pays any money to GRS operators for the use of their equipment and time is strictly illegal.

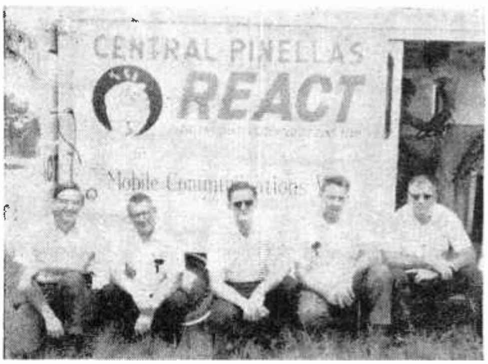
**Traffic Reports.** The FCC has recently carried through on a rule proposal to permit class D citizens radio station licensees to transmit information on highway conditions to "persons or emergency organizations furnishing such information to the motoring public by way of radio broadcast facilities." Thus road information furnished by a citizens radio station can be compiled and edited by the broadcaster and then announced over the air. The rule change was requested by National Capital REACT, Inc. Communications transmitted under the new rule are required to be addressed to specific persons or stations. The new rule became effective last Nov. 26.

### CURRENT EVENTS

**Asheville, N.C.** . . . The Tri-County REACT Team was recently awarded a Certificate of Merit by the American Cancer Society for aid during a recent fund drive. Chief Arnold B. Robinson reports, "We have had and do receive excellent cooperation from local CB operators in keeping channel 9 clear in emergencies and enjoy not only the respect of local law enforcement authorities, but our private citizens as well."

**Battle Creek, Mich.** . . . Cereal City Citizens Band Radio Club co-sponsored a post-Halloween program in their city with radio station WBCK. The CB'ers picked up candy left over from Halloween and distributed it to orphans.

(*Continued on page* 117)




Members of Central Pinnelas REACT (Clearwater, Fla.) Jack Sager, Dave Yarger, Doug Day, Tommy Thompson, and Don Williams with the team's van.

# AMATEUR RADIO

By HERB S. BRIER, W9EGQ
Amateur Radio Editor

## NEWS FROM AUSTRALIA

THE YEAR 1970 marks both the 200th anniversary of Captain Cook's discovery of Australia and the 60th anniversary of the founding of the Wireless Institute of Australia. In recognition of these events, the Australian government has authorized Australian amateurs to use the prefix *AX*, instead of *VK*, during 1970 if they wish.

Also, the WIA will issue the "Cook Bi-Centenary Award." free of charge, to amateurs who work 100 different AX stations during 1970 according to the following schedule: 3 AX1's, 30 AX2's, 30 AX3's, 11 AX4's, 11 AX5's. 6 AX6's, 4 AX7's, 1 AX8, 3 AX9's, 1 AXØ. Any overseas amateur who meets these requirements will really have earned his award. Applicants must list the stations worked by call area, date, time (GMT), band, mode, and signal report. The list must be accompanied by statements from two other licensed amateurs that they have seen the appropriate entries in the applicant's logbook. Mail to "Cook Award." Awards Manager, W.I.A., P. O. Box 67, East Melbourne, Australia 3002, before December 31, 1971.

Last July, a plane with five people aboard disappeared in the mountains near Ararat, Australia. VK3ZG and VK3ADS set out to the suspected crash area in VK3ADS's 2-way radio-equipped car. Keeping in contact with the Ararat police on 2-meter FM

AMATEUR STATION OF THE MONTH


From 1957 to 1961, Rafael M. Estevez. P.O. Box 2442, Hialeah, Fla. 33012, was CO2ZQ in Cuba. Coming to the United States cut short his amateur career until he became a citizen. He is now WA4ZZG and has worked 95 countries and 30 states. He uses a Heathkit SB-101 transceiver, SB-200 amplifier, tri-band Quad, and 80 and 40-meter dipoles. Rafael gets a 1-year subscription to POPULAR ELECTRONICS for winning this month's Amateur Station Photo Contest. You can enter the contest by sending a picture (preferably black and white) of yourself at the controls of your station with some details about your amateur career to: Amateur Contest, Herb S. Brier, Amateur Radio Editor, P.O. Box 678, Gary, Ind. 46401.


Ralph Cooper, ZL1AZN, Auckland, New Zealand, often works the United States on the 80-meter band.

via VK3AAQ, they quickly found the downed plane and two bodies. Leaving VK3ZG at the crash scene, VK3ADS returned to the nearest crossroads to lead the rescue crews to the scene. By the time they arrived, VK3ZG had located two more bodies and soon found the fifth one. VK3SE and VK3SQA monitored the entire operation to assist if needed.

**Keeping the Station Log.** Or what time is it? One problem facing amateurs is the time in which they should keep their station logs. Use local time, and you quickly learn that not every operator's time is your time. Furthermore, most sponsors of amateur contests and awards specify using Greenwich Mean Time (GMT).

One solution to the problem is to set a 24-hour, electric clock to Greenwich time and put it beside the regular station clock. Keep your log according to the new clock and keep in step with the home folks on the old one.

To help you set the new clock, Eastern Standard Time is five hours behind GMT, Central Standard Time is six hours behind, Mountain Standard Time, seven hours, and Pacific Standard Time, eight hours. Thus, if you live in the Central Time Zone, and a local broadcast or TV station announces the time as, say, 10:00 a.m., simply set your GMT clock to 1600. It will then be in step with every other GMT clock in the world.

**F.C.C. and Allied News.** The Federal Communications Commission recently introduced a new simplified form 610 amateur radio license application blank. The new form—yellow in color—is simpler than the old form to fill out: In addition, it contains spaces for use by volunteer examiners of applicants for Novice, Technician, and other by-mail licenses. Thus it saves the volunteer examiner the necessity of writing a letter to the FCC setting forth his qualifications to act as a volunteer examiner.

The FCC is considering revising all radio license application fees in an attempt to recoup more of the costs of operating the agency. Nothing definite on this, yet. Also under consideration are a number of relatively minor petitions. W6ARM wants the 6-meter CW assignment moved from 50-50.1 MHz to 53.5-54 MHz. He also wants the Advanced/Extra class segment of the band reduced from 50-50.1 MHz to 50-50.05 MHz. (There undoubtedly will be some modification of the 6-meter Extra/Advanced assignment. At present, as a result of the FCC's decision not to extend the segment to 50.25 MHz on November 22, 50 to 50.1 MHz is usable only on CW by Advanced and Extra class licensees.)

While not strictly an amateur matter, as a result of a petition by George Nims Raybin, WA2GWB/KBI0854, the FCC proposes to make CB Channel 9 an exclusive emergency channel. WA2GWB has also requested that the FCC allow more time for filing comment on its proposals. He points out that by the time the average person learns about an FCC proposal in a radio magazine, the time for filing comment on it has usually passed.

**Contests.** The American Radio Relay League's 18th Annual "Novice Roundup" is scheduled between 0001 GMT, February 7, and 2359 GMT, February 22. Novices work all comers; others work only Novices. Operate up to 40 hours and earn one point for each complete exchange of serial numbers, signal reports, and respective ARRL "section" names with each station worked. Your total score equals your contest points, plus the highest code speed indicated on

(*Continued on page* 118)

Craig Smith, WB6ZXP, San Carlos, Calif., handles messages on 40 meters and also likes to ragchew.

# SHORT-WAVE LISTENING

By **HANK BENNETT**, W2PNA/WPE2FT
Short-Wave Editor

## EDDIE STARTZ — THE END OF AN ERA

LISTENERS to the always-popular "Happy Station Program" from Radio Nederland, Hilversum, are noting a new voice on the program. Our good friend and former Master of Ceremonies for the program, Eddie Startz, has retired.

Eddie Startz has taken a most well-deserved rest from the program that he originated 41 years ago. With the exception of the World War II years, the program has been broadcast continuously and has been heard and appreciated by listeners in virtually every country of the world. All of us will miss Eddie's voice, the barnyard animals, the "nice cuppa", and the "University of Light Learning", and we offer him a rousing vote of thanks for his untiring efforts through the years and wish him well in any future endeavor that he may undertake. With nearly a half century of broadcasting behind him, though, we are fully confident that Eddie will return to the air some day in the not too distant future, possibly from an entirely different location.

Eddie Startz, former MC of Radio Nederland's "Happy Station Program", is well-known to all SWL'ers.

As we prepare this story, we have not obtained the name of Eddie's replacement (the program, itself, is to be continued) but we feel certain our readers will offer the new Master of Ceremonies the cooperation that has been prevalent in the past.

For the present, Eddie, take a good rest; you have certainly earned it!

**Time and Standard Frequency Stations.** During the past few months we have received many reports of a new time station operating on 6100 kHz. From a source that we cannot precisely pinpoint we heard that the station was in Portugal and operated by the Naval Observatory of that country. It would seem now, however, that this information was incorrect. A letter from the Observatorio Naval Portugal, signed by Sr. Jose da Cruz Moura da Fonseca, informs us that extensive monitoring by their own staff has found the station to be Observatorio Naval de Cagical located in Venezuela. For the moment we have no further positive information but as soon as we do get definite data, we shall pass it along to our readers.

**National Bureau of Standards.** WWV is considering a change of format. All interested persons who wish to take part in a survey are asked to write directly to National Bureau of Standards, WWV-1969, Boulder, Colorado 80302, requesting a survey form to be filled out and returned to them.

### CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports were as accurate as possible, but stations change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to Short-Wave Listening, P. O. Box 333, Cherry Hill, N. J. 08034, in time to reach us by the fifth of each month; be sure to include your WPE identification and the make and model number of your receiver.

**Albania**—*R. Tirana* was noted on a new frequency of 11,844 kHz from 2130 in Portuguese.

**Angola**—Listed as tentative last month, this one is still uncertain; best information tends to indicate it as being *R. Clube do Moxico,* Luso, 5126 kHz, heard from as early as 2300 to 0100 s/off. The IS is one gong, programming is a variety of music and the language is Portuguese.

**Antilles, Netherlands**—*R. Nederland,* Bonaire, has been logged on 6020 kHz at 2300-0000 in Dutch beamed to the Caribbean areas with news, talk, light music, a documentary and music of India. This xmsn continues until 0030.

**Australia**—VLI6, Sydney, 6090 kHz, is heard well around 1100 in the Home Service with music, news, and regional weather. *R. Australia's* evening service to N.A. now s/on at 0100 on 15,195 and 21,640 kHz. The new Darwin relay on 9620 kHz is often noted from 1330 s/on to 1400 s/off with non-stop orchestra music.

**Austria**—*Osterreichischer Rundfunk,* Vienna, has this new schedule to the Americas: to N.A. at 2300-0400 on 6155 and 9770 kHz, to Central America at 0000-0200 on 15,145 kHz, and to South America at 2300-0000 on 9525 kHz, 0200-0400 on 11,875 kHz and 1800-2100 on 15,210 kHz. Numerous monitors report hearing the 9770-kHz xmsn with signal strengths ranging from "terrible" to "excellent."

**Bolivia**—*R. La Cruz del Sur,* La Paz, has moved from 4985 to 5025 kHz. This station celebrated its 25th anniversary recently. CP87, *R. San Rafael,* Cochabamba, 5055 kHz, has a s/off time of 0200 but it is often noted to 0230 with music, time checks and all Spanish. CP66, *R. Centenario,* Santa Cruz de la Sierra, is on 4850 kHz and is noted at 0200-0300 in Spanish but not without severe QRM at times from a teletype station.

**Brazil**—Two rarely heard stations that might prove a challenge to your ability include ZYA1, *Radiodifusora Roraima,* Boa Vista, 4835 kHz, best, when audible at all, around 0000 in Portuguese, and ZYD9, *R. Acreama,* Rio Branco, tentatively heard on 4882 kHz with music and talks to s/off at 0303.

**Burma**—Rangoon has been noted with fairly good signals in the U.S. Southwest around 1300 on both

## DX COUNTRY AWARDS PRESENTED

*To be eligible for one of the DX Countries Awards designed for WPE Monitor Certificate holders, you must have verified stations in 25, 50, 75, 100, 125, or 150 different countries. ("Letters of Certification" will be issued to those who have over 150 countries verified in steps of 10.) The following DX'ers recently received their awards.*

### 25 COUNTRIES VERIFIED

Tim Ohrman (WPE3HHA), Monroeville, Pa.
Michael Macken (WPE1GYR), Winthrop, Mass.
Richard Stevens (WPE2OVS), Rochester, N. Y.
Dottie Weatherby (WPE2QRF), Hornell, N. Y.
Michael Wheeler (WPE7CSY), Portland, Ore.
Chris Gabanski (WPE9JGN), Lake Forest, Ill.
Mike Mickes (WPE7CVF), Gooding, Idaho
Bruce Roberts (WPE4KAH), Waynesboro, Va.
William Murray, Jr. (WPE7CLX), Eugene, Ore.
Peter Rudolph (WPE6GOR), Sylmar, Calif.
Arthur Skopec (WPE2PQJ), Whitestone, N. Y.
John Petrykowski (WPE9JKP), Milwaukee, Wis.
Don Cassel (VE3PE2NT), Don Mills, Ont.
James Daley, Jr. (WPE4JVR), Atlanta, Ga.
Scott Moeller (WPE3HLS), Villanova, Pa.
Stephan Goldstein (WPE1HNM), Providence, R. I.
Robert Rothberg (WPE2QQO), Long Beach, N. Y.
Diana Loomis (WPE6HLT), Sherman Oaks, Cal.
Michael Gouthro, Jr. (WPE2QJC), Buffalo, N. Y.
Brian Begg (WPE2JPR), New Brunswick, N. J.
Jim Kehoe (WPE9IUQ), Chillicothe, Ill.
James Farrell (WPE2QIJ), Ridgefield Park, N. J.
Edward Tafel (WPE2QBG), Syracuse, N. Y.
Daniel Girard (WPE2QEY), Utica, N. Y.
Brian Caldwell (WPE1HPG), Glastonbury, Conn.
David Reichelt (WPE4JWU), Mary Esther, Fla.
Donald Williams (WPE7CVW), Salem, Ore.
Moiz Mutlu (WPE1HME), Worcester, Mass.
Doug Stark (VE3PE2OY), London, Ont.
Sherman Wing (WPE6HBJ), Hanford, Cal.
John Costa (WPE2QAR), Massapequa, N. Y.
William Coleman (WPE4JNW), Jacksonville, Fla.
Marvin Robbins (WPEØMW), Omaha, Nebr.
Benjamin Botvenek (WPE2QQX), New York, N. Y.
Harold Hollabaugh (WPE8AHX), Toledo, Ohio
David Wessel (VE5PE6S), Prince Albert, Sask.
Robert Olson (WPE4JZF), Winston-Salem, N. C.
David Gale (WPE2QHB), Brooklyn, N. Y.
Mark Maersch (WPE3HEK), Severna Park, Md.
Nelson Doane (WPEØEYB), St. Clair, Mo.
Ken Olson (WPE4KBU), Lenoir, N. C.
Michael Mlotkowski (WPE8KAV), Troy, Mich.
E. Gordon Collister (WPEØEZK), Lawrench, Kan.
Rick Heavey (WPE8JYR), Detroit, Mich.
Bill Thompson (VE3PE2BE), Windsor, Ont.
Jim Peltz (WPE6HDR), Riverside, Cal.
Charles Mohr, Jr. (WPE2MKI), White Plains, N. Y.

### 50 COUNTRIES VERIFIED

Arnold Rosett (WPE3HIF), Philadelphia, Pa.
Vincent Geraci (WPE1HMP), Shelton, Conn.
Alan Harris (WPE8JQY), Oak Park, Mich.
Mike Macken (WPE1GYR), Winthrop, Mass.
Ron Miller (WPE9HCG), Peoria, Ill.
William Murray, Jr. (WPE7CLX), Eugene, Ore.
Woodrow Ferris (WPE5DYG), Anadarko, Okla.
Tan Yew Chong (9V1PE1C), Raffles Park, Singapore
Greg Scoggan (WPE6HIU), Costa Mesa, Cal.
Mitchell Stern (WPE2QIA), Brooklyn, N. Y.
Bob Estand (WPE5FAV), El Paso, Texas
William Blue (WPE7CTW), Seattle, Wash.
Fred Lynch (WPE9JHD), Girard, Ill.
Donald Mahler (WPE1HOK), Newton, Mass.
Benny Loveless (WPE9JLQ), Frankfort, Ind.
Robert Rothberg (WPE2QQO), Long Beach, N. Y.
Frank Moczulewski (WPE9JAU), Chicago, Ill.
Francis Wheeler (WPE6HLK), Sacramento, Cal.
Walter Miscichowski (WPE2BEH), Buffalo, N. Y.

### 75 COUNTRIES VERIFIED

Richard Shawyer (WPE6CFL), San Francisco, Cal.
Bill Migley (WPE8JEL), Lancaster, Ohio
David Conder (WPE9IHV), Centralia, Ill.
Vincent Geraci (WPE1HMP), Shelton, Conn.
Jack Bacon, Jr. (WPEØFDJ), Bloomington, Minn.
Gajendra Pal Singh (VU2PE1G), Meerut, India
Ann Parker (WPE9JJC), Chicago, Ill.
Craig Koukol (WPE9JLN), Naperville, Ill.
Mark Koukol (WPE9JKV), Naperville, Ill.

### 100 COUNTRIES VERIFIED

Donald Gross (WPE7CQX), Roseburg, Ore.
Robert Combs (WPE2PJU), APO, New York
Don Billingsley (WPE6GXM), Sacramento, Cal.
Martin Tarnowsky (WPE2PZD), Montvale, N. J.
Paul Mayo (WPE2NSG), Brooklyn, N. Y.
Bill Kaiser (WPE8JLL), Paw Paw, Mich.
Jeff Wilson (VE3PE2NL), Sarnia, Ont.
Del Hirst (WPE5CFU), Snyder, Texas
Leo Baca (WPE5CLR), East Bernard, Texas
B. L. Manohar (VU2PE1D), Lucknow, India
J. R. Hawkins (WPE8GDP), La Vergne, Tenn.
Roger Camire (WPE1GEK), Hudson, N. H.
Bob Emery (WPE3HFZ), Allentown, Pa.
Thomas Creery (WPE2PHZ), Conklin, N. Y.

A private pilot and avid DX'er, Loren K. Davis, WPE6HMA, Hayward, Calif., has DX Awards for 20 zones, 30 states and 25 countries. He uses a Hallicrafters S-108 and Mosley all-wave trap dipole.

5040 and 4725 kHz but the programs are different.

**Ceylon**—The Commercial Service of *R. Ceylon*, Colombo, can be found on 15.120 kHz from 0130 s/on in English. Their IS is a dandy: wild animals roar and native drums beat. (Editor's note: this is a Midwest logging. Are East Coast monitors hearing it? We had no luck whatever with it).

**Colombia**—Further to the listings last month: *Emisora Atlantico*, Barranquilla, has definitely left the inactive category; it's being heard on 4905 kHz from 0220 to 0500 s/off. Also, the 5943 kHz listing for *Transmitte Horizonte, Emisora Colombia,* as the ID is now being given, has moved up to 5950 kHz and is often good from 0100. *Este Onda Del Meta* seems to have moved from 4885 kHz to 6115 kHz and is being heard at 0225. QRM is provided by *R. Union*, Peru. Some say that *Onda del Meta* has moved into *La Voz del Llano's;* however, the latter is definitely on 6117 kHz.

**Conakry**—*Radiodiffusion Nationale*, Conakry, is fair to good on 7125 kHz at 2206 with native, 2216 news in French, then native and instrumental music to 2250.

**Czechoslovakia**—Prague's new English schedule is: To Europe at 1200-1230 on 9560, 11,960 and 15,285 kHz, and at 1630-1700 and 1900-1930 on 5930 and 7345 kHz. To Africa at 1530-1630 on 6055, 9605, 11,990, 15,285, 17,840 and 21,735 kHz (also to Europe on 6055 kHz and to S. Asia on 11,990 and 21,735 kHz), and at 1730-1830 on 5930, 7345, 9605, 11,990 and 17,840 kHz. N.A. service in English is at 1400-1500 (Sunday only) on 15,445, 17,840 and 21,735 kHz, 0100-0200 and 0300-0400 on 5930, 7345, 9540, 9630 and 11,990 kHz. To Far East and Australia at 0700-0800 on 6055, 9505, 9575, 11,800, 15,310, 21,485 and 21,700 kHz (also to Europe on 6055 and 9505 kHz).

**Ecuador**—A new frequency for HCJB is 21,460 kHz, heard at 1245-1500 (Saturday and Sunday to 1615) with "Call of the Andes" and "Morning In The Mountains". It is also heard at 1815 in a Nordic language, 1830 in French, and 1845 in English. This channel is scheduled 1800-2145 to Europe. Other stations reported include *R. Progreso*, Loja, 3270 kHz at 0315, *R. Nacional Espejo*, Quito, 3295 kHz at 0355, and *La Voz Del Dorado*, Pelileo, 3265 kHz at 0400; music, talks, and all Spanish language.

**Egypt**—Cairo has English at 2200-2300 s/off with news to 2210, talks, and periods of music to 2300. This is on 9740 kHz. Another channel, 9475 kHz, is noted in English at 0200-0330.

**Ghana**—Accra has this English schedule in effect: To N.A. and Caribbean at 2000-2100 on 9760 and 11,850 kHz; to South Africa, Central Africa and Australia at 1445-1530 on 17,870 and 21,545 kHz; to West Africa at 1400-2215 on 6130 kHz; to Europe at 2045-2215 on 9545 and 15,285 kHz; and to East Africa at 1400-1430 on 17,870 kHz, 1445-1530 on 21,720 kHz, 1645-1730 and 1815-1900 on 15,285 kHz. Additionally, the National Service is often good on 4915 kHz from 2230 to 2300 s/off. (We are monitoring the 4915 kHz channel while typing this column; the signal is great!)

**Greenland**—A very tentative logging is that of Godthaab, 3999 kHz, at 0005-0017 with a girl announcer, pop and light music and in an unknown language. This was logged in the Midwest at a location just ahead of a cold weather front.

**Holland**—*R. Nederland* has this current English schedule in effect to N.A.: (L-100—kW xmtr at Hilversum, Holland; B-300—kW xmtr at Bonaire, Netherland Antilles) Tuesday and Friday only at 1525-1545 on 21,570 (L) and 17,810 (L) kHz, 1725-1745 on 17,810 (B) kHz, and 1755-1815 on 17,730 (B) kHz. Monday through Saturday at 2125-2250 on 11,730 (L) and 9715 (L) kHz. Daily at 0155-0320 on 11,730 (B) kHz and 0455-0620 on 11,730 (B) and 9715 (B) kHz.

**India**—For those DX'ers who can tune beyond the signals provided by American 50-kW xmtrs on medium-wave 1130 kHz. *All India Radio*, Calcutta, has a 1000-kW station on this frequency.

**International Waters**—The Abie Nathan project, called *The Voice of Peace*, apparently is not on the air as indicated in this column last month. Late information reveals that the ship headed for the U.S. and was last reported docked at 59th Street and the East River in New York City for the purpose of raising funds and obtaining donated equipment including two 500-watt xmtrs.

**Iran**—A recent schedule from *R. Iran* included listings for some low-power regional stations. They are *R. Rezaieh*, 6940 kHz, 500 watts, *R. Sanandaj*, 5818 kHz, 400 watts, and *R. Gorgan*, 6520 kHz, 400 watts. Listed operating times are generally from 0245 to 1730. Has anyone logged any of them?

*(Continued on page 116)*

Tom Phillips, WPE1HQE, Rutland, Vt., uses a Heath GR-64 (with a Bradford tape recorder on top of it) and a Sears 2278 portable. He has DX Awards for 10 zones, 20 states and 25 countries verified.

# SOLID STATE

By LOU GARNER, Semiconductor Editor

## CASSETTES ENTER VIDEO SCENE

THE BIG THING in recording today is cassettes. Just about every manufacturer of audio equipment is going this way, while recording companies are also getting on the bandwagon.

With this great interest in cassettes, it didn't come as a great surprise when Sony recently introduced their Videoplayer and Videocassette system, which they hope will put home video tape playing in the same living room as conventional high-fidelity sound systems.

The Videocassette, measuring 8″ × 5″ × 1¼″ is a similar-looking but somewhat larger version of the conventional plastic audio cassette, and carries up to 90 minutes of monochrome or color video and two sound tracks on its ¾″-wide magnetic tape. It fits into a slot in the solid-state Videoplayer which in turn is 15″ × 16″ × 8″ and weighs 32 pounds. The player is connected to the TV set via the antenna terminals, and the outdoor antenna is connected to the player. An internal relay automatically switches the external antenna to the TV set when the cassette is removed from the player. Both the Videoplayer and TV set have to be tuned to an unused local TV channel to operate without interference.

Electronically the Videoplayer is a two-head helical video playback system, similar in operation to other video machines. Tape speed is 3¼ in./s while head to tape speed is about 400 in./s. Color resolution is 250 lines; monochrome, 300 lines. Audio frequency response is to 12 kHz.

Although the system was demonstrated in this country, it is not expected to make its commercial debut until 1971. The cost of the Videoplayer is estimated at about $350, while each Videocassette will run about $20 unrecorded. After a tape library has been built up by Sony, customers can send their tapes to their local Sony dealer, with their program selection. The tapes will be recorded at a modest cost. Each tape can be played several hundred times before resolution suffers; and of course, tapes may be erased and new programs recorded.

Sony also hopes to market a video converter that will enable owners of the Videoplayer to record what they like directly off

In new Sony system video tape cassette fits into Videoplayer which is connected to TV antenna. Due to be available in '71, Videocassette can be erased and new programs recorded at will.

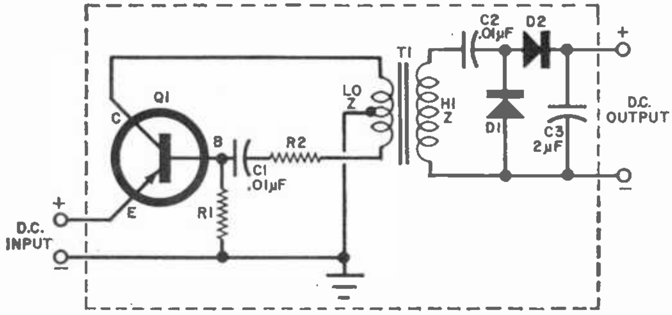



Fig. 1. A d.c./d.c. converter can be modified to provide a variety of output voltages for various low-current and high-voltage supply applications.

the air, and are also giving consideration to a miniature closed-circuit camera for recording "home tapes".

**Reader's Circuit.** Sometimes called a d.c. transformer, the d.c./d.c. converter circuit illustrated in Fig. 1 was developed using "junk-box" parts, according to its contributor, David Sharp, WA9RRJ (14715 Magnolia Blvd., Apt. #4, Sherman Oaks, California 91403). With minor modifications to meet individual requirements, the basic design can be used as a low-current, high-voltage power supply in small oscilloscopes, neon lamp displays, electric fences, Geiger counters, and similar projects.

Referring to the schematic diagram, *Q1* is used as a power oscillator in a modified Hartley circuit, with *T1*'s tapped primary providing the feedback needed to start and maintain oscillation. Voltage divider *R1-R2* determines the optimum feedback signal level, while *C1* serves as a simple d.c. blocking capacitor. Resistor *R1* also establishes *Q1*'s base bias.

The a.c. voltage developed by the oscillator is stepped up by *T1*'s transformer action and changed to d.c. by a conventional voltage-doubler network made up of series capacitor *C2,* rectifier diodes *D1* and *D2,* and filter capacitor *C3.*

Having used surplus "junk-box" parts in assembling his model, Dave did not specify component type numbers on the project. Instead he suggests that the individual builder use available components, adjusting circuit values experimentally as needed to obtain optimum performance. Transistor *Q1* is a general-purpose, medium-power *pnp* type. Transformer *T1* has a small iron core with both high impedance and tapped low-impedance windings. Typically, a small power transformer or "universal" tube-type audio output transformer could be used here. Rectifiers *D1* and *D2* are high-voltage diodes.

With relatively high voltages developed in the output circuit, *D1, D2, C2* and *C3* should have appropriate ratings. The diodes should have a PIV rating at least twice *T1*'s output voltage while *C2* and *C3* can be 3000-volt units, although the minimum ratings needed will depend on the d.c. supply voltage and *T1*'s step-up ratio.

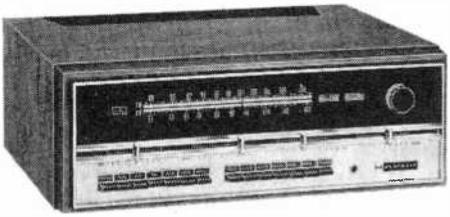
The resistor values (*R1* and *R2*) are determined experimentally. Breadboard the circuit and use 500k rheostats for *R1* and *R2,* preset for maximum resistance. A light resistive load of from 4.7 to 10 megohms (1 watt) should be connected across the circuit's d.c. output terminals for stability. With a suitable d.c. source connected (from 1.5 to 18 volts, depending on the supply to be used in the final model), adjust the rheostats to *lower* values until the circuit oscillates. In some cases, oscillation can be detected by a "whine" or hum from the transformer, but a scope, signal tracer, or similar test instrument may be used to check operation. Afterwards, disconnect the power source and measure the rheostat values, substituting appropriate fixed half-watt resistors for these units. After a second check for operation, the circuit can be reassembled in its final form.

Neither final layout nor lead dress are critical and, therefore, any construction technique may be used. The power transistor should be heat-sinked if it became warm during breadboard tests; and, of course adequate insulation and component spacing should be used in the high-voltage output circuit to avoid arcing.

**Manufacturer's Circuit.** One of over a half-dozen designs featuring photocell applications, the automatic barrier lamp circuit shown in Fig. 2 was abstracted from the *Application Notes* published by Clairex Electronics, Inc. (1239 Broadway, New York, N. Y. 10001). In operation, the lamp (*I1*) goes on at dusk, off at dawn, with the daylight current drain less than one percent of the night drain. The basic circuit can be used in a variety of useful projects—in an automatic signal light for a driveway or boat dock, for example, or even for a "night light" on camping trips.

Referring to Fig. 2, *Q1* and *Q2* form a complementary direct-coupled amplifier.

# 5 New Better-Value Kits From Heath

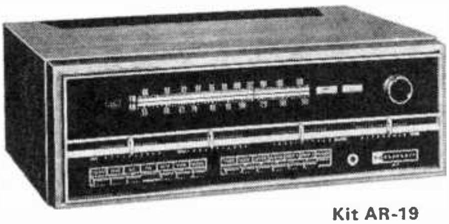


Kit AR-29
$285.00*

## New Heathkit 100-Watt AM/FM/FM-Stereo Receiver

World's finest medium power stereo receiver . . . designed in the tradition of the famous Heathkit AR-15. All Solid-State . . . 65 transistors, 42 diodes plus 4 integrated circuits containing another 56 transistors and 24 diodes. 100 watts music power output at 8 ohms — 7 to 60,000 Hz response. Less than 0.25% distortion at full output. Direct coupled outputs protected by dissipation-limiting circuitry. Massive power supply. Four individually heat sinked output transistors. Linear motion bass, treble, balance and volume controls. Push-button selected inputs. Outputs for 2 separate stereo speaker systems. Center speaker capability. Stereo headphone jack. Assembled, aligned FET FM tuner has 1.8 uV sensitivity. Two tuning meters. Computer designed 9-pole L-C filter plus 3 IC's in IF gives ideally shaped bandpass with greater than 70 dB selectivity and eliminates alignment. IC multiplex section. Three FET's in AM tuner. AM rod antenna swivels for best pickup. Kit Exclusive: Modular Plug-In Circuit Boards . . . easy to build & service. Kit Exclusive: Built-In Test Circuitry lets you assemble, test and service your AR-29 without external test equipment. The AR-29 will please even the most discriminating stereo listener.

**Kit AR-29,** (less cabinet), 33 lbs....................................**$285.00***
**AE-19,** Assembled oiled pecan cabinet, 10 lbs......................**$19.95***



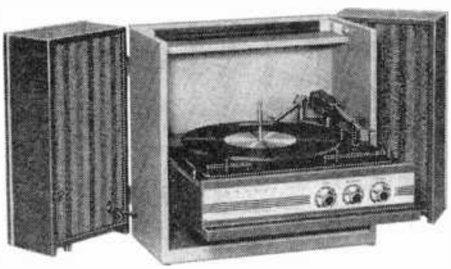
Kit AR-19
$225.00*

## New Heathkit 60-Watt AM/FM/FM Stereo Receiver

The AR-19 circuitry reflects many of the advanced concepts of the AR-29. It uses 108 transistors and 45 diodes including those in 5 integrated circuits. It delivers 60 watts music power at 8 ohms. At any power level, Harmonic and IM Distortion is less than 0.25%. Frequency response ranges from 6 to 35,000 Hz. Direct coupled outputs are protected by dissipation-limiting circuitry. A massive power supply includes a section of electronically regulated power. The assembled, aligned FET FM tuner has 2.0 uV sensitivity.

A preassembled and factory aligned FM IF circuit board gives 35 dB selectivity. The multiplex IC circuit provides inherent SCA rejection. It features two switched noise muting circuits; linear motion controls for bass, treble, volume and balance; input level controls; outputs for 2 separate stereo speaker systems; center speaker capability; two tuning meters; stereo indicator light; front panel stereo headphone jack. The Modular Plug-in Circuit Board design speeds assembly. Built-in Test Circuitry aids assembly, simplifies servicing. "Black Magic" panel lighting, black lower panel, chrome accents. Compare it with any model in its price range . . . the AR-19 will prove itself the better buy.

**Kit AR-19,** (less cabinet), 29 lbs....................................**$225.00***
**Assembled AE-19,** cabinet, 10 lbs....................................**$19.95***



Kit GD-109
$74.95*

## New Heathkit Deluxe 18-Watt Solid-State Stereo Phono

Looks and sounds like it should cost much more. Here's why: 16-transistor, 8-diode circuit delivers 9 watts music power per channel to each 4½" high-compliance speaker. Speaker cabinets swing out or lift off . . . can be placed up to 10' apart for better stereo. Has Maestro's best automatic, 4-speed changer — 16, 33-1/3, 45 & 78 rpm. It plays 6 records, shuts off automatically. Ceramic stereo cartridge with diamond/sapphire stylus. Has volume, balance & tone controls. Changer, cabinet & speaker enclosures come factory built . . . you build just one circuit board . . . one evening project. Wood cabinet has yellow-gold & brown durable plastic coated covering. This is a portable stereo you can take pride in.

**Kit GD-109,** 38 lbs....................................................**$74.95***

Kit MI-29
$84.95*

## New Heathkit Solid-State Portable Fish-Spotter

Costs half as much as comparable performers. Probes to 200 ft. Spots individual fish and schools . . . can also be used as depth sounder. Manual explains typical dial readings. Transducer mounts anywhere on suction cup bracket. Adjustable Sensitivity Control. Exclusive Heath Noise-Reject Control stops motor ignition noise. Runs for 80 hrs. on two 6 VDC lantern batteries (not included). Stop guessing — fish electronically.

**Kit MI-29,** 9 lbs...............................................**$84.95***

Kit MI-19
$69.95*

## New Heathkit Solid-State Depth Sounders

Let its flashing indicator light guide you through strange waters . . . day or night. Sounds to 200 ft. Has Noise Rejection and Sensitivity controls. Operates from your 12 VDC boat battery. Sun-shielded dial. All solid-state.

**Kit MI-19-1,** (with thru-hull transducer), 7 lbs..............**$69.95***
**Kit MI-19-2,** (with high speed transom mount), 7 lbs.......**$69.95***

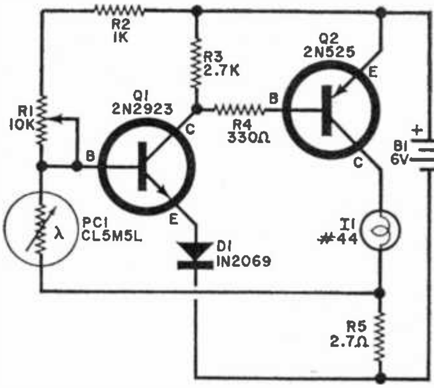



Fig. 2. Photocell circuit is used to turn a lamp on at dusk, off at dawn with low current drain.

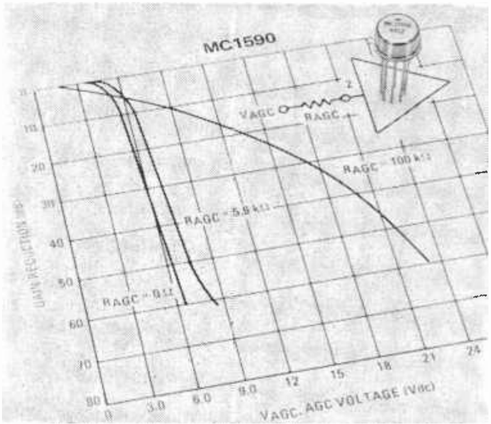
Base bias of *Q1* is established by a voltage-divider made up of sensitivity control *R1*, current limiting resistor *R2*, and photoconductive cell *PC1*. Transistor *Q1*, in turn, acts to control *Q2*'s collector load. The photocell, *PC1*, has a relatively low resistance when illuminated, a high resistance when dark.

During daylight hours, *PC1*'s low resistance effectively shorts *Q1*'s bias, holding this device in a high resistance state and preventing the application of base bias to *Q2*. Neither *Q1* nor *Q2* can conduct and the lamp remains dark. When dusk arrives, *PC1*'s resistance increases, permitting the application of base bias to *Q1* through *R1* and *R2*. As *Q1* shifts to a conducting state, base bias is applied to *Q2*, permitting a flow of collector current and lighting *I1*. The situation reverses, going back to the initial conditions, when *PC1* is once again illuminated.

With neither parts placement nor wiring arrangement critical, the project can be assembled using any method of construction. Naturally, the completed circuit should be housed in a weatherproof cabinet or case if the unit is used outdoors. Once the wiring is completed, all connections should be double-checked for errors *before B1* is connected. Sensitivity control *R1* is adjusted for optimum performance after installation in the selected location.

**New Devices.** A new monolithic IC recently introduced by Motorola Semiconductor Products, Inc. (P.O. Box 20912, Phoenix, Arizona 85036) is useful as a general purpose amplifier from d.c. to 150 MHz and has an a.g.c. capability of 60 dB minimum from d.c. to 60 MHz. Identified as Type MC 1590, the new unit can supply a typical gain of 45 dB at 60 MHz. The device's wide-range a.g.c. permits its use in audio circuits as a speech compressor as well as in the more familiar r.f. amplifier applications. Packaged in an 8-lead TO-99 case, the MC 1590 requires a single-polarity power source in the 6- to 15-volt range.

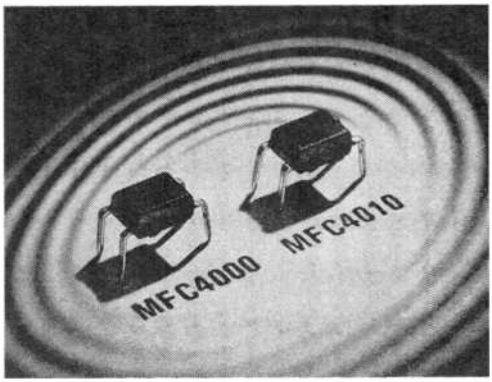
Motorola also has announced a new line of integrated circuit "gain packages" designed specifically for consumer products. Coded MFC, these plastic-packaged monolithic devices use smaller chips and contain fewer circuit elements than standard IC's and, therefore, are less expensive than




Monolithic IC type MC1590 can supply a gain of 45 dB at 60 MHz. Has wide-range a.g.c. for audio.

the more elaborate units. In addition, they are offered in special 4-lead packages with wide pin spacing to accommodate the printed circuit board layouts used by large-volume manufacturers.

The first two devices in the new line are Types MFC4000 and MFC4010. The MFC-4000 is a low-power audio amplifier containing six transistors, three diodes and five resistors. Designed for use with a 9-volt power supply, it can furnish up to 250 mW and has a low harmonic distortion of only 0.7% at 50 mW output.




New line of integrated circuits for consumer products includes an audio and a wide-band amplifier.

A wide-band amplifier, the Type MFC-4010 has high gain (60 dB min.) and is intended for general-purpose applications. It contains three transistors and five resistors and, typically, can be used as a 455-kHz AM i.f. amplifier, as a driver for the MFC-4000, or as a gain-block in microphone amplifiers or tape recorders.

If microwaves are your bag, then there's good news tonight. Firms on both the East and West Coasts have announced several new high performance—and high priced—devices.

First, TRW Semiconductors, Inc. (14520 Aviation Blvd., Lawndale, California 90260) has introduced two new 1-GHz transistors—the 3-watt type 2N5764 and the 5-watt type 2N5765. Designed to withstand severe mismatch under various load or phase conditions, both units are assembled in ultra-ceramic stripline packages, and are intended for operation from a 28-volt source.

The Microwave Semiconductor Corp. (100 School House Road, Somerset, N. J. 08873) has three new 2-GHz devices—the 1-watt type MSC 2001, 2.5-watt MSC 2003 and 5-watt type MSC 2005. Assembled in MSC's exclusive *Stripac* packages, all three are epitaxial *npn* units with 50-volt maximum ratings. Each can supply 7-dB gain in amplifier applications.

(*Continued on page* 113)

# ENGLISH LANGUAGE NEWS BROADCASTS FOR THE MONTH OF FEBRUARY

**Prepared by ROGER LEGGE**

### TO EASTERN AND CENTRAL NORTH AMERICA

| TIME-EST | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|
| 7:00 a.m. | Peking, China | 11.685, 15.095 |
| 7:15 a.m. | Montreal, Canada | 9.625, 11.72 |
| 7:30 a.m. | Melbourne, Australia | 9.58, 11.71 |
| 7:45 a.m. | Copenhagen, Denmark | 15.165 |
| 12 Noon | London, England | 21.61 |
| 4:30 p.m. | Hilversum, Holland | 11.73, 15.425 |
| 6:00 p.m. | Montreal, Canada | 9.625, 11.945, 15.19 |
| 6:45 p.m. | Tokyo, Japan | 15.445, 17.825 |
| 7:00 p.m. | London, England | 6.11, 9.58, 11.78 |
| | Moscow, USSR | 7.15, 9.655, 9.685 |
| | Sofia, Bulgaria | 9.70 |
| | Tirana, Albania | 7.30, 9.78 |
| 7:30 p.m. | Johannesburg, So. Africa | 9.705, 11.875, 15.22 |
| | Stockholm, Sweden | 5.99 |
| 7:50 p.m. | Brussels, Belgium | 6.125 |
| | Vatican City | 6.145, 9.615, 11.725 |
| 800 p.m. | Berlin, Germany | 5.955,9.73 |
| | Budapest, Hungary | 6.234, 9.833 |
| | Havana, Cuba | 9.525 |
| | Madrid, Spain | 6.14, 9.76 |
| | Peking, China | 15.06, 17.715 |
| | Prague, Czechoslovakia | 5.93, 7.345, 9.54, 9.63 |
| | Rome, Italy | 6.01, 9.575 |
| 8:30 p.m. | Berne, Switzerland | 6.12, 9.535, 11.715 |
| | Cologne, Germany | 6.075, 9.735 |
| | Melbourne, Australia | 15.17, 17.775 |
| 9:00 p.m. | Hilversum, Holland (via Bonaire) | 11.73 |
| | Lisbon, Portugal | 6.025, 9.68, 11.935 |
| | London, England | 6.11, 9.51, 9.58 |
| | Moscow, USSR | 7.15, 9.685, 9.70 |

### TO WESTERN NORTH AMERICA

| TIME-PST | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|
| 7:00 a.m. | Tokyo, Japan | 9.505 |
| 8:00 a.m. | Stockholm, Sweden | 15.315 |
| 5:30 p.m. | Melbourne, Australia | 15.17, 17.775, 21.74 |
| | Tokyo, Japan | 15.235, 17.825, 21.64 |
| 6:30 p.m. | Johannesburg, South Africa | 9.715, 11.875, 15.22 |
| 7:00 p.m. | Madrid, Spain | 6.14, 9.76 |
| | Peking, China | 15.095, 17.673, 21.735 |
| | Prague, Czechoslovakia | 5.93, 7.345, 9.54, 9.63 |
| | Seoul, Korea | 15.43 |
| | Tokyo, Japan | 15.105 |
| 7:30 p.m. | Berlin, Germany | 5.955, 6.08 |
| | Stockholm, Sweden | 5.99 |
| | Tirana, Albania | 6.20, 7.30 |
| 8:00 p.m. | Budapest, Hungary | 6.234, 9.833 |
| | Havana, Cuba | 9.525, 11.76 |
| | Lisbon, Portugal | 6.025, 9.68, 11.935 |
| | London, England | 6.11, 9.51, 9.58 |
| | Moscow, USSR (via Khabarovsk) | 11.85, 15.18, 17.88 |
| | Sofia, Bulgaria | 9.70 |
| 8:30 p.m. | Kiev, USSR (Mon., Thu., Sat.) | 7.15, 9.685 |
| 8:45 p.m. | Berne, Switzerland | 6.12, 9.72 |
| | Cologne, Germany | 6.145, 9.545 |
| 9:00 p.m. | Havana, Cuba | 11.76 |
| | Hilversum, Holland (via Bonaire) | 9.715, 11.73 |
| 10:00 p.m. | Moscow, USSR (via Khabarovsk) | 9.735, 11.85, 15.18 |
| | Tokyo, Japan | 9.505 |
| 10:30 p.m. | Havana, Cuba | 11.93 |

## OMNI-EIGHT

(*Continued from page* 73)

economize by cutting a 1′-wide strip from one end of a square yard of cloth. Use this strip in a vertical position and wrap the 2′ × 3′ remaining strip around the enclosure. However you plan it, measure the distance around the enclosure before you buy the cloth or order an extra few inches to allow for mistakes

Fasten the cloth at one corner with tacks or staples. Stretch the cloth across each side, and add a few tacks or staples at each corner to hold it taut. The vertical wood strips will cover the corner staples.

The exact lengths of the top and bottom trim pieces will depend on the thickness of the grille cloth so they must be cut to fit. These pieces of trim can be made either from solid wood or plywood with veneer-covered edges. Use small finishing nails to attach them to the top and bottom of the enclosure.

Finally, cut outside corner molding to fit tightly between the top and bottom trim. Stain and finish this molding to match the other wood before attaching the pieces. (Other surfaces can be stained and finished in place.) When they are dry, attach the corner molding with small brads (see Fig. 7).

This completes the construction of your Omni-Eight. Connect the leads from your amplifier and give it a listening test. You may find that a change in position of the Omni-Eight in your listening room requires a different tweeter control setting. —30—

## SOLID STATE

(*Continued from page* 111)

Pretty tricky is General Electric's (Electronics Park, Syracuse, N. Y. 13201) new ST3 Trigger for Triacs (almost rhymes). Actually a "kit" of two plastic encapsulated devices, the ST3 includes a zener diode in series with a silicon bilateral switch. This dual-unit arrangement provides a higher switching voltage in one polarity to offset the effect of capacitor discharge during previous half cycles.

**Hail Britannia.** British technical manufacturers are making a determined effort to penetrate the lucrative American industrial market. A number of British firms exhibited their products at WESCON in San Francisco last August, others were at the *ISA* Conference and Exhibition in Houston during October, and still others presented their products at the National Electronics Conference and Exhibition in Chicago in December. The items offered spanned the entire range from components to test equipment and from consumer products to production machinery. Naturally, semiconductor devices and a variety of solid-state equipment were included in the exhibits.

A light switch developed by Teknis Ltd. combines a silicon planar photo-diode, an IC amplifier and a trigger unit on a single substrate, encapsulated in a standard TO-18 case with a glass window. Identified as Type IPL 11, the device can supply load currents of up to 4 mA—enough to operate a small relay or drive a medium-power transistor. The firm's U.S. agent is Teknis, Inc., Plainville, Mass. 02672.

An audio oscillator, Model Si453, developed by J. E. Sugden & Co., Ltd. (Bradford Road, Cleckheaton, Yorkshire, England) can supply both sine and square wave signals from 13 Hz to 30 kHz. Its operating range is covered in six overlapping bands to minimize dial "cramping." One unique feature is an output which simulates that of a typical high-quality phono cartridge with a sensitivity of 2 mV/cm/sec and conforms to the RIAA fine-groove recording standard. This feature permits the equalization response of a phono input to be checked quickly and easily without using special auxiliary equipment or making tedious calculations. Battery operated, the instrument measures 10′ × 5′ × 8′.

**Transitips.** Perhaps the most difficult task an experimenter or hobbyist can undertake is the disassembly of an etched circuit board in an attempt to salvage components. Repeated applications of a hot soldering iron can ruin most semiconductor devices, yet, in many cases, there may seem to be no alternative to this technique.

There are, of course, a number of excellent commercial de-soldering tools available through both mail order houses and local distributors. Most of these work reasonably well, but a good selection can be somewhat expensive. However, if your budget can stand the gaff, fine!

On the other hand, your columnist has developed several personal techniques which require a minimum of equipment and which work in most cases. You might want to try these—

First, if the solder on the board is in large gobs, try holding the board *above* the soldering iron, so that the melted solder naturally flows down to the iron's tip. A clean, well-tinned iron is essential here.

Second, obtain an inexpensive wire brush of the type furnished with some brands of rough finished shoes. These are available at most hardware and some shoe stores. Try *brushing* the melted solder off the board. But work as quickly as you can.

Third, if a particular connection is hard-to-reach, try *blowing* the solder away. You can use a small blow-pipe of the type found in school laboratories, or even an eye-dropper tip attached to a short length of rubber hose. A rubber-bulb ear syringe works in some cases.

Fourth, don't try to remove *every last bit* of solder. Once a component lead is exposed, you may be able to work it loose with a short-pointed scribe, ice pick or soldering-aid. Remember that solder is not very strong mechanically.

Finally, don't work too long at one spot. Shift around and allow time for the component leads to cool a little. You may be able to remove a component a little faster, but a ruined transistor or diode is hardly worth the trouble. —*Lou.*

# POPULAR ELECTRONICS READER SERVICE PAGE

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| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |

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CITY________________STATE________ZIP CODE________

2 b

# SHORT-WAVE LISTENING


*(Continued from page 103)*


**Israel**—*Kol Israel,* Tel Aviv, was found on 9625 and 9009 kHz from 2015-2100 in English and to 2130 in French; this was beamed to Europe and England.

**Kuwait**—*R. Kuwait* is fair to good on 15.345 kHz

## SHORT-WAVE CONTRIBUTORS

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Marcus Berman *(WPE2QXO)*, Montclair, N. J.
David Gold *(WPE3HKY)*, Philadelphia, Pa.
John Black *(WPE3HRO)*, Baltimore, Md.
Jim Moon *(WPE3HWG)*, Havertown, Pa.
Gary Blau *(WPE3HWV)*, Rockville, Md.
Gary Goltz *(WPE3HZF)*, Pittsburgh, Pa.
Bart Sanders *(WPE3HZJ)*, Pittsburgh, Pa.
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Ken Olson *(WPE4KBU)*, Lenoir, N. C.
Woody Woodruff *(WPE4KJO)*, Lexington, N. C.
Richard Fortson *(WPE5EWX)*, Edinburg, Texas
Richard Murphy *(WPE5EZR)*, El Paso, Texas
David Larson *(WPE5FED)*, Harlingen, Texas
Charles Bennett *(WPE5SW)*, Sumrall, Miss.
Stewart Mac Kenzie *(WPE6AA)*, Huntington Beach, Cal.
Peter Heindel *(WPE6GLR)*, Waukagan, Ill.
Jim Stiles *(WPE6HMZ)*, Hollywood, Cal.
Fred Schulz *(WPE6HNV)*, La Mesa, Cal.
Bill Hein *(WPE6HON)*, Woodland Hills, Cal.
Jim Weber *(WPE6HPO)*, Beaumont, Cal.
Christopher Tyle *(WPE7CUV)*, Portland, Ore.
Gary Hawkins *(WPE7CWG)*, Phoenix, Ariz.
Chuck Albertson *(WPE7CWI)*, Spokane, Wash.
Dave Williams *(WPE7CWW)*, Astoria, Ore.
Charles Dobbins *(WPE8BEV)*, Detroit, Mich.
George Schnabel *(WPE9EMO)*, Rochester, N. Y.
Robert Eddy *(WPE8EQW)*, Newport, Ohio
Robert Shumaker *(WPE8KBE)*, Southfield, Mich.
George Smith *(WPE8KJJ)*, Grand Rapids, Mich.
David Cox *(WPE8KKX)*, Jackson, Mich.
Bob Smith *(WPE8KKY)*, Grand Rapids, Mich.
Robert Moser *(WPE9ASH)*, Chicago, Ill.
Gerry Dexter *(WPE9HDB)*, Lake Geneva, Wis.
Mark Koukol *(WPE9JKV)*, Naperville, Ill.
Benny Loveless *(WPE9JLO)*, Frankfort, Ind.
Kevin Kleman *(WPE9JOV)*, Tigerton, Wis.
Charles Blanchard, Jr. *(WPE9JTC)*, Aurora, Ill.
Robert Gerardi *(WPE9JUG)*, Benton, Ill.
Steve Siegel *(WPE9JUS)*, Skokie, Ill.
Frank Swanberg *(WPE9JVD)*, Dolton, Ill.
B. L. Cummins *(WPE9JVI)*, Columbus, Ind.
A. R. Niblack *(WPE9KM)*, Vincennes, Ind.
John Beaver *(WPEØAE)*, Pueblo, Colo.
C. Vernon Hyson *(WPEØCNF)*, Somerville, N. J.
Jack Perolo *(PY2PE1C)*, Sao Paulo, Brazil
David Gladstone *(VE2PE1NV)*, Chomedey, Que.
Leo Thibaudeau *(VE2PE4Z)*, St. Foy, Que.
F. R. Cook *(VE3PE1WX)*, Willowdale, Ont.
A. Leslie Hughes *(VE7PE1EH)*, Burnaby, B. C.
Joseph Bazsika, Ja., South Plainfield, N. J.
Brian Bewers, Pine Bluff, Ark.
E. G. Brooman, Ancaster, Ont.
David Farmer, Silver Spring, Md.
Samuel Fox, De Kalb, Ill.
William Geist, Kankakee, Ill.
Frank Hampshire, Fostoria, Ohio
Harold Honnold, Modesto, Cal.
Bob Mitchell, Lincoln, Nebr.
Philip Niemi, International Falls, Minn.
Ray Plante, Oshawa, Ont.
Ronald Roberts, Windsor, N. Y.
Bob Roeder, El Cerrito, Cal.
Henry Seidner, Pearl River, N. Y.
Sweden Calling DX'ers Bulletin, Stockholm, Sweden

at 1800-1810 with pop music, and on 21,685 kHz at 1530-1550; Arabic is spoken on both channels.

**Malaysia**—*R. Malaysia,* Penang, is heard from 1300 on 4985 kHz with poor signals. Before that time a teletype station is usually operating.

**Mexico**—XECMT, Ciudad Mante, 6103 kHz, is noted around 0120-0130 with native music and ID's in Spanish. Medium-wave DX'ers report good reception of XEW, Mexico City, 900 kHz, after 0100 in Spanish, and XEG, Monterey, 1050 kHz (100 kW) at 0400-0500 with considerable English. Reports for XEW go to *R. Cadena Nacional,* Apt. Postal 7892, Mexico City 4, while reports to XEG can be sent simply to XEG, Fort Worth, Texas 76111.

**Pakistan**—*R. Pakistan,* Karachi, is often good on the West Coast at 1500-1515 with English news and weather on 11,695 kHz.

**Peru**—OAX4R, *R. San Jose,* Iquitos, 4825 kHz, is somewhat irregular in its programming but often has a *VOA* Spanish relay after 2300. OCY4S, *R. 15-50,* Huancayo, 4801 kHz, is heard after 0000 in Spanish; some reports indicate the callsign to be *R. 150* but this is incorrect. OAX6H, *R. Oficial del Congreso,* Lima, 6095 kHz, is heard at times after 0300 with a relay of political speeches in Spanish.

**Seychelles**—*Far East Broadcasting Company* is testing its new xmtr at 0030-0330 on 15,165 kHz and 1300-1630 on 17,755 kHz, both beamed to India, and 1700-2000 on 21,460 kHz to the Middle East. Also being heard is 21,635 kHz at 1700-2000 in English with music, frequent ID's and requests for reports, and giving the address of P. O. Box 234, Victoria, Seychelles.

**Singapore**—*R. Singapore* is good on 5055 kHz during mornings (local time) with pop records. Another station, believed to be in Singapore, was found on 4883 kHz at 1245 with pop records but in an unidentified language.

**Spanish Guinea**—EAJ206, *R. Ecuatorial,* Bata, has been noted on 4926 kHz from 0430 s/on in Spanish, then into modern pop tunes.

**Sudan**—*R. Omdurman* was heard well on 9508 kHz at 2145-2200 s/off with a xmsn in Arabic.

**Switzerland**—Berne's current English schedule, with each xmsn one hour in length, is as follows: to Australia and New Zealand at 0700 on 9590 and 11,775 kHz; to Europe (weekdays) at 0700 on 6165 and 9535 kHz; to Japan and China at 0845 on 9665 and 11,760 kHz; to Africa at 1000 on 15,305, 17,795 and 21,520 kHz and at 1815 on 15,305 and 17,795 kHz; to United Kingdom and Ireland at 1130 on 9665 and 11,865 kHz and at 1930 on 6055 and 9665 kHz; to Far East, India, and Pakistan at 1315 on 15,305, 17,845 and 21,520 kHz; to Near and Middle East at 1500 on 15,305 and 17,830 kHz; to N.A. (East) at 0130 on 6120, 9535 and 11,715 kHz; and to N.A. (West) at 0445 on 6120 and 9720 kHz.

**Vatican City**—*Vatican Radio* was found with an IS at 2258, then Bells of St. Peters and s/on at 2300 on 11,850 kHz.

**Windward Islands**—*Windward Islands B/C Corp.,* St. Georges, Grenada, is now on 11,995 kHz as heard at 0140-0200 with pop music and time checks.

**Yemen**—*Yemeni Royalist Radio,* 9976 kHz, is fair at 0415 with local music and Arabic vocals. Does anyone know if this is actually in Yemen?

**Zambia**—Peking is to supply *R. Zambia* with two 50-kW short-wave and one 200-kW medium-wave xmtrs as gifts as a result of a recent Zambian goodwill visit to Peking. Sites are being prepared but installation has not yet gotten under way. This information from an overseas bulletin.

**Clandestine**—*R. Espana Independiente* was heard on 15,509 kHz in Spanish just prior to 1731 s/off.

## TWO-WAY REACTIONS

*(Continued from page 98)*

**Nanuet, N.Y.** . . . Citizens Radio Association of Rockland, Inc. has purchased a 40-acre campsite in the Catskill Mountains north of Ellenville, N.Y. Its use will be shared by members for recreational purposes.

**Enon Valley, Pa.** . . . Sociable 5 Watts Inc. had a very successful picnic and campout. They awarded over 250 prizes, presented 33 trophies and awards and credit the following CB groups for helping: Circle 8 Emergency Club, Independent REACT, Lorain County CB'ers, Beaver County REACT, and Derby Town CB'ers.

**Spokane, Wash.** . . . Members of the 7-11 CB Radio Club transported voters to the polls on Election Day. This was a civic project conducted in cooperation with the local Moose Lodge.

**San Bernardino, Calif.** . . . Officers of San Bernardino Valley REACT journeyed to Barstow, Calif., to assist the Barstow CB Radio Club in becoming a REACT team.

**San Bruno, Calif.** . . . REACT of the Golden Gate Area hosted a meeting of REACT teams in northern California and the result was the formation of a REACT Council in the area.

**Beachville, Ont., Can.** . . . Members of the Beachville Valley Wing Dingers are very proud of their communications trailer. Made from an old milk wagon, the trailer has seen some action on Halloween and various CB events. Fortunately, it has not been needed for an emergency, but they are ready!

**River Falls, Wisc.** . . . CB groups including West-Central Wisconsin REACT have banded together with others under Ron Miller, Civil Defense Director of Pierce County, to form a search and rescue unit. It will be trained and ready for search, rescue and communications in emergencies—including tornadoes.

## AMATEUR RADIO

*(Continued from page 100)*

your ARRL Code Proficiency certificate multiplied by the number of ARRL sections you work. (Only one contact per station counts, by the way.)

WNØVKP made 771 contacts in last year's Novice Roundup. You might not do quite that well this year, but you should be able to add a couple more states to your quest for a Worked All States Certificate. Scores go to: Communications Department, American Radio Relay League, Inc., 225 Main St., Newington, Conn. 06111. Send a stamped return envelope to the same address for "NR" log sheets and a list of ARRL "sections."

Another envelope to the above address will get rules and log sheets for the 36th Annual ARRL DX Competition. The phone contest will be between 0001 GMT, February 7, and 2359, February 8, and the same hours on March 7-8; and the CW contest on February 21-22 and March 21-22. United States and Canadian amateurs work the world, including Alaska and Hawaii. They send a signal report and the name of their state or province to each station worked; the DX operator replies with a signal report and his transmitter power. Each exchange earns three points, and a station may be worked once per band. W/VE scores equal the QSO points multiplied by the sum of the different countries worked on each band. DX operators multiply by the number of states and provinces worked on each band.

### NEWS AND VIEWS

**Joel Miller, WA7JWC,** 6870 S.W. Baylor St., Tigard, Ore. 97223, went from Novice to Advanced in about eight months. His Knight T-60 transmitter, Heathkit SB-301 receiver, and Hy-Gain 18-V vertical antenna have worked 49 states, 25 countries, and five continents. He also has a 25-w.p.m. code certificate. Joel's on-the-air time is now somewhat curtailed, however, as he is studying electrical engineering in college . . . **Don Babcock, WB4KUZ,** 2210 Talmadge Av., Titusville, Fla. 32780, is another of the amateurs who moved directly from Novice to Advanced class license. As a Novice, Don worked 23 states and two countries before getting interested in traffic handling and public service work and becoming assistant manager for the Florida Novice Hurricane Net. Don's equipment includes a Hallicrafters SR-42 transceiver for two meters, and a Hallicrafters SX-140 receiver and Heathkit MT-1 transmitter feeding a 40-meter dipole for the other bands. Besides Civil Defense work and handling traffic, Don likes to "ragchew," and has an RCC (Rag Chewers' Club) certificate to prove it . . . **Jack R. Main, W4YCZ,** 1951 Kingston Ave., Norfolk, Va. 23503, has found the secret of how to compete with the "big boys" with his mobile whip antenna and National NC-200 transceiver.

73, *Herb, W9EGQ*

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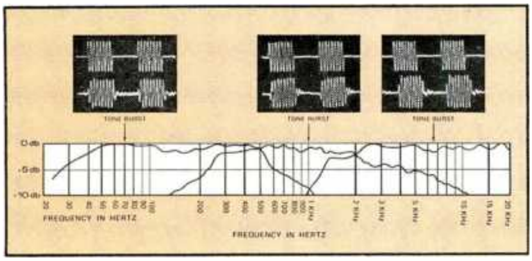


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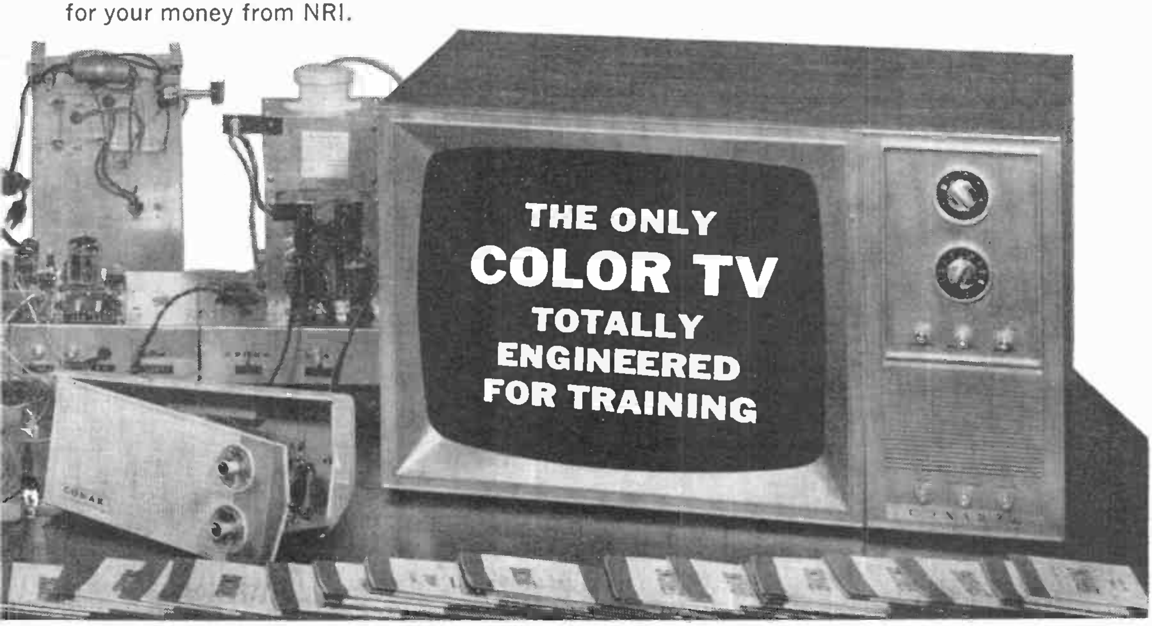

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VOLUME 32 NUMBER 6 — JUNE 1970

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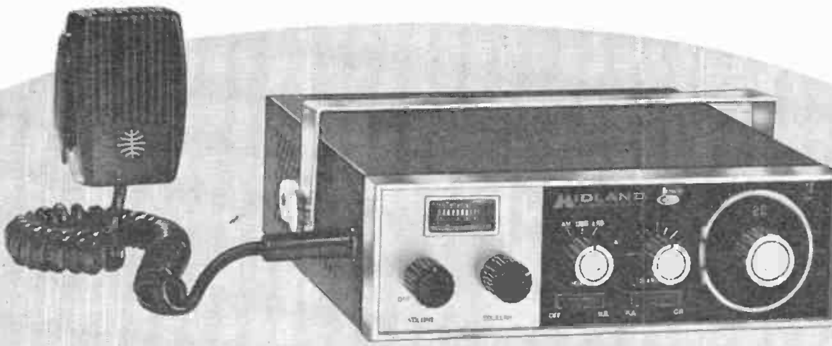


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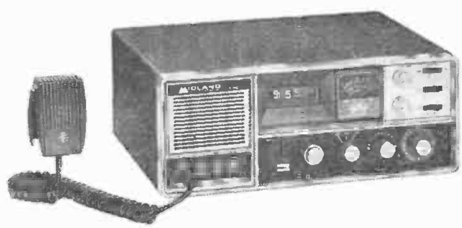


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CIRCLE NO. 20 ON READER SERVICE PAGE

# letters FROM OUR READERS

## HIGH SCHOOL ELECTRONICS

There is an error in your monthly department, "Opportunity Mirror," (March, 1970) where it is intimated that electronics is not taught in high schools.

Here at the Greater Lawrence Regional Vocational Technical High School, Andover, Mass., a curriculum involving a vocational major is combined with academic courses. These meet regular high school requirements and give the student the benefit of a high school diploma and a vocational or technical certificate for his major subject.

Being a member of the graduating class this year I look forward to the vast number of opportunities available to me as a result of being a student in the electronics program of this school. I will also have the opportunity to continue employment under the terms of our high school's cooperative work programs. It is also possible to continue on in our high school through its post graduate and institute programs, or advance into another popular area of electronics, Computer Programming.

PHILIP MARCELLO
Methuen, Massachusetts

## BINGO FOR THE BAMBOO BROADCASTER

Thank you for printing the article, "Bamboo Missionary Broadcaster" (February, 1970, p 61).

R. L. FULLER
San Mateo, Ca.

Congratulations on the foresight and character to print the excellent article on the "Bamboo Missionary Broadcaster." These people have been ignored and neglected too long. How about an article on TransWorld Radio?

R. G. THOMPSON
Milwaukee, Wis.

I enjoyed reading the wonderful story by John Kimberley on the Far East Broadcasting Company. Don't forget some of the other missionary broadcasters such as HCJB and 4VEH.

R. J. ENGEART
Princeton, Iowa

## CB LICENSE PLATE

On behalf of the Twin Ports CB Radio Club (Duluth, Minn./Superior, Wisc.), we

feel that CB'ers may be able to obtain license plates in the state of Minnesota and have petitioned our legislative representative in this district. We appreciate that there may be an additional cost for this service, but we are confident that most CB'ers will be willing to pay this extra fee.

We would like to have other known and established CB clubs in the state of Minnesota support our efforts in this endeavor.

J. C. MAUSOLF
Twin Ports Citizen's Band Radio Club
2717 East 5th Street
Duluth, Minn. 55812

## LOUD, BUT NOT TOO LOUD

To escalate a treble boost for guitar (letter from J. R. Guthrie, March, 1970, page 13) into the urban noise pollution problem is downright silly. Does this mean that POPULAR ELECTRONICS should stop printing speaker designs or hi-fi amplifiers with more than 1 or 2 watts output?

The treble boost can add a whole new world of harmonic content to low and middle register instruments. If Mr. Guthrie is concerned about noise pollution, he should participate in some of the ecological and environmental organizations now springing up to combat this serious problem. Writing to POPULAR ELECTRONICS about the fabled sins of an innocuous device does nothing to lift the cloud of noise and dirt that has settled over us.

CRAIG ANDERTON
Philadelphia, Pa.

## TAPE RECORDING, MORE LITERATURE

Your reader, R. Stoddard (April 1970, p 8), should find Skip Athey's book, *Magnetic Tape Recording*, published by NASA in 1966 a valuable addition to his library. I believe it is still available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. It was selling for $1.25. This is a general book, not one devoted to hobbyists, or even sound recording, but a study of it would benefit any tape recorder user.

W. L. SMITH, W3GKP
Spencerville, Md.

# OUT OF TUNE

Various gremlins got into the works in our April issue. In the "Micro'Lign Generator" article on page 49, the leads on the transistor case outline for *Q1-Q3*, should be E, C, and B, left to right. On page 40, "Digital Logic Microlab," the figure number should be 8. Parts I, J, and K were omitted due to lack of space. On page 57, "100-kHz Standard," the prices in the parts should be $2.15 for the board, $9.85 for the kit.

# The New COBRA 24... Wild, but never Primitive!

## Watch for It! The New 23-Channel Radio that brings order to the CB Jungle!

The COBRA 24 lurks no longer. It has struck with deadly effectiveness to prey on the weaknesses of others. With more power, more intelligence, more beauty than any other radio in its class.

- 5-watts input, maximum talk power with DYNABOOST speech compression, a Dynascan exclusive
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**CIRCLE NO. 11 ON READER SERVICE PAGE**

# ELECTRONICS library

QUIET

## NETWORK THEORY

*by J. B. Murdoch*

Classroom tested, this book can be considered two different college courses under the same cover. The first part of the book concentrates on steady-state linear networks and the latter part on free and forced behavior of such networks. The detailed material is sufficient for two whole semesters in electrical engineering.

*Published by McGraw-Hill Book Co., 330 West 42 St., New York, NY 10036. Hard cover. 525 pages. $16.*

## BASIC ELECTRICITY/ELECTRONICS, Books 1 and 2

This two-volume set, put together by Training & Retraining, Inc., is a widely used student-tested course. It provides the beginner with a solid grasp of the elements of electricity and electronics and equips the technician-level student with the basic knowledge and preparation to advance into specialized fields. Book 1 is devoted to tube and transistor circuits, test instruments, and motors and generators. Book 2 covers the principles and applications of electricity and electronics and a.c.-d.c. circuits. Both books are written in a programmed-text format. The text is well written and profusely illustrated to show and explain every item discussed.

*Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Hard covers. 640 pages Book 1, 704 pages Book 2. $9.95 each book.*

## WAVE GENERATION AND SHAPING Second Edition

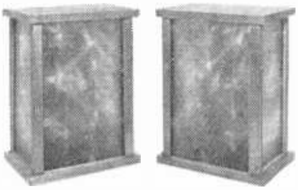
*by Leonard Strauss*

In the decade since the first edition of this book appeared, solid-state technology has revolutionized active circuit design, and IC's have replaced discrete components. Written primarily as a textbook, the objective is to present a logical unified approach to the analysis of those circuits in which the nonlinearity of the active device is the significant factor. A developmental treatment is followed as focus is placed on the essential features of practical wave generating, shaping, and logic circuits. The book is divided into

# Enjoy Discoteque Light Shows at Home — Be it Bach, Beethoven, Folk, Soul, Rock and Roll

Add a new sensation to your favorite listening pleasure. A panoramic display of sound to multi-color light patterns.

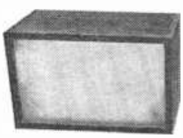
## Color Organs



**Dual Channel Color Organ Model GF-2F- $49.95 pair. User Net**
A pair of bookshelf size; 3 sided prismatic glass enclosure with walnut finish top and bottom. Each unit is a dual channel color organ. Lights respond with sound amplitude (volume) and with different sound frequencies.

**3 Channel Color Organ, Model CVA-3F — $49.95 each User Net.**
3 channel color organ. Each channel of lights have their own sensitivity control. Lights respond with sound amplitude (volume) and with different sound frequencies.

**3 Channel Color Organ Model LGF-3F—$47.95 each User Net.**
3 sided prismatic glass enclosure with walnut finish top and bottom. 3 channel color organ. Each channel of lights have their own sensitivity control. Lights respond with sound amplitude (volume) and with different sound frequencies.

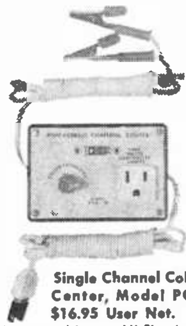


**Stereo (dual channel) Color Organ Model CVA-6F, $69.95 each User Net.**
A stereo (dual channel) system complete in one walnut finish bookshelf cabinet. Each channel is independent and uses 2 individual sensitivity controls per channel.

## Color Centers


**3 Channel Frequency Divided Color Control Center Model PCC-3LF $34.95 User Net.**
Any sound from a Hi-Fi, phono, radio, etc. may be fed into this unit. Each channel is independent and uses 3 individual sensitivity controls per channel. Lights respond with sound amplitude (volume) and with different sound frequencies.


**3 Channel Color Control Center, Model PSA-3LF — $19.95 User Net.**
Any sound from a Hi-Fi, phono, radio, etc., may be fed into this unit. The PSA-3LF will change the sound variations to light variations. 3 individual sensitivity controls are used for 3 separate channels each capable of accommodating 500 watts of external lights.



**Single Channel Color Control Center, Model PCC-10F — $16.95 User Net.**
Any sound from a Hi-Fi, phono, radio, etc. may be fed into this unit. Converts sound to light variations. Will handle up to 600 watts of plugged in lamps.

**Stereo Color Control Center Model PCS-5LF — $34.95 User Net.**
2 separate inputs and outputs for true stereo sound to light conversion. Separate sensitivity controls for each stereo channel. Each channel handles up to 500 watts of controlled lights.

## Strobe Lights

**Model ST-2F**
**$34.95 wired, $24.95 kit, User Net.**
Walnut wood case. High intensity strobe. Easy to use and build Built in Strobe speed control

**Model STCC-3F, Strobe 3-channel Color Organ Combination**
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**CIRCLE NO. 7 ON READER SERVICE PAGE**

five parts: Models and Logic; Timing; Switching; Memory; and Oscillations. The material in the text is on the graduate or advanced undergraduate engineering level.

*Published by McGraw-Hill Book Co., 330 West 42 St., New York, NY 10036. Hard cover. 775 pages. $16.50.*

## LASERS AND HOLOGRAPHY

*by Winston E. Kock*

Holography, like ordinary photography, is a way of recording a scene on film. But while the photograph displays the scene in only two planes (it has no depth), the hologram is a three-dimensional display of the scene; it actually has depth that changes perspective with the changing angle of view. In this book, the reader is introduced to the holography technique by a careful review of the underlying wave concepts, including coherence, diffraction, and interference. The atomic process by which lasers generate their special coherent light is explained. Also shown is how the unique properties of holography will make the laser a valuable instrument in the future of photography.

*Published by Anchor Books, Doubleday & Co., Inc., 501 Franklin Ave., Garden City, NY 11530. Soft cover. 103 pages. $1.25.*

## 1-2-3-4 SERVICING AUTOMOBILE STEREO

*by Forest H. Belt & Associates*

Anyone who services electronic equipment faces the dilemma of speed versus thoroughness. A simple procedure that gets the job done correctly is the best approach. And that is just what is involved in this book; getting the job done the easy way and the right way. The 1-2-3-4 method of finding troubles, coupled with the Easy-Read format of writing and editing, make even the most complicated discussions easy to understand. The topics are carefully organized and thorough explanations, supported by clear illustrations are provided. Whether you are a student, practicing technician, or curious layman, you will understand automobile stereo systems when you have finished reading this book.

*Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 192 pages. $3.95.*

## ELECTRONIC CIRCUIT DESIGN HANDBOOK

Perhaps the most interesting section in most electronics engineering magazines is the one devoted to unique circuit ideas submitted by the readers. Although complete and useful in themselves, such basic circuits may also serve as the kernel of a more complex design idea. The editors of *EEE* magazine have gathered together more than 600 such design ideas, supplemented them with more than 750 diagrams, waveforms, and parts lists, and organized them into 19 sections. Each section is devoted to a specific area, such as amplifiers, oscillators, counting and timing circuits, gat-

(*Continued on page* 100)

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**Kit GD-101**, R/C car only, 8 lbs.....................................$49.95*
**Assembled GDA-101-1**, Veco .19 R/C engine, 1 lb................$19.95*

## NEW Heathkit 3-Channel Digital Proportional R/C System
## For Planes, Gliders, Cars And Boats

Ideal for use with the new Heathkit "Spectre" R/C car to give you total control ... ease of handling. Here's what the Heathkit GD-57 R/C system includes: Transmitter with assembled, factory aligned RF circuitry; new 2 oz. miniature receiver that needs no IF alignment, in a tough nylon case; you also get two servos; all plugs; connectors; cables; charging cord; new flat-pack rechargeable nickel-cadmium transmitter and receiver batteries ... and a special soldering iron. You can have your choice of five operating frequencies in each of three bands ... 27, 53 or 72 MHz. This is the most value ever offered in a 3-channel rig.

**Kit GD-57**, transmitter, receiver, 2 servos, batteries, charging cord, switches and soldering iron, (specify freq. desired), 11 lbs.......$129.95*
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**Kit GDA-57-2**, receiver only, (specify freq.), 1 lb....................$34.95*

## NEW Heathkit Siren/PA
## For Licensed Emergency Vehicle Only

Hey Chief! Save up to 60% on a new electronic siren/PA system by ordering the low cost Heathkit GD-18. The siren gives both "wail" and "yelp" warnings at 55 watts output power, and you can adjust the pitch. As a public address it will amplify your voice with a full 20 watts of power, and it's practically immune to acoustical feedback. (Either PA or siren can be interrupted to use the other.) Incoming radio calls can be channeled through the GD-18 so you can hear them when away from your vehicle. Use it on any 12-volt auto electrical system with either positive or negative frame ground. It will operate from -20° to 150° F conditions. Control panel is lighted. Comes with gimbal bracket mounting. Take your choice of speakers ... concealed or exposed.

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**Assembled GDA-18-2**, Concealed Horn, 4½ x 4½ x 13", 9 lbs.....$49.95*
**System GD-18A**, (includes GD-18 plus exterior horn), 16 lbs........$99.95*
**System GD-18B**, (includes GD-18 plus concealed horn), 16 lbs....$99.95*

## NEW Heathkit Solid-State Portable Fish Spotter

Costs half as much as comparable performers. Probes to 200 ft. Doubles as depth sounder. Transducer mounts anywhere on suction cup bracket. Adjustable Sensitivity Control. Exclusive Noise-Rejection Control stops ignition noise. Runs for 80 hrs. on two 6 VDC lantern batteries (not included). Manual explains typical dial readings. Get set for next season; order your Heathkit MI-29 today.

**Kit MI-29**, 9 lbs...................................................$84.95*

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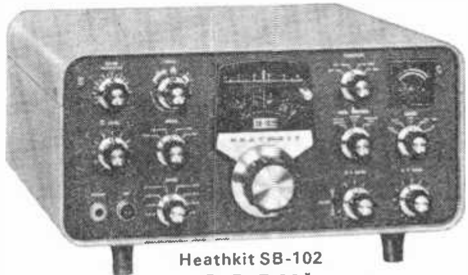
The new Heathkit SB-102 . . . proud successor to the famous "100" & "101". You can expect top performance and value from this rig . . . and you get it. An all solid-state Linear Master Oscillator delivers faster warmup, greater stability and better tracking . . . new receiver circuitry gives better than 0.35 uV sensitivity for real performance under bad band conditions. Plus all the features that made the SB-101 the world's most famous, most popular transceiver . . . 180 watts PEP SSB input . . . 170 watts CW input . . . 80 through 10 meter coverage . . . USB, LSB or CW modes . . . built-in VOX or PTT operation . . . built-in CW sidetone . . . built-in 100 kHz crystal calibrator . . . Triple Action Level Control for reduced clipping & distortion . . . fast, easy bandswitching and tune-up . . . rugged, inexpensive 6146 finals . . . separate headphone level control & front panel jack . . . simple assembly with circuit board-wiring harness construction . . . sharp Heathkit SB-Series styling plus many more features. Order yours now.

Kit SB-102, 23 lbs.............................................$380.00*
Kit SBA-100-1, mobile mt., 6 lbs..................................$14.95*



Heathkit SB-102
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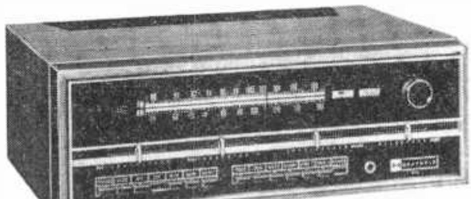
## NEW Heathkit 60-Watt AM-FM-FM Stereo Receiver

Superb stereo performance at budget price, that's the new Heathkit AR-19. A giant, electronically regulated power supply provides 60 watts IHF music power (ideal for all modular and high efficiency speaker systems) . . . frequency response is -1 dB from 6 Hz to 35,000 Hz . . . and Harmonic & IM distortion are less than 0.25% at *any* output. This advanced performance assures you of crisp, clean highs without ringing or breakup . . . solid, clean-cut lows without distortion — just pure, uncolored sound reproduction at all frequencies and power levels. The FM Stereo circuitry is unequalled by any receiver in this price class . . . a factory assembled & aligned FET FM tuners . . . superior overload characteristics & 2.0 uV sensitivity . . . a factory assembled & aligned FM IF circuit board with 4 IC's for superior AM rejection, hard limiting, greater stability and 35 dB selectivity . . . a precision ball-bearing inertia flywheel for smooth, precise tuning . . . two front panel tuning meters for exact station selection. Other features include modular snap-out circuit boards, built-in self-servicing capability, hi-fi AM reception and much more. Make the AR-19 the heart of your stereo system now.

Kit AR-19, 29 lbs...............................................$225.00*
Assembled AE-19, oiled pecan cabinet, 10 lbs.....................$19.95*



Heathkit AR-19
$225^{00}$*

## Heathkit Solid-State Metal Locator

Here's versatile, professional performance in a metal locator at lowest cost. The all solid-state GD-48 uses a unique induction balance detection system that doesn't produce a tone until metal enters the search field . . . eliminates having to listen for a change in tone. The built-in Sensitivity control allows adjustment to detect varying size objects down to 6 feet. A built-in speaker audibly signals presence of metal . . . for higher sensitivity use the accurate front-panel meter. And the front-panel headphone jack lets you use headphones to screen out annoying background noise. Look no further for an excellent metal locator . . . order the GD-48 now.

Kit GD-48, 4 lbs.................................................$59.95*
GDA-48-1, 9 V battery, 1 lb.........................................$1.30*

Heathkit GD-48
$59^{95}$*

## Heathkit Screw-Drive Radio-Controlled Garage Door Opener Now Costs Less

Like having a personal doorman. The powerful yet gentle screw-drive door mechanism gives you ease & convenience you want with the reliability & safety you need. Just a touch of a button and the factory assembled & aligned UHF electronics open your garage door from up to 150 ft. away and turns on a light too. Once inside, another push of the button closes the door safely behind you, yet the light remains on long enough for you to enter your home. Fast, easy one-night assembly . . . all wires pre-cut with connectors installed . . . no soldering. Fits any 7½' overhead, jamb or pivot single or double size residential doors. Automatic instant reverse feature prevents injury to kids, pets, etc. Send for yours now.

GD-209A, mechanism, receiver & transmitter, 66 lbs................................$139.95*
GD-209B, mechanism, receiver & 2 transmitters, 66 lbs............................$149.95*

New Lower Price
Kit GD-209A
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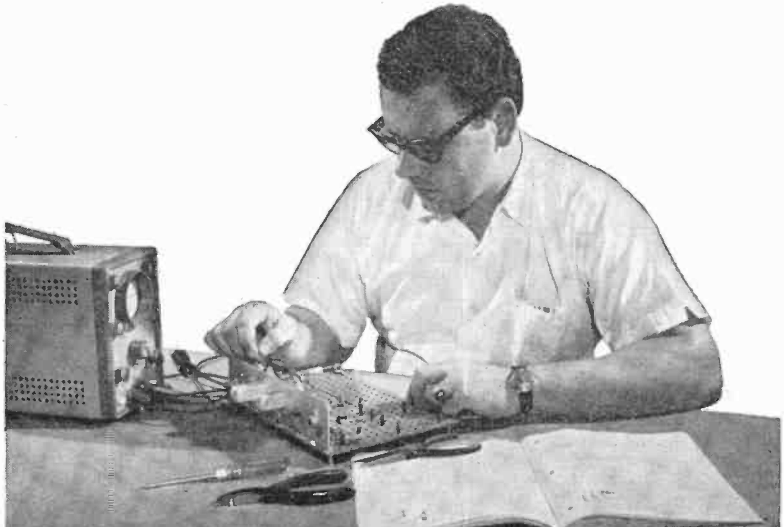
**CIRCLE NO. 17 ON READER SERVICE PAGE**

# 10 Reasons why RCA Home Training is your best investment for a rewarding career in electronics:



Performing transistor experiments on programmed breadboard — using oscilloscope

**1 LEADER IN ELECTRONICS TRAINING**

When you think of electronics, you immediately think of RCA...a name that stands for dependability, integrity and pioneering scientific advances. For over a half century, RCA Institutes, Inc., a service of Radio Corporation of America, has been a leader in technical training.

**2 RCA AUTOTEXT TEACHES ELECTRONICS FASTER, EASIER, ALMOST AUTOMATICALLY**

Beginner or refresher, AUTOTEXT, RCA Institutes' own method of programmed Home Training will help you learn electronics more quickly and with less effort, even if you've had trouble with conventional learning methods in the past.

**3 THOUSANDS OF WELL PAID JOBS ARE NOW OPEN TO MEN SKILLED IN ELECTRONICS**

RCA Institutes is doing something positive to help men with an interest in electronics to qualify for rewarding jobs in this fascinating field. Every year, literally thousands of high paying jobs in electronics go unfilled just because not enough men take the opportunity to train themselves for these openings.

**4 WIDE CHOICE OF CAREER PROGRAMS**

Start today on the electronics career of your choice. On the attached card is a list of "Career Programs", each of which starts with the amazing AUTOTEXT method of programmed instruction. Look the list over, pick the one best suited to you and check it off on the card.

**5 SPECIALIZED ADVANCED TRAINING**

For those already working in electronics or with previous training, RCA Institutes offers advanced courses. You can start on a higher level without wasting time on work you already know.

**6 PERSONAL SUPERVISION THROUGHOUT**

All during your program of home study, your training is supervised by RCA Institutes experts who become personally involved in your efforts and help you over any "rough spots" that may develop.

**7 VARIETY OF KITS YOURS TO KEEP**

To give practical application to your studies, a variety of valuable RCA Institutes engineered kits are included in your program. Each kit is complete in itself. You never have to take apart one piece to build another. At no extra cost, they're yours to keep and use on the job.

**8 FROM RCA INSTITUTES TRANSISTORIZED TV KIT, VALUABLE OSCILLOSCOPE**

Those enrolled in RCA's television course or program receive complete transistorized TV Kit. All students receive a valuable oscilloscope—both at no extra cost and only from RCA Institutes.

**9 CONVENIENT PAYMENT PLANS**

RCA Institutes offers a unique tuition plan that lets you progress at your own pace. You only pay for lessons as you order them. You don't sign a contract obligating you to continue the course. There's no large down-payment to lose if you decide not to continue. However, if you desire, RCA Institutes also offers a convenient monthly payment plan.

**10 RCA INSTITUTES GRADUATES GET TOP RECOGNITION**

Thousands of graduates of RCA Institutes are now working for leaders in the electronics field; many others have their own profitable businesses. This record is proof of the high quality of RCA Institutes' training.

## CLASSROOM TRAINING ALSO AVAILABLE

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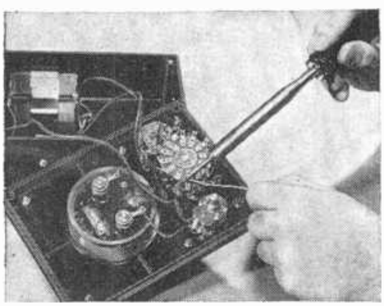
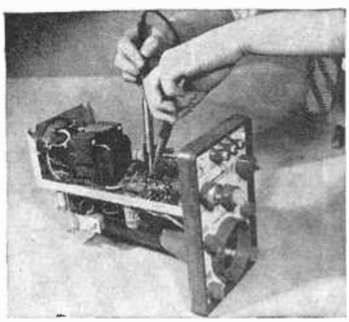
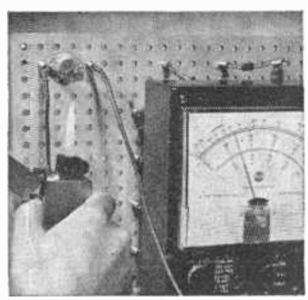
Construction of Multimeter.





Construction of Oscilloscope.

Temperature experiment with transistors.

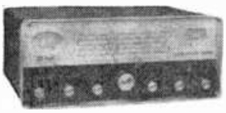


# NEW PRODUCTS

*Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15 or 95.*

## COMMUNICATIONS RECEIVER KIT

Armchair adventuring is more fun than ever when you tune in on the world with a receiver you've built yourself. This is the idea behind the new Knight-Kit Model R-195 budget-priced communications receiver kit. The kit features a "modular concept" in which most parts are already soldered to printed circuit boards and all critical adjustments have been made at the factory so that the builder merely interconnects the boards. The assembled R-195 tunes the international and domestic shortwave stations in three bands (1.8-4.8, 4.8-12, and 12-30 MHz), marine weather and navigational beacon stations on long wave (200-420 kHz), and standard AM broadcast band. A specially designed r.f. section features 2 $\mu$V sensitivity for 10 dB S+N/N. Selectivity is 4.5 kHz bandwidth at 6 dB. Other features include automatic noise limiting, a.v.c., BFO for CW and SSB reception, remote receiver muting, 4" speaker, and a headphone jack.



Circle No. 78 on Reader Service Page 15 or 95

## STEREO CASSETTE DECK

The *Lumistor Products* Model LP-1 stereo record/playback deck is unique in that it is designed to allow for conversion to play four-track "quadrasonic sound" cassettes. The deck was designed to provide the features and operation convenience of quality reel-to-reel decks while retaining the convenience of cassette handling. Featured are interlocking controls, a four-pole synchronous motor, three-digit counter, dual VU meters with separate input level controls, and all interconnecting cables. Present plans are for the four-track converter pack to be made available to those who wish to convert to quadrasonic sound capabilities as soon as prerecorded cassettes for the new sound become available.

Circle No. 79 on Reader Service Page 15 or 95

## 7-IN-1 BIAS SUPPLY FOR COLOR TV

A new bias supply for color TV alignment has been introduced by *Sencore*. The Model BE156 meets the demands of the TV receiver manufacturers by providing three separate 25-volt supplies that can be switched positive or negative as indicated by alignment instructions provided by the TV receiver manufacturers. Tube operated receivers require negative voltages, while most solid-state receivers use positive voltages. A seventh range of 0-75 volts has been provided to meet the specifications of the manufacturers who use 67.5 volts to bias the chroma amplifiers during alignment. All three supplies are well filtered at 0.1% ripple and have little or no interaction between them.

Circle No. 80 on Reader Service Page 15 or 95

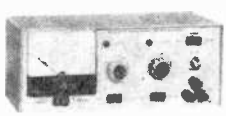
## AUTO-REVERSE STEREO TAPE RECORDER

The Sony Model 780 automated tape recorder, available from *Superscope*, is designed for the connoisseur who wants and can afford the best. It features a three-motor drive system that is completely independent of the 60-Hz line power frequency to provide precise speed control. Any external altering circumstance is automatically and instantaneously compensated for by a sophisticated regulating system. Automatic reversing is accomplished through an electronic sensory system; no metal foil or subsonic tones are required to activate the auto-reverse. The 780 is equipped with the Sony Noise Reduction System that provides noise-free playback of all recorded tapes by automatically reducing the gain of the playback amplifier during quiet passages. The Model 780 includes vari-speed tuning, front panel bias switch, and feather touch control buttons. Another new feature is the ferrite Roto-Bilateral Head that allows recording and playback in both directions with simultaneous tape monitoring.

Circle No. 81 on Reader Service Page 15 or 95

## REGULATED LOW-VOLTAGE SUPPLY

The new Heathkit Model IP-28 current-limiting regulated lowvoltage supply, available from the *Heath Company*, incorporates a number of features that will make it attractive to servicemen, experimenters, and anyone interested in solid-state circuitry. It is capable of delivering from 1 to 30 volts at 1 ampere maximum load with less than 50-mV variation. For critical circuits where the voltage drop across the supply leads is critical, the



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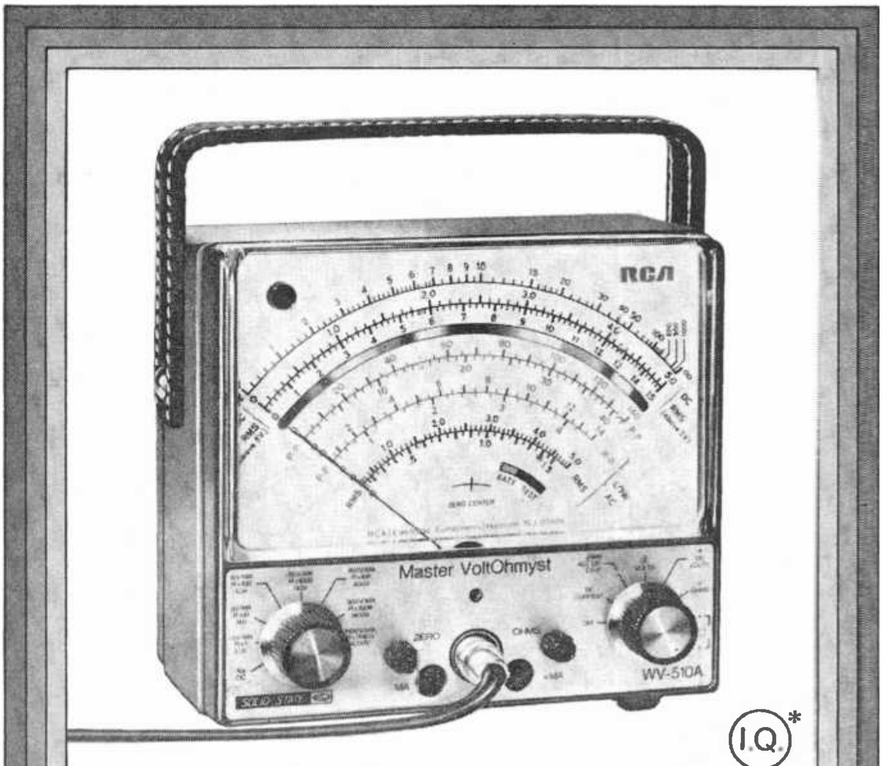


The New RCA WV-510A Solid-State Master VoltOhmyst®

*Inexpensive Quality
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The best you need is the new solid-state RCA WV-510A Master VoltOhmyst®. The most functional VOM we've ever produced, the 510A has all the features you'll ever need no matter what your requirements may be.

And we've added some extra features you won't find in any competitive VOM, at any price...features designed to make your work easier, help you get the job done faster.

For example: RCA WV-510A operates from batteries or AC. Remove the detachable AC line cord while you're taking a measurement and the batteries take over immediately without a flicker of the pointer. And you'll get maximum life from the batteries because they're always on trickle charge during AC operation. Stability? Switch from range to range and watch a whole series of measurements without constantly zero-adjusting the meter.

Some statistics:

Current:
 0.01 milliampere to 1.5 amperes in 8 ranges.

Resistance:
 0.02 ohm to 1000 megohms in 7 ranges.

DC Volts:
 0.01 volt to 500 volts in 8 ranges.

AC Volts:
 0.2 to 1500 rms AC volts in 7 ranges plus peak-to-peak voltages of complex waveforms.
 21 megohm resistance on all DC ranges.

And it's only $128,† complete with DC/AC ohms probe and flexible shielded input cable with BNC connector, and removable AC line cord.
Some statistics! For complete details, contact your local RCA Distributor.

RCA|Electronic Components|Harrison, N. J. 07029

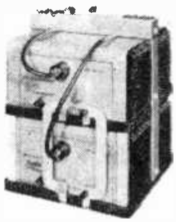
CIRCLE NO. 27 ON READER SERVICE PAGE

## PRODUCTS *(Continued from page 22)*

IP-28 is equipped with a remote sensing feature that reduces the voltage variation to less than 20 mV. A front panel rocker switch selects range of either 1-10 volts d.c. or 1-30 volts d.c., and the output on both is continuously variable. Variable current limiting in two switch-selected ranges from 10-100 mA or 10 mA-1 ampere is also included to protect the load. A 3½" meter can be switched to indicate either voltage or current.

Circle No. 82 on Reader Service Page 15 or 95

### MOBILE POWER INVERTER



The new "Quad-Continental" inverter available from *Terado Corp.* converts 12-volt d.c. to 117 volts a.c. at 60 Hz while maintaining the a.c. frequency within 0.25 Hz, regardless of input voltage or load. The Model 50-110 inverter can handle up to 1200 watts of output loading. Hence, it is ideal for powering small-to-medium compressor type refrigerators. The Quad is completely filtered for operation of sound equipment. It comes with a control harness and features solid-state circuitry and forced air cooling.

Circle No. 83 on Reader Service Page 15 or 95

### STEREO FM RECEIVER FOR CARS

*Stereo Magic* recently announced a stereo FM receiver as an add-on accessory to fit all cars. With the Model DFM-888 receiver, any car owner can enjoy stereo FM broadcasts while on the road. The DFM-888 is all solid state in construction, employing 21 transistors, 11 diodes, and 4 thermistors. The result is a powerful circuit with 101dB sensitivity (signal-to-noise ratio of 30 dB), 5 watts r.m.s. of audio output power, and only 3% distortion at 1 watt. The receiver features a.f.c. with a holding range of 600 kHz and a frequency range of 50-10,-000 Hz. The DFM-888 operates on 12 volts d.c., negative ground, and fits easily under the dash in most cars.

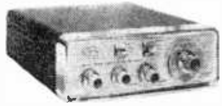
Circle No. 84 on Reader Service Page 15 or 95

### PORTABLE CASSETTE RECORDER

A portable cassette recorder with random function controls and door loading has been made available by the *Ampex Corp.* Designated the "Micro 9," the recorder has positouch controls that allow random switching from one function to another without using the stop control. The door loading feature allows rapid and easy insertion and removal of cassettes. The Micro 9 operates on a built-in battery supply or from 117 volts a.c.; and with an optional adapter, it can even operate from a 12-volt source. Automatic record control, transistor regulated motor, and earphone monitoring during recording are among the extra features of the new recorder.

Circle No. 85 on Reader Service Page 15 or 95

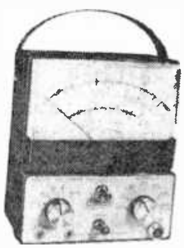
### HI/LO BAND MONITOR RECEIVER



A new Hi/Lo Band VHF-FM monitor receiver, Model COP-50HL, from *Courier Communications,* has a built-in 117-volt a.c. power supply for home or office use; yet, it can be operated as a mobile receiver from 12-volt d.c. sources. It has six high-band frequencies between 150 and 175 MHz and six low-band frequencies between 25 and 50 MHz. Other features include exclusive crystal control on all channels (crystals not included) to assure on-frequency monitoring; solid-state design incorporating IC's exclusive r.f. peaking control for obtaining maximum sensitivity; adjustable squelch; and tone control switch for emphasizing highs or lows.

Circle No. 86 on Reader Service Page 15 or 95

### PROFESSIONAL VTVM



The *Mercury Electronics Corp.* Model 1700C is an advanced design vacuum-tube voltmeter that will met the demands of the technician's most rigid requirements. It has a large 6" wide-view meter featuring double jeweling at the pivot (with individual side and tail weights), anti-parallax mirrored scale, and easy-to-read scale markings. The highest quality components are said to be used throughout. Wide frequency response is featured in the a.c. voltage mode for compatibility with color TV receiver servicing, FM multiplex troubleshooting, and general industrial applications. Also available in kit form.

Circle No. 87 on Reader Service Page 15 or 95

### AM/STEREO FM RECEIVER

*Olson Electronics'* 85-watt solid-state AM/stereo FM receiver, Model RA-194, has a brushed aluminum front panel with a three-dimensional effect that contrasts strikingly with its oiled walnut enclosure. Contemporary styling is enhanced by an illuminated slide rule dial, FM stereo indicator lamp, and precise tuning meter. Technical specifications: 2-$\mu$V FM sensitivity; greater than 30 dB multiplex separation; 30-20,000 Hz audio range; 4-16-ohm output impedance; 22-transistor, 13-diode, 2-IC, and one-FET complement; circuit breaker overload protection; headphone jack; tape output.

Circle No. 88 on Reader Service Page 15 or 95


# Grrrrrr.

(The Tiger 23. $149.95)

The Tiger 23. The new untamable radio from Pearce-Simpson, a Division of Gladding Corporation.

The Tiger 23. A radio you'll have to reckon with. Because no other CB in the world can offer all these features at the same price. Only $149.95.

Start with styling. Smart, clean lines. Wood-grain finishing. Brushed chrome. Illuminated dials. Velvet smooth controls.

And more. 23 channels plus PA, modulation light, external speaker jack, plug-in dynamic microphone, and large illuminated combination RF-S meter.

But that's still not all. The Tiger 23 includes an Automatic Noise Limiter *with manual over-ride*. Automatic Modulation Control for ultimate talk power. Television Interference Trap. Receiver Delta Tune Switch that corrects for the other guy's off-frequency transmissions.

And inside, the latest in solid state circuitry including ceramic filter to bring in sharp clear signals, Integrated Circuit, and Field Effect Transistor.

Put it all together and you've got a radio that won't quit. A radio from Pearce-Simpson, the finest name in Marine radios, CB's, antennas, and electronic communication equipment. And backed by Gladding Corporation, first in outdoor recreation since 1816.

The Tiger 23. If you can handle it.

**Pearce-Simpson**

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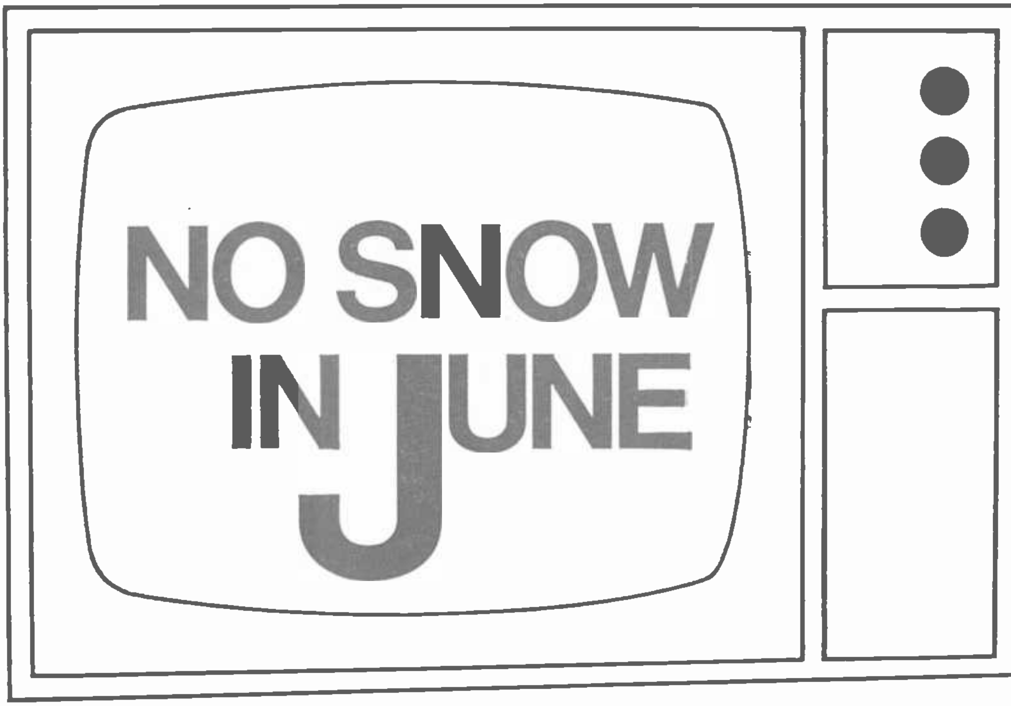
First in outdoor recreation since 1816. GLADDING

CIRCLE NO. 24 ON READER SERVICE PAGE



# NO SNOW IN JUNE

## MATCH YOUR TV ANTENNA TO RECEIVER FOR BEST POSSIBLE PICTURE

**BY GEORGE MONSER**

GOOD TV RECEPTION is not obtained by accident; it is carefully sought for and designed into your antenna system. You can get the best antenna and lead-in cable money can buy, but if the antenna is not impedance-matched to the cable and/or the cable is not matched to the TV receiver, you might just as well be using outdated "rabbit ears." This is especially true for color TV reception—and not just in the "fringe" reception areas.

Everything in your TV receiving system must be just perfect, and the only way you can make sure that it is is to do the job right—the first time. But do not think that you have to be a TV antenna/transmission line expert to set up a receiving system. With the help of the information provided in this article, you can set up the best possible antenna system.

**The Loss Factor.** Nothing is perfect. No matter whether it is an automobile engine or an electronic circuit, every system suffers from some type of loss which reduces its efficiency. While you cannot completely eliminate receiving system losses (known as signal attenuation), you can limit them to an acceptable level.

To demonstrate how loss becomes a critical design factor, consider a 300-ohm folded dipole antenna (tuned or cut to any TV channel) connected to a length of 300-ohm twin-lead cable. Very little loss would occur between the antenna and cable for the channel to which the antenna is tuned. But for all other channels in the TV band, the loss might be as high as 3-4 dB; and over the complete band, an average loss of 2 dB would be typical, enough to cancel the characteristic 2-dB gain of the folded dipole (favorably oriented) antenna.

Now, consider a resonant 300-ohm folded dipole, reflector, and several director array (representative of most commercial TV receiving antennas). An estimated 2-dB loss would occur at the antenna/cable connection due to the lowering of the dipole's impedance. (The effect of placing a reflector and directors in close proximity to the folded dipole is to lower the 300-ohm characteristic impedance of the dipole to about 70-100 ohms). But since this antenna array provides 6-10 dB of gain, a 2-dB loss, severe in our first case, can usually be acceptable, particularly in good reception areas.

For both cases cited above, the cable lead-in loss, assuming about 40′ of twin-lead at VHF, amounts to between 0.6 and 1 dB. Hence, the total loss in antenna signal strength is 3 dB. This means that only 50% of the antenna signal power would be delivered to the TV receiver.

**Reducing the Losses.** The choice of improving the antenna-to-transmission line match basically involves inserting an impedance-matching transformer between antenna and line. The drawing in Fig. 1 illustrates the makeup of one type of

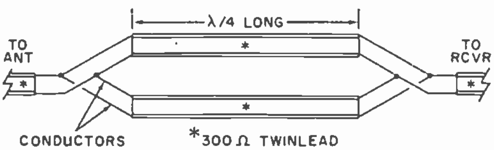



Fig. 1. Transformers are cut to specific lengths for individual channels or for multichannel band.

transformer you can use. It is easy to fabricate and consists of two lengths of 300-ohm twin-lead cable.

The decision of whether to fabricate your own transformer as opposed to buying one that is commercially made should depend on the end results. Tests made with both types show that at the 70-MHz frequency of channel 4, the commercial ferrite-core balun *lowers* the signal level by about 2 dB, while the quarter-wave, twin-lead homebrew transformer *improves* the signal level by 1.5 dB.

Lead-in attenuation, the other loss (amounting to less than 1 dB) can be slightly reduced, but not without considerable effort. Here, two possibilities exist: transition from the antenna to a homebrew 600-ohm open-wire lead-in and back to 300 ohms at the TV receiver; or transition from the antenna to homebrew 1″-diameter, 77-ohm coaxial line and back to 300 ohms at the receiver. Neither of these alternatives will yield a line loss less than 0.3-0.5 dB, which hardly seems worthwhile by itself. However, if a choice were to be made, it would probably be easier to stay with a balanced line and use 600-ohm open line. (Fig. 2 illustrates how this can be accomplished

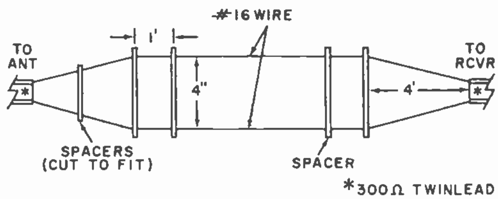



Fig. 2. Insulator spacers support gradual tapers when matching 600-ohm open line to 300-ohm cable.

with #16 wire and a wire separation of 4″ to yield a line loss of about 0.25 dB/100′ at 88 MHz, or less than 0.15 dB for a typical 40′ run.)

You may be wondering when and where it is advantageous to use these methods for improving signal transfer. As a general rule, they should be employed in "fringe" reception areas to improve weak TV channel reception. When making your own transformer or transformers, refer to the Table for the proper quarter-wave transformer lengths to use for each TV channel in the VHF spectrum. The lengths listed were computed assuming standard 300-ohm twin-lead cable with a phase factor of 0.84, which is typical for polyethylene-jacketed twin-lead.

Now, take three practical examples to show how to improve TV reception. In the first example, suppose you have a good quality commercial antenna array and wish to improve reception on Channel 4 by inserting a transformer section between the antenna and a 300-ohm twin-lead line. Select the transformer length section from the Table; in this case, 36″ is indicated. Cut two pieces of twin-lead cable to *exactly* 36″ (plus about ½″ extra at each end). Strip away ½″ of insulation from each end of both cables. Then, connect the lengths of twin-lead in parallel with each other (see Fig. 1).

| TRANSFORMER SIZES | | |
|---|---|---|
| VHF Channel | Transformer Length (inches) | |
| 2 | 43 | 36 |
| 3 | 40 | |
| 4 | 36 | |
| 5 | 32 | |
| 6 | 29 | |
| 7 | 14 | 13 |
| 8 | 13.6 | |
| 9 | 13.1 | |
| 10 | 12.8 | |
| 11 | 12.4 | |
| 12 | 12.0 | |
| 13 | 11.7 | |

Insert the transformer section between the antenna and twin-lead lead-in cable. This should yield an improvement of 1.5 dB in signal strength and a noticeable improvement in Channel 4 fringe-area reception.

For our second example, suppose you use the same antenna and want the best possible reception. Rather than running 300-ohm twin-lead cable, try using lower loss 600-ohm open line. This can be done fairly easily by following the instructions detailed in Fig. 2. At both the antenna and TV receiver, the line must be tapered gradually to the 600-ohm spacing of the open line. When completed, the installation should yield about a 2-dB improvement in signal reception, slightly better than in the first example.

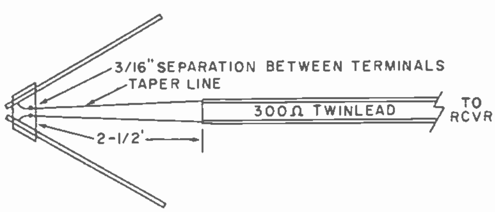



Fig. 3. Gradual taper matches 300-ohm twin-lead cable to 150-ohm impedance of Pyramidal Antenna.

As a final example, assume you are planning to erect the Pyramidal TV/FM Antenna ("Build The 'Pyramidal' TV/FM Antenna," POPULAR ELECTRONICS, July 1969). This antenna's impedance is about 150 ohms, which means that 300-ohm twin-lead cable is reasonably ideal to use. However, for the ultimate match, you should insert a tapered section of line between the antenna connecting terminals and the 300-ohm twin-lead lead-in cable as shown in Fig. 3 to improve reception by about 0.5 dB.

The added complication of tapering the line in the last example might not be

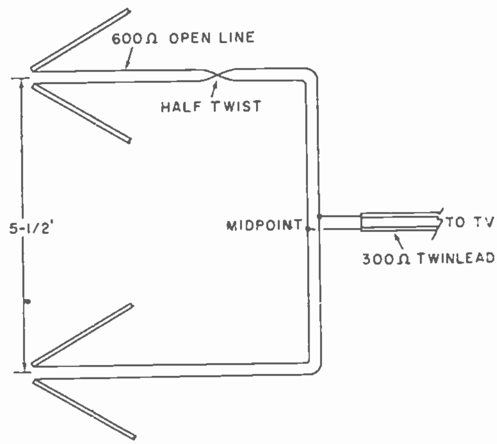



Fig. 4. Open line matches two Pyramidal Antennas to 300-ohm cable. Note half twist in 600-ohm line.

justified, considering that this antenna has a nearly flat gain characteristic of 10 dB for all VHF TV channels.

Finally, suppose that even 10 dB of gain is not enough to provide quality fringe-area reception. You could stack two Pyramidal antennas as shown in Fig. 4 to obtain 13 dB overall gain. Here, the individual antenna connecting point impedances can be tapered to 600 ohms and then paralleled, providing an ideal match to the 300-ohm twin-lead cable line to the receiver. In the illustration, the center-to-center spacing between the antennas is 5'. Of course, the antennas could just as easily be placed side by side to yield the same resultant gain; but erection on a single mast is usually easier to implement.

Now that you have been apprised of good receiving system basics, you can start designing your own system. And with the warm weather here, what better time is there to tackle the job? —30—

# VECTOR-CIRCUIT MATCHING QUIZ

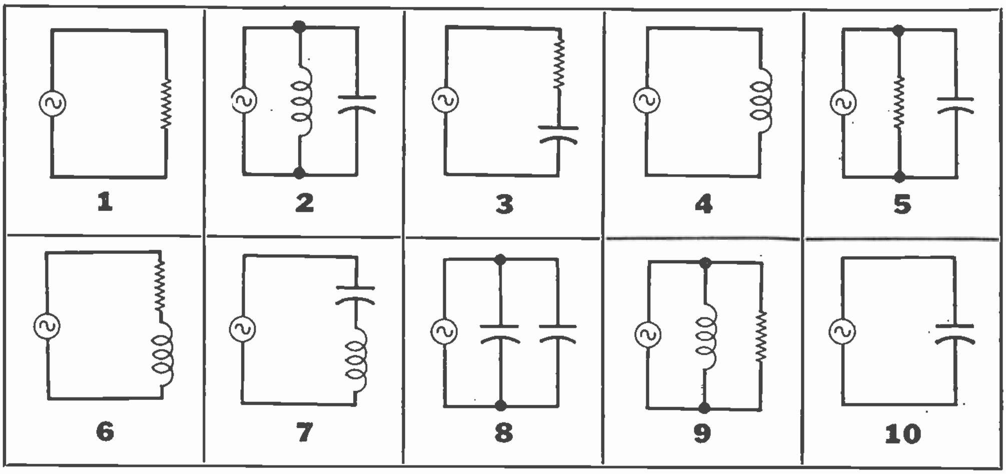
BY ROBERT P. BALIN

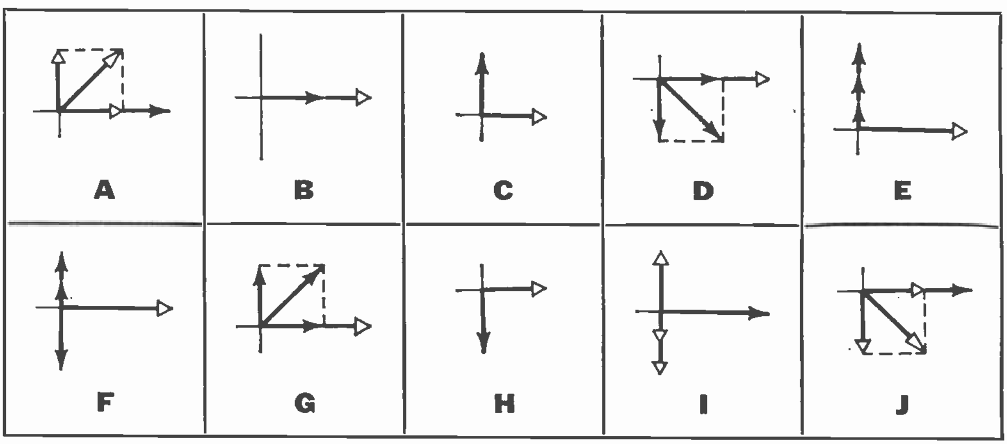
Vector diagrams are widely used to show the magnitude and phase relationships between voltages and currents in an a.c. circuit. A knowledge of vectors is a must for understanding the theory behind frequency modulation and detection, color TV and feedback circuits.

Ten circuits (1-10) are shown below; vector diagrams (A-J) representing the voltages and currents in the circuits are also shown. To test your knowledge of vectors, match the diagrams to the circuits. Note that this is a simple matching quiz—obviously special cases might exist if the effects of resonance were considered. It is also assumed that all elements are pure (that is, capacitors have only capacitance, inductors only inductance, and resistors only resistance).

Standard counterclockwise vector rotation is used to indicate angles of lead and lag. A white arrowhead represents a voltage vector; a black arrowhead is a current vector. In all cases, the reference is the line along the horizontal, extending to the right. Relative vectors are shown for all voltages and currents in each circuit.

*(Answers on page 96)*



# BUILD A TRANSCIPITOR

## GIVES YOU GOOD, CLEAN AIR FOR MANY APPLICATIONS

**BY WALDO T. BOYD**

HAVE YOU EVER painted a very special piece of equipment, only to have it ruined by dust or bugs while drying? Or have you ever had a delicate biological or chemical experiment spoiled by strange gases and smoke in the air? If you have either of these, or any other, needs for a source of truly clean air, the "Transcipitor" is for you.

This clean-air device uses a high-voltage charge in an enclosed column of moving air to remove dust, smoke, and other particulant matter. The column enclosure can be made from a stack of discarded coffee cans (with the ends removed) or from a length of sheet-metal downspout, topped with a small blower. The electronic "heart" of the Transcipitor is a 10-kV d.c. power supply. Power for the device can be obtained either from a 12-volt battery or a transformer/rectifier combination operated from the 117-volt a.c. line.

**How It Works.** A single isolated conductor, connected to the high-voltage source, is run up through the center of the metal column—the latter being grounded. When air moves through the column all particulants receive a charge from the static field within the column. They immediately fly to the grounded column and cling there where they are joined by millions of other particles until there is actually a visible coat of dust on the inside of the column. When the power is turned off, the dust particles fall slowly to the bottom of the column and can be removed easily.

This system is essentially a miniature version of the type used in factory chimneys to remove residue from the smoke.

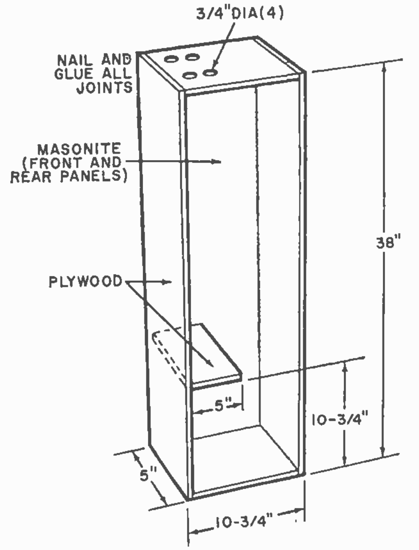



Fig. 1. The cabinet is made from soft pine and Masonite. The front door is not shown.

### BILL OF MATERIALS

*2—5" x 38" pieces of ½" pine**
*2—5" x 10¾" pieces of ½" pine*
*1—10¾" x 38" piece of thin hardwood*
*1—10¾" x 31" piece of thin hardwood*
*1—5" x 5" piece of ½" pine*
*Misc.—Plastic-covered vacuum cleaner hose; blower/motor from auto defroster, heater, etc., 12-volt or small 117-volt unit; sealant for motor mounting (RTV-102 or similar); mounting hardware; etc.*
**All dimensions may vary. See text.*

**Cabinet Construction.** Dimensions of the case for the Transcipitor are not critical. A layout of the author's prototype is shown in Fig. 1. Any kind of wood (such as pine) can be used for the sides, top and bottom but the front and back panels are of thin hardwood. A 5" shelf, located 10¾" from the bottom of the cabinet is attached to the side and rear, with another screw inserted through the front panel when it is put into place.

Four ¾" ventilation holes are drilled in the top, while the front panel is cut 6" or 7" short to allow air to enter at the bottom. The height of the column (in this case six 1-lb coffee cans, plus the fan) dictates the height of the cabinet. It is best to assemble the column first and then build the cabinet.

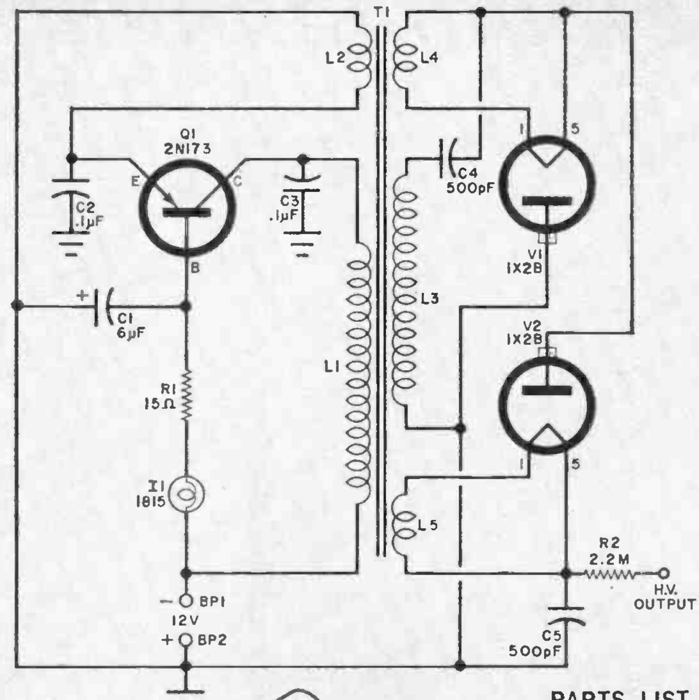
If you are going to use coffee cans for the column cut the bottoms out of five of them, but leave the bottom in the sixth for mounting the fan. Stack five cans together, align them as closely as possible and spot solder them together. Wrap tape around the seams to make them airtight.

The fan is mounted on the sixth (top) can. The fan can be salvaged from an old automobile heater or an evaporative cooler, or you can buy one at a surplus supply house. A small 12-volt type is best, but a fan with a 117-volt motor can be used. The fan and motor assembly should be smaller than the top of the coffee can on which it is to be mounted.

Cut a hole in the bottom of the sixth can to fit the fan intake and mount the fan as shown in Fig. 2. Temporarily set this can (and fan) aside.

Stand the 5-can stack up. In the bottom can, drill a series of $\frac{3}{16}$" holes about ⅛" apart around the can about 1½" from the bottom. (Most cans have an indentation ring around the can at about


Fig. 2. The small fan is cemented to its hole in top of can. Make sure that the joint is airtight.



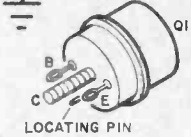




Fig. 3. The circuit is a simple power oscillator driving a voltage-doubler circuit. The two high-voltage capacitors and the flyback transformer can be salvaged from old television set.

## PARTS LIST

*BP1,BP2—Binding post (one red, one black)*
*C1—6-µF, 15-volt electrolytic capacitor*
*C2,C3—0.1-µF capacitor*
*C4,C5—500-pF, 20-kV "doorknob" capacitors (used in TV high voltage)*
*I1—12-volt pilot lamp (GE 1815 or similar)*
*Q1—2N173 or HEP 223 power transistor*
*R1—15-ohm, 5-watt resistor*
*R2—2.2-megohm, ½-watt resistor*
*T1—TV horizontal flyback transformer (Stancor HO-290 or similar)*
*V1,V2—1X2B high-voltage rectifier tube*
*Misc.—Heat sink (Wakefield NC621B or similar); insulated mounting hardware for transistor; silicone grease; pilot light holder; 9-pin anti-corona high-voltage rectifier sockets (2); ceramic supports for sockets (2); feedthrough insulator (E.F. Johnson 135-48 or similar); length of ½" high-voltage tubing; length of ⅛" plastic tubing; length of nichrome wire; suitable metal chassis.*

that point which you can use as a guide.) Deburr the holes. About 1½" from the top of the can (or in the top indentation ring if it has one), drill four holes 90° apart around the can. Use a thin bit (#43) for these holes. Drill four similar holes in the fifth or top can.

Thread a #6 nylon string through the four holes in the bottom can so that a "crosshair" is created. Make the string tight and apply a little glue on the outside knots to make sure that they hold. Do the same thing on the fifth can. These crosshairs will be used to support and insulate the high-voltage wire in the center of the column. Do not attach permanently the can with the fan at this time.

Place a plastic lid over the open end of the bottom can and stand the stack in the cabinet.

If you use sheet-metal downspout for the column, make the column as high as six coffee cans and drill all holes in approximately the same places. You will have to mount the fan on a piece of metal and secure this to the column later.

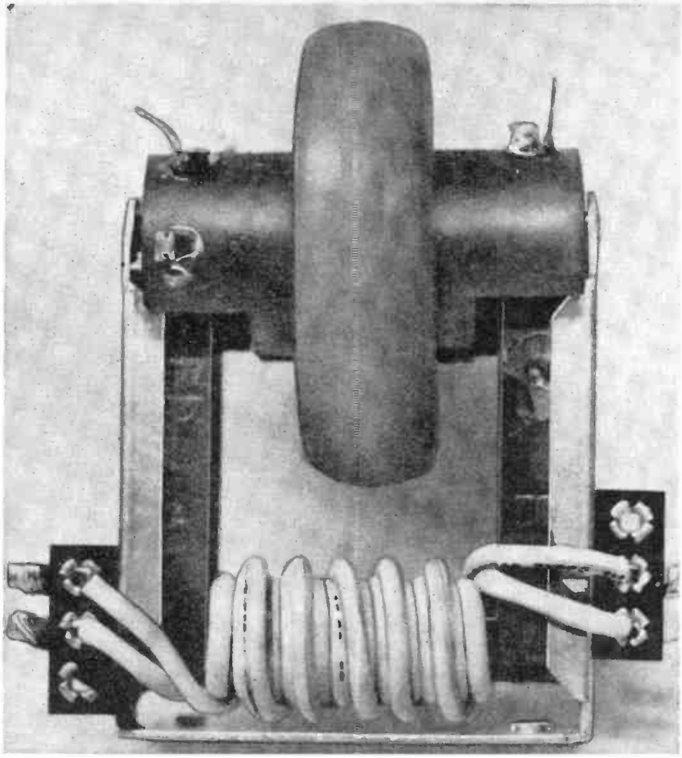


Fig. 4. The two terminal strips are affixed to the side straps of the flyback transformer and support the two ends of new coils (L1 and L2). Wrap layer of insulating tape around the core before winding the coils.

**Power Supply.** The circuit for the high-voltage power supply is shown in Fig. 3. For safety, the device is enclosed in a grounded metal container and the high-voltage output is taken through a feed-through insulator.

The supply is a simple transistor oscillator using extra windings on a conventional TV high-voltage horizontal output transformer. Two of these extra coils, a primary and a tickler feedback (*L1* and *L2* in Fig. 3), in conjunction with the transistor, form a regenerative feedback network similar to that used in receivers. When the power is turned on, current flows through *L1* and the transistor. The magnetic field set up by this current generates a voltage in *L2* that increases the forward bias on the emitter of *Q1*. The collector current through *L1* then increases. Eventually, the core of the transformer saturates and the magnetic field around *L2* stops building so that the emitter bias is reduced and the collector current drops. The process is then reversed. The magnetic field set up by the decreasing collector current produces a voltage in *L2* that drives the transistor to cutoff. When no current flows through *L1*, there is no voltage across *L2* and the emitter returns to ground potential. The cycle then repeats. The oscillator frequency is near the upper end of the audible range.

The transistor is biased by *R1*, which is bypassed by *C1*. Capacitors *C2* and *C3* protect the transistor from static discharges.

The current through *L1* varies from zero to about 5 amperes. Because of the turns ratio between *L1* and *L3*, about 5000 volts a.c. is developed across *L3*. A voltage-doubler/rectifier combination (*V1* and *V2* with *C4* and *C5*) raises the voltage to about 10,000 volts d.c.

**Caution.** Although the current is low, voltages at the 10-kV level can be very dangerous. Do not, under any circumstances, turn on this high-voltage generator unless the case is completely closed and the high-voltage feedthrough is well in the clear. When the system is turned off for any reason, always discharge the high-voltage terminal using an insulated cable, with one end secured to ground and the other end held at the end of an insulated rod to touch the terminal.

**Power Supply Construction.** Remove the insulated filament winding from the flyback transformer. If there is a sponge-rubber pad between the core and the mounting bracket, remove it. Caution: the core is made of a brittle ferrite material in an epoxy binder. Therefore, do not force or twist it in any way. Gently remove the rectifier plate connector lead from the coil. Make sure that you can identify the high-voltage winding terminals.

Solder a two-lug terminal strip to each side of the mounting bracket as shown in Fig. 4. Wrap a layer of insulating tape on the bare horizontal ferrite core, feeding the tape between the core and the mounting bracket. Wind 12 turns of #18 stranded hookup wire in a close layer around the core. This forms *L1*. Solder the ends to the bottom insulated tie points of the terminal strips. If the winding does not pack tightly, remove it, and rewind with a slightly larger wire.

Wind a five-turn coil, using the same gauge wire, on top of *L1*. This forms *L2*. Solder the two ends to the top lugs on the terminal strips. Wind *L2* in the same direction as *L1* with the windings spaced evenly across *L1*.

Using the same type of wire originally used for the filament winding (removed in an earlier step), wind the two one-turn coils between the turns of *L2*. These form *L4* and *L5* and will be connected to the filaments of the rectifier tubes. Locate one end of the high-voltage winding and connect it to the nearest ground—the transformer mounting bracket will do.

Obtain a metal box, large enough to accommodate the transformer and the rectifier tubes, yet small enough to fit between the metal column and the side of the cabinet. It should be less than 10″ high (including the insulator for the high-voltage feedthrough) so that the entire assembly will fit below the shelf in the cabinet.

The transistor is mounted on a heat sink using appropriate hardware and insulating material. Coat both sides of the transistor insulator with silicone heat-conducting grease. The heat sink assembly is mounted at the outside lower end of the rear panel to keep it away from corona discharges set up in the high-voltage section (see Fig. 5). Appropriate holes must be drilled in the rear panel to mount the heat sink and to provide access to the transistor terminals.

The flyback transformer is mounted at one side of the power supply enclosure (see Fig. 6) so that the high-voltage and filament leads face the two rectifier tubes. The tube sockets (of the anti-corona type) for the rectifiers are mounted on ceramic insulators, one on the top and the other on the bottom of the enclosure. Mount the other components as shown in Fig. 6 and wire them, point-to-point, as shown in Fig. 3. Take care to make neat, smooth joints and avoid sharp edges to prevent corona discharges. Resistor *R2* connects from the rectifiers to the feedthrough insulator.

**Checkout.** Connect a 2- to 3-volt d.c. source to the battery input terminals,

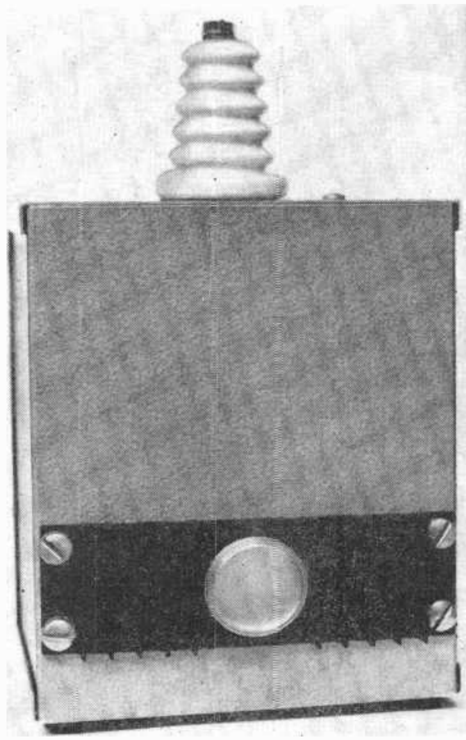
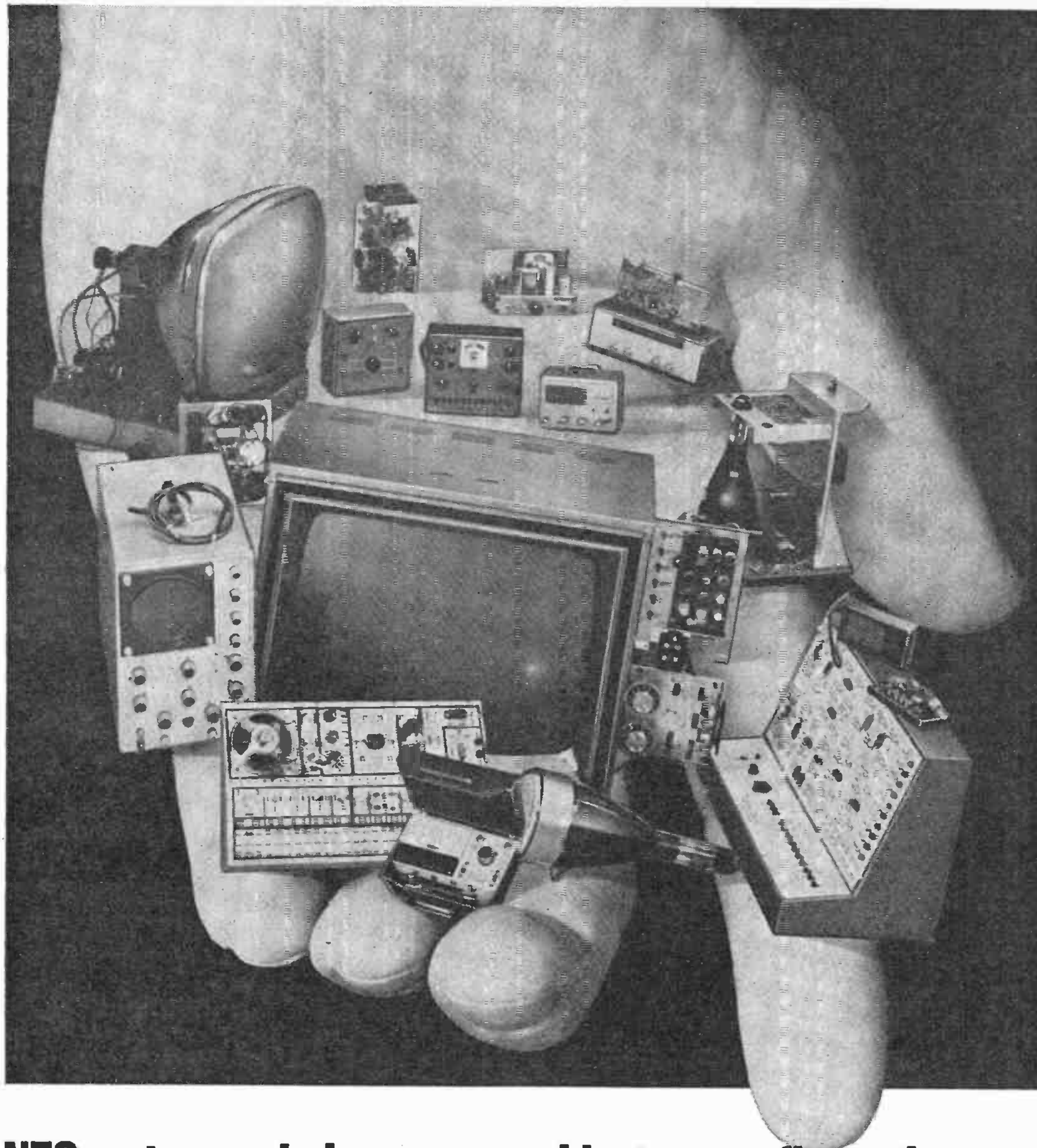


Fig. 5. The transistor is electrically insulated from its heat sink, and the heat sink is attached to the rear of the metal chassis. Make sure that no metal can contact the case (collector) of Q1.



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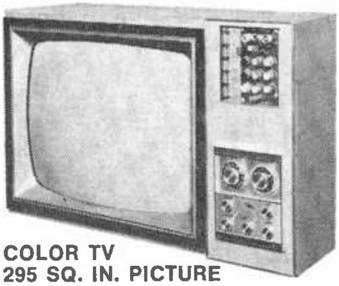

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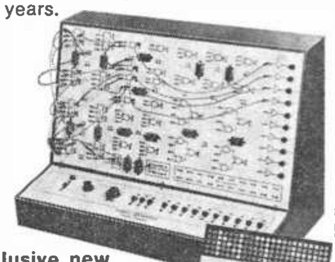

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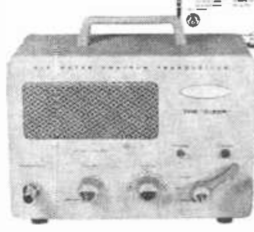

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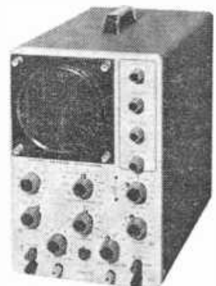

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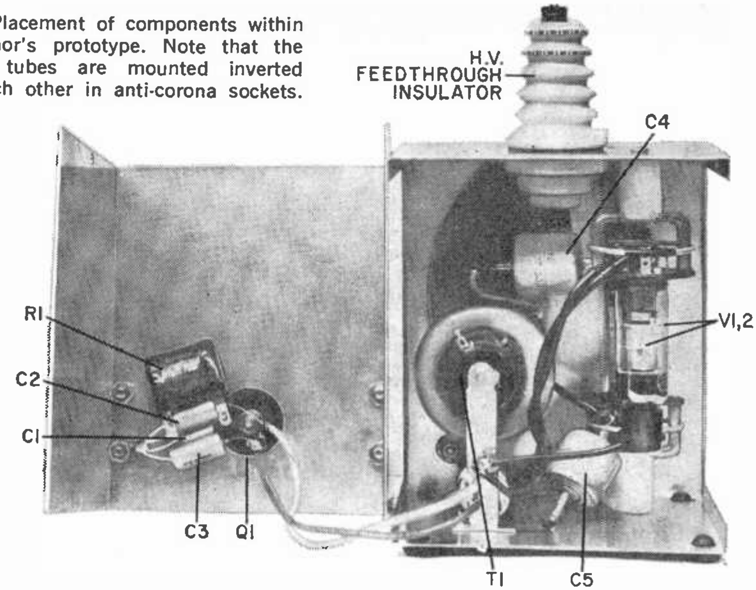
Fig. 6. Placement of components within the author's prototype. Note that the rectifier tubes are mounted inverted from each other in anti-corona sockets.




with positive to ground. A pair of flashlight D cells will do. The circuit will oscillate with this low supply but voltage levels will be down. Try to draw an r.f. arc from the transformer high-voltage terminal using a well-insulated screwdriver. If there is no arc, even a small one, reverse the connections to *L2*. In some cases, it may be necessary to add or remove turns from *L1* to obtain the proper core saturation.

Once you know the oscillator is working, connect 12 volts d.c. to the circuit and, being extremely careful, measure the voltage at the filaments of the rectifiers. It should be between 1.2 and 1.5 volts a.c. Make sure that no part of the voltmeter or your body touches ground when making this measurement! Once filament voltage has been confirmed, shut down the power supply, discharge the high-voltage feedthrough, and assemble the metal enclosure, making sure that it is completely sealed.

As a final check, connect the circuit to a heavy-duty 2- to 12-volt power supply (such as a battery charger) capable of handling 5 amperes. Connect an ammeter in the input lead. With a 2-volt input, the ammeter should indicate about 0.5 ampere. With 12 volts input, current should be about 2 amperes. The reading could go as high as 5 amperes if the circuit is loaded with a high-voltage experiment.

**DANGER!** There is at least 10,000 volts present on the top of the feedthrough insulator! Treat it with the greatest respect. Don't try to draw arcs with a pencil, and don't short this terminal to ground when the supply is energized. Also, don't touch the transistor case while the supply is operating.

Shut down the power supply, discharge the high-voltage feedthrough, and place the power supply in the cabinet as shown in Fig. 7, with the battery terminals and pilot light facing front.

Mark the point on the metal column that is directly opposite the top of the high-voltage feedthrough. Drill a ¼″ hole at this point and deburr it. Obtain a length of high-voltage plastic tubing long enough to go from the top of the feedthrough to the center of the column. For still better insulation, insert another piece of ⅛″ tubing inside the first one. Feed a length of #22 or smaller wire through this insulator leaving enough at one end to make a connection to the feedthrough and a small loop at the other (column) end, at the center of the crosshairs.

Attach a length of fine nichrome wire (obtained by dismantling an old wirewound resistor) to the loop of wire at the bottom crosshair (wind the copper wire around the nichrome) and to the crosshair itself for support. Pass the nichrome wire up through the column and attach the top end to the upper nylon crosshair, making sure that the wire is reasonably straight and does not come near the sides of the metal column. Cut off any loose end.

(Nichrome wire is used here because the high voltage produces a tiny corona which would ruin copper wire but does not harm the nichrome. Steel wire can be used, but it will eventually rust and disintegrate.)

Do not use any mechanical device to connect the nichrome wire to the high-voltage lead since this joint will have to be disassembled occasionally so that the column can be removed for cleaning. Replace the plastic cover on the bottom of the column. Place the blower container on top of the column, making sure that the exhaust is toward the front of the cabinet. Secure this can in place by wrapping tape around the seam. Make a wire connection between the metal column and the metal chassis of the power supply by soldering at both ends.

The appearance of the stack can be improved by spraying it with paint, but don't get paint in the blower mechanism or on the high voltage leads.

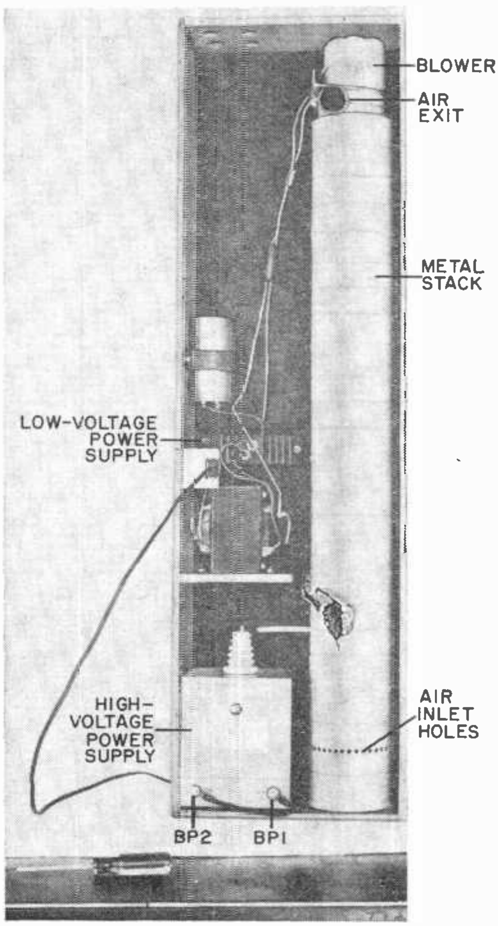
**Line Operation.** The Transcipitor can be operated from a conventional low-voltage d.c. power supply such as that shown in Fig. 8. Mount the transformer on the small shelf in the cabinet and the filter capacitor on a clamp secured to the cabinet wall. A TV power socket is mounted on a small piece of metal and located on the cabinet wall so that power can be applied to the system only when the front panel is in place. A TV "cheater" supplies power to the socket and is mounted on the front panel aligned with its receptacle. The two rectifier diodes are mounted on a heat sink on the rear wall. Wire the power supply point-to-point as shown in Fig. 8.

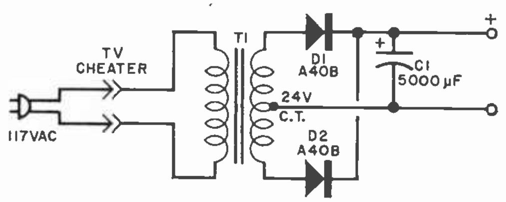
If the fan motor is of the 12-volt variety, wire it to the power supply, observing proper polarity. If the motor is 117 volts a.c., connect it in parallel with the input to the power transformer.

**Final Assembly.** The finished project should now look like the one in Fig. 7. The column, with the fan at the top should just fit snugly within the cabinet. It may have to be wedged if too loose; or the cabinet top may have to be hollowed out slightly if the fit is too tight. Recheck all wiring, making sure that the metal column is connected to the positive battery input (at ground) on the supply. Make sure that the high-voltage feed is in the clear and that all parts attached to the cabinet walls are on tightly.

Obtain a length of flexible vacuum cleaner hose. The hose should be covered with plastic rather than cloth to make cleaning easier. Wash the hose thoroughly, inside and out, with a good detergent and then rinse thoroughly. Cut a hole in the front of the cabinet so that the end of the hose and the exhaust on the fan can be mated. It may be necessary to make up some type of size-matching device if the two are greatly different in size. Check all dimensions, and then mount the front panel on the cabinet using a few screws to secure it.

Fig. 7. Coffee-can stack was painted before installation to make a more pleasing appearance. The four top vents provide cooling for power supply.






## PARTS LIST

*C1—5000-µF, 15-volt electrolytic capacitor*
*D1,D2—Silicon rectifier (GEA40B or similar)*
*T1—Power transformer, secondary 24 volts, center tapped*
*Misc.—TV "cheater" cord and receptacle; diode heat sink (Delta NC403K or similar); capacitor clamp; mounting hardware; etc.*

Fig. 8. This power supply operates both the air purifier and fan and is mounted on the case wall above the h.v. supply. Use a heat sink for the two rectifiers.

**Operation.** With the front panel in place and the a.c. supply connected, the blower should start up and moving air should be felt at the outlet. Hold a lighted cigarette or other source of smoke near the ring of holes at the bottom of the column. If everything is working properly, smoke will enter the column, but the air coming out will be clean with no trace of smoke.

For conducting delicate experiments or for drying paint on small items, another cabinet such as that shown in Fig. 9 can be constructed. The vacuum-cleaner hose is coupled to this cabinet; and a small vent in one wall permits the air to escape from the interior. The front door can be constructed with a glass insert and a light bulb can be installed within the cabinet for viewing experiments.

When it comes to removing pollen, dust, etc. from an area as large as a room, the Transcipitor will work—to an extent. It does not have the capacity to handle a very large room; but, in a small room, with windows and doors closed, its effect is quite noticeable.

Every so often, inspect the metal column for dust accumulation. Remove the column from the cabinet, hold it over a paper sack and remove the bottom plastic cover. Shake the column gently to remove dust particles stuck to the sides. Clean the inside walls before reinstalling the column in the cabinet. The stack can be inspected from the outside by shining a flashlight through the bottom array of holes and looking into the other holes. If you can see the dirt, empty the column. –30–

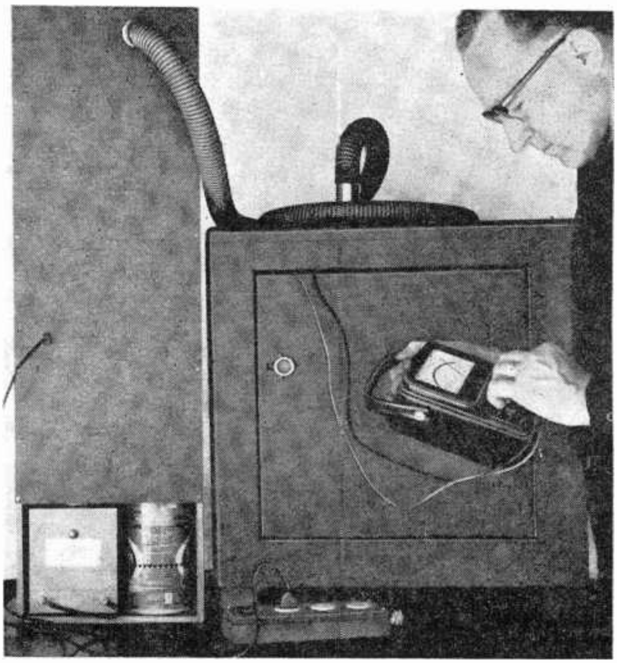
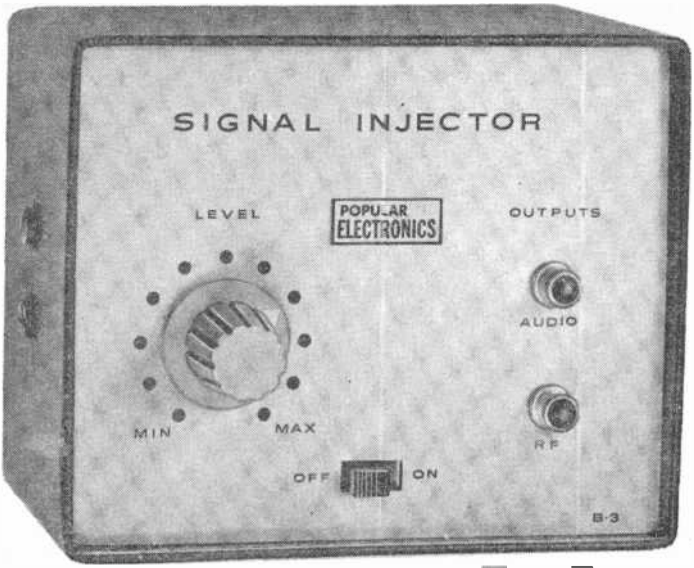


Fig. 9. The front door does not come down to the bottom of the cabinet to allow for air intake and observation of the indicator lamp. To prevent operation when the door is open, a TV "cheater" system is door operated.




# Build a Signal Injector

QUICK WAY
TO CHECK
AUDIO CIRCUITS

BY DON LANCASTER

THE SIGNAL INJECTION technique, most electronics technicians agree, is the quickest way to troubleshoot radio receivers and audio equipment. Using a signal injector, he can check an entire unit with only one hookup—no matter how complex the receiver or amplifier. Time-consuming voltage or ohmmeter checks are required only when the faulty stage is located.

Whether you plan to use it on the job or at home to keep your own equipment in working order, you will find many uses for the "IC Signal Injector" described here. This Injector is basically a battery-powered 1000-Hz multivibrator that generates square waves. The amplitude of the output square waves is continuously variable and is great enough, with the amplitude control wide open, to drive or test a loudspeaker. The Injector also provides a wide band-width r.f. signal which is extremely useful in testing AM receivers.

**IC EXPERIMENTER'S CORNER**

**NO. 5 of 5**

**Construction.** As you can see from the schematic diagram in Fig. 1, the circuit of the IC Signal Injector is very simple. However, since it does employ an integrated circuit with closely spaced pin leads, it is essential to use a printed circuit board. You can obtain a prepunched and etched board from the source listed in the Parts List, or you can make your own with the aid of the etching guide provided in Fig. 2.

Install the components on the board as shown in the photo in Fig. 3, paying particular attention to the orientation of the indexing groove on *IC1*. Use a low-wattage, fine-pointed tool when soldering component leads to the foil pattern on

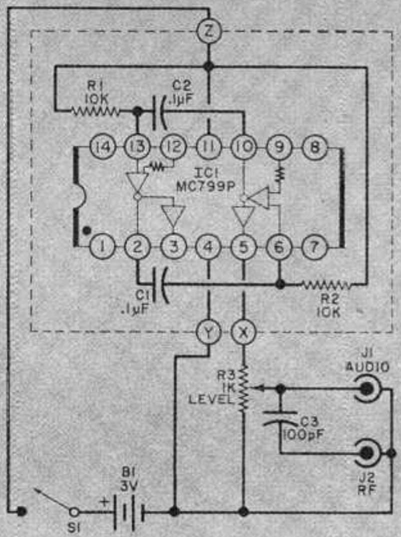



Fig. 1. One-IC circuit provides both audio and r.f. tracing signals; each output signal is continuously variable in amplitude.

### PARTS LIST

*B1—Two 1.5-volt D cells in series*
*C1,C2—0.1-µF, 10-volt disc capacitor*
*C3—100-pF disc capacitor*
*IC1—MC799P or HEP571 dual-buffer integrated circuit (Motorola)*
*J1,J2—Phono jack*
*R1,R2—10,000-ohm, ¼-watt resistor*
*R3—1000-ohm linear-taper potentiometer*
*S1—S.p.s.t. slide or toggle switch*
*Misc.—Keystone #176 battery holder; control knob; 5" x 4" x 2½" case; spacers; #6 machine hardware; hookup wire; solder; etc.*
*Note—The following items are available from Southwest Technical Products Corp., Box 16297, San Antonio, TX 78216: etched and drilled printed circuit board, $1.78; complete kit of parts, including prepunched vinyl-clad case but less batteries, $7.30, postpaid in U.S.A.*

the PC board, and apply heat only long enough to allow the solder to flow.

Next, mount *R3*, *C3*, *S1*, and *J1* and *J2* on the front panel. Use ⅜"-long spacers and #6 machine hardware to fasten the circuit board to the front panel in the position shown, and interconnect with hookup wire all components and the circuit board.

Battery *B1*, two 1.5-volt D cells connected in series, can be mounted to the rear panel of the enclosure with a dual-cell holder. However, if you plan to use another type of d.c. supply (see sidebar), make the hookup wires connected to *S1* and ground on the circuit board as long as necessary.

**How To Use.** To test the IC Signal Injector, close *S1* and connect a small 3.2- or 8-ohm loudspeaker to the AUDIO jack on the front panel. Rotate LEVEL control fully clockwise; you should hear a 1000-Hz tone coming from the speaker. An

### HOW IT WORKS

Integrated circuit *IC1* in Fig. 1 is a dual inverting buffer. Each input has two outputs, one low- and the other high-level. The low-level outputs are cross-coupled to each buffer input through capacitors *C1* and *C2* and charging resistors *R1* and *R2* to form an astable multivibrator.

One high-level output is fed to level control *R3* and AUDIO jack *J1* as a 1000-Hz signal. Internal isolation between low- and high-level outputs prevents heavy loads—or even short circuits—from stalling or radically shifting the operating frequency of the multivibrator.

Capacitor *C3* couples only the high-frequency energy (derived from the harmonic-rich leading edges of the square waves generated by the multivibrator) of the audio waveform to RF jack *J2*. At *J2*, there is available a series of impulses that can be used for signal injection and other AM radio receiver work.

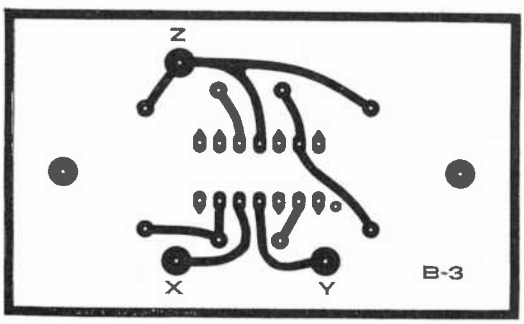
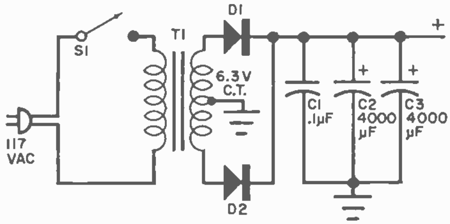



Fig. 2. Actual size circuit board etching guide is designed to accommodate components not mounted on front panel of the project. Isolated dots locate mounting holes.

## IC EXPERIMENTER'S POWER SUPPLY

The low-voltage power supply whose schematic is shown here can be used with any and all of the "IC Experimenter's Corner" projects presented in this series. Note that the supply has full-wave rectification and very good filtering to supply a stable d.c. voltage source for the IC projects. Output voltage from the supply is approximately 6.3 volts d.c.

The power supply can be assembled by any conventional method, including point-to-point wiring. Very few components are used and they are relatively small in size. Hence, the supply can be fit inside any of the enclosures suggested for the various projects.




### PARTS LIST

*C1—0.1-µF disc capacitor*
*C2,C3—4000-µF, 15-volt electrolytic capacitor*
*D1,D2—25 PIV, 1.5-ampere silicon diode*
*S1—S.p.s.t. slide or toggle switch*
*T1—6.3-volt, center-tapped filament transformer (Stancor No. P-6134 or similar)*
*1—line cord with plug*
*Misc.—Hardware, hookup wire, solder, etc.*
*Note—A kit of parts for the power supply is available at $4.50 postpaid from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216.*

alternate test method would be to connect the audio output of the injector to an audio system, setting the LEVEL control as needed, and listen for the tone.

The output from the RF jack on the injector is rich in harmonics to allow the checkout of the front ends in most receivers, including those that operate in the standard AM broadcast spectrum.

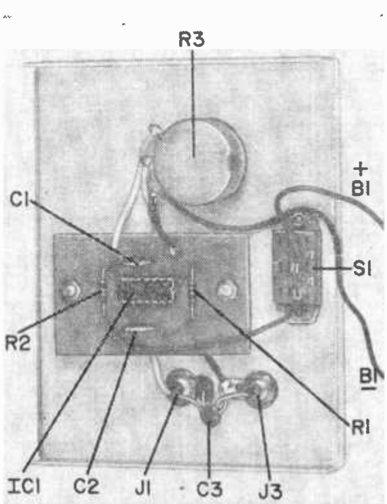



Fig. 3. Pay particular attention to location of notch on IC1 during assembly of project. Mount C3 between J1 and J2.

For example, assume you want to troubleshoot a faulty AM transistor radio receiver. First check the receiver's battery under load with a voltmeter. If it checks out good, proceed to your signal injection tests:

First inject the audio signal into the speaker, directly across the speaker terminals. If you hear the tone, the speaker is in operating order. Then, stage by stage, work back toward the front end of the receiver until the signal ceases to be heard from the receiver, at which time you will have located the faulty stage. (Note: when injecting into the audio circuits, use the audio output; for the i.f. and r.f. stages, use the r.f. output.) You should end up at the antenna input if the receiver is in perfect operating order.

If you wish to change the audio frequency of the tone, you can change the values of *C1* and *C2*. Higher capacitance values decrease the signal frequency, and vice versa.

Current drain for the IC Signal Injector is on the order of 80 mA at 3 volts d.c., assuring long life from a battery supply, especially if you use heavy-duty alkaline cells. If you prefer a built-in power supply, however, you can build your own by referring to the schematic diagram shown in box above. Or, you can use any good bench supply capable of delivering 1.6 to 6 volts d.c. at about 100 mA for full-load operation. -30-

# PHOTOCELL MOTOR CONTROL DEMONSTRATOR

*Great learning and teaching aid*

BY BOB KOVAL

THE MOST EFFECTIVE teaching aids and the most interesting science fair projects are working models of mechanical, electrical, or electromechanical devices. The photocell motor control demonstrator described here falls into this category. Unlike most such projects, however, it offers audience participation. Passersby are invited to turn on and off a motor themselves simply by shining a beam of light on a photocell.

By spreading out the circuit on a large 15¼" × 24" piece of ½"-thick plywood and running the wires on the front surface of the board a twofold objective is achieved. First, the project has eye appeal (an important consideration at science fair judgings). Second, since there is no hidden circuitry on the rear of the board, it is more convenient to explain how the system operates.

**How It Works.** Photocell *PC1* (see Fig. 1) is connected across the emitter/base junction of transistor *Q1*. Then when light strikes *PC1*, a slight voltage is generated which causes *Q1* to conduct. This, in turn, causes relay *K1* to be energized and power is applied to the motor. Simultaneously, *K3* is energized and latched in since its circuit is completed through the contacts of *K2*. (If the light beam is removed from *PC1*, relay *K1* will drop out.) The entire sequence takes place in just a few milliseconds, so just a quick flash of light on *PC1* is enough to operate the circuit.

To turn off the motor, a beam of light must be directed at *PC2*. which generates a voltage that causes *Q2* to go into conduction. Now, *K2* is energized, opening its normally closed contacts and de-energizing *K3*. When *K3* drops out, the motor circuit is opened, and the motor stops operating. Again, the action is almost instantaneous.

**Construction.** Begin by selecting a ½"-thick piece of clear plywood measuring 15¼" × 24" (or substitute a close-grained piece of particle board, cut to the same dimensions). If you use plywood, make sure the top lamination is birch so that there will be less of a tendency for the wood to crack after it has been painted. Sand the wood to obtain a smooth, flat finish, remove all wood dust, and apply a thin coat of sealer.

When the sealer has thoroughly dried, sand and clean once more. Now paint the board with thin coats of white or light gray enamel, using as many coats as nec-

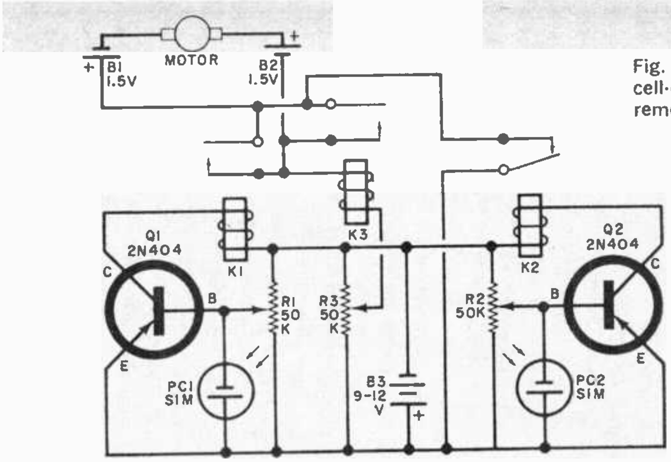



Fig. 1. Relays, operated by photo-cell-driven amplifiers, apply and remove power from the motor.

## PARTS LIST

*B1,B2—1.5-volt D cells (see text)*
*B3—9- or 12-volt power source (see text)*
*K1-K3—1000-ohm, 7-mA s.p.s.t. relay (Sigma Type 11F-1000-G/SIL)*
*PC1,PC2—Solar cell (International Rectifier Corp. S1M, or similar)*
*Q1,Q2—2N404, 2N1191, or SK3006 transistor*
*R1,R2—50,000-ohm, linear taper potentiometer*
*R3—50,000-ohm miniature trimmer potentiometer*
*1—24" x 15¼" piece of ½" birch plywood or close-grained particle board*
*1—3-volt d.c. hobby motor*
*Misc.—6-32 brass machine hardware; crimp-on solder lugs; #14 plastic-jacketed solid hook-up wire; sandpaper; sealer; white or light gray paint; battery connectors (2) for B1; etc.*

essary to give a hard reflective finish. Remember to sand and clean between each coat and allow sufficient time to dry.

Note that the board is painted before the holes are drilled. The reason for this is to prevent the screws from picking up paint when they are pushed through the holes.

Using the information provided in Fig. 2, drill ⅛" holes for parts mounting on the board. Drill through from the painted side so that as the drill point exits from the wood, any flaking or chipping will be on the unseen side of the board. (Note that holes for the relays are not dimensioned into the drawing since different types of relays require different mounting hole centers.)

Pass a 6-32 × 1" brass machine screw through each hole from the rear of the board, and fasten in place with machine nuts. Next, mount the motor in its appropriate location by any convenient method, and epoxy cement *PC1* and *PC2* in place. The size D flashlight batteries are soldered to #14 solid wire and connected to the appropriate screws with solder lugs, making a neat and sufficiently strong arrangement.

The potentiometers should be made self-supporting by soldering their contacts to solder lugs (see Fig. 3) and fastening them to the screws. The leads of transistors *Q1* and *Q2* are simply connected to the screws directly or via solder lugs.

Wiring is best accomplished by cutting the leads to the appropriate sizes and attaching to each end a solder lug, after which the leads are simply bolted into place with machine nuts. Use #14 solid, plastic insulated wire to obtain the neatest layout and so it can be seen for a considerable distance. Remember, the bold appearance of the wire adds to the success of your project.

The power source for the transistors consists of two 9-volt batteries in parallel. No switch is provided, since the battery connector easily snaps on and off the batteries. (When the demonstrator is to be used for long periods, such as at Science Fairs, two heavy-duty 6-volt lantern batteries can be connected in series and hooked up to the circuit in place of the 9-volt batteries.) Mount the 9-volt batteries as shown, and route their wires behind the board. The dashed lines in Fig. 3 show where the battery leads terminate in the circuit.

No switch is provided in the motor power supply since the D cells supply no

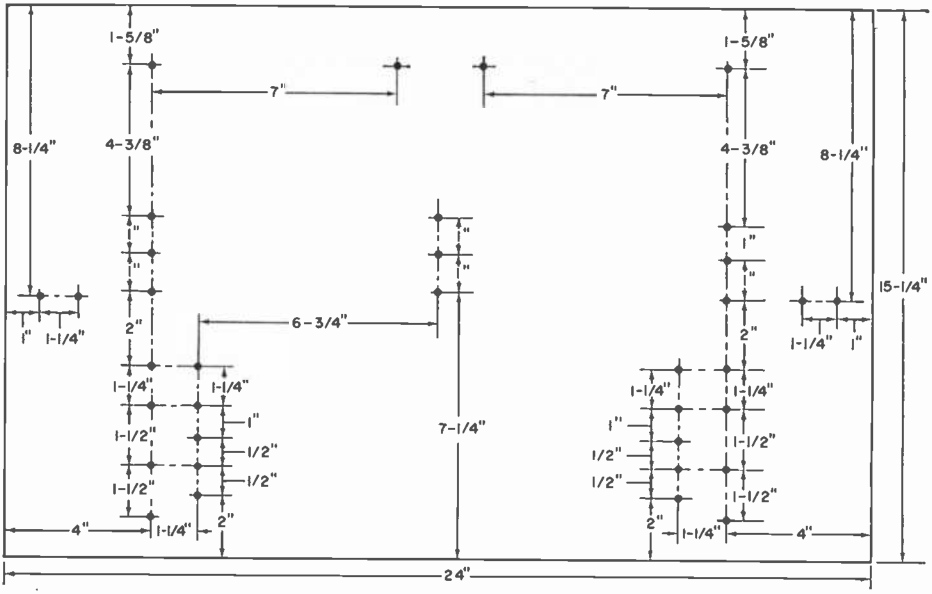



Fig. 2. Holes drilled through demonstrator board are for machine-hardware mounting screws and terminals.

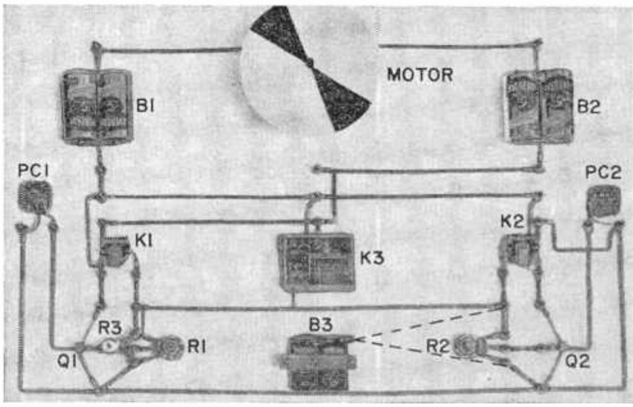



Fig. 3. Neat, symmetrical layout is accomplished with aid of heavy-gauge insulated wire and machine hardware.

power when the circuit is in standby. The D cells are in a series-parallel configuration to provide long life.

**Adjustment and Use.** After making a complete check of your wiring, cover *PC1* and *PC2*, and set *R1* and *R3* to their mid-range positions. Connect the 9- or 12-volt power source to the circuit, but do *not* install *B1* and *B2* yet.

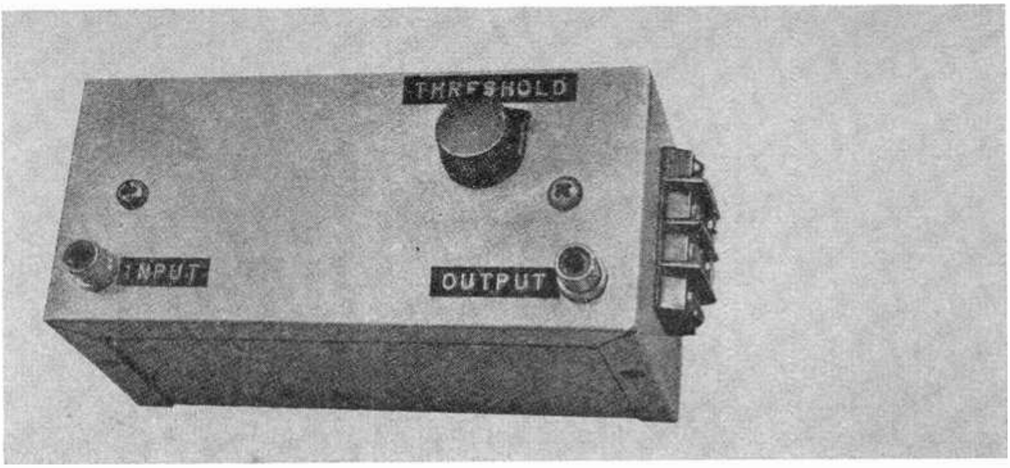
Uncover *PC1* and from about 5′ away, direct a light beam onto it and adjust *R1* so that *K1* is energized when the light strikes *PC1*. Move the beam away from *PC1*; *K1* should be immediately deenergized. Listen for the clicks.

Now, with *PC1* covered and *PC2* exposed, again from about 5′ away direct a beam of light onto *PC2*. Adjust *R2* so that when the beam strikes *PC2*, *K2* is energized. Then, when the beam is moved away from *PC2*, *K2* should immediately drop out.

Uncover both photocells. Now direct the flashlight beam onto *PC1*, and adjust *R3* until *K3* pulls in when the light strikes *PC1*. Check that *K3* remains locked in and is deenergized only when the light beam is directed at *PC2*.

Now install *B1* and *B2* and recheck the operation of the circuit.

Potentiometers *R1* and *R2* are sensitivity controls that can be adjusted for optimum circuit operation under whatever ambient light conditions exist in the vicinity of the demonstration setup. –30–




# Simple SCA Adapter

## FM MUSIC SANS COMMERCIALS

BY WILLIAM F. SPLICHAL, JR.

MANY FM BROADCAST stations transmit a secondary frequency-modulated subcarrier that is offset from the regular carrier frequency by 67.5 kHz. This sub-carrier channel (called SCA for Subsidiary Communications Authorization) provides the listener with continuous music programming that is uninterrupted by commercials, news, weather, or other reports. The SCA should not be confused with the 38-kHz subcarrier normally used to carry the complementary channel in normal stereo FM broadcasts; it is a separate system which no home entertainment receiver is designed to receive.

Perhaps you are already familiar with the SCA broadcasts. You hear them in such places as restaurants, supermarkets, and other commercial establishments as "background" music. If you would like to receive the SCA subcarrier with your present receiver, all you need is a simple multiplex adapter that can extract the program material without interference from the "normal" program channel transmissions from the FM station.

Adding the SCA Adapter (described in this article) to your FM receiver will in no way interfere with the receiver's normal operation. If anything, it will add to the receiver's versatility by providing an extra source of entertaining music.

**How It Works.** Referring to Fig. 1, the frequency-modulated SCA subcarrier is introduced into the adapter through input jack *J1* where it encounters a 67.5-kHz parallel-tuned circuit consisting of radio frequency choke *RFC1* and capacitor *C3*. Then it is passed through a high-pass filter made up of *C2*, *C4*, and *RFC2*. From here, the frequency-modulated subcarrier is amplified and limited by *Q1* and *Q2*, respectively. At this point, the frequency modulation will have been converted to a series of pulses whose frequency is the same as that of the original frequency modulation.

Once amplified and limited, the signal is coupled to monostable multivibrator stage *Q3-Q4*. Here, *Q3* is normally conducting, while *Q4* is held in cutoff. Potentiometer *R12* acts as a "threshold" control, allowing only the higher amplitude 67.5-kHz subcarrier signals to trigger the multivibrator. Each time the multivibrator fires, a negative pulse is generated at the collector of *Q4*.

Since the width of the generated pulse is essentially independent of the triggering rate, the average voltage level appearing at the collector of *Q4* will be directly proportional to the triggering frequency (the 67.5-kHz modulation) up

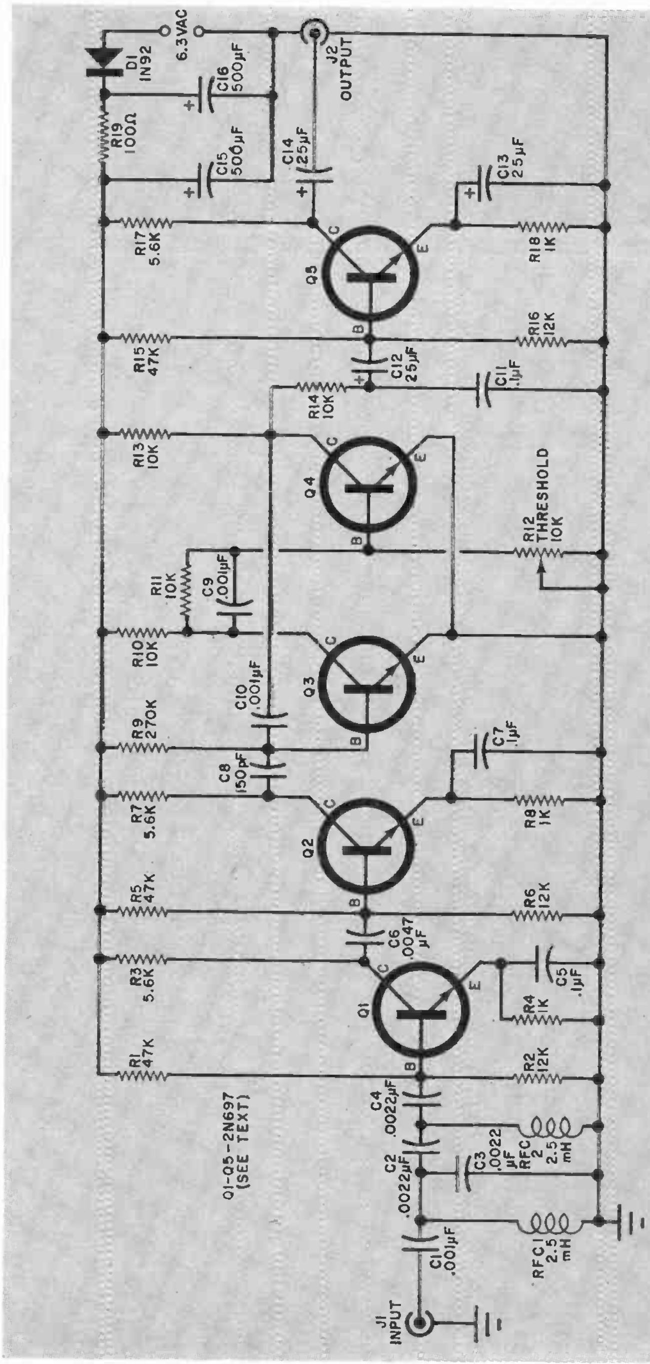



Fig. 1. Adapter circuit is almost a complete unit. All that is needed to make it totally independent is to connect a 6.3-volt, 1-ampere filament transformer, power switch, and a.c. line cord at upper right.

## PARTS LIST

*C1,C9,C10—0.001-µF disc capacitor*
*C2-C4—0.0022-µF (2200-pF) disc capacitor*
*C5,C7,C11—0.1-µF disc capacitor*
*C6—0.0047-µF (4700-pF) disc capacitor*
*C8—150-pF disc capacitor*
*C12-C14—25-µF, 15-volt electrolytic capacitor*
*C15,C16—500-µF, 15-volt electrolytic capacitor*
*D1—1N92 diode*
*J1,J2—Phono jack*
*Q1-Q5—2N697 transistor (see text)*
*R1,R5,R15—47,000-ohm*
*R2,R6,R16—12,000-ohm*
*R3,R7,R17—5600-ohm*
*R4,R8,R18—1000-ohm* — *All resistors ½-watt*
*R9—270,000-ohm*
*R10,R11,R13,R14—10,000-ohm*
*R19—100-ohm*
*R12—10,000-ohm linear-taper potentiometer*
*RFC1,RFC2—2.5-mH r.f. choke*
*Misc.—5" x 2¼" x 2¼" aluminum utility box; control knob; two-contact screw-type barrier block; tag strip (or printed circuit board); hookup wire; solder; hardware; etc.*

to the point where $Q4$ is cut off completely all the time. This point is slightly above the audio spectrum; therefore, the multivibrator will deliver an output for the full subcarrier modulation range.

Power for the SCA adapter is derived from any 6.3-volt, 60-Hz, source. A built-in half-wave rectifier/filtering circuit, consisting of *D1* and *C15*, *C16* and *R19*, provide the d.c. voltage required for proper operation of the adapter.

Although the SCA Adapter so far described makes use of five commonly available *npn* silicon transistors, germanium or *pnp* transistors can be substituted. Merely change the polarities or values of a few components. The changes that must be made for transistor substitutions are given in the table on the next page.

**Construction.** The circuit of the SCA Adapter is really very simple, lending itself to just about any type of chassis

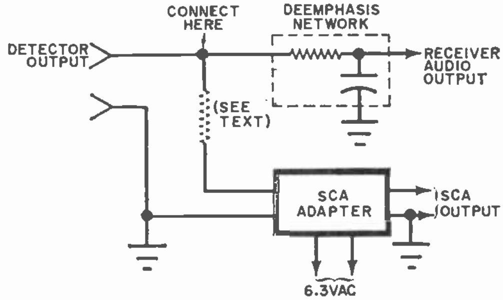



Fig. 2. For proper operation, SCA adapter must be connected between detector and deemphasis net.

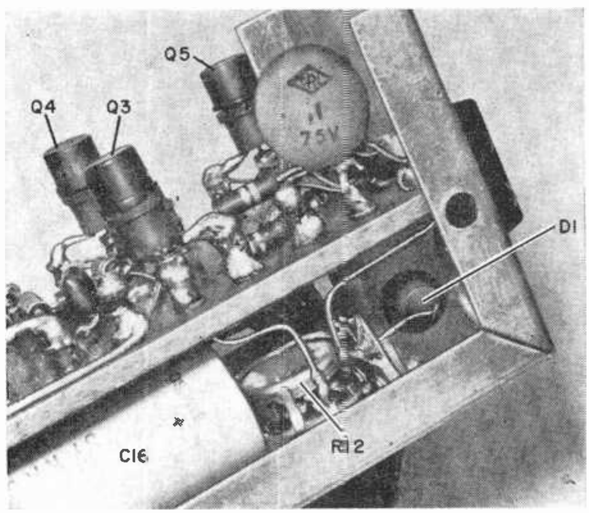
construction you prefer. While the photos show the original prototype assembled on a double-row solder-terminal tag strip, which is essentially point-to-point wiring, a printed circuit board layout would have been just as appropriate for assembly.

The circuit can be assembled in any enclosure you choose. A 5″ × 2¼″ × 2¼″ aluminum utility box was used for the prototype, with *J1* and *J2* mounted at opposite ends of the top surface. Threshold control *R12* was also mounted to the top, while to one side is located a screw-type barrier block for bringing in the 6.3 volts a.c. for the power supply circuit.

### A NOTE ABOUT THE LAW

There is no FCC Regulation that prohibits the reception of Subsidiary Communications Authorization broadcasts for private home entertainment purposes. However, there are regulations that do prohibit the use of SCA programs to promote business (or any other reason) by commercial establishments unless such businesses are authorized subscribers and use only the SCA channel to which they subscribe.

**Installation and Use.** To operate properly, the SCA adapter must be electrically connected to your receiver. This is a simple process that can be performed in a couple of minutes.




Transistors can be installed in sockets or soldered directly to lugs. Locate a.c. filter capacitors on underside of terminal board and the barrier block at end of box.

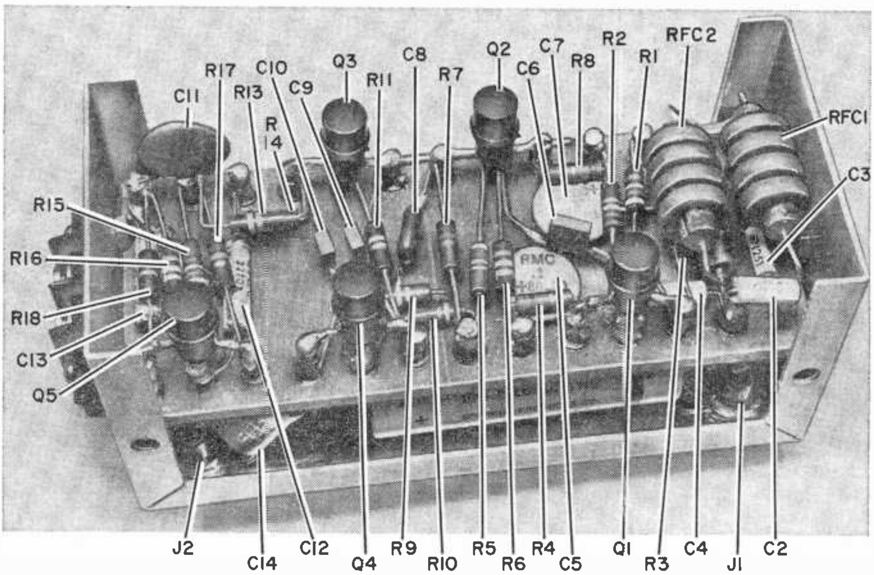
Before digging into your receiver (or tuner), carefully study its schematic diagram to locate the detector stage and resistor/capacitor de-emphasis network. Then, study the receiver layout to locate the point indicated in Fig. 2. You will notice that the SCA Adapter's input must be connected to a point *between* the detector output and the de-emphasis network. If the connection is made *after* the de-emphasis network, no SCA signal will pass through!

The filter (SCA Adapter) was designed to operate most efficiently with a 3000-ohm load. So, it may be necessary to couple the adapter to the receiver circuit via an isolation resistor with a value of a few thousand ohms, depending on your particular receiver.

Now, connect a twisted-pair cable between the 6.3-volt a.c. winding on your receiver's power transformer and the screw-type barrier block on the adapter. If 6.3 volts a.c. is not available from your receiver, use a separate 6.3-volt filament transformer. Then connect a shielded audio cable from the adapter's output jack to the auxiliary (AUX) input jack on the rear apron of your receiver.

Turn on and tune the receiver to a local FM station known to be broadcasting SCA program material. Set the receiver's source switch to AUX and function switch to MONO, and adjust threshold for the clearest audio. (Note: in some receivers, when the source switch is moved out of the TUNER or FM position, the power is disconnected from the tuner. In this case, connecting the output of the adapter to the receiver's AUX input will not work—a separate amplifier will be required unless you can figure a way of restoring power to the tuner when the source switch is in the AUX position.

Although a printed circuit board or multi-lug terminal strips could be used, wiring is just as simple with a parallel-row terminal board having 13 solder lugs per row as shown here.




| TRANSISTOR SUBSTITUTION TABLE | |
|---|---|
| **Transistor Type** | **Changes** |
| PNP silicon | Invert polarities of D1, C12-C16 |
| NPN germanium | Change R2,R6,R16 to 6800 ohms |
| PNP germanium | Combine both of the above changes |

Tuning across the dial, you may find that several SCA programs are available. This is true especially in the large cities where different types of background music are required by the subscribers. So much the better for your choice of programs. -30-


BY JOHN S. SIMONTON, JR.

# MODIFY YOUR ELECTRONIC GUITAR SOUND

## VARY "ATTACK" TIME WITH THIS DELAY UNIT

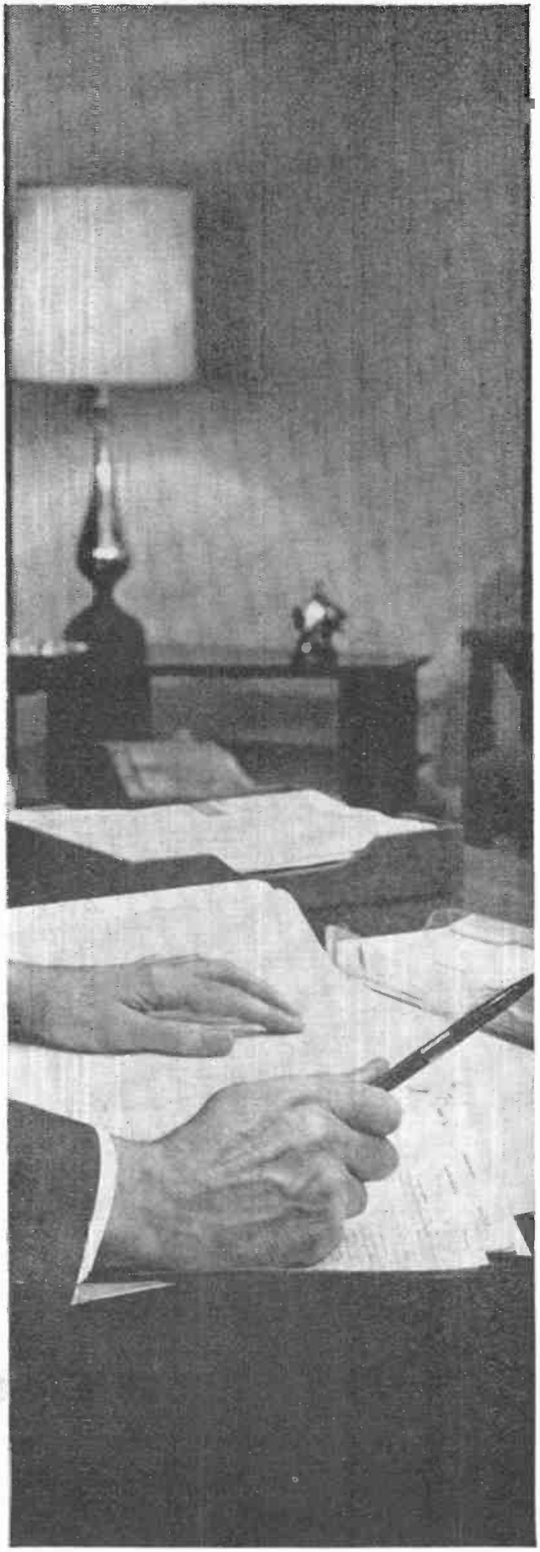
EVERY MUSICAL instrument owes its unique sound to a certain combination of inherent characteristics. For instance, the number of harmonics produced, combined with their magnitudes and phase relationships, play an important role in creating the instrument's distinctive sound.

Another important characteristic is attack time—the speed with which sound is built up after a tone is initiated. Reed instruments such as the clarinet produce sounds which can be described as "soft" because they have a relatively slow attack caused by the time it takes for the reed to build up to its maximum vibration. On the other hand, instruments such as the guitar have a very rapid attack because maximum amplitude vibration is started as soon as the string is plucked or struck.

By changing an instrument's attack, we can make it sound different and, at the same time, not like any other instrument. That is what the "Attack Delay Unit" (ADU) does for the guitar. By slowing down the guitar's attack, a brand new sound can be obtained. The effect can also be produced by recording a guitar passage on tape and then running the tape backwards through the player. Instead of sharp, clean tones, a hard-to-describe "whoop" is heard for each note played. Although the note is on pitch, it doesn't sound like it belongs to any known musical instrument.

Using the ADU, attack can be delayed for a very short period so that only the sound of the pick hitting the string is eliminated or it can be delayed so that the music builds up over the length of a run. A foot control switch makes it easy to delay particular notes selectively.

**Construction.** The circuit of the ADU, shown in Fig. 1, is fabricated on a printed circuit board whose foil pattern is shown in Fig. 2. Once the board has been made (or purchased), install the components as shown in Fig. 2. Be sure to install the semiconductors and electrolytic capacitors correctly. Use a heat sink (such as long nose pliers) on the transistor and diode leads while soldering to avoid possible thermal damage. Also, use a low-power (35 watts) soldering iron.





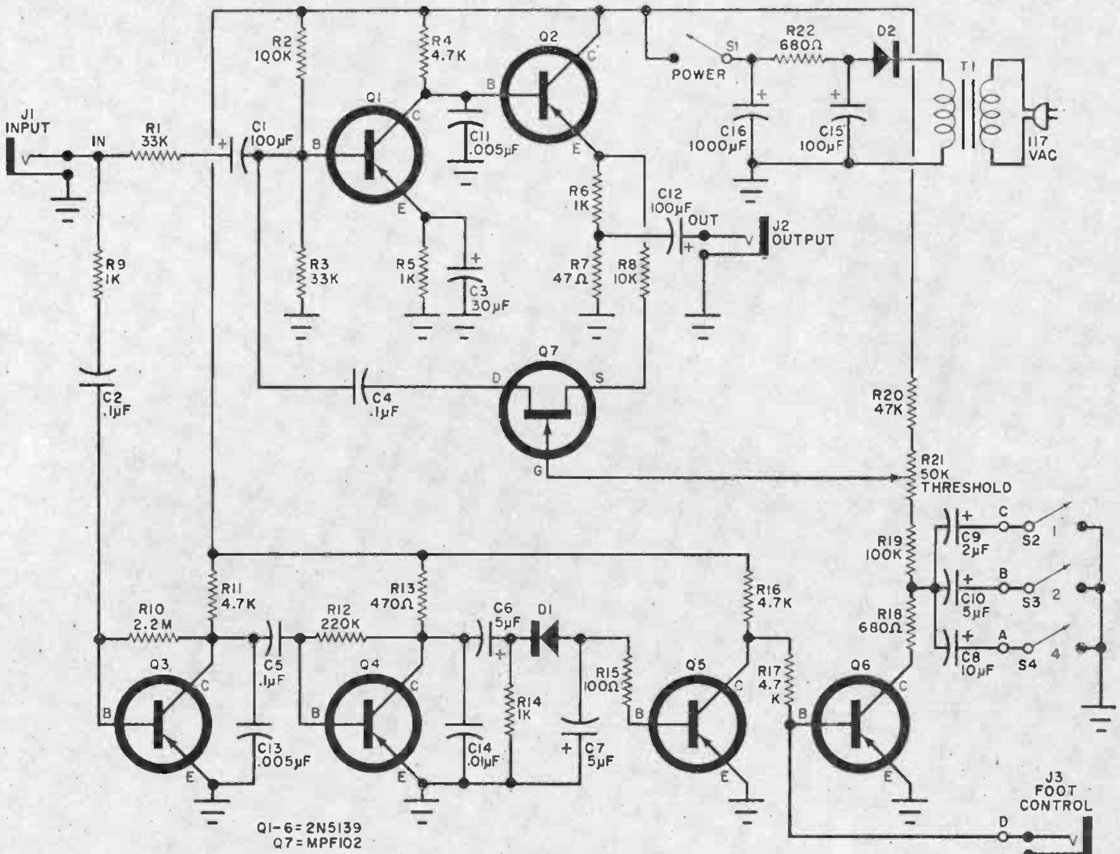



Fig. 1. The circuit is essentially a two-transistor, high-gain audio amplifier with negative feedback controlled by a FET. The remainder of the circuit generates the feedback control signal which is determined by a switch-selected capacitor.

## PARTS LIST

*C1,C12—100µF, 6-volt electrolytic capacitor*
*C2,C4,C5—0.1-µF disc capacitor*
*C3—30-µF, 6-volt electrolytic capacitor*
*C6,C7,C10—5-µF, 6-volt electrolytic capacitor*
*C8—10-µF, 6-volt electrolytic capacitor*
*C9—2-µF, 6-volt electrolytic capacitor*
*C11,C13—0.005-µF, disc capacitor*
*C14—0.01-µF, disc capacitor*
*C15—100-µF, 15-volt electrolytic capacitor*
*C16—1000-µF, 10-volt electrolytic capacitor*
*D1,D2—1N4001 diode*
*J1-J3—Open-circuit phone jack*
*Q1-Q6—Transistor, pnp (National 2N5139 or similar)*
*Q7—Field-effect transistor (Motorola MPF102)*
*R1,R3—33,000-ohm*
*R2,R19—100,000-ohm*
*R4,R11,R16,R17—4700-ohm*
*R5,R6,R9,R14—1000-ohm*
*R7—47-ohm*
*R8—10,000-ohm*
*R10—2.2-megohm*
*R12—220,000-ohm*
*R13—470-ohm*
*R15—100-ohm*
*R18,R22—680-ohm*
*R20—47,000-ohm*
*All resistors ½-watt*
*R21—50,000-ohm trimmer potentiometer (PC type)*
*S1-S4—S.p.s.t. toggle switch (see text)*
*T1—Power transformer, secondary, 12.6 volts at 300 mA.*
*Misc.—Chassis, line cord, rubber grommet, 7-lug terminal strip, ¼" insulated spacers (4), rubber feet (4), wire, solder, etc.*
*Note—The following are available from PAIA Electronics, P.O. Box 14359, Oklahoma City, OK 73114: etched and drilled PC board, $3.00, postpaid continental U.S.A.; complete kit of parts including PC board and case, $19.25, plus postage for 3 lb. Oklahoma residents add 3% sales tax.*

Connect sufficiently long leads to the various external connection pads before mounting the board in the chassis.

Almost any type of metal chassis may be used as long as it will hold the PC board, the power transformer, and the associated rectifier and will permit the installation of four switches on the front and three phone jacks on the back.

The choice of switches for *S2*, *S3*, and *S4* should be made carefully. During use, it may be necessary to manipulate these switches rapidly in various combinations so they should have large paddle-type handles and operate with a light pressure. Any type of s.p.s.t. switch may be used for power switch *S1*.

Mount the power transformer (*T1*) and a seven-lug terminal strip at one end of the chassis and drill a hole in the wall for the line cord. Put a grommet in this hole. Build up the power supply and attach the positive lead to *S1*. Do not ground either side of the a.c. to the chas-

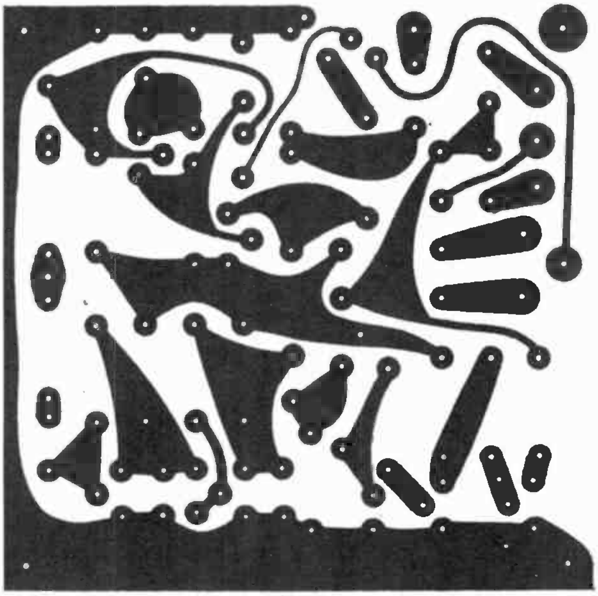
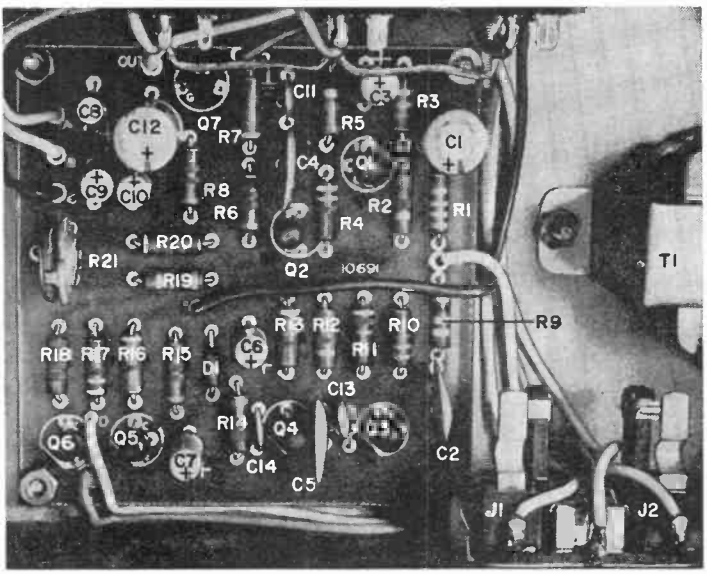
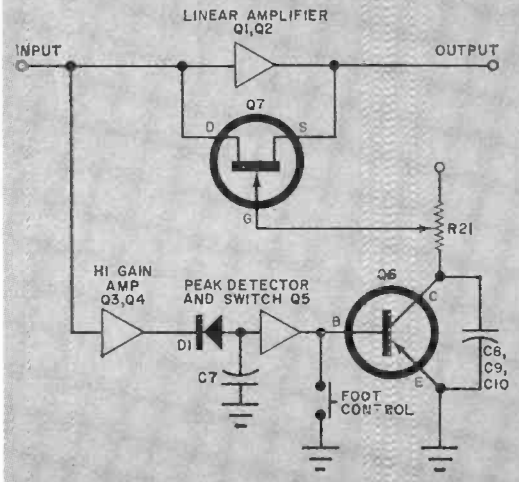


Fig. 2. The actual size foil pattern is shown at the left, while component installation is illustrated below. The PC board is mounted on four spacers, and the power supply is mounted elsewhere in the cabinet. Alternatively, the ADU can be built in an existing amplifier console, with the control switches readily accessible to user.



## HOW IT WORKS




With no signal input, transistor *Q6* is turned on and acts as a short circuit around the switch-selected capacitors *C8*, *C9*, and *C10*. The gate bias of FET *Q7*, in this case, is such that the FET is turned on and its low source-to-drain resistance results in a large amount of feedback for the linear amplifier formed by *Q1* and *Q2*. Since this amplifier is designed for unity gain with no feedback, for all practical purposes, no input signal passes through it.

When there is an input signal, it is amplified by high-gain amplifier *Q3* and *Q4* and then rectified by peak detector *D1*. The resulting d.c. voltage appearing across *C7* turns on *Q5*, which then turns off *Q6* and allows the selected capacitor to charge. As the capacitor charges, the bias on *Q7*'s gate changes to increase its source-to-drain resistance. The increase in resistance around the linear amplifier loop decreases the feedback and causes the gain to go from nearly zero to approximately unity. The time required for this to take place depends on the capacitance value selected. Trimmer potentiometer *R21* acts as a threshold control and sets the bias on the gate of *Q7* when *Q6* is on.

When the foot control switch is closed, the base of *Q6* is shorted to ground, allowing the selected capacitor to remain charged. This holds the linear amplifier at unity gain and defeats the attack delay.

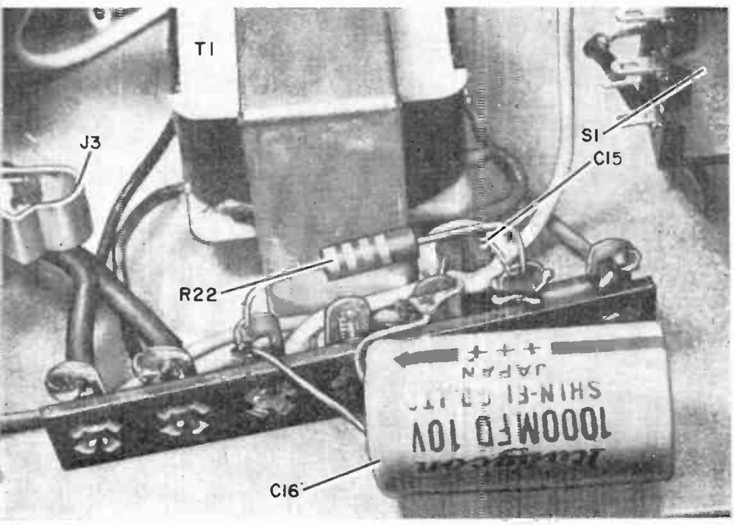
sis. Mount the three capacitor-selector switches (*S2*, *S3*, and *S4*) on the front wall and three phone jacks (*J1*, input; *J2*, foot control; and *J3*, output) on the rear wall.

Mount the PC board on four ¼" insulated spacers so that *R21* will be accessible from the side. Wire the complete circuit as shown in Fig. 1. Put four rubber feet on the chassis bottom to keep it from slipping around when in use.

**Setup.** Prepare the unit for operation by running a short length of cable from the output of the ADU to your amplifier input and plugging the instrument output into the ADU input. For the time being, do not use the foot control switch. Turn the ADU on and set the delay to 4.

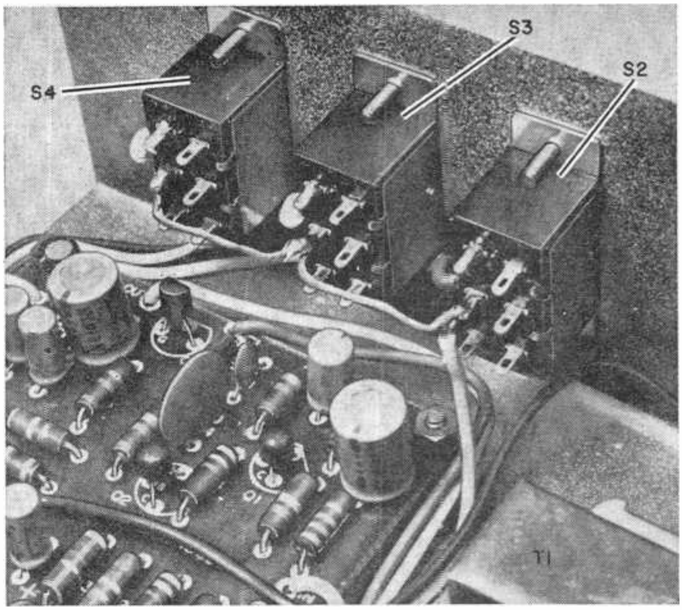
Since a certain minimum signal is required to operate the delay unit, the instrument's gain should be turned up almost all the way and the volume adjusted by using the amplifier's control.

The only thing that needs adjustment in the ADU is potentiometer *R21*. At one




The power supply is built up on a seven-lug terminal strip which also carries the input a.c. line cord. The arrangement is not critical, but make sure that neither side of the power line makes electrical contact with the chassis.

When obtaining switches for the delay selection, remember that they may be operated a considerable number of times, in various orders, and possibly in a hurry. Pick switches with long handles and smooth operation.

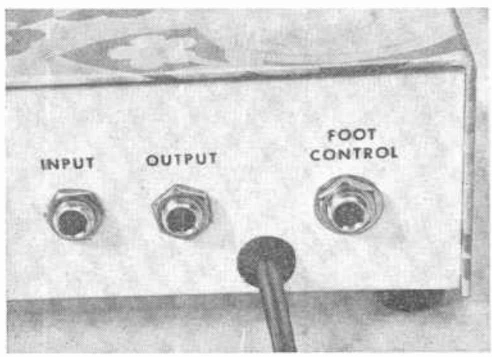



end of this pot's rotation, there is little or no delay in the instrument attack; with the opposite setting, there is no sound for an instant and then the volume will come up full. Between these two extremes, are a variety of settings which can be selected strictly as a matter of personal taste. Ideally there should be very little or no sound when the note is first struck, followed immediately by a noticeable increase in volume with a smooth glide to maximum.

**Operation.** The three delay switches on the ADU can be used singly or in combinations to yield up to seven different delays. The numbers above the switches represent some arbitrary unit of delay (which varies with the setting of *R21*) and may be added together to get the longer delays. For instance, if the "2" and "4" switches are down, the attack delay is 6 times longer than if only the "1" switch is down.

Since the ADU requires a short, no-signal dead time for the circuits to reset, all strings on a guitar must be silenced before the next chord or note is struck. If single notes are being played, just lifting the finger from the finger board will ordinarily accomplish the deadening, but for chords with open strings, it is necessary to deaden the strings with the palm of the strumming hand. The resetting time is actually very short (on the order of a tenth of a second) so very rapid runs can be played with the delay still occuring on each note.

The foot control switch is a single-pole, single-throw type and can be housed in a sturdy case of metal or a block of wood. The switch can be a push-on/push-off type but experience has shown that a spring-loaded, normally closed switch works best. With this arrangement, selective delay can be accomplished by pressing the switch when delay is desired and releasing it to sustain a note. -30-




Phone jacks for input, output, and foot control are located most conveniently on back of chassis. Colorful vinyl cloth was used to cover prototype.

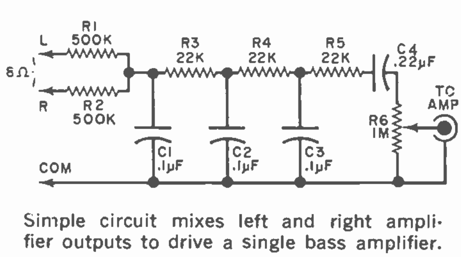
# BUCK UP BASS RESPONSE WITH A SUPER WOOFER

BY ERIC PAVLAK

ONE OF THE BEST methods of getting good bass response from your stereo system is to use a super-powerful woofer in addition to your regular speaker systems. Since the very lowest bass notes, those under 100 Hz, are non-directional, a single super woofer setup will serve both stereo channels. Consequently, your regular speaker systems can have less than full bass response and still be quite satisfactory.

A super woofer, for best results, should be powered by a separate amplifier. This provides several distinct advantages over systems connected by an LC crossover network. For one thing, the independent bass amplifier (actually, it can be any amplifier with very good bass response) can be adjusted without interfering with the main amplifier. So, the volume level of the super woofer can be set in relationship to the rest of the system without introducing resistance in series with any of the speakers—a resistance that would prevent good speaker damping.

Also, a separate amplifier allows the lowest bass to be increased without upsetting the balance of the rest of the system. And it permits the use of steep-sloped filters of 18-dB/octave that would otherwise be impractical. One further advantage of using a single super woofer is that no phasing problems exist.



Simple circuit mixes left and right amplifier outputs to drive a single bass amplifier.

**The amplifier** for the super woofer should be coupled to both the right and left channel outputs of your regular amplifier. For this, you will need a circuit like that shown in the schematic diagram. This circuit is simpler than an electronic crossover network with active elements and it introduces less distortion than a passive filter which uses both capacitive and inductive elements.

Crosstalk introduced by this adapter circuit is minimal. Signal level is adjusted by control *R6*. When assembling the circuit, mount it inside a shielded box. Parts placement is not critical, but be sure to use shielded cable between the circuit output and the input of your super woofer amplifier.

The super woofer itself can be as big as your listening room will allow and as expensive as your budget can take. Several 12″ or 15″ woofers can also be used; or, better yet, you can use one of the horn-type woofers available from Altec or Klipsch.

**The best place** in a room to set the super woofer is in a corner. And since only the lowest frequency sounds are to be radiated, it matters little if furniture or thin draperies are located between the super woofer and listener. But be wary of standing waves which can result when large, flat surfaces are directly opposite the speaker.

A super woofer is just the thing to improve weak bass systems. Adding one is relatively simple and inexpensive yet it can provide really thunderous lows without mid-bass thumping or booming. —30—

# KOOL-KEEPING KWIZ

BY CARL KOHLER

*How well do you cope with life's bruises and abrasions?*

IT'S A PHILOSOPHICAL fact that into every existence a little pain must crawl. The question is, "How well do you withstand the pain?" To find out, take the following pseudological test, consisting of several theoretical **Life Situations** no electronics enthusiast is likely to encounter. The test does not purport to increase your self-knowledge, but it may add to your confusion. A dubious scoring system, found at the conclusion of the test, is based on whichever of the multiple-choice reactions you instinctively and neurotically selected. No cheating now—and good luck!

### Supermouth

*While attending a social gathering, you hear a loud-mouthed type bragging that his CB antenna has broken the height regulations for years, and you realize that he is unaware that another guest is the FCC Field Engineer. What would you do?*

A. Whisper a warning.
B. Feel embarrassed for him.
C. Belch nervously.
D. Listen carefully as he prattles on.
E. Ask the lout to repeat his brag to the FCC employee.

### Hurry—I'm Double Parked

*A neighbor with more gall than most borrows your constant-current ohmmeter. Within an hour he brings it back, asking you to repair it so he can get on with his testing. What would you do?*

A. Graciously comply with his request.
B. Coldly refuse.
C. Feel stunned.
D. Talk real dirty.
E. Brandish a soldering iron at him.

### It Is Nobler to Receive

*Quite accidentally you learn that your wife is planning to give you a costly set of living-room furniture and drapes for a wedding anniversary present. What would you do?*

A. Feel pleased.
B. Try to talk her out of it.
C. Give her a bound file of POPULAR ELECTRONICS project schematics.
D. Surprise her with a collection of every other Heathkit item on the market.
E. Sulk.

### I've Gathered You Here

*Having generously agreed to share your vast knowledge of solid-state theory with an electronics club, your lecture is off to an impressive start when your mind goes blank on the whole subject. What would you do?*

A. Admit you can't remember a thing.
B. Ask for help in getting restarted.
C. Smoothly divert their interest to a faked-out history of electronics.
D. Sing and dance.
E. Sprint for the nearest exit.

## I Gave at the Office

*Having worked long and hard to build your own specially modified Universal Frequency Counter, you find your wife has given it to a shut-in to take apart for the therapeutic fun of having something to do. What would you do?*

A. Consult your attorney about institutionalizing her.
B. Report her to the Westinghouse people.
C. Stamp your foot.
D. Offer the shut-in some tools.
E. Proceed with the next project—from the safety of another country.

## Part 95 Violation

*You're a bachelor and you've finally succeeded in becoming chummy enough with the curvy little blonde who moved into the next-door apartment to be invited over for a friendly drink. Once there, you discover that the delectable creature is blithely operating a CB rig with a 250-watt linear. What would you do?*

A. Reprimand her sternly.
B. Report her to the FCC.
C. Decide to meet another girl.
D. Drink your drink and say nothing.
E. Teach her how to work skip on channels 24A and 24B.

## But I Learned That in School

*By sheer accident your cable TV has gone berserk and channel 13 is showing "educational" stag films. What would you do?*

A. Tune to another channel.
B. Have the cable TV send a repairman.
C. Keep the information to yourself.
D. Call the neighbors in for a party.
E. Write a protesting letter to FCC Commissioner Johnson.

## Wanted: One Anechoic Chamber

*After laboring diligently for weeks you've scratch-built a magnificent hi-fi stereo system with speakers and a beautiful cabinet of your own design. Just as you're ready to try it out, your mother-in-law, who is visiting you and your wife, becomes ill, and the doctor prescribes quietude—bordering on complete silence—for her recovery. What would you do?*

A. Wait with clenched teeth.
B. Have the doctor's credentials checked out.
C. Go on an aspirin diet.
D. Buy her a matched set of earplugs.
E. Write a complaining letter to "Dear Abbey".

## You'll Never Get It off the Ground

*A slight acquaintance lets you talk him into installing your multi-proportional R/C system in his newly built, highly expensive model airplane—and it crashes into splinters. What would you do?*

A. Offer to replace the airplane.
B. Buy him a cup of consolation coffee.
C. Deride his flight dexterity.
D. Yawn.
E. Bill him for your ruined system.

## Of Course They Could

*While casually tuning your short-wave receiver, you overhear two stations discussing a plot to kidnap the Statue of Liberty and hold it for ransom. What would you do?*

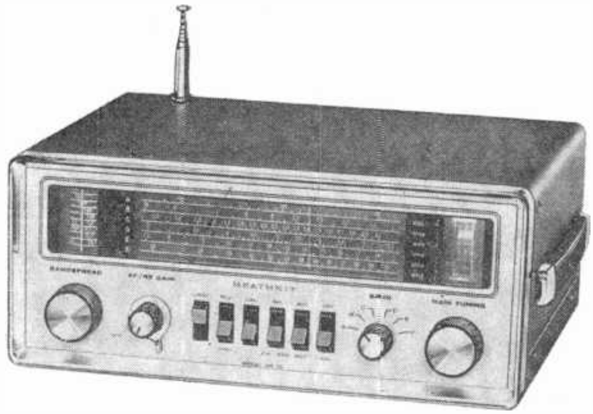
A. Call President Nixon direct.
B. Mail an anonymous letter to the FBI.
C. Jam their radio frequency.
D. Fly United to Bedloe's Island to see it happen.
E. Offer to sell a statue of Sophia Loren to the Government as a replacement.

## CHECK YOUR SCORE HERE

All righty, now that you've checked the various reactions to these dismal *Life Situations*, it's analysis time. If you have mostly A reactions, it could indicate that you *are* Mr. Straight Arrow. Mostly B reactions might mean that you're a flexible individual. Mostly C reactions clearly indicate a warm, human will to survive. Mostly D reactions show that you tend to have an enviable Kool indeed. If you have mostly E reactions, it's a sad hint that you are an accomplished loser. Of course, if you actually bothered to check any choices at all, you're putting *us* on more than we did you with this screwy thing. —30—

# the Product Gallery

## REVIEWS AND COMMENTARY ON ELECTRONIC GEAR AND COMPONENTS




### GENERAL COVERAGE RECEIVER (Heathkit GR-78)

MAYBE it's hard to believe that a kit which goes together as readily as does Heath's new GR-78 can look so attractive and also perform so well—but it's true. With its low-profile styling, handsome two-tone gray cabinet and polished aluminum bezel, this 190-kHz to 30-MHz solid-state portable receiver matches in appearance what it can do as a top-notch performer.

Within just a little more than 24 hours after its assembly and calibration—and using only the receiver's built-in 39″ whip antenna—this reviewer's GR-78 had logged stations on all six continents!

Let's take a look at what makes such performance possible in a receiver costing only $130. The two factors most important in determining the value of any general-coverage receiver are its selectivity and its useful sensitivity. The term "useful sensitivity" is significant, because the ability of a receiver to bring in weak stations is determined, not by gain alone, but by gain in the presence of a low receiver-noise level. Unless a signal can make it through the hiss or "shot noise" generated in the front end of every receiver, the signal cannot be heard, no matter how high the gain of the stages which follow.

**The Important Front End.** The tuner in the GR-78 uses the latest in MOSFET's* to maximum advantage, providing high gain, minimum crosstalk, and a low inherent noise level (typically 3.5 dB at 200 MHz for these transistors). It is especially well shielded and, most important of all to the average kit builder, it has short leads for minimum stray capacitance. It is by far the *easiest* tuner to assemble that we have ever seen.

Each of the tuner's four stages is wired as an assembly on a separate PC board and then plugged into its own shielded compartment. The result is a neat, factory-made appearance and high gain with high stability. Six ferrite-core pretuned coils are used in each stage since the receiver covers 190 kHz to 30 MHz in six settings of the band switch instead of the usual four or five.

The GR-78 can be aligned without instruments if necessary; but to peak it for top performance and sensitivity all you need is a calibrated signal generator and the receiver's own built-in S-meter. It isn't mentioned in the Assembly Manual, but you can zero the calibration in very close to the dial legends by zero-beating the built-in 500-kHz crystal calibrator against WWV, then zero-beating your signal generator against the calibrator. We aligned our GR-78 by this method and have found, so far, that calibration has been satisfyingly stable for a receiver in this price range. There is some slight drift for the first few minutes as the receiver "warms up," but even this would not be noticeable were it not for the GR-78's outstanding selectivity.

**Latest in I.F. Amplifiers.** Sensitivity is of little value without selectivity—especially on

*They are RCA's dual-gate MOSFET'S with built-in gate-protection circuits. Special back-to-back diodes are formed into the transistor pellet and connected between each of the two gates and the source electrode of the FET. These diodes shunt any transient potential exceeding ±10 volts, thereby protecting the gates in the course of general handling and application. Thanks to the dual-gate configuration, feedback capacitance is low (high gain is obtained without neutralization), oscillator pulling is virtually nonexistant and the a.v.c. is as simple as that of a receiver using vacuum tubes.

crowded short-wave bands. An i.f. pass band only 7 kHz wide at 6 dB down, with adequately steep sides, provides this receiver with excellent selectivity. It's done with ceramic filters—four tiny plastic encapsulated units, each no larger than your little fingernail.

Not only do the ceramic filters determine the intermediate frequency and the width of the i.f. pass band, they do away with i.f. alignment forever! There are no i.f. transformers to adjust in the GR-78. The ceramic filters will remain tuned within 0.5% for at least 10 years! Intermediate frequency is 455 kHz except on the highest frequency setting of the bandswitch (18 to 30 MHz), where a double-conversion circuit is used with a first i.f. of 4.034 MHz. The oscillator for the second mixer is crystal controlled.

**Other Features.** The GR-78 has both a highly stable BFO and CW/SSB product detector. A MOSFET, identical to those used in the front end, is the product detector and there is no significant pulling of the BFO. Also included are a switchable series noise limiter; switchable amplified a.v.c.; a receive-standby switch; manual r.f. and a.f. gain controls; and bandspread with speed reduction tuning and a dial which can be calibrated for either the amateur bands or the international broadcast bands, as you prefer. It's as simple as selecting the appropriate decal for the bandspread dial drum.

The 9.6-volt internal battery is a high-quality nickel-cadmium rechargeable unit with a 500-mA-hr capacity, which means that, beginning with a full charge, you can run the receiver for about eight hours at a reasonable listening level before recharging is needed. A transformer-type 120/240-volt a.c. charger is built into the receiver, and there's a separate circuit for charging from a 12- to 15-volt source—such as the electrical system of a car or boat.

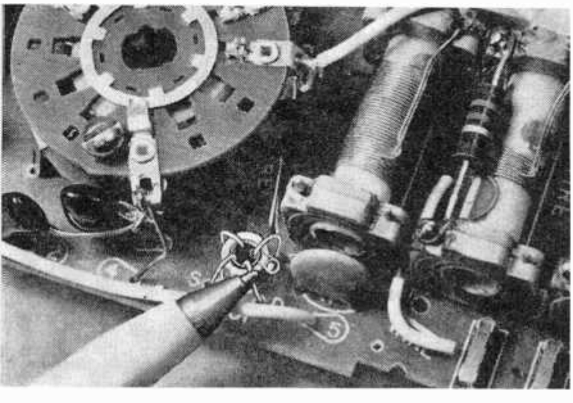
The GR-78 went together more easily than many a kit-type broadcast-band receiver this reviewer has assembled. You don't need the dexterity of a circus performer to build it—there are no hard-to-reach places for either the screwdriver or the soldering iron. Assembly instructions are clear, easily understood, and thoroughly detailed with illustrations. Heath supplies a 120-page Assembly Manual with the kit.

However, take care in soldering the trimmers to the PC boards in the tuner. There is plenty of room to accommodate the solder tabs on the trimmers, but assembly without careful attention to the positioning of the tabs can result in a short circuit to adjacent soldered connections. Look all around the tab for clearance before applying the iron.

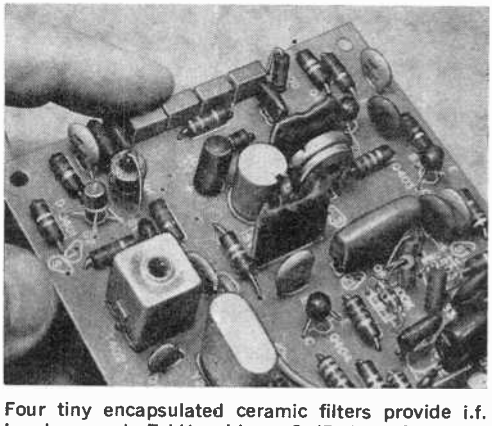
The S-meter is attached to the front subpanel with only one screw. The meter mounting tabs are thick, so probably single-screw mounting is sufficient; but, if you'll feel better about it, you can secure the meter's other mounting tab to the subpanel with a couple of spots of plastic household cement.

The GR-78 is a lot of good receiver for the money. Conservatively designed and ruggedly built, it is a fine performer at home or on the go. (Front-view photo and ceramic-filter i.f. response curve courtesy Heath Co. MOSFET data courtesy RCA.)

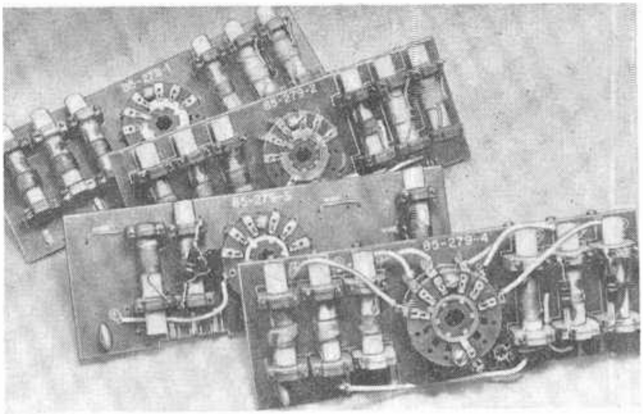
Circle No. 89 on Reader Service Page 15 or 95



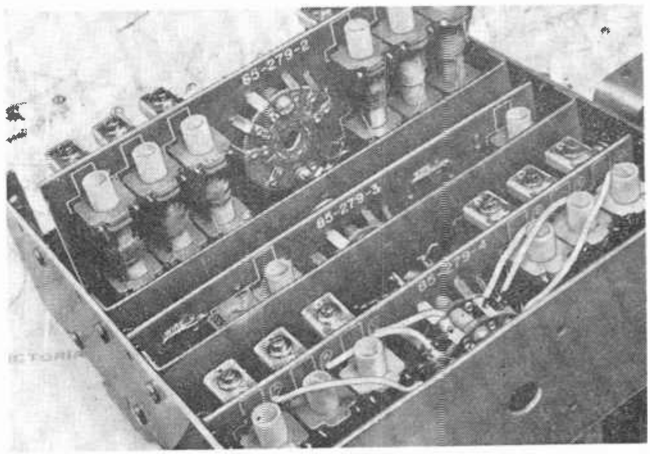
Because of their sensitivity to damage from stray voltages induced by any one of a number of ways, including handling, MOSFET's come with protecting shorting rings. Rings must remain in place until MOSFET's are installed and soldered into circuit.



Four tiny encapsulated ceramic filters provide i.f. bandpass only 7 kHz wide at 6 dB down for excellent receiver selectivity. Capable of remaining tuned within 0.5% accuracy over period of at least ten years, these filters replace i.f. transformers.

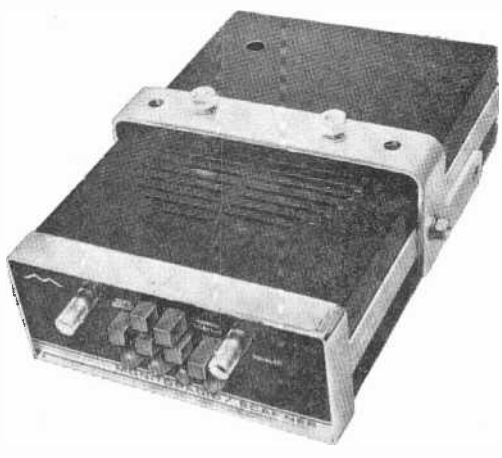


These four printed circuit boards actually represent the band switch and tuning components in front end of GR-78. Printed circuit design slashes assembly time and virtually eliminates chances of wiring errors.



For maximum stability, band switch decks are mounted in chassis with metal shields isolating them from each other. Then shaft is installed.

## REGENCY MONITORADIO SCANNER (Model TMR-4)



THE DAY of the blinking red light is upon us. Garage and gasoline service stations, volunteer firemen, newspaper reporters, and hundreds of just plain listeners are buying VHF monitor receivers. The latest innovation is the VHF radio receiver that automatically tunes (or "scans") a certain number of fixed-frequency channels. Usually these channels are set for the local police and fire departments, certain business radio services, the weather broadcaster on 162.55 MHz, etc. The scanning is fully automatic and stops to listen in on the first occupied channel. As soon as that transmission is finished, scanning resumes until another signal is picked up.

Your reviewer recently had the opportunity to set up the new Regency Monitoradio Scanner Model TMR-4. This is a modest-cost version ($129; crystals are available at $4.95 each) of the larger 8-channel model with the same general characteristics. The four frequencies selected included the 3 police services in the surrounding northern New Jersey area, plus the weather broadcaster KWO-35. The police frequencies were 240 kHz apart and the receiver had been "peaked" around 155-156 MHz.

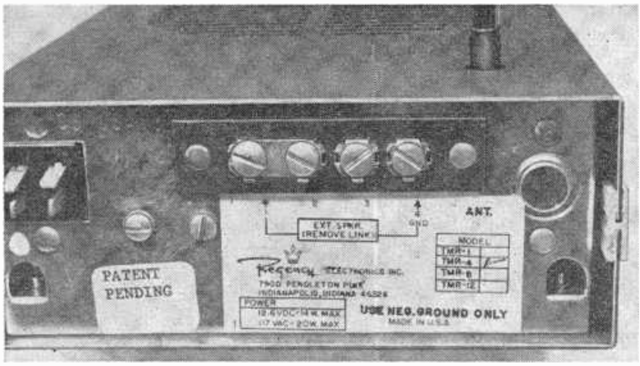
Using the fully extended built-in antenna, we had no difficulty receiving all 3 base stations and all of the mobile units within 5 to 6 miles of our location. Using an outdoor antenna (cut for 155 MHz), all mobile units could be heard, as well as a variety of miscellaneous police services sharing the same frequencies—though some were 50 miles away.

Squelch action is positive and there is no "hang-on" after the received carrier goes off the air. Scanning action in the TMR-4 is rapid and the four channels are scanned about twice a second. Of course, this can be speeded up by locking out the weather station (scanning 3 channels) so that the scanning action is not immobilized by the constant carrier of KWO-35.

Besides the excellent sensitivity, there was no indication of any problems that might arise from inadequate or poor selectivity. Other channels known to be occupied and only 40 kHz away from one of the preset channels could not be heard (splatter or cross-modulation).

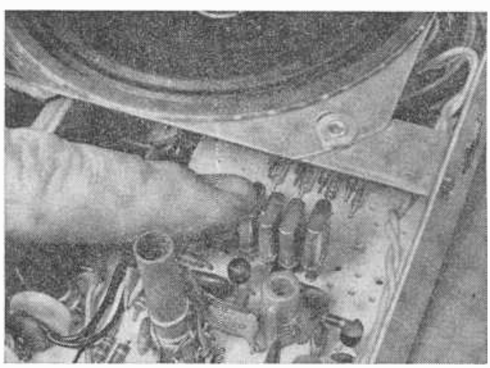
The TMR-4 is usable in the home or office operating from a 117-volt power line and can be installed in a mobile vehicle with a 12-volt negative-ground system.






The TMR-4 is a compact solid-state receiver measuring only 7½" x 5½" x 2¼". Use is made of 4 integrated circuits and 23 transistors. Nine transistors and 2 of the IC's are involved in the scanning part of the circuit. A built-in speaker faces upward. An external antenna may be connected to the TMR-4 through a Motorola-type plug (extreme right). An external speaker may be added by following steps given on rear panel.


The front panel of the TMR-4 has two rotary controls (volume and squelch) and 6 pushbuttons. As the face plate indicates, the upper left button places the TMR-4 in either the fully automatic scanning mode of operation or permits the user to select any one of the 4 channels manually. In manual operation, the selector button is repeatedly depressed until the proper channel (indicated by the light) has been tuned in. The four channel pushbutton permits the user to by-pass an undesired signal or channel. When any one of the 4 pushbuttons is depressed, scanning is started; releasing the pushbutton deactivates the channel.



Crystals are plugged into the TMR-4 by removing top cover. Miniature HC-18/u crystals are used with plug-in type pin leads. Crystals are easily obtained by mail order from Shepherd Industries, Overland Park, Kansas, at a price of $4.95 each.

# OPPORTUNITY MIRROR

## Thoughtful Reflections On Your Future

Fourth in a Monthly Series, BY DAVID L. HEISERMAN

### VA-Approved Schools

*I am fully qualified for educational benefits under the GI Bill. I like the new electronics school in my home town, but found that it isn't approved for VA training. The school tells me that they can't get VA approval until they have been in operation for two years. Is this true or just a phony excuse?*

● It is, indeed, true that a school must be in business at least two years before it can qualify for VA approval. The VA people have told us that even the old, well-established schools are not automatically granted approval for a new branch school until it has been set up and has been in operation for at least two years.

If the school is working toward obtaining VA approval, it would certainly indicate that the courses will meet some of the stiff standards that have been set up by your State Board of Education.

As far as the business end of the school is concerned, you can always check with your local Better Business Bureau. If the BBB has received any complaints about the school and its business operation, they'll tell you to read your contract carefully.

### To Relocate, or Not to Relocate

*I have just received my diploma in electronics technology from a well-known home study school. I live in a very small town, and there is only one electronics company within five miles of my home. My friends advise me to move to a large city (about 100 miles away), although I am quite reluctant to leave home. Is it true that I can earn a lot more money and will have greater job opportunities in the larger city, as opposed to working only a few miles from my present home?*

● There can only be a general answer to this question. It is certainly true that salaries are higher in and around the larger cities than in a small town. However, this in itself is misleading, because the cost of living is also much higher. I suggest that you visit the city, interview for several jobs and compare salaries. Find out where you might live and approximately how much it would cost you each month. In terms of dollar income, you will undoubtedly find it more economical to take a job in the smaller local electronics company.

The notion that people can earn more money by working in a major city does have one real advantage. Electronics firms tend to have a large turnover of employees. This means that you may have more chance to upgrade your career than working for the local manufacturer. If you are in a big hurry to advance your career and salary you should move to the city where you can probably change jobs several times in just as many years. If you are a good technician, you will be able to offset quickly the higher cost of city living by making the appropriate job changes.

If on the other hand you want to wait for opportunities to come your way, perhaps you should stay at home and build up a sound reputation and security with the one local company. Although the opportunities to advance may not come along as often, you will certainly encounter less competition when they do.

### Electronics Consulting

*For the past 10 years I have been employed in a highly responsible position as an electronics engineering technician. Although I don't have a college E.E. degree, I think that I have enough engineering experience to start my own consulting business. Are there any special pitfalls that I should avoid.*

● There certainly are! First, you will find it necessary to clarify the exact nature of

your "consulting" business. It is impossible to call yourself an "engineer" without being duly certified as a Professional Engineer by your state government.

There are different kinds of consulting businesses that you can enter, as long as you do not pretend to be a bona fide Professional Engineer. You could, for example, open a sound system consulting firm. Such consulting firms plan music and intercom systems for homes and offices. Another consulting business might deal with computer programming. In practically every state it is not necessary to be a certified P.E. to write and sell computer programs. However, it is expected that within the near future, an examination program will be established to certify qualified computer programmers. This is being developed by the Council of the Processing Management Association. The first examinations are expected to be given in late 1970.

The problem is in drawing the fine line between "consulting" and engineering. If you want to do real engineering design, you can probably be certified as a Professional Engineer by passing the pertinent examinations in your state.

Throughout most of the country, the P.E. exams take two days to complete. The first day covers general engineering principles while the second deals exclusively with electrical engineering. You can usually take the exams as many times as necessary should you fail one part the first time—although there is a waiting time required between each examination.

Besides passing the state examination, all of your college-level education and work experience must add up to at least eight years. Many engineers take their state examinations right after graduation from a four- or five-year engineering college. Even though they pass the exams, they can not qualify for certification until they have the necessary three or four years of work experience. Your 10 years of electronics technical experience should more than fulfill this part of the P.E. requirement.

We have discussed your problem with a representative from the National Society of Professional Engineers. It is agreed that anyone thinking about stepping into any kind of consulting business should first spend several years in someone else's consulting firm. Like any other profession, there are certain techniques and business problems, plus many unwritten rules of the game, that are not taught in engineering colleges and business schools. The most practical idea is to let someone else pay your salary while you learn the business end.

You can get more information on the consulting business by writing for the free pamphlet, "So You Want to Start a Consulting Firm" from the National Society of Professional Engineers, 2029 K Street, N.W., Washington, DC 20006.

## Engineering-Level Home Study

*I noticed in the article "Engineering Opportunities For You"* (POPULAR ELECTRONICS, *Feb. 1970) that only four schools are listed as offering engineering electronics courses through home study. Are there any other schools you can add to this list?*

● Aside from the four schools mentioned in this article, five more offer engineering-level courses in electronics through home study. These are: Bell & Howell Schools and DeVry Institute of Technology, both of which are based at 4141 W. Belmont Ave., Chicago, IL 60641; Commercial Trades Institute, 1400 W. Greenleaf Ave., Chicago, IL 60626; International Correspondence Schools, Scranton, PA 18515; and National Radio Institute, 3939 Wisconsin Ave., N.W., Washington, DC 20016. The excellence of the material offered by these schools is the same as that of the schools listed in the "Engineering Opportunities For You" article.

## Sleep Learning—Real or Hoax?

*A friend tells me that "sleep learning" would solve my problems concerning the memorization of formulas used in electronics. I have only read one advertisement about sleep learning and wonder if it isn't a big hoax.*

● About 10 years ago, sleep learning was in vogue and a dozen or so "schools" sold tape or disc recordings that repeated certain phrases while the student was asleep. Some people said that sleep learning was very effective—others ridiculed the idea.

Recently two professors of psychiatry at Duke University have established that, although the brain is alert (a mother will awake at her baby's cry), it is in a state of internal communications. Memory and thinking do continue during sleep, but unless the

(*Continued on page* 85)

# Build a LOW-COST TIME DELAY RELAY

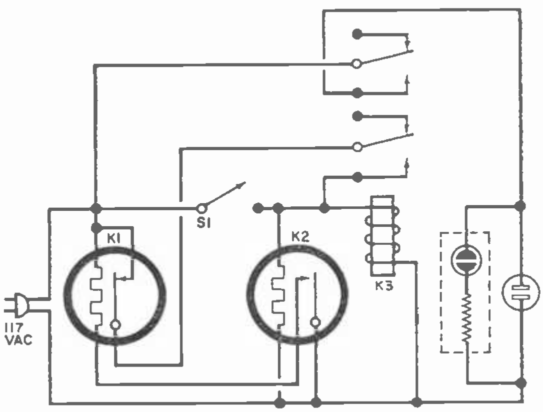
BY JOHN STAYTON

AN INEXPENSIVE, semi-variable time delay relay is a handy item to have around if you do a lot of experimenting. While solid-state timers give excellent results, they are often more precise than required and prohibitively expensive for simple experimenting and occasional use. However, commonly available and inexpensive thermostatic delay relays can be arranged in a circuit to provide the time delay or delays you would normally require.

Keeping in the low price range, it was found that a maximum of only three minutes could be obtained from any given thermal relay. However, with two thermal relays, as in the schematic diagram, you can obtain anywhere from four seconds to six minutes of delay time.

Circuit operation is easy to follow. When pushbutton switch *S1* is momentarily depressed, electromagnetic relay *K3* energizes, simultaneously delivering power to the heating element of thermal relay *K3* and the a.c. outlet. The indicator lamp lights up whenever the a.c. receptacle is "live."

After some specified time, depending on the characteristics of *K2*, the thermal relay's contacts close and supply power to the heater of *K1*. Then, when *K1*'s time delay has elapsed, its contacts open and break the circuit that latches *K3* closed. Relay *K3* deenergizes, and the delay cycle ends. The variable feature is not built in; it is actually a function of a combination of delay times selected for *K1* and *K2*.




Thermal relays K1 and K2 are selected to give desired delay time. Depending on the relays, delay can be between 4 seconds and 6 minutes.

## PARTS LIST

*K1—S.p.s.t. normally closed 117-volt thermostatic relay*
*K2—S.p.s.t. normally open 117-volt thermostatic relay*
*K3—D.p.d.t. 117-volt electromagnetic relay with 10-ampere contacts*
*S1—S.p.s.t. normally open momentary-action push button switch*
*Misc.—Neon lamp assembly with built-in current-limiting resistor; chassis- or line-cord-mounting a.c. receptacle; sockets for K1 and K2; chassis; line cord and plug; hardware; wire; solder; etc.*

Since the circuit is so simple, it can be laid out as desired during construction. The prototype shown here was built on a 5¼" × 3" × 2" metal utility box to conserve space. Although the a.c. outlet is shown mounted to the rear of the box, it could just as easily have been located at the end of any desired length of twin-conductor power cable.

In use, the delay relay's power cord is plugged into an a.c. outlet, and the appliance to be operated connected via the a.c. receptacle. The delay relay is capable of handling up to 1000 watts; so a fairly high load can be safely controlled.

—30—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What do you need to break into the ranks of The Troubleshooters? You might think you need a college diploma, but you don't. What you need is know-how—the kind a good TV service technician has—only lots more.

## Think With Your Head, Not Your Hands

The service technician, you see, "thinks with his hands." He learns his trade by taking apart and putting together, and often can only fix things he's already familiar with.

But as one of The Troubleshooters, you may be called upon to service complicated equipment that you've never seen before or *can't* take apart. This means you have to be able to take things apart "in your head." You have to know enough electronics to understand the engineering specs, read the wiring diagrams, and calculate how a circuit should test at any given point.

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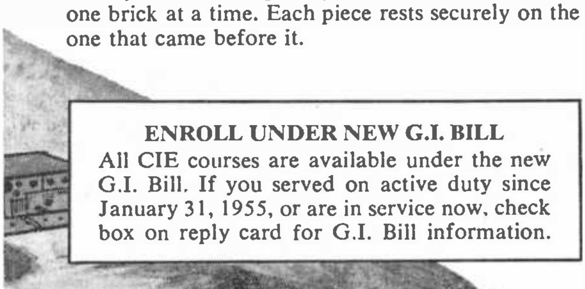

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CIRCLE NO. 10 ON READER SERVICE PAGE

# SHORT-WAVE LISTENING

By **HANK BENNETT**, W2PNA/WPE2FT
Short-Wave Editor

## REPORTING BY TAPE RECORDING

REPORTING to DX stations via tape recordings is a subject that has been discussed at considerable length in various club publications. Tom Meijer of *Radio Nederland*, who took over the duties of Master of Ceremonies for the "Happy Station Program" has listed certain conditions that must be met by the individual reporter who is applying for a QSL.

Foremost is that all tapes submitted must be single-track with a speed of seven and one-half inches per second. (Many reporters send double-track tapes at 3¾ in./sec.)

Tom also reminds listeners that the tape must contain such fundamental items as date, time, frequency, and enough program information in order to qualify for a QSL. In the event that any of the items cannot be included on the tape (date and time, for example) this information should be included in a separate letter enclosed with the tape.

"Happy Station" shows are presently being recorded up to seven days in advance of actual broadcast time. SWL's should not be alarmed at the belated mention of certain requests; simply send your requests earlier than you normally would have in the past.

**Guide to Broadcasting Stations.** A brand-new edition of this favorite British listing of long-wave, medium, and short-wave stations has just been published. Increased to 224 pages, this station/frequency listing is prepared from information collected by the BBC monitoring facilities. It is a remarkably accurate book—better than the World Radio TV Handbook—and includes a special notation showing the seasonal schedule changes of all short-wave broadcasters. Obviously, the schedule information is based on past history, but at least it gives the user a "fighting" chance of knowing whether or not a particular broadcaster has ever used a certain frequency and when (seasonally) he is likely to be back in operation. The new edition is being sold by Gilfer Associates, Inc., Park Ridge, NJ 07656 for $2.50.

John Leger, WPE4KKK, Louisville, Ky., uses a Hallicrafters S-120A and a Truetone DC3972 receiver. Member of 2 DX clubs, he has logged 37 countries.

### CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports were as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used.

**Albania**—*R. Tirana* has been found on 11,866 kHz with s/on in Portuguese at 2130, and on 7295 kHz from 0700-0726 with English news and commentary.

**Angola**—CR6RF, *R. Clube de Benguela*, 5042 kHz, has been s/on at 0545 with the schedule for the day, then pop tunes non-stop at 0600. This is in Portuguese.

**Antilles**—Word is out that *Trans World Radio*, Bonaire, will increase the power of their 800-kHz transmitter from the present 500 kW to a whopping 2 MW. (That's two million watts!). No target date for the new power has been released.

**Austria**—*R. Osterreich*, Vienna, is now on a new frequency of 11,925 kHz as noted at 2130-2157 in German to northern Europe. Also still well heard is 9770 kHz at 0030-0045 in English.

**Belgium**—Brussels presents "Belgium Speaking" in English at 2305-2315 on 11,790, 9550 and 9740 kHz and at 0050-0100 on 11,790, 6125 and 9740 kHz.

**Bolivia**—CP105, *R. Ibare*, Trinidad, continues to

# DX ALL-ZONE AWARDS PRESENTED

*To be eligible for one of the new DX All-Zone Awards designed for WPE Monitor Certificate holders, you must have verified stations in 10, 20, 30, or 40 of the radio zones of the world. The following recently qualified for and have received awards.*

### 10 ZONES VERIFIED

Dimitur Alipiev (WPE2QXL), Syracuse, N. Y.
Ronald Nawrot (WPE3HUO), Owings Mills, Md.
Mitchell Kassoff (WPE2QTK), Little Neck, N. Y.
Kevin Slater (WPE7CNF), Salem, Ore.
Ivan Waufle (WPE2QVD), St. Johnsville, N. Y.
Arthur Bolduc (WPE1HQU), Biddeford, Maine
Robert Brown (WPE6HKR), Yucaipa, Calif.
Edward Reichard, Jr. (WPE2QZE), Bloomsbury, N. J.
James Jankowski (WPE2QVE), Corfu, N. Y.
Sgt. George Weir (3W8PE1G), APO (South Vietnam)
Charles Clay (WPE2QWE), Climax, N. Y.
Terry Ward (WPE5EZX), El Paso, Texas
Howard Rosenberg (WPE2PQE), Queens Village, N. Y.
Joseph Perge (WPE8JKD), Newark, Ohio
John Griffin (VE6PE7V), Calgary, Alta.
John Karien (WPE3GOC), Franklin, Pa.
Tom Frisz (WPE9JRU), South Bend, Ind.
G. Shadwell (VE3PE2QZ), Ottawa, Ont.
Tom Kennedy (WPE8KKE), Battle Creek, Mich.
William Castellani (WPE8KGE), Detroit, Mich.
Philip Scribani (WPE2QSY), Maspeth, N. Y.
Sheldon Carson (WPE6HMF), Glendale, Calif.
David Larrabee (WPE1HRB), Bucksport, Maine
Alan Faustner (WPE3HYK), Northampton, Pa.
Robert Rattner (WPE2RBL), Forest Hills, N. Y.
Peter Thomas (WPE9JQT), Michigan City, Ind.
Jim Townsend (WPE8KJT), Painesville, Ohio
David Porter (WPE2QSU), Cherry Hill, N. J.
Steven Fix (WPE2RAS), Rochester, N. Y.
Robert Fruehwald (WPE4KHQ), Jeffersontown, Ky.
Scott Fruehwald (WPE4KIH), Jeffersontown, Ky.
Steven Brewer (WPE1HSX), Westminster, Mass.
Steve Nack (WPE3HTU), Conshohocken, Pa.
Jim Miles, III (WPE7CXI), Seattle, Wash.
Jon Love (VE6PE8D), Edmonton, Alta.
Robert Rose (VE4PE7M), Fort Garry, Man.
Angelo Casella (WPE2RAH), Staten Island, N. Y.
Todd Basche (WPE2RAR), Nutley, N. J.
Stephen Kennedy (WPE3HZT), Newville, Pa.
Philip Creasy, Jr. (WPE3HWT), Bloomsburg, Pa.
Sam Fulp (WPE4KIM), Lexington, N. C.
Richard Niles (WPE2QRB), Fort Lee, N. J.
Robert Lurie (WPE2QVQ), Howard Beach, N. Y.
James Sanders (WPE4KCH), Savannah, Ga.
Anthony Toscani (WPE3HVN), Philadelphia, Pa.
Roger Horie (WPE7COV), Mountain Home Air Force Base, Idaho
Wayne Gentry (WPE6HMR), Foster City, Calif.
Ken Brookner (WPE5EWM), Memphis, Tenn.
Maury Weiner (WPE6HPC), Palm Desert, Calif.
Jim Fox (WPE9JVS), Indianapolis, Ind.
Richard Eddie (WPEØFFT), St. Louis, Mo.
Kevin Kleman (WPE9JQV), Tigerton, Wisc.
Jack Graham (WPE2QNT), New Milford, N. J.
Michael Caditz (WPE6HOA), Los Angeles, Calif.
Michael Zyda (WPE6HJL), Northridge, Calif.
Ronald Dudinski (WPE3IAF), Plymouth, Pa.
Frank Harris (WPE8JRG), Edison, Ohio
Dave Schoeller (WPE9IQQ), Springfield, Mo.
Robert McLarnon (WPE1HQL), Natick, Mass.
Tom Smith (WPE4KCP), Daytona Beach, Fla.
Robert Walker (WPEØFPO), Wichita, Kansas
Mike Witkowski (WPE9JFT), Stevens Point, Wisc.
Roy Neese (WPE7CWZ), Kent, Wash.
James Kobus (WPE7CGW), Ferndale, Wash.
Chuch Nobles (WPE4KIG), Winter Haven, Fla.
Mike Carrick (WPEØFLX), Omaha, Nebr.
Brian Hajder (WPEØFPI), Crystal, Minn.
Robert Keller (WPE7CND), Brigham City, Utah
Philip Thibodaux (WPE5FEB), Morgan City, La.
Peter Vegter (VE5PE6G), Regina, Sask.
Bill Buckley (WPE2RDI), New York, N. Y.
Roland Hamel (WPE1HEE), Waterbury, Conn.
Ted Romanow (WPE1HQH), Waban, Mass.
Tommy Buchanan (WPE4KGA), Darlington, S. C.
James Murray (WPE2RFR), Troy, N. Y.
Carroll Patterson (WPE4KHW), Decatur, Ga.
Gary Hubbard (WPE6HQA), Northridge, Calif.
Robert Galka (WPE8HWS), Tallahassee, Fla.
James Haberman (WPE9JWS), Indianapolis, Ind.
Donald Jones (WPE8KLV), Parma, Ohio
Tony D'Agostino (VE3PE2SD), Hamilton, Ont.
Marvin Van Sickle (WPEØFPD), Dubuque, Iowa
Joseph Ulrich (WPE6HGA), Los Angeles, Calif.
Henry Seidner (WPE2REP), Pearl River, N. Y.
Bradley Krohn (WPE2REA), Amherst, N. Y.
Robert Haase (WPE4KHT), Brunswick, Ga.
Wayne Randall (WPE1HFA), Danbury, Conn.
Daniel Lindley (WPE4KEA), Florence, S. C.

### 20 ZONES VERIFIED

Mitchell Stern (WPE2QIA), Brooklyn, N. Y.
Martin Miron (WPE8JTN), Warren, Mich.
Stefan Lai (VS6PE1H), Causeway Bay, Hong Kong
Thomas Alleman (WPE2QFR), Rochester, N. Y.
Loren Davis (WPE6HMA), Hayward, Calif.
Tom Christian (WPE7CXG), Seattle, Wash.
James Ziegler (WPE9JOW), Milwaukee, Wisc.
Joseph Breton (WPE1HKW), Methuen, Mass.
Michael Dopson (WPE4KCF), Enterprise, Ala.
Brian Heller (WPE2OVP), Lawrenceville, N. J.
Gary Kromer (WPE2PIH), Auburn, N. Y.
Lawrence Plummer (WPE7CRV), Bellevue, Wash.
Peter Macinta (WPE2ORB), Kearny, N. J.
J. H. Mac Neill (WPE6GWX), Redwood City, Calif.
Dean Frey (VE6PE7N), Fort Saskatchewan, Alta.
Daniel Polansky (WPE2QFH), Rochester, N. Y.
Michael Lynch (WPE2QEA), Auburn, N. Y.
Lance Kimmel (WPE2QQY), Forest Hills, N. Y.
Robert Hagerman (WPE8INH), Hemlock, Mich.
Charles Loftis (WPE4KEF), Landrum, S. C.
Everett Slosman (WPE2QZB), Endicott, N. Y.
Steve Sox (WPE4KEU), Asheboro, N. C.
Charles Clay (WPE2QWE), Climax, N. Y.
Robert Scott (WPE4HHX), Kingsport, Tenn.
Nick Chinn (WPE6HKB), San Leandro, Calif.
John Adams (WPE3HXT), Beltsville, Md.
Mrs. Mildred Marshall (WPEØFIR), Devils Lake, N. D.
Donald Appling (WPE7CNG), Spokane, Wash.
Steven D'Adolf (KX6PE1B), APO (Marshall Islands)
Delbert Fant (WPE6HMY), San Luis Obispo, Calif.
Tim Ohrman (WPE3HHA), Monroeville, Pa.
Frank Swanberg III (WPE9JVD), Dolton, Ill.
Paul Metro (WPE2QZM), Colonia, N. J.
G. W. Fisher (WPE7CXZ), Longview, Wash.
Robert Fleck (WPE3DXZ), Schiller Park, Ill.
Ken Piper (WPE6GVB), Stockton, Calif.
Douglas Stark (VE3PE2OY), London, Ont.
Carroll Patterson (WPE4KHW), Decatur, Ga.
Bruce McCoy (WPE9JMY), La Porte, Ind.
Bill Potorti (WPE2QYH), Ithaca, N. Y.
Jack Dashper (WPE4KCJ), Camden, Tenn.
Marvin Robbins (WPEØMW), Omaha, Nebr.
Gregory Kelley (WPE4JGI), Staunton, Va.
Kurt Leonhardt (WPE9FLI), Blue Island, Ill.

### 30 ZONES VERIFIED

Everett MacLeod, II (WPE1HTG), Gloucester, Mass.
Mark Connelly (WPE1HGI), Arlington, Mass.
Jeff Wilson (VE3PE2NL), Sarnia, Ont.
Tom Christian (WPE7CXG), Seattle, Wash.
Thomas Creery (WPE2PHZ), Conklin, N. Y.
Vincent Geraci (WPE1HMP), Shelton, Conn.
Richard Shawyer (WPE6CFL), San Francisco, Calif.
John Sgrulletta (WPE2MFX), Bedford Hills, N. Y.
Steve Kamp (WPE5EUT), Irving, Texas
Marvin Robbins (WPEØMW), Omaha, Nebr.
Clifford McKinstry (WPE6CXS), Hampton, Va.

be heard on 4958 kHz at fair level until s/off at 0200 in all Spanish programming.

**Brazil**—ZYW25, *Radiodifusora Jatai,* Jatai (Goias), is on 2470 kHz and verified after five reports; no schedule or power was stated. It's audible at times around 2300 in Portuguese but does not seem to be on any definite schedule. . . ZYO23, *R. Vitoria,* Vitoria, has settled down on 5053 kHz and is heard daily in Portuguese until s/off between 0200-0230. . . *R. Braganca,* Braganca Paulista (Sao Paulo), is on 2480 kHz but with a strong harmonic at times on 4960 kHz; it's been logged there after 2200 in Portuguese.

**Chile**—*R. Sociedade Nacional de Mineria* is noted daily on 9750 kHz from 0100 with many talks and ID's in Spanish.

**Columbia**—Reports are being received on a superpowered station operating on 810 kHz, mediumwave. Heard evenings (local time) causing heavy QRM to WGY, Schenectady, N. Y., we have not as yet obtained a definite ID. Listed for the channel is *R. Sutatenza,* Bogota; the power is said to be 250 kW. This is undoubtedly strong competition to the Antilles station on 800 kHz.

**Czechoslovakia**—*R. Prague* is on 5930 kHz with IS and time ticks at 0058-0100 and opens with this schedule: to US and Canada at 0100 and 0400 on 5930, 7345, 9540, 9630 and 11,900 kHz, rebroadcast to Europe at 0700 on 6055 and 9505 kHz; to Australia and New Zealand at 0700 on 9575, 11,800, 15,310, 21,485 and 21,700 kHz; Sundays to N.A. at 1400 on 15,445, 17,840 and 21,735 kHz.

**Dominican Republic**—HIBB, *Voz de Papagayo,* La Romana, 5030 kHz, has a most elaborate s/off at 0400 with a sad-voiced announcer, playing of "Taps", then a stirring march. A station that we've been hearing on 2500 kHz from 0000-0200 is thought in some quarters to be a second harmonic of HIBC, *La Voz del Progreso,* 1250 kHz.

**Ecuador**—HCJB, Quito, is good on 11,740 kHz with English religious programs heard at 0805 and 0410; "DX Party Line" was logged at 0230-0300. . . *R. Vision,* Manta, long inactive, is again on the air on 6141 kHz and heard from 0400-0430 with music, commercials and time checks in Spanish. . . HCAK2, *Cadena Radiodifusora Ecuatoriana,* Guayaquil, was heard from 2355-0105 on 4655 kHz with L.A. music and radio drama.

**Egypt**—Cairo is testing numerous channels in the 31-meter band. English news is noted on 9550 kHz at 2200; Arabic with chanting can be heard at 0000-0040 on 9860 kHz. The 9475 kHz channel is still heard well at 0230-0245 with English news and music as is 9740 kHz at 1830-2300 in Italian, French, German and English. Reports go to P.O. Box 566, Cairo, United Arab Republic.

**El Salvador**—YSS, San Salvador, 5980 kHz, is reportedly planning more extensive English and French programs to be aired Monday to Saturday at 0300-0330 and Sunday at 0030-0100. This will be dual to 9555 kHz.

**Ethiopia**—ETLF, Addis Ababa, opens at 0330 in Swahili to E. Africa on 9725 kHz, a new frequency.

**Germany (East)**—*R. Berlin International* is on 15,145 kHz in English to Africa until 1900 closing and requesting reports.

**Gilbert and Ellice Islands**—VSZ1, Betio, Tarawa, 844 kHz, seems to now be using 10 kW as indicated by increasingly better signals on the West Coast at 0600.

**Guantanamo Bay**—If you need this country for DX Awards, look for KG4AA in the 20-meter ham radio band; he often operates around 0000-0100 weekdays on single sideband.

**Guatemala**—Possibly a new frequency for *R. Nacional-La Voz de Quezaltenango* is 9680 kHz as noted from 0305 with marimba music.

**Guiana (French)**—Cayenne, 3385 kHz, has French from 0915 s/on; news is given at 0930. This one often fades out by about 1000.

**International Waters**—A good catch was that of the New Zealand Navy Survey Ship "Lachlan", callsign ZMCU. On 8236 kHz with 250 watts, it was noted at 0911 in contact with ZLW, Wellington. It verified in nine days by letter and by signing a prepared card.

**Italy**—Rome was heard in Italian to N.A. at 2300-0000 on 6010 and 9710 kHz, both unlisted channels, then shortly afterward, on 5990 and 9575 kHz, in a dual frequency move.

**Mexico**—XEVJ, Chilpancingo, a 250-watt station, has been heard on 2160 kHz at 1347 in Spanish. . . . *R. Mexico* is on a new frequency of 9745 kHz, dual to 11,718 kHz at 0500 but with heavy QRM on the lower channel.

**Monaco**—The English test transmissions to Great Britain over *R. Andorra* on 701 kHz have been moved to *R. Monte Carlo* on 1466 kHz and are aired at 2300-0100 every Saturday-Sunday night under the name of *Radio 205.* Reports go to Geoffrey Bass, 1 Harley Street, London W1, England.

**Nigeria**—*Voice of Nigeria,* Lagos, was heard at 2130-2300 and at 0450-0525 with mostly English programs of music, news, commercials and time checks on 3986 kHz. Some African chanting was noted around 0450-0455.

**Norway**—"Norway This Week" in English is aired on Sundays to East Coast N.A. at 2000-2030 on 21,655 kHz and 2200-2230 on 11,860 kHz, at 1600-1630 to East Coast on 25,900 kHz and to West Coast on 21,730 kHz, and on Mondays to West Coast at 0200-0230 on 9610 kHz and at 0400-0430 on 9610 and 11,735 kHz.

**Paraguay**—An overseas source reports that this country is planning an international service with a transmitter of 100 kW. Further details as they become available.

**Peru**—OBX10, *R. Atlanta,* Chulucanas, 4990 kHz, can be occasionally logged under severe QRM from a Venezuelan on the same channel from 0200 with the usual L.A. format.

**Portugal**—A new frequency for Lisbon is 15,340 kHz as noted in Portuguese from 0445 s/on. Other frequencies reported recently include 11,870 kHz at 0200 to N.A., 11,840 kHz with English around 0245-0305, and 11,935 kHz at 0020 with "Radio Safari" using the facilities on the second Monday in each month.

**Seychelles**—*R. Seychelles,* Victoria, was logged on 15,265 kHz from 1536-1630 s/off with light music at 1550, "Back to the Bible" at 1600, ID, frequency, and time, in an all-English xmsn.

**South Africa**—*R. RSA,* Johannesburg, is now operating to N.A. at 2330-0020, 0030-0120, 0130-0220 and 0230-0320 on 9695, 9705, 11,875 and 15,220 kHz, and to Africa in English and Afrikaans at 1100-1450 on 25,790 kHz. Two other new frequencies noted include 15,249 kHz at 1805 with English news, and 15,320 kHz at 0150 with an interview-type program, also in English.

**Sudan**—*R. Omdurman* broadcasts at 0700-0900 and 1600-1900 on 4994 and 11,835 kHz with English usually at 1715-1800.

**Switzerland**—New frequencies in use by Berne include 6055 kHz in French with s/off at 2245, and 11,720 kHz at 2310-0000 s/off in Portuguese.

**USSR**—Two of the time stations listed last month, RID and RKM, are being noted by Your Editor. RID is usually audible around 2300-0200 and RKM around 1100-1300, both on 15,004 kHz. ID's are given every 10 minutes in slow Morse starting with "VVV CQ CQ CQ" and sounds like it is being hand-sent. So far we have not yet located RTA on 14,996 kHz . . . Vladivostok, 5015 kHz, was noted in the clear at 1045 in Russian with two bars of organ music and an ID at 1100, then man and woman alternating in Russian news . . . A report to *R. Moscow* for reception of Kalinin, listed in this column last October on 15,470 kHz, brought a fast reply to one of our readers that the Soviet Union has no xmtr's on that frequency!

**Vatican City**—A new frequency in use by *R. Vaticano* is 6135 kHz as noted at 2358-0015 in Spanish to L.A. dual to 11,845 kHz and a third channel which we could not copy. English news is given

*(Continued on page 91)*

# SOLID STATE

By LOU GARNER, Semiconductor Editor

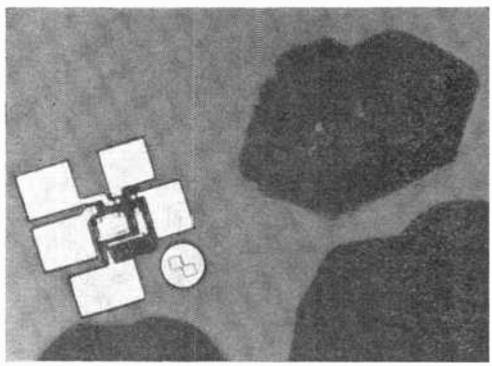
## NEW PROCESS MAY REDUCE IC COSTS

INTEGRATED CIRCUITS may be less costly in the future as a result of a new manufacturing process developed by the Bell Telephone Laboratories (BTL). Requiring fewer production steps than previous methods, the new IC fabrication technique can produce reliable, high-quality devices which are smaller than a grain of sugar.

Conventional bipolar integrated circuits require from five to seven photolithographic masking steps before the contacts to the silicon are formed. In contrast, the new circuit configuration needs only three such steps and, appropriately, is called a "Tri-Mask" (TRIM) structure. In both techniques, of course, additional processing is required to make contacts to other circuits and to protect the device from the environment.

As illustrated in Fig. 1, the new TRIM structure is based on the use of lateral transistors—devices in which injected carriers flow parallel to the surface rather than perpendicular to it. The collectors and emitters are diffused simultaneously and, therefore, need only one masking operation. Thus, all of the important transistor properties are determined by this one step.

The TRIM process starts with a silicon substrate lightly doped with boron to provide general *p*-type characteristics. A shallow *p*-plus base layer is diffused into the substrate. Next, silicon oxide is grown over the entire surface, then etched away selectively using the first photolithographic mask to establish the emitter and collector areas. Phosphorous-doped emitter and collector regions (*n*-type) are diffused through the *p*-type base and then all of the exposed silicon oxide is removed. Another silicon oxide layer is now grown on the surface with a second mask defining the emitter, collector, base, and surface contact holes. Metal is



TRIM technique produces high-quality IC chips that are smaller than grains of sugar (black objects).

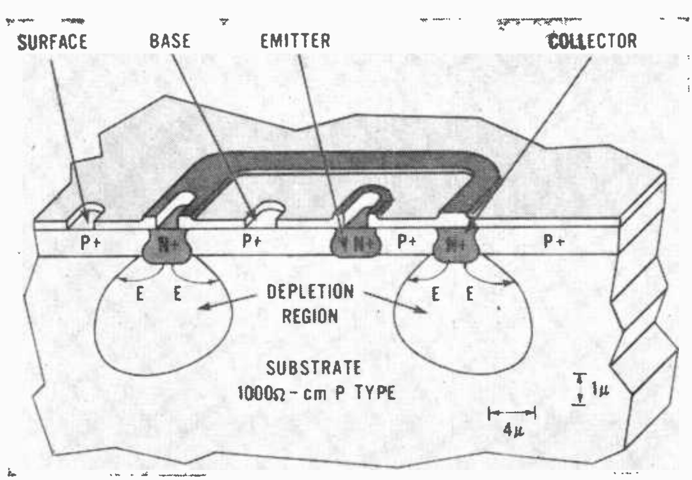



Fig. 1. TRIM structure, based on use of lateral transistors, has collectors and emitters diffused simultaneously. It requires only one masking operation. One step determines all of transistor properties.

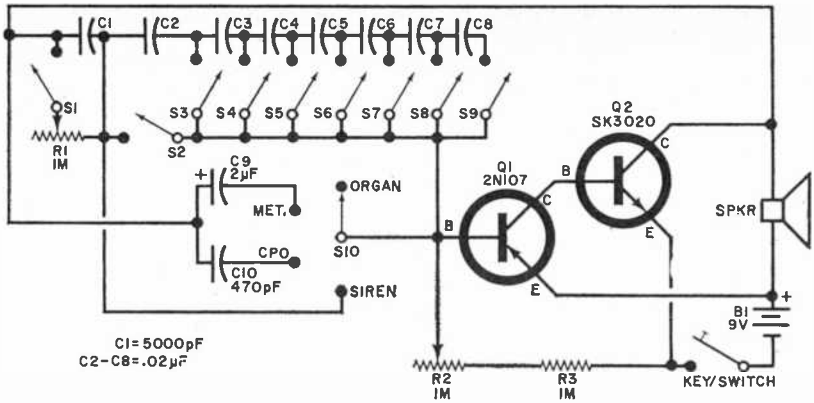



Fig. 2. Switching arrangement allows wide-range relaxation oscillator to operate as an electronic organ, metronome (and thermometer), code practice oscillator, or siren.

evaporated over the entire surface and etched away except where the third mask defines the metal conductor paths. The final contacts to external circuits are provided through beam leads, with a layer of silicon nitride providing environmental protection.

Thus far, the TRIM method has been used primarily for the fabrication of integrated circuit logic gates of the type used in computers and telephone switching system; but, conceivably, it could be used in linear devices as well. A transistor in such circuits occupies less than one millionth of a square inch.

**Reader's Circuit.** In developing a Science Fair project, reader Paul Serafin, WN4OEG (707 Cathy Ct., Murfreesboro, TN 37130) first selected a reader's circuit described here in March 1969. Encountering minor difficulties, he modified the design using a circuit we described in February 1966. Additional modifications and adpatations resulted in the multi-purpose project whose schematic is shown in Fig. 2. Operating, variously, as an electronic organ, a metronome (and electronic thermometer), CPO, or siren, his final design won an Honorable Mention Award at the 1969 Vanderbilt University Regional Science Fair.

Essentially a wide-range relaxation oscillator, Paul's circuit features a two-stage, direct-coupled complementary amplifier using *pnp* (*Q1*) and *npn* (*Q2*) transistors to drive a PM loudspeaker. The circuit's operational mode and basic repetition rate (frequency range) are determined by the feedback arrangement chosen by function switch *S10*, while its exact operating frequency can be adjusted by bias control *R2*, in series with current limiting resistor *R3*. Switches *S2* through *S9* serve as the organ "keys," while *S1* is used as the siren switch. Circuit power is furnished by *B1*, controlled by a familiar handkey or switch.

Standard, readily available, parts are used in the project. Transistor *Q1* is a general purpose *pnp* transistor such as RCA's SK3020. Capacitors *C1* through *C8* and *C10* are low-voltage ceramic or tubular paper types; *C9* is a metallized paper or electrolytic unit; and switches *S1* through *S9* are s.p.s.t. normally open momentary pushbuttons. Almost any PM loudspeaker may be used; but better results generally will be obtained with units having high-impedance voice coils (8, 16, or 45 ohms).

Neither layout nor lead dress is critical and the circuit can be assembled using any preferred construction technique. Paul assembled his display model on a three-section poster, with the schematic diagram and actual circuit in the center and an explanation of the project operation on the sides.

The circuit's performance as an electronic organ, metronome or CPO is fairly straightforward. In its "siren" mode, however, *R1* must be adjusted for optimum signal with *S1* closed. Finally, the circuit may be used as an electronic therometer" by switching to the metronome mode and physically varying *Q1*'s temperature. The output beat rate will change as *Q1* is heated or cooled.

**Manufacturer's Circuit.** With a variety of potential applications in experimental projects as well as in commercial and industrial systems, RCA's TA5371B is a unique integrated circuit which combines light-sensitive elements and an amplifier in a single device. Two typical circuits using this unit are shown in Fig. 3. Both were abstracted from the engineering bulletin/specification brochure published by RCA describing the new device.

(*Continued on page* 88)

# AMATEUR RADIO

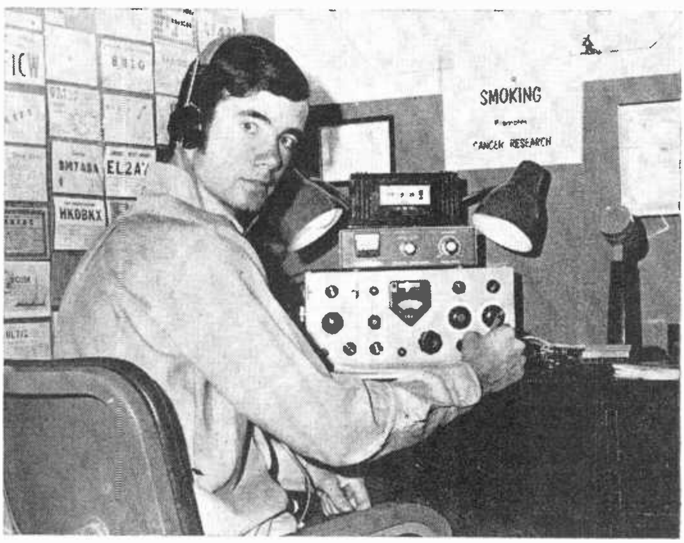
By HERB S. BRIER, W9EGQ
Amateur Radio Editor

## FIELD DAY, 1970

MOST IMPARTIAL observers agree that amateur radio's ability and willingness to supply emergency communications are two of its most valuable functions. This was demonstrated dramatically when Hurricane Camille struck the Gulf Coast in the fall of 1969 and in other less publicized disasters.

On the fourth weekend of each June, "Field Day," sponsored by the American Radio Relay League, Inc., gives amateurs a chance to show and test their abilities at supplying communications under emergency conditions. Between 1900 GMT, Saturday, June 27, and 2200 GMT, Sunday, June 28, amateurs all over the United States and Canada will set up temporary, self-powered stations in forest preserves, parking lots, athletic stadiums, etc., to contact other amateurs. Each contact made on each code or phone sub-band earns a number of points determined by the power source and the amount of transmitter power used.

Large groups may operate 20 or more transmitters simultaneously during the event; although the greatest number of entries is usually in the one-, two-, three-, four-, and five-transmitter groups. And of course there are always a few "iron-man" entries in which a single operator attempts to keep his field day station in operation during the entire period. Undoubtedly, however, the most enjoyable and valuable Field Day operations are the co-operative ven-

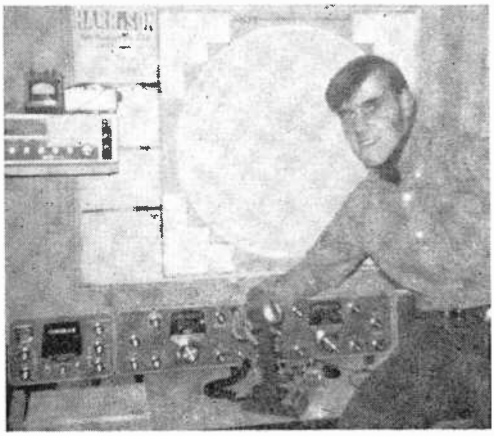



AMATEUR STATION OF THE MONTH

Jim Rafferty, WA9UCE, 529 Buckingham, Libertyville, IL 60048, became a Novice in 1967 and was a General in three more months. His Collins KWM-1 SSB/CW transceiver is older than he, but its 175 watts fed into a Mosley TA-33-Jr., tri-band beam, 30 ft high, has worked all states and 97 countries. Jim attends Western Illinois U., where he is president of the radio club, W9YOL, and lives at the fire station, where he signs WB9AZW. We are sending WA9UCE a 1-year free subscription to POPULAR ELECTRONICS for sending this month's Amateur Station Photo. You can enter by sending a clear (black and white preferably) photo of yourself at the controls of your stations and some details about your amateur career to Herb S. Brier, W9EGQ, P.O. Box 678, Gary, IN 46401.

tures in which amateurs from the newest Novice to the hoariest old timer (and their families) work to make Field Day a success.

Collecting equipment, erecting antennas, installing the equipment, and keeping a number of transmitters going around the clock under conditions that simulate an actual emergency present real challenges to any amateur club. So, starting Saturday afternoon, June 27, you can expect many bosky glens and other likely (and unlikely) spots to echo with the call "CQ Field Day" from approximately 12,000 throats and keys until the affair ends Sunday evening. Drop a request (with a stamped, business size envelope) to Communications Dept., ARRL, 225 Main St., Newington, Conn., 06111, for full Field Day rules and score sheets.



Gilbert Kunster, Jr., WB2DKZ, 225 W. 232 St., Bronx, NY 10463 needs Montana and Hawaii for his WAS certificate. His Heath "S" line and Hustler vertical antenna worked 62 countries in 6 months.

**FCC and Related News.** Amateur license fees are going up! In an attempt to obtain its entire budget from fees charged for license processing, the FCC proposes in Docket 18,802 to increase basic amateur license fees from \$4.00 to \$9.00 and for applications for special callsigns from \$20.00 to \$25.00. The CB fee will jump from \$8.00 to \$19.00.

While April 20, the date set by the Commission for filing original comments on the docket, will have passed before you read this, we assume that the Commissioners will consider any well-reasoned "late" comments from interested parties. Most comments that we have heard claim that the increases are inflationary. We strongly suspect that the protests will not prevent the increases, but enough protests might delay the effective date.

The Commission also issued its proposals to formalize the regulations governing amateur repeater operation on the frequencies above 50 MHz. Such repeaters receive signals on one frequency and simultaneously retransmit them on another frequency. The most important part of the new proposals limits the repeaters to 200-kHz segments in the 50-, 144-, 220-, and 430-MHz bands and also specifies the frequencies to be used to transmit to the repeater. The rest of the proposal clarifies and consolidates the informal rules that have been put into effect since repeaters became so popular.

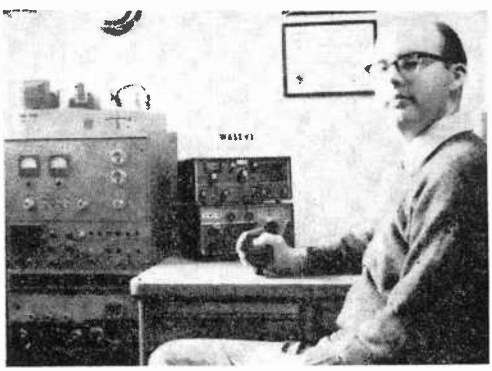
In a recent speech, Everett G. Henry, W3BG, Chief, Amateur and Citizens Radio Division, FCC, stated that surveys of the Advanced and Extra class segments of the amateur bands show that they are not the deserted wastelands that some opponents of incentive licensing claim. Rather, they are well occupied during the popular operating hours. Some of them are rather sparsely occupied at other times, but the other parts of the bands are not overly crowded then, either.

W3BG also stated that 85% of the applicants for the Advanced license who must take the code test (Novices, Technicians, Conditionals, and brand new applicants) pass it. Also, 81% of all who take the Advanced class written exam pass it. Similarly, 80% of the applicants pass the Extra class code test; and 77% of those that get by the code also get by the Extra class written examination.

**Thoughts on Silver Plating.** It is common practice to silver plate UHF/VHF coils, cavities, etc., to reduce "skin effect," which increases the r.f. resistance of conductors above their d.c. values. But many UHF/VHF workers say that the results do not justify the effort.

R. S. Stone, VK5PB, reports in *Amateur*

(*Continued on page* 86)



Jim Labo, WA5ZVI, Enid, OK 73701, uses an SBE-34 transceiver and Drake R4 for the "d.c." bands. His main interests are in the frequencies above 50 MHz, however, as demonstrated by VHF/UHF gear.

# ENGLISH LANGUAGE NEWS BROADCASTS FOR THE MONTH OF JUNE

**Prepared by ROGER LEGGE**

## TO EASTERN AND CENTRAL NORTH AMERICA

| TIME-EDT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|
| 7:00 a.m. | Stockholm, Sweden | 15.315 |
| 7:30 a.m. | Melbourne, Australia | 9.58, 11.71 |
| 8:00 a.m. | Peking, China | 11.685, 15.095 |
| 8:15 a.m. | Montreal, Canada | 9.625, 11.72 |
| 12 Noon | London, England | 21.61 |
| 5:30 p.m. | Hilversum, Holland | 11.73, 15.425 |
| 6:00 p.m. | Ankara, Turkey | 15.16 |
| 7:00 p.m. | Montreal, Canada | 9.625, 11.945, 15.19 |
| 7:45 p.m. | Tokyo, Japan | 15.445, 17.825 |
| 8:00 p.m. | London, England | 6.11, 9.58, 11.78, 15.14 |
| | Moscow, U.S.S.R. | 11.87, 11.96, 15.15 |
| | Sofia, Bulgaria | 9.70 |
| | Tirana, Albania | 7.30, 9.50 |
| 8:30 p.m. | Johannesburg, South Africa | 5.98, 9.695, 11.875 |
| | Stockholm, Sweden | 11.95 |
| 8:50 p.m. | Brussels, Belgium | 6.125 |
| | Vatican City | 11.725, 15.285, 17.80 |
| 9:00 p.m. | Berlin, Germany | 11.89, 15.17 |
| | Budapest, Hungary | 9.833, 11.91, 15.16 |
| | Havana, Cuba | 9.525 |
| | Madrid, Spain | 6.14, 9.76 |
| | Peking, China | 15.06, 17.715 |
| | Prague, Czechoslovakia | 7.345, 9.54, 11.99, 15.365 |
| | Rome, Italy | 11.81, 15.41 |
| 9:30 p.m. | Berne, Switzerland | 9.535, 11.715, 15.305 |
| | Cologne, Germany | 6.075, 9.735 |
| | Melbourne, Australia | 15.32, 17.82 |
| 10:00 p.m. | Cairo, Egypt | 9.475 |
| | Hilversum, Holland (via Bonaire) | 11.73 |
| | Lisbon, Portugal | 6.025, 11.935, 15.34 |
| | London, England | 6.11, 9.58, 11.78 |
| | Moscow, U.S.S.R. | 9.70, 11.87, 15.15 |

## TO WESTERN NORTH AMERICA

| TIME-PDT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|
| 8:00 a.m. | Tokyo, Japan | 9.505 |
| 6:30 p.m. | Melbourne, Australia | 15.32, 17.82, 21.74 |
| | Tokyo, Japan | 15.235, 17.825, 21.64 |
| 7:00 p.m. | Oslo, Norway (Sun.) | 11.86 |
| 7:30 p.m. | Johannesburg, South Africa | 5.98, 9.695, 11.875 |
| 8:00 p.m. | Madrid, Spain | 6.14, 9.76 |
| | Moscow, U.S.S.R. | 9.70, 11.96, 15.15 |
| | Peking, China | 15.095, 17.673, 21.735 |
| | Prague, Czechoslovakia | 7.345, 9.54, 11.99, 15.365 |
| | Seoul, Korea | 15.43 |
| | Tokyo, Japan | 17.785 |
| 8:30 p.m. | Berlin, Germany | 9.73, 11.84, 15.45 |
| | Stockholm, Sweden | 11.705 |
| | Tirana, Albania | 6.20, 7.30 |
| 9:00 p.m. | Budapest, Hungary | 9.833, 11.91, 15.16 |
| | Havana, Cuba | 9.525, 11.76 |
| | Lisbon, Portugal | 6.025, 11.935, 15.34 |
| | London, England | 6.11, 9.58, 11.78 |
| | Moscow, USSR (via Khabarovsk) | 15.14, 17.865, 17.88 |
| | Sofia, Bulgaria | 9.70 |
| | Tokyo, Japan | 17.785 |
| 9:30 p.m. | Kiev, USSR (Mon., Thu., Sat.) | 11.96, 15.15 |
| 9:45 p.m. | Berne, Switzerland | 11.715, 15.305 |
| | Cologne, Germany | 9.545, 11.945 |
| 10:00 p.m. | Havana, Cuba | 11.76 |
| | Hilversum, Holland (via Bonaire) | 9.715, 11.73 |
| 11:00 p.m. | Moscow, USSR (via Khabarovsk) | 15.14, 17.865, 17.88 |
| | Tokyo, Japan | 15.105 |
| 11:30 p.m. | Havana, Cuba | 11.93 |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**STRAUSS:** Festive Prelude, Op. 61 (excerpt) DGG.
**DEBUSSY:** Feux d'artifice (excerpt). Connoisseur Society.
**BEETHOVEN:** Wellington's Victory (Battle Symphony) (excerpt from the first movement) Westminster Records.
**MASSAINO:** Canzona XXXV à 16 (complete) DGG Archive.
**CORRETTE:** Concerto Comique Op. 8, No. 6, "Le Plaisir des Dames" (third movement) Connoisseur Society.
**KHAN:** Raga Chandranandan (excerpt) Connoisseur Society.
**RODRIGO:** Concert—Serenade for Harp and Orchestra (excerpt from the first movement) DGG.
**MANITAS DE PLATA:** Gypsy Rhumba (complete) Conn. Soc.
**MARCELLO:** (arr. King): Psalm XVII "The Heavens are Telling" (complete) Connoisseur Society.
**PRAETORIUS:** Terpsichore: La Bourrée XXXII (complete) DGG Archive.
**BERG:** Wozzeck (excerpt from Act III) DGG.
**BARTÓK:** Sonata for two pianos and Percussion (excerpt from the first movement) Cambridge Records.
**BEETHOVEN:** Wellington's Victory (Battle Victory) (excerpt from the last movement) Westminster.

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State ______ Zip ______

PAYMENT MUST BE ENCLOSED WITH ORDER

## OPPORTUNITY MIRROR

*(Continued from page 70)*

subject under study was in danger or might be rewarded (the mother example again), it is not possible to impress "new" material or learn while sleeping.

### Jobs for "First Phone" Holders

*I have a First-Class Radiotelephone license, but my interest is not in commercial AM or FM broadcasting. What other kinds of jobs can I get to take advantage of my First-Class FCC license?*

● The non-broadcasting jobs that you can get will depend upon the amount of training that you have above and beyond that required to get the First-Class license. If your training covered only the material necessary to pass the examination, you can only get a job that involves operating, maintaining and troubleshooting communications gear. There are a lot of governmental jobs of this kind currently available. Law enforcement agencies ranging from the local police to the FBI all report a shortage of qualified radio operators and troubleshooters. And, all branches of the Armed Forces also hire "first phone" men for their civilian repair facilities.

There are some private business openings and I would suggest trying taxicab companies, the local telephone company, and any other outfit that uses a lot of mobile radio gear. Put an application in with a reputable, nationwide employment agency. Many jobs for men with a "first phone" license are fee-paid.

The best jobs go to the men who have both a "first-phone" license and a solid background in general electronics technology. Almost every electronics company that designs and builds communication gear is looking for men who have an FCC license and at the same time can design solid-state logic and control circuits.

Keep your eye on the classified employment ads in your local newspaper. Visit any major airport and you'll probably find a cluster of small companies that specialize in airborne radio communications equipment. However, you'll find that the engineering electronics technician job is a lot more exciting than the plain and simple "first phone" maintenance and operation job. If you don't have the training to let you design communications *and* control circuits, I suggest you enroll in a home study course in electronics.

# AMATEUR RADIO

*(Continued from page 82)*

*Radio,* Melbourne, Australia, that work done by Alan Fowler of the Australian Post Office Research Department, indicates that these "doubting Thomases" may be right. He says that, unless that silver plating is nearly 100% pure, its resistance becomes excessively high. Furthermore, not only is it difficult to keep the plating solution clean; but commercial platers usually add contaminants called "silver brites" to obtain a bright finish. Compounding the difficulty, many silver-plated electronic components are also gold plated to inhibit corrosion. Gold brighteners also increase the resistance of gold plating sharply—and its resistance is greater than copper or silver.

VK5PB (who is a professional plater) recommends skipping silver plating entirely. Instead, buff the material to a smooth, shiny surface; electroplate it with copper (even if the material is copper to begin with); polish again; and lightly flash with pure gold to inhibit corrosion.

Gary Kent, WNØSZY, Eddyville, IA, 52553, is waiting for his General license. His Heathkit DX-60B, Drake 2B, Hy-Gain 18-AVQ have worked 34 states.

**$1,000,000 TVI Suit—Final Report.** As we reported previously, the $1,000,000 TVI suit against "Grid" Gridley, W4GJO, has been withdrawn. Legal costs were $6,500, of which $5,200 were covered by contributions. Further contributions may be sent to the Sarasota Amateur Radio Association, P.O. Box 3323, Sarasota, Fla. (Tnx *Florida Skip*)

### NEWS AND VIEWS

**Ron Del Buono, WA2JUI,** 415 41 St., Union City, NJ 07087, collected over 450 QSL cards as a Novice! His best Novice DX was Spain, but he is most proud of his card from WA6UIL at the San Diego Naval Base. Ron used a Hallicrafters S-120 receiver and a Heathkit DX-20 as a Novice. He is now using a Heathkit Sixer on 6 meters . . . **Ken Sobel, WN2MQI,** 1560 E 102 St., Apt. 3-G, Brooklyn, NY 11236, worked 22 states his first three weeks on the air and expected to pass the General exam during Easter vacation. He uses a DPZ "Vacationer" window-mounted antenna in conjunction with a Heathkit DX-60B transmitter and HR-10B receiver on 15 meters. The antenna is 4½ feet long and 30 feet high . . . Across country, **Dave Wetherbee, WN6GTE,** uses an Ameco AC-1 transmitter and R-5A receiver in conjunction with a Gotham V-80 vertical antenna. Dave has three states confirmed after a few days on the air and is studying hard for his General ticket.

The Medical Amateur Radio Council, Ltd., will hold its 4th Annual meeting in Chicago at the Sheraton-Blackstone Hotel on June 25 at the time of the American Medical Association Meeting. Reservations at $7.50 can be obtained from Joseph J. Boris, P.O. Box 229, Manchester, CT 06040. The MARCO nets meet on 14,280 kHz at 0200 GMT and on 7260 kHz at 0100 GMT. Last September, the MARCO net, with help from the International Missionary Radio Net, obtained 10 ampoules of Dilantin needed for a 3-year-old ill with encephalitus in Lima, Peru, and put them on a plane in Miami. The drugs arrived in time, and the child was relearning how to use her muscles in February.

**Ray Ilich, WN8FMZ,** 446 Alameda Ave., Youngstown, OH 44504, was so excited when his license arrived that he fell down the stairs getting to his radio shack. Picking himself up, it took him a month to work 16 states and Canada on 40 meters.


Don Babcock, WB4KUZ, Titusville, FL 32780, likes to ragchew and he is also a member of the local Radio Amateur Civil Emergency Service (RACES).

A Heathkit HW-16 transceiver drives Ray's 40-meter vertical antenna, and he has plans for a 15-meter beam . . . **R. H. Mattox, W9ADT/MM,** *SS Green Bay* (5457 Hatch Lane, West Palm Beach, FL 33406, when he's home) has been a ham for over 35 years. He has also been a disc jockey and engineer for AM and FM BC stations, teacher of code and radio engineering, seaman, etc. The shipboard equipment includes a Heathkit SB-300 receiver, SB-400 transmitter driving an SB-200 linear amplifier to 1000 watts input into a Hy-Gain 14-AVQ vertical antenna. On shore, Bob signs WB4IPP. Get him to tell you how he was blown 100 miles out to sea on his honeymoon, spending 35 hours lashed to the tiller of the 34-ft ketch. By the way, the captain of the *Green Bay* is WA5TKV, thanks to Bob's tutoring . . . **Faris Howat, WN2GJM,** 115 Ocean Ave., Brooklyn, NY 11225, alternates between a homebrew 10 watter and a Heathkit DX-60V transmitter. His antenna is a Hy-Gain 14-AVQ vertical, and his receiver is a Drake 2C. It all adds up to 41 states and 10 countries. When Faris gets his code speed built up a little more, he will go for his Advanced ticket. As he already holds 2nd class Commercial Radiophone license with Radar endorsement, he isn't too worried about the theory. Being in the U.S. Navy may explain the radar endorsement . . . **C. D. Anandasegar, VU2AI/W2,** Box 253, Manasquan, NJ 08736, first got on the air in Madras, India, using a 25-watt, homebuilt transmitter to feed a folded dipole antenna. He received on a BC-342 and worked over 80 countries. Anand is in the United States for electronics training and has been operating under the Indian/USA reciprocal operating agreement through the cooperation of Charles, W2AIW. The best time to catch Anand is on weekends on 20 meters . . . **James W. Andrews, WN8FRQ,** 4240 Otis Dr., Dayton, OH 45416, feeds his 40-meter dipole with a Drake 2-NT transmitter and receives on a Drake 2C. Jim has worked 11 states and is president of the Miami Valley SWL Association . . . **Daniel Roy, WN1MJC,** 19 Standard Ave., West Warwick, RI 02893, has separate dipoles for the 80-, 40-, and 15-meter Novice bands. He operates them in conjunction with a Heathkit DX-60B transmitter and a Realistic DX-150 receiver. Dan wants to start an amateur radio club at his high school and would appreciate advice from officials or members of established clubs.

**Jim Labo, WA5ZVI,** 1700 Mosher Dr., Enid, OK 73701, was KH6FKB in Hawaii for six months before becoming WA5ZVI. He was thrilled at working 45 Novices in 12 states on 15 meters, but his big frustration was being unable to convince many of them that his call was KH6FKB, *not* K6FKB. Jim uses an SBE-34 transceiver on 15 meters, but he is now a VHF man with homebrew or kit gear for 50, 144, 220, and 432 MHz.

Good luck on Field Day. Keep your "News and Views," pictures, and club bulletins coming to P.O. Box 678, Gary, Ind. 46401. *73, Herb, W9EGQ*

## SOLID STATE

(*Continued from page* 80)

The TA5371B is a developmental IC consisting of a photosensitive section and a power amplifier on a single monolithic silicon chip assembled in a modified TO-5 package fitted with a transparent window. The light-detector portion includes two photosensitive Darlington pairs connected in parallel, while the amplifier is a direct-coupled multi-stage circuit using seven *npn* transistors, four diodes, and ten fixed resistors.

Depending on external connections, the TA5371B can be used either as an amplifier providing a linear output signal or as a sensitive light-actuated switch with two outputs. One output (terminal 6) supplies power to the load when the photosensitive elements are illuminated, while the other (terminal 2) furnishes current in the absence

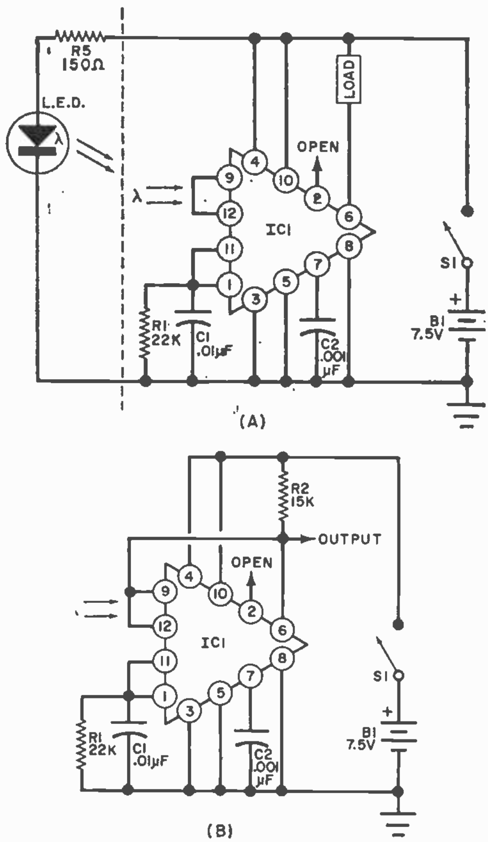



Fig. 3. New RCA TA5371B IC is shown in circuit (A) connected as light-actuated on/off switch. In circuit (B), same IC is used as a linear amplifier.

of light. Designed for operation on a 7.5-volt d.c. power source, the device can furnish up to 100 mA output. Its peak sensitivity is to infrared light at 7250 Angstroms. but it responds to visible light as well.

An on/off switching action is provided by the circuit shown in Fig. 3A. In operation, the load is energized when light strikes the sensitive elements located between pins 9 and 12. A reverse action—load energization in the absence of light—can be obtained by connecting the load to pin 2 with 6 open. A gallium-arsenide light-emitter diode (LED). RCA type 40598A, may be used as the controlling infrared source, and will provide greater sensitivity than an incandescent source.

The linear amplifier arrangement (Fig. 3B) may be used in test equipment or communications applications. In practice, the output signal developed across load resistor *R2* can be coupled to a high-impedance voltmeter, to an output amplifier and speaker system, to an oscilloscope, or to other instrumentation, depending on system requirements.

In both circuits, all resistors are half-watt types and the capacitors low-voltage ceramic or tubular paper units. The switching circuit's load can be a tone source, such as a Mallory Sonalert, or a moderately sensitive 6-volt electromagnetic relay. If a relay is used, however, a small diode should be connected across its coil to absorb the transient pulse voltages generated during switching (anode to pin 6).

While conventional construction and wiring techniques may be used for assembling either of the two circuits, reasonable care in regard to layout and lead dress is necessary to prevent feedback and instability due to the amplifier's inherently high gain. Signal leads must be kept short and direct. RCA, in fact, suggests that the external components (*R1*, *R2*, *C1*, *C2*, etc.) be connected directly to the appropriate IC terminals.

**Device News.** Motorola Semiconductor Products Inc. (P.O. Box 10912, Phoenix, AZ 85036) has announced the production of an integrated circuit UFH duplexer. Identified as type MCH5890, the unit is essentially a solid-state s.p.d.t. switch designed to operate at frequencies between 400 and 500 MHz with inputs of up to 40 watts.

Although primarily a transmit/receive switch, the new device also can be used as a monitor network in a transmitter, as a sampling unit in an a.f.c. or a.g.c. circuit, or in similar communications applications. With a typical 0.1-dB transmit-mode insertion loss and 25-dB transmit-mode isolation figure, the MCH5890 is supplied in a

## SOLID STATE

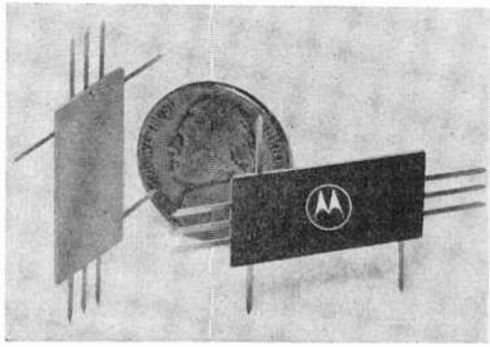
(*Continued from page* 89)

thin plastic-ceramic package measuring ½" by 1" overall.

An interesting solid-state "relay" has been developed by Ebeko of Urloffen, West Germany. Featuring an integral four-transistor direct-coupled amplifier, the unit employs a conventional electromagnetic input coil. Instead of operating a mechanical armature, however, the coil acts to control the resistance of a Hall-effect indium-antimonide element. The Hall-effect resistor, in turn, adjusts the amplifier's bias to provide output switching, with one driver transistor used as the normally off and another as the normally on contact. Suitable for use in d.c. as well as pulsed a.c. circuits, the new relay has the advantages of virtually unlimited life, fast, bounceless, arcless operation, and excellent input/output isolation.

Field-effect transistors capable of handling 10 to 12 watts at 2 GHz have been developed by Siliconix, Inc. (1140 W. Evelyn Ave., Sunnyvale, CA 94086) as the first products in a planned line of microwave semiconductor devices. Future products will include additional special purpose FET's and bipolar devices as well as both multiplier and tuning varactors.

A line of "Magnistors" at prices within the reach of the serious experimenter is being offered by the Hudson Corp. (Box 867, Manchester, NH 03105). A Magnistor is a silicon planar transistor which has two collectors and a single emitter, with its construction so arranged that an external magnetic field gives a lateral motion to the charge flow from the emitter, causing a differential change in the relative collector currents. Used as magnetic sensors, these devices can be employed in test and control applications. Unit prices range from $3.50 for the HM 111 B to $5.00 for the HM 111 G, although there is a minimum order requirement of $30.



The Motorola MCH5890 is a UHF duplexer integrated circuit for the frequencies from 400 to 500 MHz.

**Transitips.** Engineer Bob Botos of Motorola Semiconductor Products Inc., has passed along some very worthwhile tips for anyone concerned with minimizing feedback and oscillation problems when working with linear integrated circuits. He points out that linear monolithic IC's, even if specified for audio applications, are potential r.f. amplifiers and, therefore, must be treated with respect and care.

Good r.f. breadboard techniques must be observed, with both signal carrying and power supply leads kept short and direct to minimize distributed inductances and feedback capacities. In addition, bypass and frequency compensation capacitors, where used, should be connected directly to the device's leads (or socket terminals). Naturally, ground loops must be avoided.

According to Bob, improper breadboard techniques can result not only in frustration but in a tendency to blame the IC's manufacturer for producing poor-quality merchandise. *—Lou*

## SHORT-WAVE LISTENING

*(Continued from page 78)*

### SHORT-WAVE CONTRIBUTORS

Bill Jarvis *(WPE1GEP)*, Wakefield, Mass.
Richard Pendleton *(WPE1HMV)*, E. Braintree, Mass.
Bob Raymond *(WPE1HOE)*, Bradford, Mass.
Joseph Smith, Jr. *(WPE1HRA)*, Saugus, Mass.
Rick Mills *(WPE1HSA)*, Berwick, Maine
Andy Emars *(WPE1HVQ)*, Willimantic, Conn.
Bill Feidt *(WPE2AM)*, Lanham, Md.
John Banta *(WPE2PHU)*, Bay Shore, N. Y.
Bob Arnold *(WPE2QPR)*, Canastota, N. Y.
Paul Wolcott, Jr. *(WPE2QVL)*, Linwood, N. J.
T. R. Dieber *(WPE2QVT)*, Summit, N. J.
Bradley Krohn *(WPE2REA)*, Amherst, N. Y.
John Brandt *(WPE2REL)*, Brooklyn, N. Y.
Bennett Pine *(WPE2RER)*, Brooklyn, N. Y.
Michael Fallarino *(WPE2RFC)*, Catskill, N. Y.
Neil Berman *(WPE2RGC)*, Brooklyn, N. Y.
George Sprout *(WPE3GMW)*, Reading, Pa.
Larry Gilboy *(WPE3HVL)*, Pittston, Pa.
Bill Martin *(WPE3HZI)*, Wilmington, Del.
Fred Heutte *(WPE3IBI)*, Brookland, Md.
Grady Ferguson *(WPE4BC)*, Charlotte, N. C.
John Carson *(WPE4JZB)*, Durham, N. C.
Bruce Roberts *(WPE4KAH)*, Waynesboro, Va.
M. F. Dressler *(WPE4KHJ)*, Jacksonville, Fla.
Guy Fisher *(WPE4KIK)*, Cape Coral, Fla.
Sam Fulp *(WPE4KIM)*, Lexington, N. C.
John Leger *(WPE4KKK)*, Louisville, Ky.
Alan Parker *(WPE5FFF)*, New Orleans, La.
John Wheeler *(WPE5FFS)*, San Angelo, Texas
Charles Bennett *(WPE5SW)*, Sumrall, Miss.
Walter Schivo *(WPE6AFN)*, San Francisco, Calif.
Jim Young *(WPE6ENA)*, Wrightwood, Calif.
Wallace Glavich *(WPE6EPX)*, Eureka, Calif.
Richard Loustau *(WPE6HPS)*, Woodland Hills, Calif.
Robert Hymes *(WPE6HRW)*, Palo Alto, Calif.
David Williams *(WPE7CWW)*, Astoria, Ore.
Anthony Marks *(WPE7CYQ)*, La Grande, Ore.
Wayne Benkinney *(WPE8EEI)*, Flint, Mich.
R. D. Bolling *(WPE8EJX)*, APO (Qui Nhon, Vietnam)
George Smith *(WPE8KJJ)*, Grand Rapids, Mich.
Tom Kennedy *(WPE8KKE)*, Battle Creek, Mich.
Bruce Call *(WPE8KKR)*, Akron, Ohio
Bob Smith *(WPE8KKY)*, Grand Rapids, Mich.
Bill Brown *(WPE8KNI)*, Corunna, Mich.
Ben Mancine *(WPE8KNJ)*, S. Euclid, Ohio
Gerry Dexter *(WPE9HDB)*, Lake Geneva, Wisc.
Robert Zilmer *(WPE9IJV)*, Milwaukee, Wisc.
Jim Siers *(WPE9JNS)*, Franklin Park, Ill.
Jerry Reichman *(WPE9JPG)*, Chicago, Ill.
John Hedstrom *(WPE9JTQ)*, Wheaton, Ill.
David Speegle *(WPE9JUH)*, Plymouth, Ind.
Mike Rogers *(WPE9JWC)*, Glencoe, Ill.
Robert French *(WPE9JXA)*, Fort Wayne, Ind.
Robert Mackey *(WPE9JXS)*, Rockford, Ill.
Arthur Nelson *(WPE9JYG)*, Rockford, Ill.
A. R. Niblack *(WPE9KM)*, Vincennes, Ind.
John Beaver *(WPEØAE)*, Pueblo, Colo.
Gary Lovegren *(WPEØFAN)*, St. Paul, Minn.
Art Burke *(WPEØFOJ)*, Topeka, Kan.
Carl Larson *(WPEØGA)*, Mount Ayr, Iowa
Jack Perolo *(PY2PE1C)*, Sao Paulo, Brazil
Mark Paull *(VE2PE1OG)*, Chomedey, Que.
Jeff Wilson *(VE3PE2NL)*, Sarnia, Ont.
Paul Cau *(VE3PE2OZ)*, St. Catharines, Ont.
Anthony D'Agostine *(VE3PE2SD)*, Hamilton, Ont.
Leo Cellini *(VE3PE2SK)*, Hamilton, Ont.
Ken Asmus *(VE4PE7W)*, Winnipeg, Man.
Les Hughes *(VE7PE1EH)*, S. Burnaby, B. C.
Shawn Daniels, St. Louis, Mo.
Homer Fort, Midland, Texas
Bruno Haineault, Montreal, Que.
Harold Honnold, Modesto, Calif.
Jon Jayroe, Baltimore, Md.
Kirk Kolpitcke, Wausau, Wisc.
Capt. P. Lefevre, Carcavelos, Portugal
Cass Lewart, Holmdel, N. J.
William Milus, Plymouth Meeting, Pa.
Garry Murch, Tewksbury, Mass.
Jim Sight, Kansas City, Mo.
Robert Tomaine, Jermyn, Pa.
Dan Tschopp, Humble, Texas

*(Continued on page 92)*

## SHORT-WAVE LISTENING

(*Continued from page 91*)

on 9645 kHz at 2055-2105 and around 0055 on 6175 and 11,725 kHz. Numerous reports received within the past few days also list 9615, 9690 and 15.285 kHz as having English church news during that 0050 xmsn.

**Vietnam (North)**—*V. of Vietnam*, Hanoi, now runs an English time slot on 10.042 kHz at 2300-2330 for American Forces in South Vietnam with usual slanted propaganda, some old American pop records and the voice of "Hanoi Hattie".

**Clandestine**—*Radio Nordsee International* is being reported on 6210 kHz at 2120-2300 with rock music and anmt's in English and German.

## DX COUNTRY AWARDS PRESENTED

*To be eligible for one of the DX Countries Awards designed for WPE Monitor Certificate holders, you must have verified stations in 25, 50, 75, 100, 125, or 150 different countries. ("Letters of Certification" will be issued to those who have over 150 countries verified in steps of 10.) The following DX'ers recently received their awards for 25 countries.*

### 25 COUNTRIES VERIFIED

Howard Rosenberg (WPE2PQE), Queens Village, N. Y.
Lewis West, Jr. (WPE4JYL), Charlotte, N. C.
David Perry (WPE2QFK), Pleasant Valley, N. Y.
Dennis Davenport (WPE9JLT), Edwardsville, Ill.
Edward Sue (WPE1HMA), Brookline, Mass.
John Ward (WPE1HJH), Springfield, Mass.
Horace Steinhaeusser (VE3PE2JO), Kenora, Ont.
Jack Dashper (WPE4KCJ), Camden, Tenn.
E. F. P. Lloyd (VE7PE1ED), N. Vancouver, B. C.
David Galletly (WPE2QHG), Sound Beach, N. Y.
T. R. Wieber (WPE2QVT), Summit, N. J.
Richard Moore (VE3PE2NZ), London, Ont.
Michael Dopson (WPE4KCF), Enterprise, Ala.
Steve Swift (WPE7CVV), Olympia, Wash.
Barry Lavine (WPE2QHM), Elmira, N. Y.
James Ziegler (WPE9JOW), Milwaukee, Wisc.
Robert Olszewski (WPE8KFW), Toledo, Ohio
Loren Davis (WPE6HMA), Hayward, Calif.
Fred Parkinson (WPE2QTW), Hewlett, N. Y.
Charles Loftis (WPE4KEF), Landrum, S. C.
John Burda, Jr. (WPE8KAO), Willard, Ohio
Joseph Cooper (WPE9JRT), Milwaukee, Wisc.
David Yoder (WPEØEZU), Denton, Kansas
Everett Slosman (WPE2QZB), Endicott, N. Y.
Craig Seufert (WPE1HNS), Newtown, Conn.
Gregory Martin (WPE8KFL), Wyoming, Mich.
Walter Robison (WPE2RAK), Bellmawr, N. J.
Daniel Laurier (WPE2QHP), Walton, N. Y.
Glenn Tamasi (VE7PE1DY), Vernon, B. C.
Ron Taylor (WPE9JSA), Benton, Ill.
Richard Lewis (WPE5BST), Blackfoot, Idaho
David Lubar (WPE9JFD), Elmwood, Ill.
Donald Asp (WPE6HGY), Tustin, Calif.
Willie Martin (WPE5FBJ), Blytheville Air Force Base, Ark.
Thomas Gongaware (WPE5HWU), Latrobe, Pa.
Joel Bahl (WPE9JFY), Worth, Ill.
Charles Albertson (WPE7CWI), Spokane, Wash.
Clayton Ruth (WPE9JGY), Munster, Ind.
Michael Schackner (WPE1HSJ), Pawcatuck, Conn.
John Limbach (WPE4KCV), Fayetteville, N. C.
David Winfree (WPE4KBA), Jupiter, Fla.
Curtis Philips (WPE3HNS), Hellertown, Pa.
James Maker (WPE4HB), Tampa, Fla.
David Weinberger (WPE3HVV), Philadelphia, Pa.
Mrs. Mildred Marshall (WPEØFIR), Devils Lake, N. D.
Robert Byers (VE3PE2PX), Gananoque, Ont.
Ronald Richmond (WPE9JIH), Alexandria, Ind.
Alan Macnaughton (VE3PE2PP), Kitchener, Ont.
Warren Flack (WPE4KEL), Atlanta, Ga.
Stanley Starks (WPE8KDR), Midland, Mich.
Thomas Blossom (WPE9FHQ), Fort Wayne, Ind.
Kim Stenson (WPE1HPU), Wilmington, Vt.
John Adams (WPE3HXT), Beltsville, Md.
Dennis Sheppard (WPE4JTH), Stone Mountain, Ga.
Dimitur Alipiev (WPE2QXL), Syracuse, N. Y.
Mitchell Kassoff (WPE2QTK), Little Neck, N. Y.
Ivan Waufle (WPE2QVD), St. Johnsville, N. Y.
Gary Marks (WPE2QZK), Tonawanda, N. Y.
James Jankowski (WPE2QVE), Corfu, N. Y.
Timothy Gjenvick (WPE9ILO), Brookfield, Wisc.
Charles Clay (WPE2QWE), Climax, N. Y.
Anthony Baleno (WPE3HWY), Verona, Pa.
Bruce McCoy (WPE9JMY), La Porte, Ind.
Keith Fritzinger (WPE3HSW), Shillington, Pa.
Brian Heller (WPE2QVP), Lawrenceville, N. J.
Michael Garrett (WPE8KBA), Grosse Pointe Park, Mich.
Joseph Perge (WPE8JKD), Newark, Ohio
Lawrence Plummer (WPE7CRV), Bellevue, Wash.
Thomas Porzio (WPE2PXI), Butley, N. J.
Randy Curtis (WPEØFKE), Omaha, Nebr.
Ken Piper (WPE6GVB), Stockton, Calif.
James Hurst (WPE3HWP), Vienna, Md.
Dave Denbow (WPE6HJT), Claremont, Calif.
Ronald Del Buono (WPE2PYJ), Union City, N. J.
Steve Smith (WPE5FAU), El Dorado, Ark.
Ronald Nawrot (WPE3HUO), Owings Mills, Md.
Tom Frisz (WPE9JRU), South Bend, Ind.
Christopher Martin (WPE1HRG), Naugatuck, Conn.
George Shadwell (VE3PE2QZ), Ottawa, Ont.
Robert Rattner (WPE2RBL), Forest Hills, N. Y.

Edes Matsukado (KH6PE3Z), Honolulu, Hawaii
Robert Frieden (WPE4KIA), Norfolk, Va.
Thomas Phillips (WPE1HQE), Rutland, Vt.
Alan Silver (WPE6HNW), Los Angeles, Calif.
Richard Thompson (WPE3HQW), Suitland, Md.
Chris Goodwin (WPE3HXB), Ridley Park, Pa.
Edward Horne (VE7PE1DA), Watson Lake, Yukon
Frederick Webster (WPE2PRD), Secaucus, N. J.
J. Arthur Frederick (WPE3FWX), New Kensington, Pa.
Steve Legler (WPEØFKU), Lawrence, Kansas
David Peters (WPE6HDM), Modesto, Calif.
Robert Shumaker (WPE8KBE), Southfield, Mich.
Raymond Fortman (WPE2PLW), Grand Island, N. Y.
Andre Lavigne (VE2PE1NO), La Salle, Que.
G. Clinton Myers (WPE4KEO), Atlanta, Ga.
James Milburn (WPE5FDQ), Baton Rouge, La.
Ralph Collins (WPE2RBO), FBO, New York, N. Y.
Jerry Smith (WPE5FCX), Longview, Texas
Richard Sheehan (WPE9JOV), Park Forest South, Ill.
Ted Romanow (WPE1HQH), Waban, Mass.
Gary Smith (WPE1HRP), Torrington, Conn.
Paul Metro (WPE2QZM), Colonia, N. Y.
Nick Chinn (WPE6HKB), San Leandro, Calif.
Mike Witkowski (WPE9JFT), Stevens Point, Wisc.
Peter Heindel (WPE6GLR), Waukegan, Ill.
Philip Scribani (WPE2QSY), Maspeth, N. Y.
Joseph Williams (WPE9JKD), Milwaukee, Wisc.
Tom Felton (VE7PE1EA), Vancouver, B. C.
David Lavin (WPE5FCY), Corpus Christi, Texas
William McGraw (WPE3HRM), Burgettstown, Pa.
Joseph Molon (WPE1HSC), Torrington, Conn.
Frank Swanberg III (WPE9JVD), Dolton, Ill.
Roger Horie (WPE7COV), Mountain Home Air Force Base, Idaho
Bill Potorti (WPE2QYH), Ithaca, N. Y.
Larry Wood (WPEØFNY), Potosi, Mo.
Ken Edl (WPE9JPU), Franklin Park, Ill.
Matthew Shifman (WPE2RAZ), E. Brunswick, N. J.
Alan Carpenter (WPE8JXS), Fairmont, W. Va.
Donald Appling (WPE7CNG), Spokane, Wash.
Bud Nation (WPE6HJA), Mill Valley, Calif.
G. W. Fisher (WPE7CXZ), Longview, Wash.
Richard Wells, Jr. (WPE2QHY), Wayne, N. J.
Delbart Fant (WPE6HMY), San Luis Obispo, Calif.
James Brenner (WPE2QUL), Nutley, N. J.
Dennis Wolfs (WPEØERJ), Waterloo, Iowa
Jack Graham (WPE2QNT), New Milford, N. J.
Lloyd Zeidner (WPE2QRC), Bayside, N. Y.
Richard Mayer (WPE2QOJ), Bronx, N. Y.
James Tracz (WPE9JRD), Morton Grove, Ill.
Roger Boyd (WPE4KEK), Valdosta, Ga.
Ray Good (WPE9BAK), River Forest, Ill.
Robert Bacal (VE2PE1NK), Montreal, Que.
Richard Gee (VE7PE1EG), Victoria, B. C.
Arthur Bolduc (WPE1HQU), Biddeford, Maine
Robert Mc Larnon (WPE1HQL), Natick, Mass.
Scott Fruehwald (WPE4KIH), Jeffersontown, Ky.
Robert Sylvester (WPE5FEW), Metairie, La.
Robert Halprin (WPE2QZU), Fair Lawn, N. J.
Wayne Mitchell (WPE2PVI), Elmont, N. Y.
Jim Townsend (WPE8KJT), Painesville, Ohio
Robert Fruehwald (WPE4KHQ), Jeffersontown, Ky.
Philip De Silva (WPE5CHD), Bremerton, Wash.
Robert Keller (WPE7CND), Brigham City, Utah
Lt. Paul Steen (WPE2RBA), FPO (Guam)
Bill Buckley (WPE2RDI), New York, N. Y.
Steven Solomon (WPE2QTM), Saddle Brook, N. J.
Steve Houston (WPE4KDC), Knoxville, Tenn.
Dave Porter (WPE2QSU), Cherry Hill, N. J.
James Sanders (WPE4KCH), Savannah, Ga.
Homer Ingler (WPE4JJY), Durant, Fla.
Philip Thibodaux (WPE5FEB), Morgan City, La.
Greg Raymond (WPE1HRW), Bradford, Mass.
Tommy Buchanan (WPE4KGA), Darlington, S. C.
Marcus Berman (WPE2QXO), Montclair, N. J.
Rick Schiffer (WPE3HLL), Franklin, Pa.
James Murray (WPE2RFR), Troy, N. Y.
Barry Gelb (WPE2QZY), Flushing, N. Y.
Dwight Snyder (WPE9JHY), Farmersville, Ill.
Graham Chloupek (WPE6FZE), Oakland, Calif.
Daniel Lindley (WPE4KEA), Florence, S. C.
G. Alan Hickrod (WPE9JPJ), Bloomington, Ill.
William Cangemi (WPE2PII), Staten Island, N. Y.
Ronald Carnes (WPE2RBV), Spotswood, N. J.
Edward Svec (WPE2RFN), College Point, N. Y.
Andrew Finick, Jr. (WPE9JPF), Highland, Ind.
Mark Androw (WPE9JUZ), Lincolnwood, Ill.

# OPERATION ASSIST

*Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information, write him directly—he'll appreciate it. If you need help, send a postcard to Operation Assist, POPULAR ELECTRONICS, One Park Avenue, New York, N.Y. 10016. Give maker's name and model number of the unit. If you don't know both the maker's name and the model number, give year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Do not send an individual postcard for each request; list all requests on one postcard. Because we get so many inquiries, none of them can be acknowledged. POPULAR ELECTRONICS reserves the right to publish only those items not available from normal sources.*

**Crosley** Model 51 Receiver. Schematic and tubes needed. (John Von Dollen, 820 Ambrose Dr., Salinas, CA 93901)

**National** NC-183D receiver. Operating manual needed. (A. G. Barry, 538 E. Samford Ave., Auburn, AL 36830)

**MusiCraft** Model MS 30-30 stereo basic amplifier. Schematic needed. (Wm. Jachim, 8338 Baker Ave., Chicago, IL 60617)

**Scott** Marine Radio Model SLRM receiver. Schematic needed. (Joseph Talley, 163 Charles Circle, Seaford, VA 23428)

**Montgomery Ward** Model 62-297 "Airline" receiver. Schematic needed. **Heathkit** Model 0-9 oscilloscope. Schematic and calibration info needed. (Peter Rebuzzini, 78 Tanners Marsh Rd., Guilford, CT 06437)

**RCA** Model RC-6108 AM-FM radio, circa '34. Schematic and operation manual needed. (Eric Urscher, 620 10th Ave., Huntington, WV 25701)

**Triumph** Model 841 oscillograph. Instruction book and schematic needed. (Leo Bellarts, 1920 State St., Everett, WA 98201)

**Norelco** Model EL 3541/54B tape recorder. Instruction manual needed. (Donald Rubin, 3919 Bancroft Rd., Baltimore, MD 21215)

**Motorola** Model LO3-F3 FM receiver. Manual needed. (R. Bell, 20146 Beachcliff, Rocky River, OH 44116)

**Realtone** Model VT-2466 TV. Operating manual and schematic needed. (Bruce Friedman, 21 Stuyvesant Oval, New York, NY 10009)

**Atwater Kent** Model 60. Speaker needed. **Philco** radio chassis type 89 (or 19 series). Schematic needed. (Delmar Pond, 11 Stevens Court, Exeter, NH 03833)

**Precision Apparatus** Model 920 tube and set tester. Instruction manual and schematics needed. (Mike Morrow, 506 Manchester Dr., Chattanooga, TN 37415)

**Lysco** Model 600 CW transmitter. Schematic and parts list needed. (Stephen Smith, 2011 Broad St., New Castle, IN 47362)

**Revere** Model T-100 tape recorder. Schematic needed. (George Dewey, 512 N. Shore Dr., Crystal Lake, IL 60014)

**Precise** Model 300 oscilloscope. Schematic needed. (R. Arguin, 8595 Blvd., Levesque, Laval, P.Q. Canada)

**Motorola** Model KM 202R vibrasonic. Schematic needed. (Cris Holmes, 1723 Orchard, Fresno, CA 93703)

**Kadette** Model 36 by International Radio Corp. Schematic needed. (Terry Shotts, 18009 Marden Ln., Sandy Spring, MD 20860)

**Brunswick** Model 5KR. Schematic and 1-UX71A, 2-UX226 tubes needed. (Larry Fahr, 1103 Hampton Circle, Elmira, NY 14904)

**Dynatron** Radio Model 1000 monitor oscilloscope, manufactured in 1949. Schematic needed. (T. Felton, 3697 W. 15th Ave., Vancouver 8, B.C. Canada)

**Zenith** Model 55119 shortwave receiver. Source for parts needed. (Bob Patton, 2800 Elm, Parsons, KS 67357)

**Globe** Scout Model 680 transmitter. Schematic and instruction manual needed. (Ken Countess, 110 Sycamore Circle, Stony Brook, NY 11790)

**Hallicrafters** Model S-76. Alignment data and operating manual needed. (John Davis, 2607 Colgate Ln., Lake Worth, FL 33460)

**Heathkit** AR-2 receiver **Setchell Carlson** Model 416 radio-intercom. Schematics needed. (John Moran, 605 N. Maple Ave., Cookeville, TN 38501)

**E. H. Scott** Model 800 5761 console receiver. Schematic and operating manual needed. (S. Petrie, 1925 Newell Ave., Walnut Creek, CA 94598)

**RCA** Model T4-8 receiver. Schematic, manual and source of tubes needed. (Gary Lueck, 692 4th Ave., Newport, MN 55055)

**Eico** Model 315 signal generator kit. Manual, operating instructions and schematic needed. **Sentinel (RCA)** Model 1U622C TV receiver. Schematic, alignment data needed. (Dan Houser, 3393 Greenwich Rd., Norton, OH 44203)

**Satellite** FM receiver (channel A) to match FM-10T transmitter. Schematic needed. (Bruce Weinel, Box 691, 5115 Margaret Morrison St., Pittsburgh, PA 15213)

**Temco** Model RA-150 amateur transmitter. Schematic, operating manual, and source for plug in coils needed. (Stephen Farkaly, 2653 S. St. Louis Ave., Chicago, IL 60623)

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# VECTOR-CIRCUIT QUIZ ANSWERS

*(Quiz appears on page 30)*

**1-B** In a series circuit containing only resistance, the current is in phase with the applied voltage.

**2-F** In a parallel circuit, there are three currents and a single voltage, which is used as the reference vector (directed horizontally to the right). The current in an inductor lags the voltage across the inductor by 90 degrees. The current into a capacitor leads the voltage across the capacitor by 90 degrees. The total circuit current is the difference between the branch currents.

**3-J** The current is used as the reference vector. The voltage drops across the capacitor and resistor add vectorially to equal the applied voltage.

**4-H** The applied voltage is the reference vector. The current in the circuit lags the voltage by 90 degrees.

**5-G** The applied voltage is the reference vector. The two branch currents add vectorially to equal the circuit current.

**6-A** The current is used as the reference vector. The voltage drops across the resistor and inductor add vectorially to equal the applied voltage.

**7-I** The current is the reference vector. The voltage drops across the inductor and capacitor are 180 degrees out of phase, and the difference between them is equal to the applied voltage.

**8-E** The applied voltage is the reference. The leading currents in each branch are in phase and add to equal total circuit current.

**9-D** The applied voltage is the reference. The two branch currents add vectorially to equal total circuit current.

**10-C** The applied voltage is the reference. The current in the inductor leads the applied voltage by 90 degrees.

# TAKE ONE new literature

*To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15 or 95.*

A new leaflet, Form No. 7260, recently issued by *Nortronics Co., Inc.*, is written to show the owner of a tape recorder how to determine whether or not his tape head is worn enough to warrant replacement. The leaflet describes the company's "Look-Touch-Listen" test, which gives the visible, aural, and tactile indicators on tape head wear. Worn heads, or heads where the gap has widened, tend to lose their effectiveness in reproducing high frequency sound clarity; worst of all, the deterioration takes place so gradually that the listener is usually unconscious of the change. In view of this, the leaflet recommends periodic head examination even if there is no active dissatisfaction with the performance of the tape recorder.

Circle No. 75 on Reader Service Page 15 or 95

A new company, *Antenna Corporation of America,* is offering to distributors a complete line of TV and FM receiving antennas that are suitable for color and monochrome TV. The antenna line will be marketed under the name "Citation." The VHF-UHF-FM antennas include a number of features, such as tetrapole collector elements, dual-action director/reflector screen, and die-cut impedance collators. Also being offered are electronic accessories, including set couplers, solid-state preamplifiers, booster couplers, and matching transformers. A complete-line brochure is available from ACA.

Circle No. 76 on Reader Service Page 15 or 95

An easy-reference brochure featuring the company's entire line of home entertainment products is available from *Koss Electronics, Inc.*, manufacturer of stereo headphones and accessories. The catalog, P/N11-1351, lists and describes Koss' exclusive electrostatic line of three stereo headphones and six dynamic models. Included also is a listing of accessories, encompassing remote control stations, connector box, monitoring adapter, extension cables and cords, and a high-impact plastic stereophone carrying case with sponge liner.

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# LIBRARY

*(Continued from page 14)*

ing and logic circuits, etc. And each circuit illustrated is complete, accompanied by at least one schematic diagram and parts list.

*Published by TAB Books, Blue Ridge Summit, PA 17214. Hard cover. 384 pages. $17.95.*

## BIOLOGICAL ENGINEERING

*edited by Herman P. Schwan*

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*Published by McGraw-Hill Book Co., 330 West 42 St., New York, NY 10036. Hard cover. 556 pages. $18.50.*

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## LEARN ELECTRONICS THROUGH TROUBLESHOOTING

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# POPULAR ELECTRONICS
# JUNE 1970
# ADVERTISERS INDEX



Printed in U.S.A.

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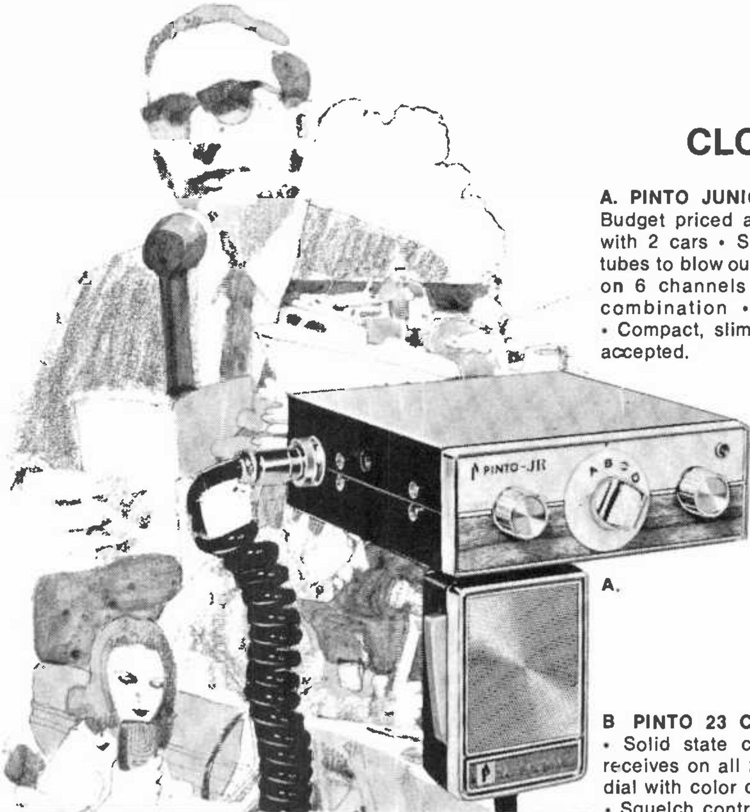
# CB talk is cheap!

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CIRCLE NO. 3 ON READER SERVICE CARD

# Cancel Noise 8 Ways!


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Intelligibility. It's the essential ingredient in voice communications. As field tests prove (and lab tests confirm) the Electro-Voice noise cancelling microphones perform best when the going gets toughest. E-V offers better cancellation over a wider range of frequencies, with a special advantage over common (and troublesome) low frequency noise.

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And E-V hand-held models have improved RF shielding, a new positive-detent switch (you *know* when you're on the air), high impact Cycolac® cases, and a host of other features. Indeed, the Model 602FTR is one of the few civilian products of any type to earn a military designation (M-109) with no more significant change than a new nameplate.

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BUILD LASER BEAM COMMUNICATION SYSTEM


# POPULAR ELECTRONICS

MAY 1970

50 CENTS

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SUPER-FLASH BLINKER LIGHT

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PRODUCT GALLERY REPORTS:

- Mosley SWV-7 SWL Antenna
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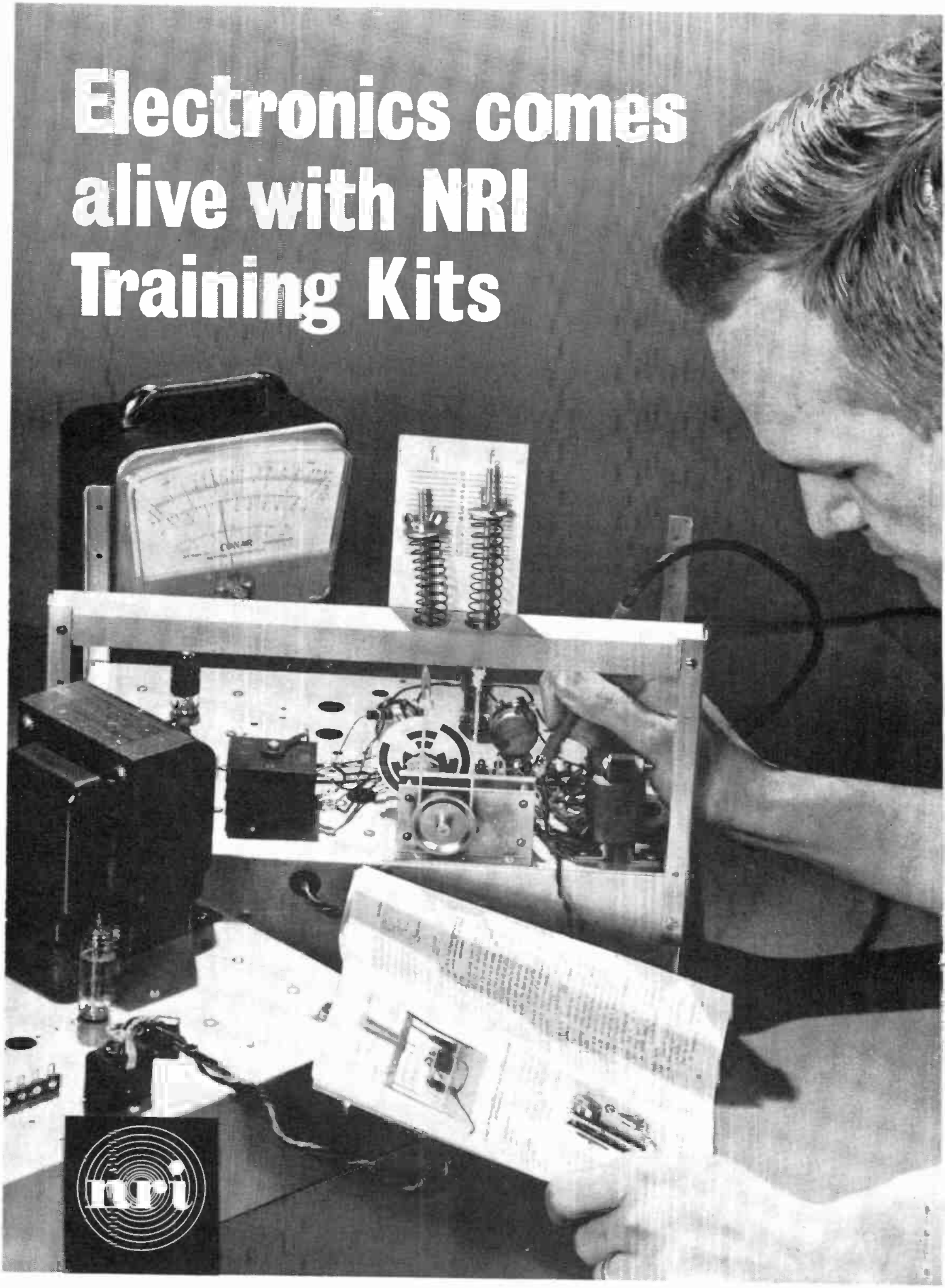
One cf two versions of our Laser Communicator uses low-cost astronomical ref'ector telescope (page 27)

# Electronics comes alive with NRI Training Kits



# POPULAR ELECTRONICS

VOLUME 32 NUMBER 5

MAY 1970

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE


## SPECIAL FEATURE



## FEATURE ARTICLES



## DEPARTMENTS




POPULAR ELECTRONICS is indexed in the Readers' Guide to Periodical Literature

This month's cover photo by Justin Kerr





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Features like the exclusive Dyna-Boost circuit that controls voice modulation to give you maximum talking power. A pre-amplifier that increases the strength of incoming voice signals. And a receiver that selects those signals from adjacent channel and image interference.

You even get an illuminated 3-in-1 master meter: An accurate SWR scale for determining impedance match to your antenna. An 'S' scale for received signal strength. Plus a third scale for power output.

Add it all up and you can see why the Cobra 98 may be the best CB you can buy. Prove it to yourself, as so many others have.

Ask your distributor for the "snake," or write us for complete information.

*Product of*
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CIRCLE NO. 6 ON READER SERVICE PAGE

CIRCLE NO. 30 ON READER SERVICE PAGE




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CIRCLE NO. 12 ON READER SERVICE PAGE→

# letters
## FROM OUR READERS

### READER TAKES EXCEPTION

I would like to take exception to a few of your comments in the article "Engineering-Level Opportunities for You" (February 1970). My main objection is your reference to "gimmicky training kits or home-built TV receivers . . . costly kits and training aids . . ." This is an obvious rap at technical instruction and their advertising efforts.

I am a student at one of the schools which uses training aids and kits in their course of instruction, and I object to paying for a magazine which belittles my technical proficiency and the manner in which I spend my money. When I became interested in electronics about a year ago, I had no background in either the technical fields or in mathematics. I enrolled in a home study course and have been delighted with the methods used to instruct me.

I trust that in the future you will practice some discretion.

EDWARD J. FREEMAN
New Haven, Conn.

*The phrases you have extracted from the article were meant to apply only to engineering-level—not technician-level—home study courses. Admittedly, training aids and kits are a necessary tool in teaching the practical aspects of elementary electronics. However, in engineering-level training, where previous experience in electronics and with its associated equipment is required, any kits or training aids would have to be "gimmicky" if the cost of the program is to remain within reason. As an example, suppose you took a course in computer design: would you expect or want to pay an extra $150 a month for a computer terminal in your home as part of the course? Of course not! And any school that offered such an item as part of its course would find very few applicants indeed.*

*Rest assured, there was no intent to "belittle" home study courses—on any level.*

(Continued on page 10)

## LETTERS (Continued from page 8)

### SAFETY, AND OTHER COMMENTS

While you don't believe in lasers that have an output greater than 3 milliwatts, many of your construction projects are potentially dangerous (in terms of voltage) and/or capable of jamming legitimate communications.

Also, why not an author's biography with each article?

S. S. Coles
Tacoma, Wash.

*The dangers involved in dealing with electrical voltages are well-known and, in the opinion of the editors, recognized and accepted by all readers. (Even so, we do often caution the reader when unusual circumstances exist.) The laser to most people is a new device and we feel our self-imposed restrictions are necessary. In addition, the hazards involved with the laser are important not only to the user or the reader who builds the project, but may also affect an unknowing bystander. That's another reason we are being "extravagant" with our warnings.*

*On the biographies, we have printed a few in the past, and will be publishing more in the future.*

### HI-FI, OF A SORT

Robert MacDonald ("Stereo Scene," March 1970) may have the right idea, but I suggest a new twist: use a heavy-duty musical instrument speaker for the woofer. I have a Utah 75-watt rated MI speaker (bought on sale from Allied Radio) coupled in with an inexpensive tweeter (also Allied) to a Heathkit AA-14. It sounds great and at full volume will entertain the whole block!

R. M. Blacklock
Merritt, B. C., Canada

### PE ON TAPE

We are quite pleased, and hope that you will be glad to know, that several persons have responded to your printing of our letter regarding the availability of excerpts from Popular Electronics on tape for the blind and physically handicapped.

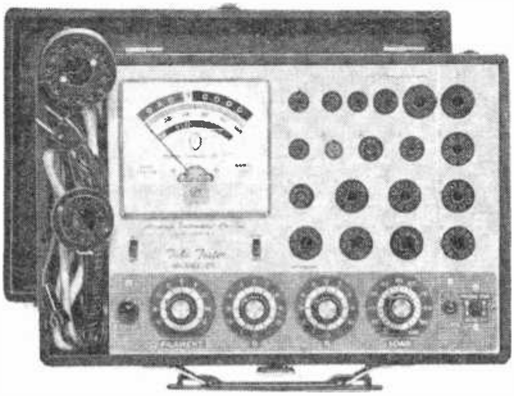
We have recently completed a survey of our present readership and it proves that those who receive our tapes are very grateful for them, as they are for everything else which helps them lead a more "normal" life.

Mrs. L. Fuller
Science for the Blind

*Popular Electronics is available to the blind and physically handicapped on magnetic tape from* SCIENCE FOR THE BLIND, *221 Rock Hill Road, Bala Cynwyd, Pa. 19004. The magazine is read onto tape by volunteer readers with the publisher's permission and is intended solely for the use of the blind and the physically handicapped. If you know someone who could use this service, please pass the word.*

The New 1970 Improved Model 257 **A REVOLUTIONARY NEW**

# TUBE TESTING OUTFIT



- Tests all modern tubes including Novars, Nuvistors, Compactrons and Decals.
- All Picture Tubes, Black and White and Color

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**COMPLETE WITH ALL ADAPTERS AND ACCESSORIES, NO "EXTRAS"**

### STANDARD TUBES:

- ✔ Tests the new Novars, Nuvistors, 10 Pins, Magnovals, Compactrons and Decals.
- ✔ More than 2,500 tube listings.
- ✔ Tests each section of multi-section tubes individually for shorts, leakage and Cathode emission.
- ✔ Ultra sensitive circuit will indicate leakage up to 5 Megohms.
- ✔ Employs new improved 4½" dual scale meter with a unique sealed damping chamber to assure accurate, vibration-less readings.
- ✔ Complete set of tube straighteners mounted on front panel.

### BLACK AND WHITE PICTURE TUBES:

- ✔ Single cable used for testing all Black and White Picture Tubes with deflection angles 50 to 114 degrees.
- ✔ The Model 257 tests all Black and White Picture Tubes for emission, inter-element shorts and leakage.

### COLOR PICTURE TUBES:

- ✔ The Red, Green and Blue Color guns are tested individually for cathode emission quality, and each gun is tested separately for shorts or leakage between control grid, cathode and heater. Employment of a newly perfected dual socket cable enables accomplishments of all tests in the shortest possible time.

The Model 257 is housed in a handsome, sturdy, portable case. Comes complete with all adapters and accessories, ready to plug in and use. No "extras" to buy. Only......... **$52.50**

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CIRCLE NO. 1 ON READER SERVICE PAGE

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building and racing radio-controlled Grand Prix cars up to scale speeds of 200 mph. The Heathkit "Spectre" R/C car reaches that speed and has already proven itself a winner. And no wonder; its design is unique. It has a chrome plated steel chassis, adjustable caster and toe-in, specially formulated rubber tires that lock onto the cast nylon wheels, independent front suspension for excellent cornering and a 5.5:1 gear ratio for maximum torque at all speeds. The snap on, ⅛ scale car body (length: 19¾") is of high impact plastic — almost indestructable. Suspension is by real coil springs. The radio equipment compartment is dirt and oil proof. The Heathkit "Spectre" is the only complete car kit available. You get the body, chassis, wheels & tires, 4 oz. fuel tank & tubing, equipment case & protective foam, centrifugal clutch & gears, axles, servo linkages & mounting tape, all hardware, decals, numbers and a comprehensive manual. The "Spectre" accepts any .15 to .23 cubic inch R/C engine and any proportional R/C electronics system. It requires only two servos to operate the steering, brake and throttle. Get in on all the thrills of R/C car racing at the lowest possible price . . . order a Heathkit "Spectre".

**Kit GD-101**, R/C car only, 8 lbs....................................$49.95*
**Assembled GDA-101-1**, Veco .19 R/C engine, 1 lb................$19.95*

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**Kit GD-57**, transmitter, receiver, 2 servos, batteries, charging cord, switches and soldering iron, (specify freq. desired), 11 lbs.......$129.95*
**Kit GDA-57-1**, transmitter, battery, charging cord, (specify freq. desired), 5 lbs....................................................$54.95*
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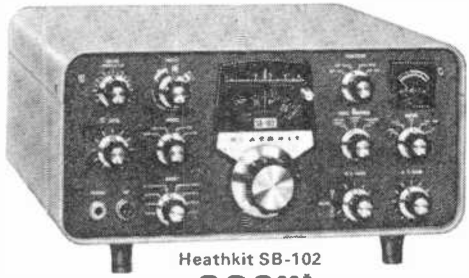

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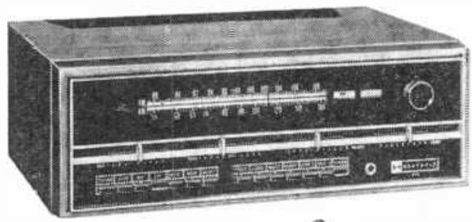
Heathkit SB-102
$380.00*

## NEW Heathkit 60-Watt AM-FM-FM Stereo Receiver



Superb stereo performance at budget price, that's the new Heathkit AR-19. A giant, electronically regulated power supply provides 60 watts IHF music power (ideal for all modular and high efficiency speaker systems) . . . frequency response is -1 dB from 6 Hz to 35,000 Hz . . . and Harmonic & IM distortion are less than 0.25% at *any* output. This advanced performance assures you of crisp, clean highs without ringing or breakup . . . solid, clean-cut lows without distortion — just pure, uncolored sound reproduction at all frequencies and power levels. The FM Stereo circuitry is unequalled by any receiver in this price class . . . a factory assembled & aligned FET FM tuners . . . superior overload characteristics & 2.0 uV sensitivity . . . a factory assembled & aligned FM IF circuit board with 4 IC's for superior AM rejection, hard limiting, greater stability and 35 dB selectivity . . . a precision ball-bearing inertia flywheel for smooth, precise tuning . . . two front panel tuning meters for exact station selection. Other features include modular snap-out circuit boards, built-in self-servicing capability, hi-fi AM reception and much more. Make the AR-19 the heart of your stereo system now.

Kit AR-19, 29 lbs. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $225.00*
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Heathkit AR-19
$225.00*

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Here's versatile, professional performance in a metal locator at lowest cost. The all solid-state GD-48 uses a unique induction balance detection system that doesn't produce a tone until metal enters the search field . . . eliminates having to listen for a change in tone. The built-in Sensitivity control allows adjustment to detect varying size objects down to 6 feet. A built-in speaker audibly signals presence of metal . . . for higher sensitivity use the accurate front-panel meter. And the front-panel headphone jack lets you use headphones to screen out annoying background noise. Look no further for an excellent metal locator . . . order the GD-48 now.

Kit GD-48, 4 lbs. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $59.95*
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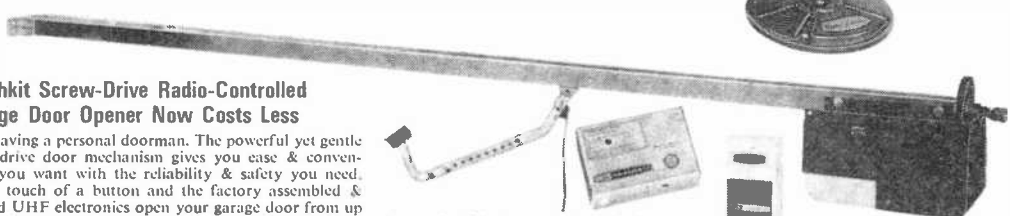
Heathkit GD-48
$59.95*



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# TAKE ONE new literature

*To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15 or 97.*

A 20-page booklet, Form AT-622, featuring tips on how to improve TV reception and a do-it-yourself approach to installing MATV systems is available from *Mosley Electronics, Inc.* Titled "How To Improve Your TV Picture," the booklet outlines how you can have a TV receiver in every room in your house operating from a single roof-top antenna, using accessory equipment. Divided into two parts, the booklet focuses on reception requirements and conditions in the first part, while the second deals with a listing of the various accessories that can be used to improve reception and operate receivers from a single antenna.

Circle No. 75 on Reader Service Page 15 or 97

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A 12-page catalog describing the company's complete line of advanced electronic test equipment for service and industry is available from *Sencore, Inc.* The Form No. 517 catalog features five new instruments, two color signal generators, a FET tester, and a seven-in-one bias supply. Other instruments listed include FET VOM's, a sweep and marker generator, sweep circuit analyzer, combination oscilloscope/vectorscope, combination transistor/FET testers, CRT tester, and special-purpose instruments. All listings have complete performance data listings and prices.

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*TDK Electronics Corp.* has just released an eight-page, full-color technical bulletin on its "Super Dynamic" cassette tape. The comprehensive bulletin describes the features of Super Dynamic cassette tape plus its characteristics and specifications. Included are photomicrographs of magnetic particles and tape surfaces. Graphic comparisons between conventional and SD tape are given, showing bias current curve, dynamic range, and harmonic distortion. The brochure concludes with a section on how to handle and store cassette tapes.

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# POPULAR ELECTRONICS READER SERVICE PAGE

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*Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Hard cover. 304 pages. $6.95.*

## BASIC ELECTRIC CIRCUITS

*by Donald P. Leach*

For the electrical/electronics technician, this book provides the background necessary to study advanced subjects in fields such as power, commercial and industrial electronics, and communications. No previous background in physics or electronics is assumed; so the book is eminently suited for go-it-alone study. However, a course in college algebra should be taken currently or prior to the study of the material in this book. The text can be divided into two main categories: the first ten chapters deal with the fundamentals of electricity and steady d.c. circuits; the remaining chapters focus on circuits in which the currents and voltages vary with time. There are more than 300 example problems, each of which is worked out in detail, and more than 400 review questions.

*Published by John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. Hard cover. 665 pages. $9.95.*

## INFORMATION TRANSMITTAL AND COMMUNICATING SYSTEMS

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(*Continued on page* 100)

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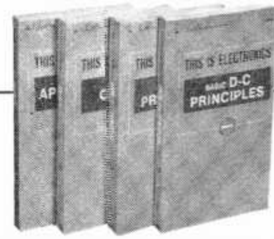


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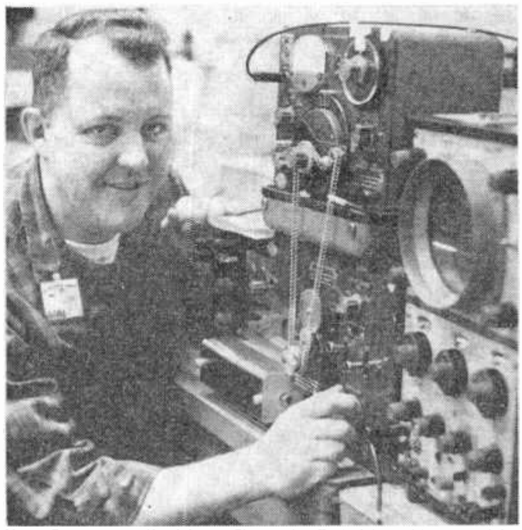

Harry Remmert on the job. An Electronics Technician with a promising future, he tells his own story on these pages.

## By Harry Remmert

AFTER SEVEN YEARS in my present position, I was made painfully aware of the fact that I had gotten just about all the on-the-job training available. When I asked my supervisor for an increase in pay, he said, "In what way are you a more valuable employee now than when you received your last raise?" Fortunately, I did receive the raise that time, but I realized that my pay was approaching the maximum for a person with my limited training.

Education was the obvious answer, but I had enrolled in three different night school courses over the years and had not completed any of them. I'd be tired, or want to do something else on class night, and would miss so many classes that I'd fall behind, lose interest, and drop out.

### The Advantages of Home Study

Therefore, it was easy to decide that home study was the answer for someone like me, who doesn't want to be tied down. With home study there is no schedule. I am the boss, and I set the pace. There is no cramming for exams because I decide when I am ready, and only then do I take the exam. I never miss a point in the lecture because it is right there in print for as many re-readings as I find necessary. If I feel tired, stay late at work, or just feel lazy, I can skip school for a night or two and never fall behind. The total absence of all pressure helps me to learn more than I'd be able to grasp if I were just cramming it in to meet an exam deadline schedule. For me, these points give home study courses an overwhelming advantage over scheduled classroom instruction.

Having decided on home study, why did I choose CIE? I had catalogs from six different schools offering home study courses. The CIE catalog arrived in less than one week (four days before I received any of the other catalogs). This indicated (correctly) that from CIE I could expect fast service on grades, questions, etc. I eliminated those schools which were slow in sending catalogs.

### FCC License Warranty Important

The First Class FCC Warranty* was also an attractive point. I had seen "Q" and "A" manuals for the FCC exams,

*CIE backs its FCC License-preparation courses with this famous Warranty: graduates must be able to pass the applicable FCC License exam or their tuition will be refunded in full.

and the material had always seemed just a little beyond my grasp. Score another point for CIE.

Another thing is that CIE offered a complete package: FCC License and technical school diploma. Completion time was reasonably short, and I could attain something definite without dragging it out over an interminable number of years. Here I eliminated those schools which gave college credits instead of graduation diplomas. I work in the R and D department of a large company and it's been my observation that technical school graduates generally hold better positions than men with a few college credits. A college degree is one thing, but I'm 32 years old, and 10 or 15 years of part-time college just isn't for me. No, I wanted to *graduate* in a year or two, not just *start*.

If a school offers both resident and correspondence training, it's my feeling that the correspondence men are sort of on the outside of things. Because I wanted to be a full-fledged student instead of just a tagalong, CIE's exclusively home study program naturally attracted me.

Then, too, it's the men who know their theory who are moving ahead where I work. They can read schematics and understand circuit operation. I want to be a good theory man.

From the foregoing, you can see I did not select CIE in any haphazard fashion. I knew what I was looking for, and only CIE had all the things I wanted.

### Two Pay Raises in Less Than a Year

Only eleven months after I enrolled with CIE, I passed the FCC exams for First Class Radiotelephone License with Radar Endorsement. I had a pay increase even before I got my license and *another* only ten months later. I'm getting to be known as a theory man around work, instead of one of the screwdriver mechanics.

These are the tangible results. But just as important are the things I've learned. I am smarter now than I had ever thought I would be. It feels good to know that I know what I know now. Schematics that used to confuse me completely are now easy for me to read and interpret. Yes, it is nice to be smarter, and that's probably the most satisfying result of my CIE experience.

### Praise for Student Service

In closing, I'd like to get in a compliment for Mr. Chet Martin, who has faithfully seen to it that my supervisor knows I'm studying. I think Mr. Martin's monthly reports to my supervisor and generally flattering commentary have been in large part responsible for my pay increases. Mr. Martin has given me much more student service than "the contract calls for," and I certainly owe him a sincere debt of gratitude.

And finally, there is Mr. Tom Duffy, my instructor. I don't believe I've ever had the individual attention in any classroom that I've received from Mr. Duffy. He is clear, authoritative, and spared no time or effort to answer my every question. In Mr. Duffy, I've received everything I could have expected from a full-time private tutor.

I'm very, very satisfied with the whole CIE experience.

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Perhaps you too, like Harry Remmert, have realized that to get ahead in Electronics today, you need to know much more than the "screwdriver mechanics." They're limited to "thinking with their hands"...learning by taking things apart and putting them back together...soldering connections, testing circuits, and replacing components. Understandably, their pay is limited—and their future, too.

But for men like Harry Remmert, who have gotten the training they need in the fundamentals of Electronics, there are no such limitations. As "theory men," they think with their heads, not their hands. For trained technicians like this, the future is bright. Thousands of men are urgently needed in virtually every field of Electronics, from two-way mobile radio to computer testing and troubleshooting. And with this demand, salaries have skyrocketed. Many technicians earn $8,000, $10,000, $12,000 or more a year.

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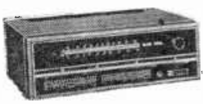
CIRCLE NO. 8 ON READER SERVICE PAGE

# NEW PRODUCTS

*Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15 or 97.*

### 60-WATT AM/STEREO FM RECEIVER KIT

The Model AR-19 deluxe medium-power stereo receiver made by the *Heath Company* features advanced FET and IC design to provide the ultimate in hi-fi listening. Contained in its five IC's are a total of 57 transistors and 35 diodes to provide a frequency response of 6-35,000 Hz with less than 0.25% harmonic and i.m. distortion at any power level. There are also breakthroughs for the kit builder—like snap-in/out circuit board construction and a built-in test circuit that eliminates the need for test equipment. The factory-assembled and aligned FM tuner has a 2-$\mu$V sensitivity; and for AM reception, there is a built-in antenna that swivels in two planes. The audio output of the AR-19 receiver is rated at 60 watts music power into 8 ohms.



Circle No. 78 on Reader Service Page 15 or 97

### PORTABLE ELECTRONIC TUNING FORK

*Schober Organ Corp.* recently made available the Schober Electronic Tuning Fork that provides 12 steady tones from middle C through B above middle C for tuning keyboard and other musical instruments. The pitch accuracy is said to be within 5 cents (5% of a semitone). A special knob on the instrument sets the scale at A = 440 Hz, but it permits resetting between 435 and 445 Hz. The tone harmonics allow easier zero-beating so that the user can tune instruments in higher and lower octaves. The Electronic Tuning Fork operates from two 9-volt transistor batteries and has a voltage regulator that maintains pitch accuracy during the entire life of the batteries. The circuitry is entirely solid-state, and a built-in loudspeaker is featured.

Circle No. 79 on Reader Service Page 15 or 97

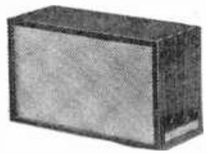
### CUTTING DEVICE FOR PLASTICS

Designers, engineers, scientists, model makers, artists, architects, sign makers, and all types of craftsmen will find a great many uses for the "Model Machine" for cutting plastic foam made by *Technical Devices*. The Model Machine cuts plastic foam, such as Dow Chemical's Styrofoam, up to 6" thick with ease and accuracy. The cutting wire does not vibrate, "saw," or move—it works by melting a fine cut through the plastic material.

Circle No. 80 on Reader Service Page 15 or 97

### PSYCHEDELIC COLOR ORGAN KIT

Now you can enjoy a psychedelic light show at home with the new *Knight-Kit* Model KG-338 color organ kit. This fascinating music system accessory provides a brilliant display of flashing lights and colors, perfectly synchronized to the music being played. The lights flash in time with the music, varying in color and intensity according to the amplitude and frequency of the music being used to drive them. All-solid-state, three-channel circuitry separates the high, mid-range, and low frequencies into blue, green, and red lights, respectively, that provide a three-dimensional display through a prismatic screen. The KG-338 connects in moments to the speaker terminals of any receiver, amplifier, or console system, yet does not affect the sound quality of the system in any way.



Circle No. 81 on Reader Service Page 15 or 97

### SINGLE-CHANNEL VHF MONITORADIO

*Regency Electronics, Inc.*, is marketing its compact Model TMR-1, a new base or mobile VHF receiver. The TMR-1 is capable of operating in either the 30-50- or 148-174-MHz bands. The receiver is provided complete with a.c. and d.c. power cords, mobile mounting bracket, detachable telescoping antenna, and a built-in 4" speaker. External speaker terminals and a standard auto antenna jack are available on the rear apron of the TMR-1. The chrome-trimmed front panel is equipped with an on/off-volume and a variable-squelch controls. Five watts of audio output power is complemented by a 0.5-$\mu$V sensitivity and 50-dB selectivity at $\pm$ 15 kHz. The TMR-1 measures 2¼" x 5½" x 7½".

Circle No. 82 on Reader Service Page 15 or 97

### CASSETTE STEREO RECORD/PLAY SYSTEM

*Norelco*'s Model 2400 is a versatile self-contained stereo cassette recorder and playback system with its own sealed satellite speakers. Solid-state circuitry, pushbutton controls, illuminated VU meter, digital counter, automatic end-of-tape stop, and monitoring facilities are featured. With a frequency range of 60-10,000 Hz, the 2400 is ideal for home recording through its own dynamic

# Need an 80-db blast?

Actual size

You'll get it from our 1¼-ounce Sonalert® electronic audible signal.

With as little as 6 VDC and 3 ma., Sonalert produces a piercing sound that's hard to ignore. Yet it weighs only a couple of ounces because it's all solid state. Even the transducer is a crystal. This makes Sonalert reliable, efficient and long lasting. And because it's solid state, there's no danger of arcing, no RFI or EMI noise.

Standard units vibrate at a fixed frequency of 2900 ± 500 Hz or 4500 ± 500 Hz depending on model. Pulsing, warbling and AC models are also available. The penetrating sound covers a wider area than alarm lights and demands instant action. Examples: electrical overload, computer error, automobile door ajar, headlights-on warning, shipboard, communications alarms, etc.

For an informative 48-page booklet of projects and circuit ideas, write for folder No. 9-406. Address Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

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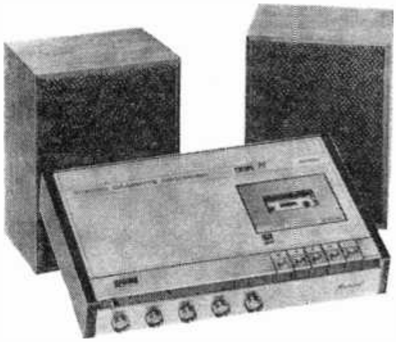
CIRCLE NO. 17 ON READER SERVICE PAGE

## PRODUCTS *(Continued from page 22)*

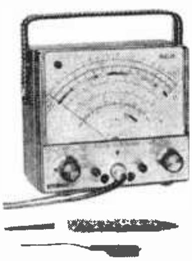


stereo microphone. Also included are patch cords for recording from radio receivers, phonographs, or another tape recorder. Controls provided include volume, balance, treble, bass, and recording.

Circle No. 83 on Reader Service Page 15 or 97

### SOLID-STATE VOLT/OHMMETER

A portable all-solid-state Master VoltOhmyst, Model WV-510A, especially designed for service, industrial, and laboratory applications was announced by *RCA Electronic Components* recently. The new solid-state meter can be operated from either internal batteries or a 117-volt a.c. power line. The WV-510A measures d.c. voltage from 0.01 to 1500 volts; direct current from 0.01 mA to 1.5 amperes; a.c. voltage from 0.2 to 1500 volts; a.c. peak-to-peak voltages of complex waveforms from 0.5 to 4200 volts; and resistance from 0.2 ohm to 1000 megohms. Seven overlapping ranges are provided for a.c., resistance, and current measurements, and eight ranges for d.c. voltage measurements. Accuracy for all voltage and current functions is 3% of full-scale. The d.c. input resistance of the WV-105A is 21 megohms.



Circle No. 84 on Reader Service Page 15 or 97

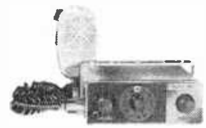
### HIDDEN-MICROPHONE RECORDER

For those people who are "mike shy," *Superscope* has introduced the Sony Model 110 Cassette-Corder featuring a hidden built-in electret condenser microphone that is no bigger than a quarter but has exceptionally good pick-up characteristics. The Model 110 has the exclusive Sonymatic Recording Control which automatically adjusts varying sound levels to a constant level during recording. An end-of-tape alarm gives an audible signal when the tape has reached the end. The recorder has piano-key pushbutton controls.

Circle No. 85 on Reader Service Page 15 or 97

### MINI-MOBILE CB TRANSCEIVER

The Micro-12 miniature CB transceiver now available from *Lafayette Radio Electronics* combines a powerful three-stage 5-watt transmitter and a sensitive, highly selective receiver into a package that measures only 7½" x 5" x 1¾". Its crystal-controlled transmit and receive positions can be used to select any 12 of the 23 available CB channels. The receiver section utilizes an r.f. amplifier stage for 1-$\mu$V sensitivity at 10 dB signal-to-noise ratio. An automatic noise limiter, mechanical filter, and variable squelch permit convenient quiet operation. Other features include a TVI trap, illuminated channel indicator, earphone/speaker jack and Range Boost audio circuitry.



Circle No. 86 on Reader Service Page 15 or 97

### C-D IGNITION SYSTEM

A radical new design that utilizes only recently developed silicon semiconductors instead of germanium types is featured in the Mach II capacitive-discharge ignition system made by *C-D Systems*. The design permits reliable operation under the most severe driving conditions; and, since only silicon components are used, the Mach II will operate even when under-the-hood temperatures reach 300° F. A silicon controlled rectifier is used to discharge a 450-volt pulse into the stock coil, generating a voltage at the spark plugs in excess of 60,000 volts. Current drain is less than one ampere at idle, 7 amperes at 12,000 r/min. Maximum current through the points is 0.25 ampere, extending point life to 100,000 miles or more. The Mach II is designed to work with stock ignition parts, requires no rewiring, and can be used in any 12-volt, negative ground system. It comes with a three-year guarantee.


Circle No. 87 on Reader Service Page 15 or 97

### BREAKTHROUGH IN AUDIO RECORDING

*Bell & Howell* has entered the magnetic tape market with the introduction of its Ultra High Density (UHD) and High Density (HD) audio tapes with exclusive gamma-oriented coating process. The UHD tapes are said to give appreciably higher fidelity at all speeds, regardless of factory bias settings, than magnetic tapes currently on the market. The HD tapes have the characteristics most needed for voice and music recording on modern

*(Continued on page 99)*

# Now it costs less to own the best oscilloscope you need.


I.Q.*

The New RCA WO-505A Solid-State Oscilloscope

*Inexpensive Quality
†Optional Distributor Resale Price

**RCA**

The best you need is the new 5-inch RCA WO-505A, all solid-state oscilloscope. It makes yesterday's general-purpose 'scopes look old-fashioned.

At just $298.50† the WO-505A offers an unmatched list of features usually found only in more expensive, laboratory-type instruments. For example there's the all solid-state circuitry... an illuminated graph screen calibrated directly in volts, and a deep-lip bezel for exceptional clarity. The regulated power supply minimizes trace bounce and provides excellent stability. And the camera mounting studs offer still more evidence of the functional value built into the new WO-505A.

But you've got to see this new RCA 'scope in operation—see the sharp, clean trace it provides—to appreciate it.

Some statistics:

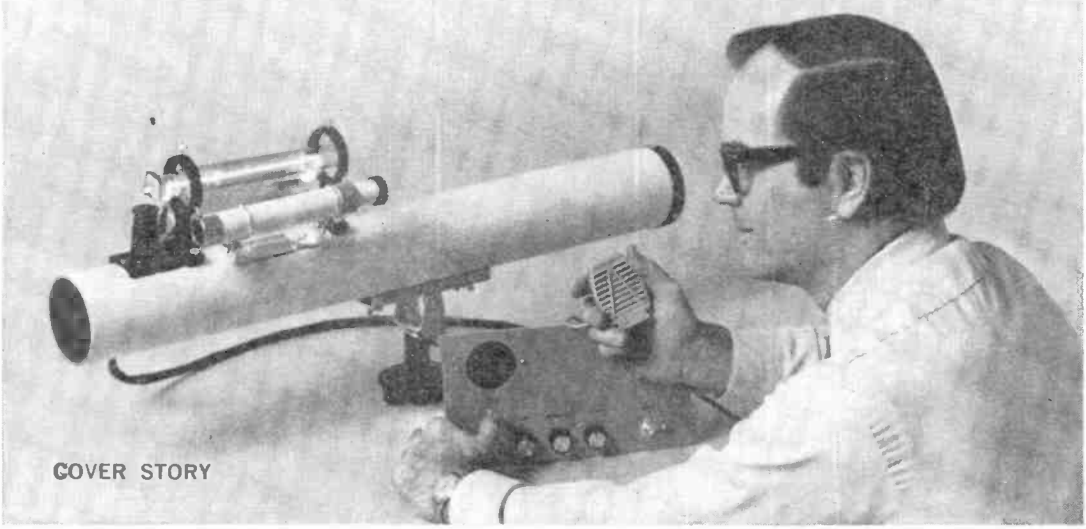
- High-frequency response, usable to 8 MHz.
- High Sensitivity (.05 V p-p range).
- DC vertical amplifier; DC/AC input.
- Return trace blanking...Trace polarity reversal switch... Phase control.
- High-frequency horizontal sweep; solid lock-in on 5 MHz.
- Preset TV "V" and "H" frequencies for instant lock-in.
- Built-in square-wave signal for calibrating P-P voltage measurements.
- Provision for connection to vertical deflection plates of CRT.

Some statistics! For complete details, contact your RCA Distributor.
RCA|Electronic Components|Harrison, N. J. 07029

CIRCLE NO. 27 ON READER SERVICE PAGE

POPULAR ELECTRONICS EXCLUSIVE DEVELOPMENTAL PROJECT

# LASER BEAM COMMUNICATOR



COVER STORY

## AUDIO MODULATE OUR LOW-COST LASER

BY C. HARRY KNOWLES

COMMUNICATING by means of a laser beam is as fresh and new as the tomatoes picked from your garden tomorrow morning. The mere idea of being able to transmit information on a beam of coherent laser light suggests all sorts of possibilities for secret, non-jammable, interference-free communications. And it is possible today!

Communications by laser beam offers several advantages over conventional radio links. Neither atmospheric lightning nor airborne electrical noise affects laser communications though they can completely ruin radio communications. On the debit side, however, laser performance is degraded, over any reasonable distance, by heavy fog, rain, snow, or terrestrial heat.

Unlike radio, in which the signal is "sprayed" out over a wide area, a laser beam communications system operates on a line-of-sight basis and the beam is tight enough to provide excellent privacy. Of course, obstructions cannot be permitted to interrupt the beam but conventional optical mirrors can be used to bend the light beam around obstructions if necessary.

Two approaches to laser communications are described in this article. The

### PE AT SMITHSONIAN

A pair of POPULAR ELECTRONICS laser communicators, similar to the one described in this article, is scheduled to be shown in operation at the Laser-10 exhibit at the Smithsonian Institution's National Museum of History and Technology in Washington, D. C. this spring and summer. Readers living in the area or visiting Washington will want to see this excellent exhibit, which features a wide variety of lasers in many unique applications. The POPULAR ELECTRONICS laser communicators will be set up to carry two-way conversations.

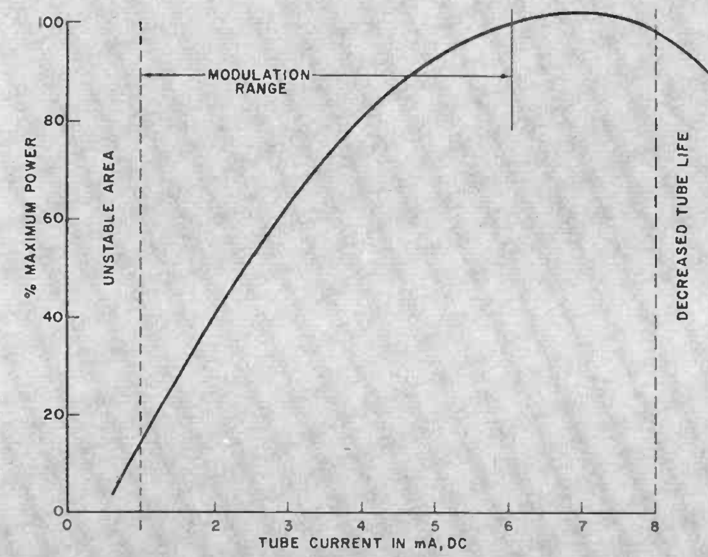


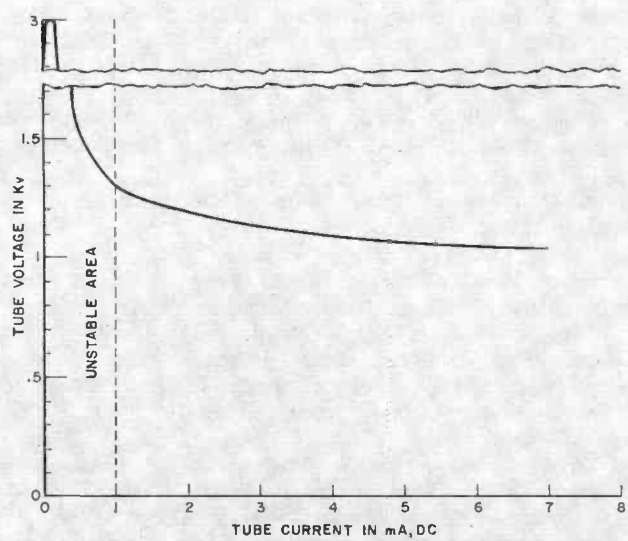

Fig. 1. Light output of the laser is a function of tube current. Modulation 90% or better can be obtained easily by this modulation method.

first involves only a simple addition to the basic laser described in POPULAR ELECTRONICS in December 1969. This system has a range of about 100 ft, and can be used for experimenting within a room and provides a "breadboard" for use in understanding modulated laser action. It also makes an excellent science fair project.

The second approach uses a modulation and receiving scheme similar to the first but it operates through conventional low-cost telescopes to achieve a range of several miles (depending on atmospheric conditions).

**Laser Modulation.** The light output of a gas laser such as the 0.5-mw helium-neon type described in our previous article is a function of the current flowing through the laser tube (see Fig. 1). At very low currents, the laser becomes unstable and

Fig. 2. Negative-resistance characteristic of the laser shows that a large-value variable resistance is required for stable operation over the entire operating range.



tends to turn itself off. The light output increases reasonably linear with tube current up to approximately 5 mA. Above that, the light output drops drastically and tube life is decreased. If the current is centered on the middle of the linear portion of the curve and varied about that point, the light output can be made to swing in a linear fashion and very high modulation levels can be obtained.

The voltage-current curve in Fig. 2 shows that the laser tube has a negative resistance characteristic (voltage decreases as current increases). Stable, linear operation thus depends on the use of a ballast resistor. When the tube is operating at 5 mA, approximately 1100 volts are required. At this point, the negative dynamic resistance is about 30,000 ohms. As the current is decreased the required voltage rises until, at about 1 mA, it is approximately 1300 volts. Here the negative resistance is 80,000 ohms. Therefore, the ballast resistor must have an effective value well above 80,000 ohms to keep the tube operating.

A basic modulator circuit, using a pentode with a large dynamic resistance, is shown in Fig. 3. The pentode is in series with the laser tube and forms a simple amplitude modulator. The dynamic resistance of the pentode is a function of the applied audio signal on its control grid. A potentiometer in the cathode circuit of the pentode determines the basic operating resistance of the tube and, hence, the operating point of the laser. Once the latter point (located on the curve in Fig. 1) has been set by the bias potentiometer, an audio input to the pentode causes the laser current to fluctuate about the operating point and the emitted light is amplitude modulated.

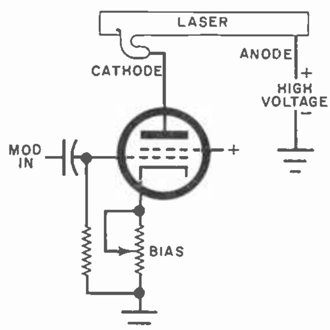



Fig. 3. The basic amplitude modulator uses a conventional pentode in series with the laser. The suppressor grid is electrically connected to the cathode.

Almost any type of audio driver can be used to generate the input audio signal to the pentode.

**Basic Modulator.** The circuit for converting the original laser project into a light-beam transceiver is shown in Fig. 4. A photograph of the finished project is shown in Fig. 5. A complete vacuum-tube system is used simply because a high resistance device is required and the tube that will do the job is inexpensive and readily available. In addition, the +175 and 6.3-volt sources required by the pentode can be used elsewhere in the circuit.

The modulator circuit can be divided into two portions. The transmitter (*V1*) consists of the pentode modulator driven by the triode half of the tube acting as a microphone preamplifier. Potentiometer *R4* provides modulation level control. The three gas tubes in series (*I1-I3*) are 200-volt breakdown lamps which chop off the high-voltage spikes that trigger the laser. Although the operating plate voltage of the tube is below its maximum rating, a much higher voltage spike is used to trigger the laser. The three gas lamps limit this spike to 600 volts. Unlike semiconductors, a vacuum tube can withstand an overvoltage for a short time. The trigger spike here lasts only about one millisecond so no damage can be done to the tube. If you can't locate the gas tubes called for in the Parts List, use any combination of conventional neon lamps that add up to approximately 600 volts.

The receiving portion of the modulator consists of a three-stage conventional audio amplifier driven from the output of the solar cell. Unlike a conventional light-dependent resistor, a solar cell generates a voltage that is a function of the amount of light striking the photosensitive surface.

**Construction.** If you built the original laser project, the same metal chassis may be used. Drill or punch holes for two 9-pin and one 7-pin tube sockets. These may be located on the top of the chassis, next to the laser tube. (Be sure to remove the laser tube when doing mechanical work on the chassis.) On the wall opposite the high-voltage laser power supply, mount the three potentiometers (*R6*, bias; *R4*, modulation level; and *R12*, receiver volume), the microphone input jack (*J1*), and the photocell input jack (*J2*) (see Fig. 5). Mount power transformer *T2* on the outside of the chassis using the same mounting hardware as were used for the original 600-volt transformer. (It was *T1;* now it is *T3*.)

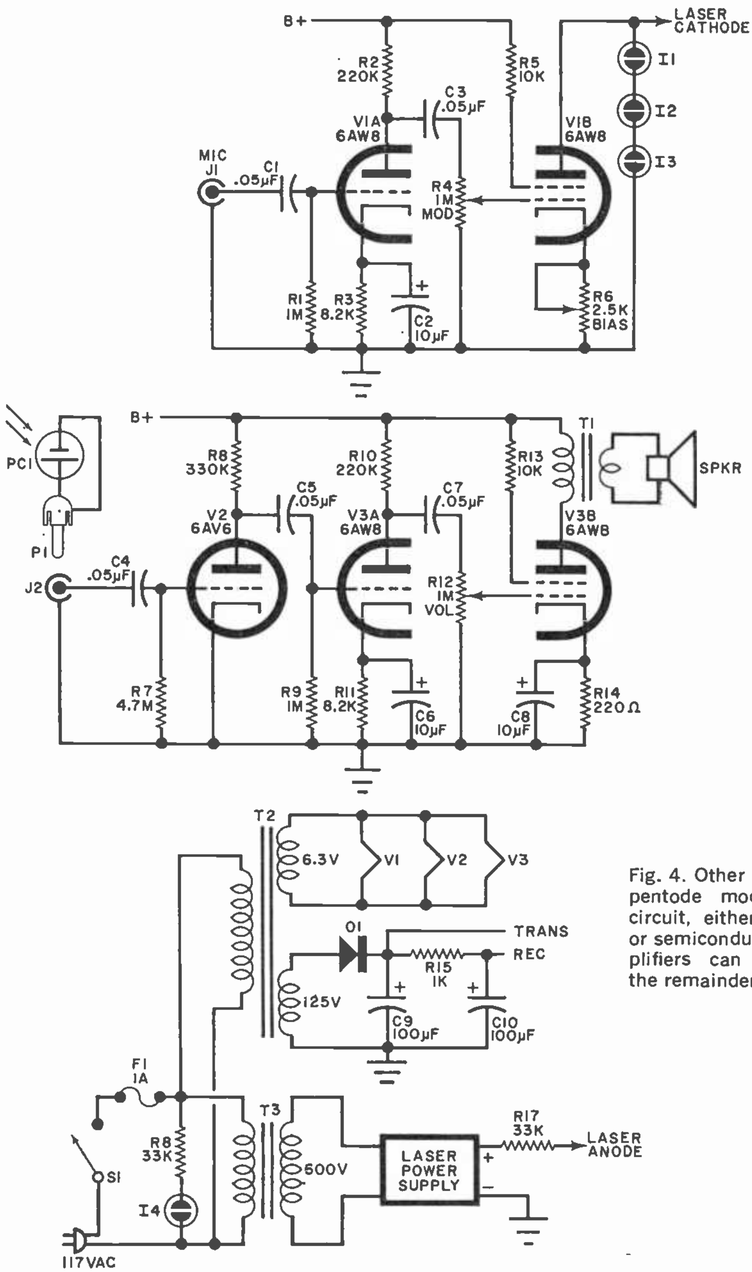



Fig. 4. Other than the basic pentode modulator (V1B) circuit, either vacuum-tube or semiconductor audio amplifiers can be used for the remainder of the circuit.

Once all the components are installed, wire up the circuit point-to-point (using terminal strips as required) following the circuit shown in Fig. 4. Of course, it is not necessary to use vacuum tubes for the microphone amplifier. You can use the 6AU6 pentode for the laser driver and, for the amplifier, any one of several commercially available transistor amplifiers. The author used one of the new RCA IC kits—the KC4000 microphone pre-amplifier—in one model and found that it worked fine. The solid-state receiver consisted of a KC4000 microphone preamplifier for the photocell preamplifier and a KC4003 ½-watt audio amplifier to drive the speaker.

The receiving photocell in this simple light communicator is mounted at one end of a dark plastic tube. (A cleaned out container of Polaroid print coater works very well.) If you use a cardboard tube, paint the interior a dull black before installing the cell. For testing and experimentation, make up a microphone cable with a phono connector at one end. Use a phone jack to make the connection to the earphone output of a conventional transistor radio. The radio is silent when the earphone jack is plugged in and produces a non-tiring audio signal for testing.

### PARTS LIST
### ONE-WAY COMMUNICATOR

*C1,C3-C5,C7—0.05-µF capacitor*
*C2,C6,C8—10-µF, 15-volt electrolytic capacitor*
*C9,C10—100-µF, 250-volt electrolytic capacitor*
*D1—Silicon rectified diode (1N4001 or similar)*
*F1—1-ampere fuse and holder*
*IL—13—200-volt breakdown lamp (Signallite A-259 or similar)*
*I4—NE-2 neon lamp*
*J1,J2—Phono jack*
*P1—Phono plug*
*PC1—Solar cell (Allied Electronics 60D7569)*
*R1,R9—1-megohm*
*R2,R10—220,000-ohm*
*R3,R11—8200-ohm*
*R5,R13—10,000-ohm*
*R7—4.7-megohm*
*R8—330,000-ohm*
*R14—220-ohm*
*R15—1000-ohm*
*R16—33,000-ohm*
(*All resistors ½-watt*)
*R4,R12—1-megohm potentiometer*
*R6—2500-ohm potentiometer*
*S1—S.p.s.t. switch*
*Spkr—3.2-ohm speaker*
*T1—5000-to-3.2-ohm output transformer*
*T2—Power transformer; secondaries, 6.3 volts at 2 amperes and 125 volts at 50 mA (CTC PA8421 or similar)*
*T3—Power transformer; secondary 620-650 volts at 50 mA*
*V1,V3—6AW8A*
*V2—6AV6*
*Misc.—Laser power supply, laser, nine-pin socket (2), seven-pin socket, multi-lug terminal strip, mounting hardware, insulated wire, microphone, speaker, etc.*
*Note—The following are available from Metrologic Instruments Inc., 143 Harding Ave., Bellmawr, NJ 08030: laser model 205, 0.3 to 0.7 mW power output, 2.0 milliradians beam divergence, multimode, $50.50, postpaid; or laser model 215, 0.5 to 1.0 mW output, 0.8 milliradians divergence, single mode, $70.50, postpaid; model 60-141 power supply kit complete with PC board, all components and transformer, $18.50, postpaid; model 60-203 complete one-way communicator (except laser and its power supply) including chassis, PC boards, microphone, solid-state 1-kHz oscillator, amplifiers, speech compressor, power supply, solar cell, speaker, and instruction book, $74.25, postpaid (this kit is convertible for telescope transmission and reception).*

**Testing.** Place the volume, modulation, and bias potentiometers in their minimum resistance positions. Connect up the speaker, photocell, and radio and turn on the power. The laser tube will start to blink at a low level until the modulation pentode warms up. Once the tube is hot, the laser will operate at its full brightness. A slight increase in the resistance of *R6* should cause the laser beam to dim slightly. This shows that the bias control is operating properly. Now set the control for full brightness. Increasing the volume control should produce some hum in the speaker. If conventional room light is allowed to fall on the sensitive face of the solar cell, it will produce a distinctive hum. This is the reason the solar cell should be mounted in a dark tube.

Separate the laser and the solar cell by a few feet and aim the beam at the receiver. Alternatively, aim the laser beam at a mirror so that it is reflected back to the cell. (The beam must be aimed straight down the cell tube and not at the interior wall.)

With the laser beam shining on the solar cell at full brightness, turn on the radio, tune to a station, and plug in the earphone jack. On the laser chassis, turn up the receiver volume control and note that, as the hand is passed through the laser beam, a thump is heard in the speaker.

Slightly reduce the bias control to dim the laser a little, and turn up the modulation control slightly. These two controls interact somewhat so you will have to "juggle" them for best modulation.

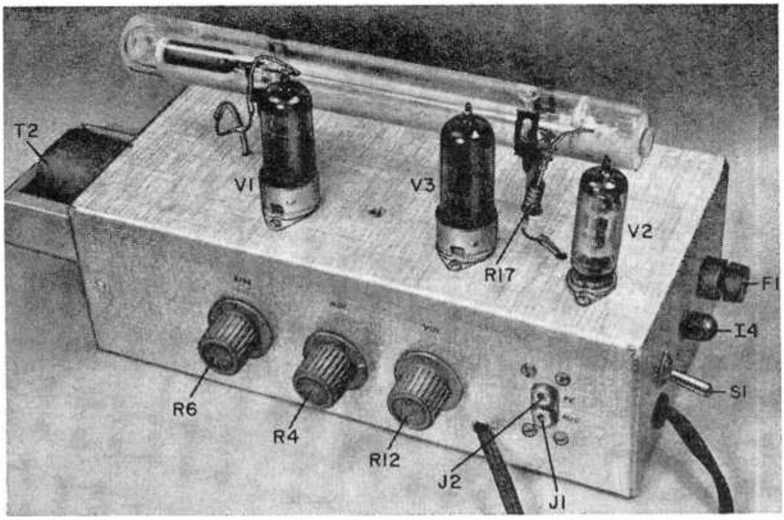



Fig. 5. The prototype was built on the original laser chassis (December 1969 issue). Any other layout will do as long as the pentode modulator is as close as possible to the laser.

Make sure that the radio volume is turned up sufficiently.

Once the communicator is working, you can experiment with the controls and the circuit (always retaining the pentode as the laser modulator) to increase your understanding of laser communications.

**Optical Systems.** Depending on how you want to use it, the laser communicator can be set up with any one of three optical systems. The simplest, which can be used for point-to-point communications around a room (to a total of 100 ft round trip), is as described above. without any lenses. To improve the reception somewhat, a simple lens can be placed in the beam path at the receiver end to reduce the size of the diverged beam.

The second type of optical system, requires the use of a set of binoculars, one eyepiece for the transmitter and the other for the receiver. Simple toy telescopes may also be used. The range for this type of system is a few hundred feet.

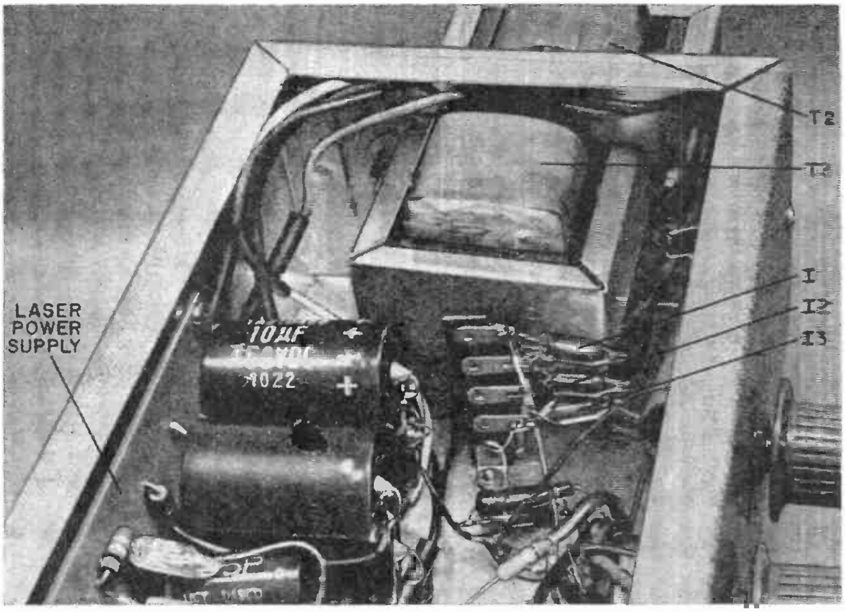
For communicating over greater distances, a reasonably high-power telescope is necessary. Such a telescope, attached to the laser communicator, acts like a high-gain antenna on a conventional radio system. In both cases the transmitted and received signals get a boost from the "antenna." And in both cases, the telescope or antenna is used for both transmitting and receiving through a simple mechanical switching process.

How far can you transmit using a telescope? It depends on a number of factors, the most important being beam divergence and atmospheric conditions. As the beam travels along its path, it tends to enlarge (diverge). This means that, although the beam leaving the laser is quite small (1 millimeter in the POPULAR ELECTRONICS laser), it does enlarge considerably—though not as much as a comparable beam of conventional light. Using a telescope improves this condition considerably.

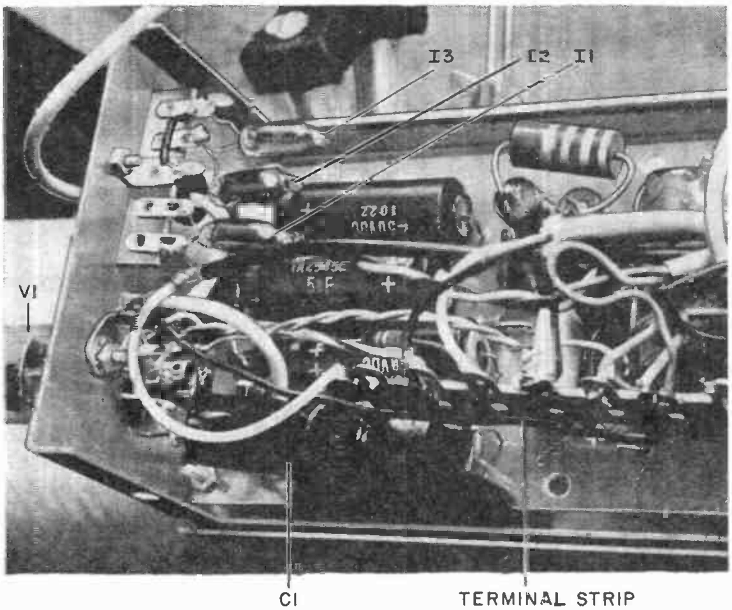
Atmospheric disturbances of the laser beam cause it to wander.

As the beam of light is projected over a long distance, it may encounter various forms of air turbulence, such as localized temperature changes. In each of these turbulences, the density of the air changes and each change in density acts as a prism as the beam passes through it, changing the beam's direction slightly. The amount of wander can be as much as several feet per mile. In the still, relatively even temperature of morning, before the sun has had a chance to warm up the air, beam wander may be as little as a few inches per mile.

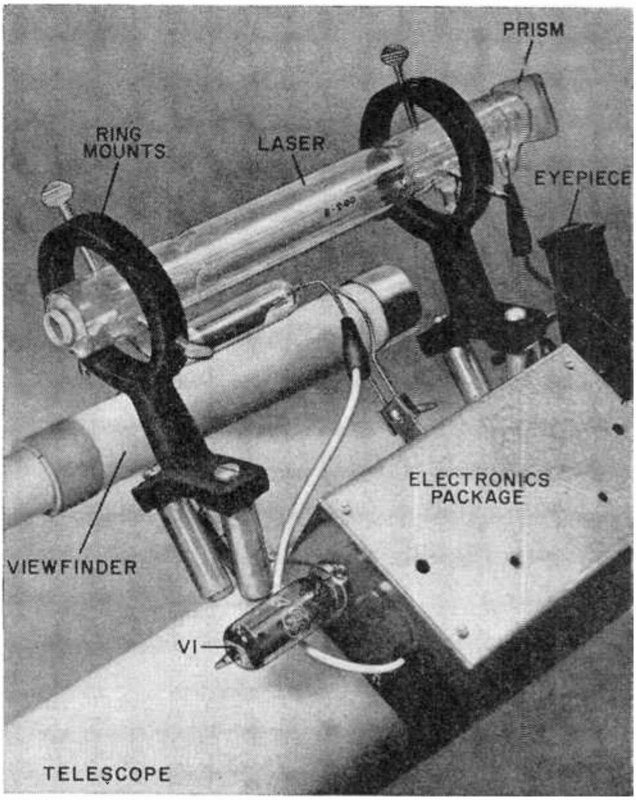
In using a reflector telescope such as that described later in this article, the beam should be collimated as closely as possible to the distant receiver, allowing for thermal refractive variations for the time of day and the atmospheric conditions. If the air is still and of an even temperature, the beam will wander only a few inches per mile. In this case, also,




Internal layout of the prototype transceiver (above) showing the laser power supply mounted on one wall with the rest of the components occupying the remaining space. The internal arrangement of the telescope electronics (shown below) shows the modulator tube and its associated components arranged within its smaller metal enclosure.




the beam may be focussed so that at the receiver, the beam diameter has diverged only about one foot per mile. If the atmosphere is clear, there is little absorption by airborne particulants (smoke, dust, etc.) ; and the overall result is that about 3 to 5% of the transmitted beam power is obtained at the receiver. This extremely high efficiency is one of the many attractive features of laser communications that will help make it the system of the future.




The complete telescope system can communicate as far as a 12-inch target can be clearly seen via the telescope. At night, this target will have to be illuminated. In good visibility, range can be very great but is dependent on certain conditions (see text). To assist distant communications, an optional 1-kHz audio oscillator is used to modulate the transmitter, and both ends must be "juggled" until the received audio tone is at a maximum. To get around opaque objects, a large-size front-surface mirror (not a ladies compact mirror) may be used to reflect the laser beam.

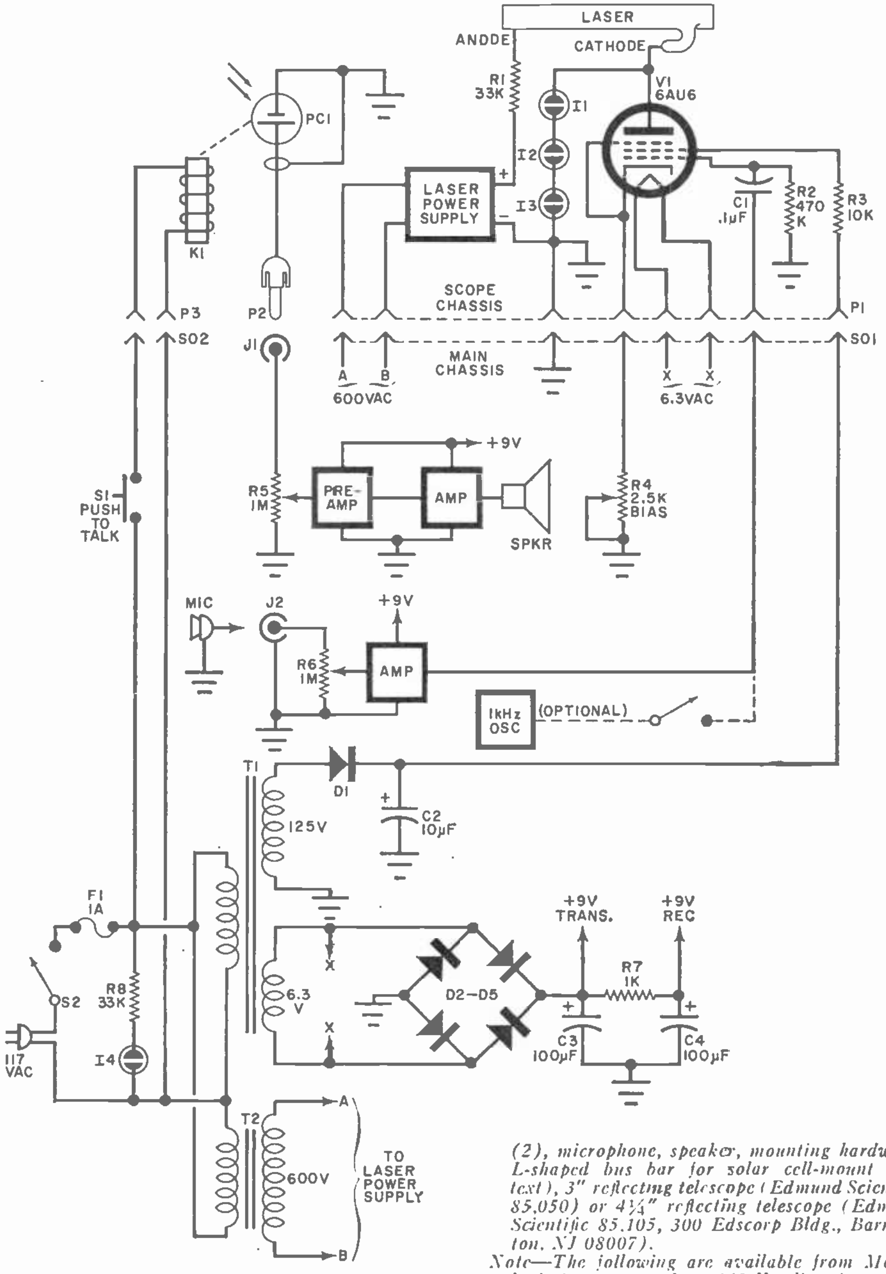
**Reflector Telescope Construction.** A telescopic system is shown in Fig. 6. The laser tube is supported by a pair of viewfinder ring mounts attached to the telescope tube. The laser is positioned within the mounts so that the light-emitting end is almost directly over the telescope eyepiece. (Check your laser tube to make sure whether the light beam comes out of the anode or the cathode. Some models are one way; some the other.)

Make up an L-shaped length of heavy bus bar with the long side about 2½"—the other about 1" long. Cement (with epoxy) the short end of the bus bar to the relay armature so that it swings back and forth as the relay is energized and de-energized. Position the relay about 90° from the telescope eyepiece so that when the long end of the bus bar is placed through a slot cut in the telescope tube and with the relay energized (talk position) the end of the bus bar is out of the beam path. With the relay de-energized (listen position) the wire should be in the beam path. Remove the telescope eyepiece to watch this.

Fig. 6. Complete telescope communicator showing the use of semiconductor audio amplifiers. Any neon lamps may be used for I1, I2, or I3 if their breakdown totals up to about 600 volts.

### PARTS LIST
### TELESCOPE COMMUNICATOR

*C1—0.1-μF capacitor*
*C2—10-μF, 250-volt electrolytic capacitor*
*C3,C4—100-μF, 25-volt electrolytic capacitor*
*D1-D5—Silicon rectifier diode (1N4003 or similar)*
*F1—1-ampere fuse and holder*
*I1-I3—200-volt breakdown lamp (Signallite A259 or similar)*
*I4—NE-2 neon lamp*
*J1—Phono jack*
*K1—117-volt relay*
*P1—Octal plug*
*P2—Phono plug*
*P3—2-lead plug*
*R1—33,000-ohm, 2-watt resistor*
*R2—470,000-ohm, ½-watt resistor*
*R3—10,000-ohm, ½-watt resistor*
*R4—2500-ohm potentiometer*
*R5,R6—1-megohm potentiometer*
*R7—1000-ohm, ½-watt resistor*
*R8—33,000-ohm, ½-watt resistor*
*S1—Normally open s.p.s.t. pushbutton switch*
*SO1—Octal socket*
*SO2—2-lead socket*
*T1—Power transformer; secondaries, 6.3 volts at 2 amperes, 125 volts at 50 mA (CTC PA8421 or similar)*




*T2—Power transformer; secondary 620-650 volts at 50 mA*
*V1—6AU6 tube*
*Pre-Amp—Microphone preamplifier (RCA KC 4000 or similar)*
*Amp.—Half-watt amplifier (RCA KC4003 or similar)*
*Misc.—5¼" x 3" x 2" two-piece metal enclosure, main chassis, laser, laser power supply, 7-pin socket, multi-lug terminal strip, 90° plastic prism, lengths of multi-lead and coaxial cable, 2" ID telescope viewer mounting rings (2), microphone, speaker, mounting hardware, L-shaped bus bar for solar cell-mount (see text), 3" reflecting telescope (Edmund Scientific 85,050) or 4¼" reflecting telescope (Edmund Scientific 85,105, 300 Edscorp Bldg., Barrington, NJ 08007).*
*Note—The following are available from Metrologic Instruments Inc., 143 Harding Ave., Bellmawr, NJ 08030: a kit to convert from one-way to telescope reception and transmission, model 60-204, $24.50, postpaid, including deflection prism and tube mount, solar cell and solenoid, laser ring mounts, telescope mounting kit (for 3" to 6" tubes), and instruction book; 4¼" metal tube reflecting telescope with stand, model 60-205, $94.50 or 4¼" metal tube telescope without stand, model 60-206, $67.50 transportation charges collect. (These telescopes are complete with lenses and are suitable for astronomy).*

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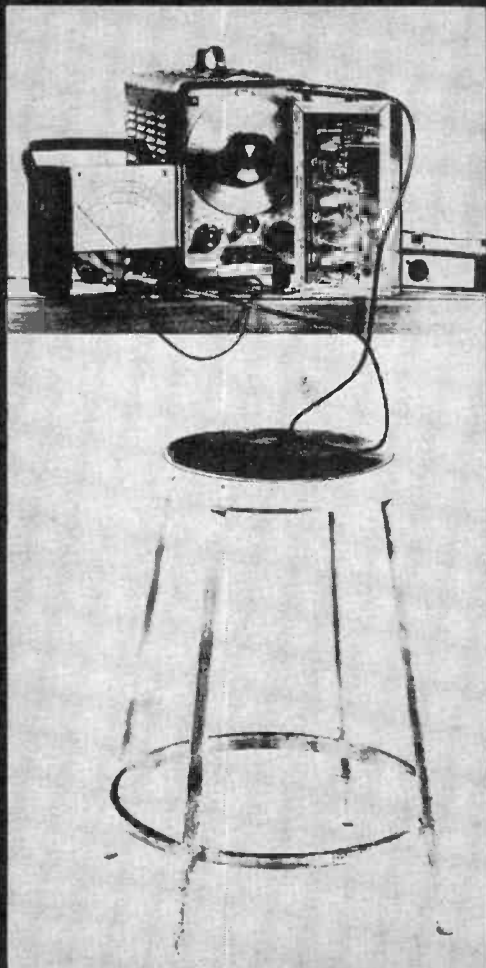

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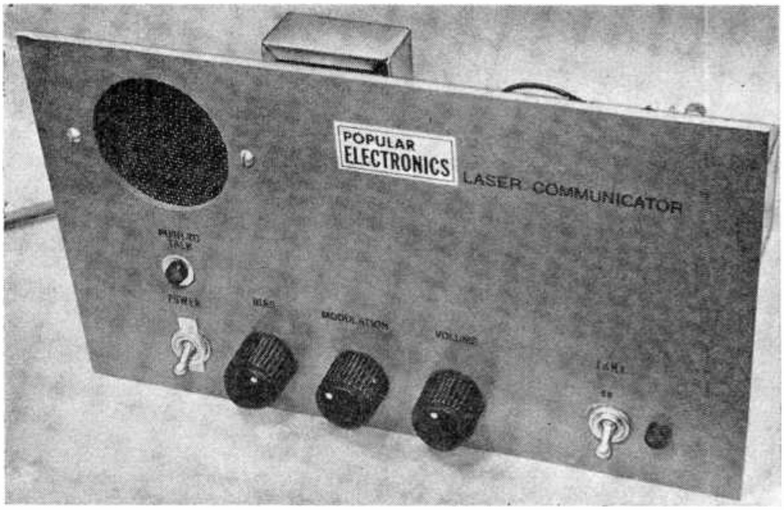



The main chassis for the telescope communicator mounts the relatively heavy power supplies (except for the laser), all controls, and is connected to the telescope electronics via a multi-lead flexible cable. Microphone plugs into the rear.

On the solar cell called for in the Parts List of Fig. 4, the black side is the sensitive area. Cement the shiny side of the cell to the bus bar and then slide the cell and relay assembly into position. Make sure that the cell switches cleanly in and out of the beam path as the relay is operated. The two leads from the solar cell are taken out of the same slit and terminated on a two-lug terminal strip mounted near the relay.

Mount the empty half of the two-piece electronic chassis on the telescope tube. just below the two laser mounting rings. drilling mating holes in both chassis and telescope tube. Use short mounting hardware so as not to interfere with the beam path. Recheck all mechanical work and tighten the telescope tripod screws.

To keep weight to a minimum, only the modulator pentode and the laser power supply are mounted in the chassis on the telescope. This is necessary to reduce the possibility of oscillation in the circuits.

Mount the power supply on the inside of the chassis, using an insulated spacer (about ¼") at each corner. Be sure that the high-voltage end is far enough from the metal to avoid arcing. The seven-pin tube socket for the pentode is mounted at one end, while a multi-lug terminal strip supports the ends of the wiring. A ½" grometted hole should be provided for the incoming cable.

The circuit for the scope-mounted electronics is shown in Fig. 7. Only the relay, solar cell, and laser are external to the chassis. The circuit above *SO1* is mounted at the scope. The lower portion is built in a larger conventional chassis.

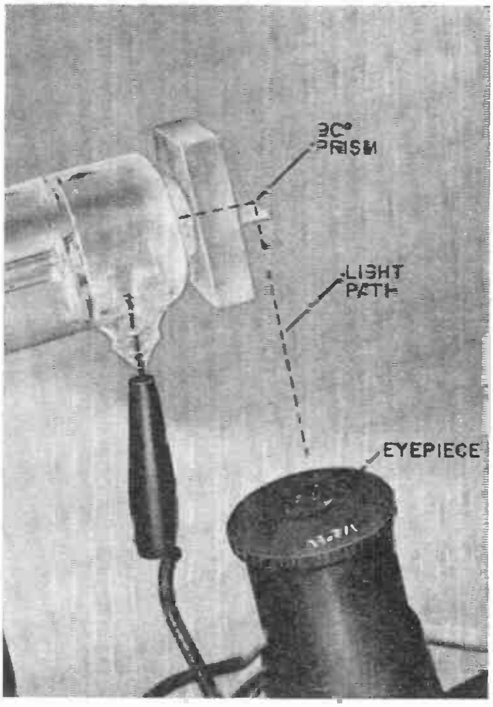
Once again, either vacuum-tube or semiconductor amplifiers may be used. The latter save quite a bit of work. Connections between the two chassis are made with multi-lead cable, with the exception of a small coaxial cable for the solar cell leads. Make the connections long enough to allow plenty of space between the telescope and the other chassis. The cables may be taped at intervals to keep them from separating.

When all electronic work is finished, attach the second half of the chassis to the one on the telescope. The cable should be placed where it will not interfere with scope operation.

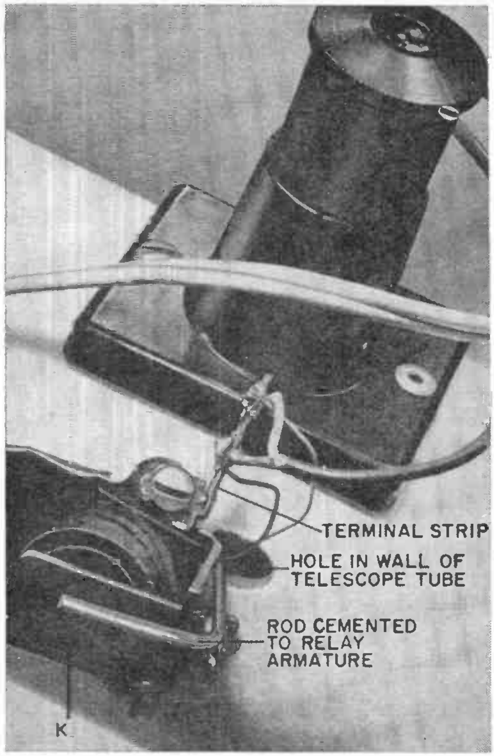
Fully open the ring mount thumbscrews and slide the laser into position as described above. Tighten the thumbscrews gently to avoid damaging the tube. Attach the plus side of the high-voltage supply to the laser anode and the negative side to the cathode.

Make up a phono connector to connect the solar cell leads to *J1*. Connect the two leads to the relay.

**Setup.** Connect the far end of the multi-



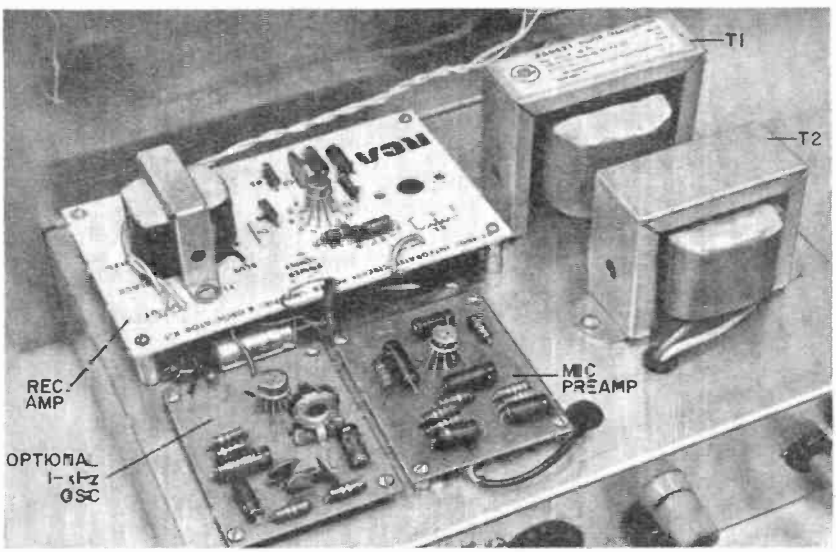

A small 90° prism is cemented to a plastic block to aim the laser light at the telescope eyepiece. The plastic block is press fit to the laser end.



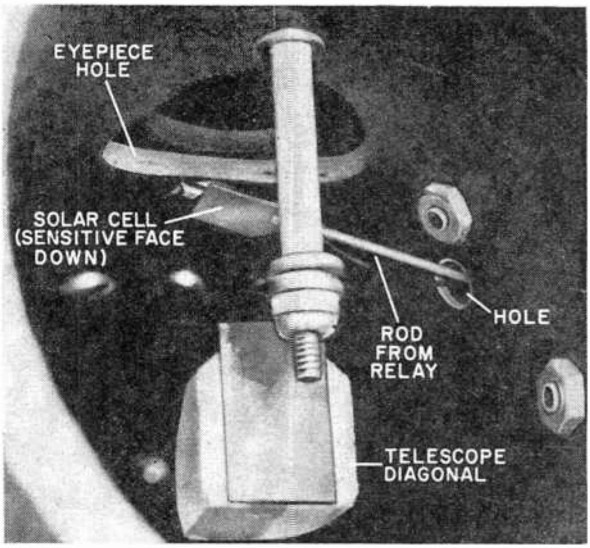

The transmit-receive relay is mounted to the telescope tube with the solar cell and rod passed inside through a hole cut in the telescope tube wall.

lead cable to the main chassis, along with the solar cell and microphone connectors. (You can substitute a radio for the microphone for testing.) The push-to-talk button may be temporarily shorted to keep the solar cell out of the beam path during the following optical alignment.

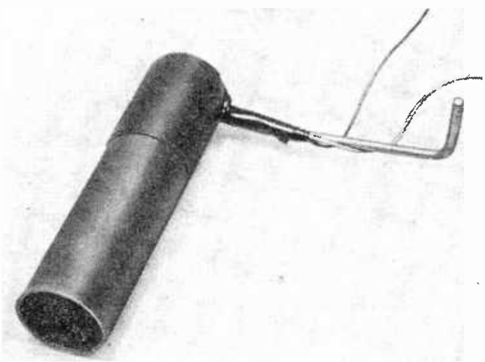
Three commercial IC audio kits were used for all stages except the pentode modulator. Power supplies are mounted under the chassis. Telescope cable termination is on rear apron.



View looking into end of telescope shows how the solar cell, in transmit condition, is out of beam path from laser to diagonal. In the receive mode, the cell enters the beam path between diagonal and eyepiece. Make sure that sensitive side of solar cell faces the diagonal.




In the simple transceiver, the solar cell is mounted within a tube having a dark interior—in this case, it's a clean Polaroid print coater. Cell is affected by ambient light so that it must be shielded during use. Any method of mechanical mounting may be used to position the cell correctly.



It is assumed that the telescope optics have been set up as described in the telescope operating manual.

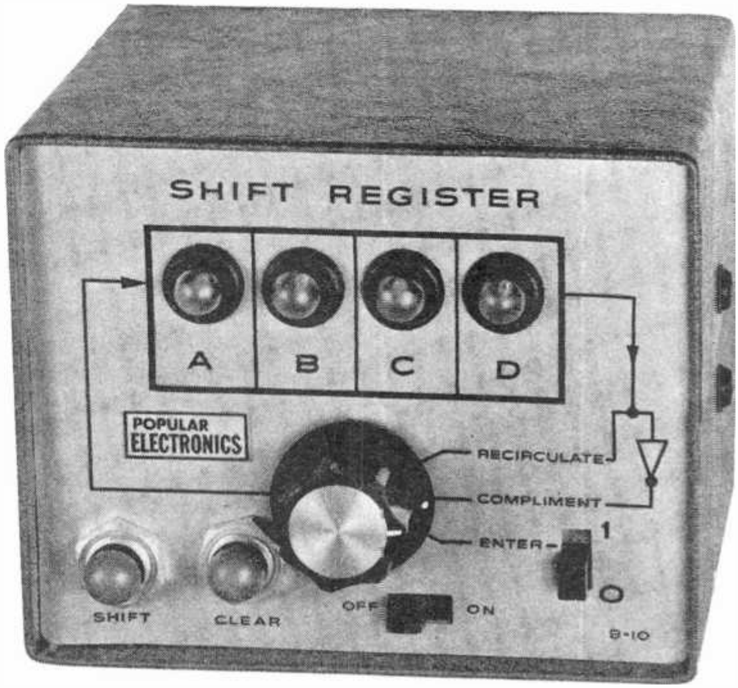
On the main chassis, set bias control *R4*, volume control *R5*, and modulation control *R6* to minimum resistance. Plug in the 117-volt line cord and turn on the power. The laser tube will blink a few times until *V1* warms up. After the laser starts to glow at full power, allow the entire system to stabilize for a few moments. Adjusting the bias control should cause the laser glow to diminish a little. Set this control for maximum laser brilliance.

Place the 90° plastic prism over the protuberance at the laser exit hole and adjust the prism so that the laser beam is reflected down the telescope eyepiece. Aim the telescope at a wall and keep adjusting the prism—and if necessary the position of the laser—until a red circle, with the diagonal mirror shadow centered in it, is clearly visible on the wall. At this point, the laser has been properly set up and should not be moved.

If you have to keep looking at the laser beam, a pair of blue sunglasses may be worn to reduce the red glare.

To test the system, aim the telescope at a distant mirror and reflect the beam back to a duplicate solar cell that has been connected to the main chassis. You can also use the second telescope of the communications system if you have built it at this time.

With the light beam shining on the solar cell, make sure that the radio is playing at a reasonable volume and turn up the laser volume control *R5*. If artificial light falls on the solar cell, a hum will be heard; so for best reception keep the ambient light dim. Slowly adjust the bias control (*R4*) until the laser dims a little. Then bring up slightly the modulation control (*R6*) until music is heard from the main chassis speaker. Since *R4* and *R6* are interlocking in their action, you will have to adjust them together to get the desired results. If *R4* is set for too low a beam level and *R6* is set too high, modulation peaks may extinguish the laser. The automatic power supply will retrigger the laser, but the controls should be adjusted to prevent the dropout. Once clean modulation has been obtained, the radio can be replaced by the microphone and *R6* adjusted for this type of input. -30-




# Build a SHIFT REGISTER

*Storage for digital computers, computer logic*

BY DON LANCASTER

HAVE YOU EVER wondered how computers and electronic calculators perform arithmetic operations, or how they move data and numbers about? A unique circuit known as a "shift register" is responsible for these operations. The shift register is an electronic device that stores numbers, commands, words or locations when programmed to do so. Later, it "plays back" the stored information, either all at once or bit by bit until the register is empty or is back where it started from.

If you would like to experiment with the shift register, you can make one of your own at very little cost, using the instructions provided here. Your project can then be used as an entry in a science fair, a teaching aid, or simply as an interesting device for studying digital integrated circuits and computer logic.

This shift register employs three IC's and four transistors, arranged to form a "four-bit, serial-in/serial-out parallel-read" system. The functions provided are *enter*, *recirculate*, *compliment*, *shift*, and *clear*. The same project also demonstrates "walking ring counters" and "disallowed subroutines."

**IC EXPERIMENTER'S CORNER**

**NO. 4 of 5**

**Shift Registers in General.** Almost all digital computers and computer circuits

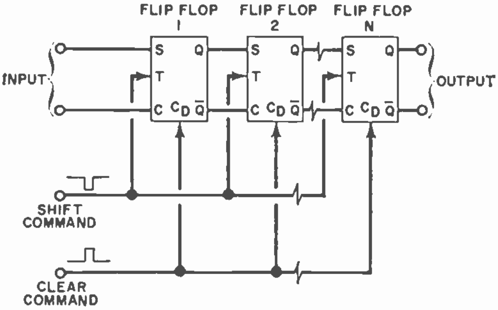



Fig. 1. Shift register is basically string of JK flip-flops connected in cascade. Any number of JK flip-flops can be connected in the manner shown.

are made up of simple elements that can have only two states: *on* and *off*, voltage and no voltage, or, most commonly, 1 and 0. The 1 or 0 represented at any time in a single element is called a *bit* (for binary digit). A string of related bits is a *word* (sometimes referred to as a *byte*). A word can represent a number (in binary, octal, binary coded decimal, decimal, or any other coding system), an address (a specific location or element in the machine), or an instruction (such as a "multiply" command).

A computer or calculator gets its words from a program on tape, cards, discs, drums, or a programmer (the person operating the computer). It then stores all the words it needs and later manipulates them as instructed.

The length of a word is simply the number of bits required to make up the word. The longer the word, the more accurate it can be. For example, for six-place accuracy using binary coded decimal (BCD) numbering, 25 bits are needed in each word.

The words are often stored in shift registers. A shift register comprises a number of stages, each of which can store one bit; 25 stages are needed to store a 25-bit word, and so on. There are several ways to get information into and out of a shift register, and there are several types of shift registers. For those of interest here, information is put in and taken out one bit at a time. This type is known as a "serial-in/serial-out" register.

The *shift* operation takes place when it is desired to move the stored word. On a shift command, every bit moves one—and only one—element to the right as the first element accepts a new bit from outside. (The sidebar on page 47 summarizes how this operation takes place.) The input can be an outside *enter* command, or the output *recirculated*, or the opposite of the output known as the *compliment* for special counter circuits.

Some shift registers, including this one, also have provision for a *clear* instruction that automatically puts all 0's in the register.

A shift register can be built with a train of conventional JK clocked flip-flops as shown in Fig. 1. Assuming that a *clear* command is first fed into the circuit, all stages are reset to a 0 condition. Upon receipt of a *shift* command, each stage passes its 0 one stage to the right, and the first stage accepts a new input.

Shift registers are then a means of accepting, storing, and later providing digital words when given the proper commands. In the *recirculate* mode, a shift register can march its word around bit by bit, produce one bit at a time as an output, and end up with the word right back where it started, ready for another use.

## PARTS LIST

*C1—0.1-µF disc capacitor*
*C2—100-µF, 6-volt electrolytic capacitor*
*I1-I4—X1490 panel lamp*
*IC1—Dual two-input gate integrated circuit (Fairchild µL914)*
*IC2, IC3—Dual JK flip-flop integrated circuit (Motorola MC790P)*
*Q1-Q4—2N4400 transistor (or Motorola MPS6554)*
*R1-R6—470-ohm, ¼-watt resistor*
*S1—S.p.s.t. slide switch*
*S2—S.p.s.t. normally-open snap-action pushbutton switch*
*S3—Dual s.p.s.t. snap-action pushbutton switch; one pair of normally closed, other pair of normally open contacts*
*S4—Two-pole, three-position non-shorting rotary switch (Mallory No. 3223J)*
*S5—D.p.d.t. slide switch*
*Misc.—Printed circuit board (see text); dialplate; 3½" x 4" x 5" case; ¾" metal or fiber spacers (3); ⅜"-inner diameter rubber grommets for mounting lamps on front panel (4); #24 insulated wire for circuit board jumpers; control knob; #6 hardware; hookup wire; solder; etc.*
*Note—A metalphoto aluminum dial plate is available for $3 postpaid in U.S. from Reill's Photo Finishing, 4627 N. 11 St., Phoenix. AZ 85014. The following items are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216: Etched and drilled printed circuit board, #1726, $1.90; complete kit of parts including prepunched vinyl-clad case and dialplate, #172c, $9.75 postpaid in U.S.*

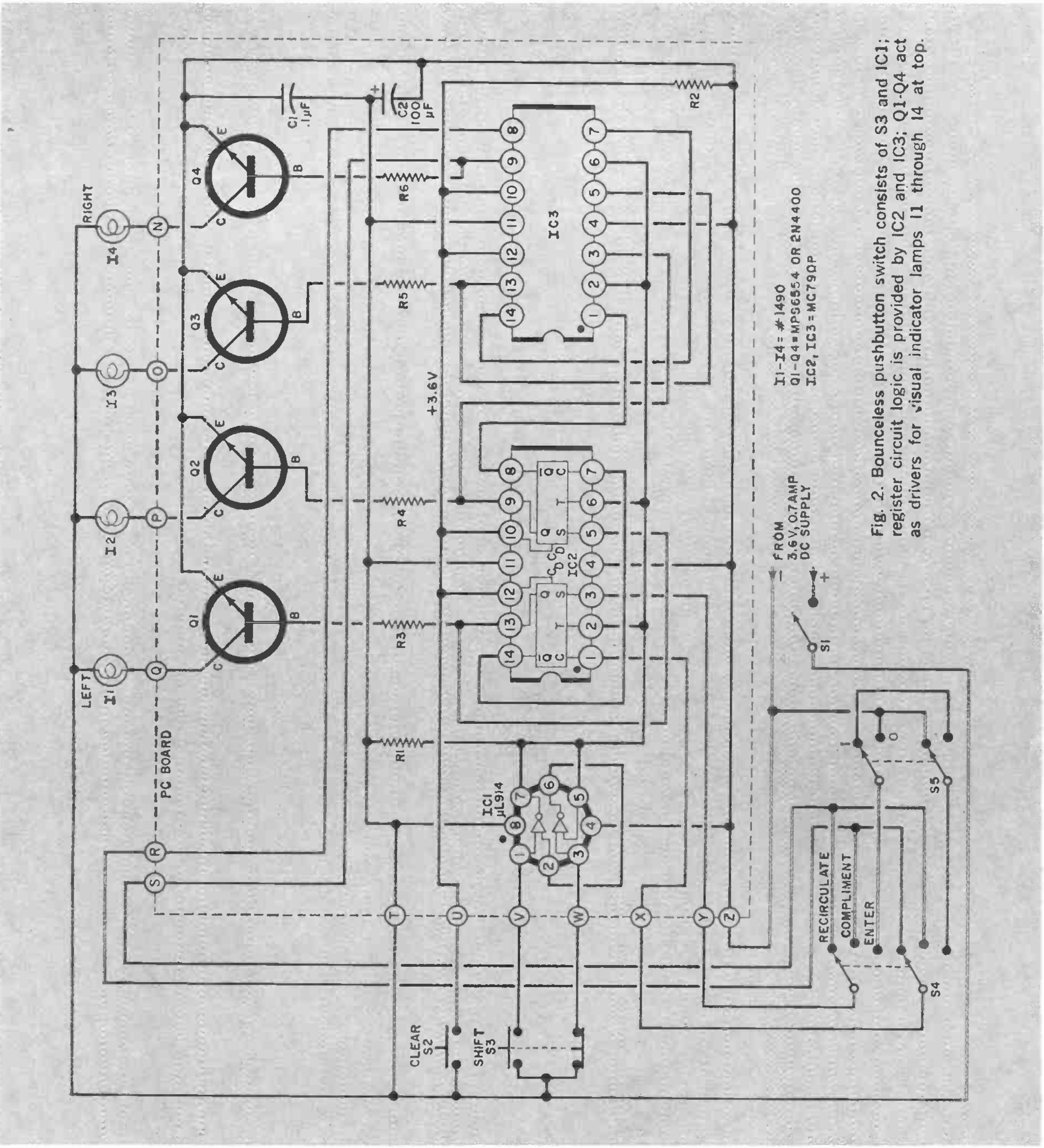



Fig. 2. Bounceless pushbutton switch consists of S3 and IC1; register circuit logic is provided by IC2 and IC3; Q1-Q4 act as drivers for visual indicator lamps I1 through I4 at top.

**How It Works.** Four JK flip-flops, *IC2* and *IC3* in Fig. 2, are used as the storage elements. These flip-flops are cascaded, with the first stage being driven from a source selected by switch *S4*. The source of the input data can be from switch *S5* (*enter*), the output (*recirculate*), or the opposite of the output (*compliment*).

A shift command is delivered to the toggle, or T, input of each stage from the bounceless pushbutton circuit made up of *IC1* and *S3*, which moves each bit one stage to the right for each shift command received. The clear operation is accomplished when $S2$ delivers a positive voltage to the CD input of each stage, forcing the register into the 0000 condition.

The condition or state of each stage is indicated by lamps *I1-I4*. A lighted lamp indicates a "1" state, while an extinguished lamp indicates a "0" state.

**Construction.** A printed circuit board is a must for this project. The PC board can be purchased etched and drilled (see Parts List), or you can make your own by following the actual size etching guide provided in Fig. 3.

Component placement on the circuit

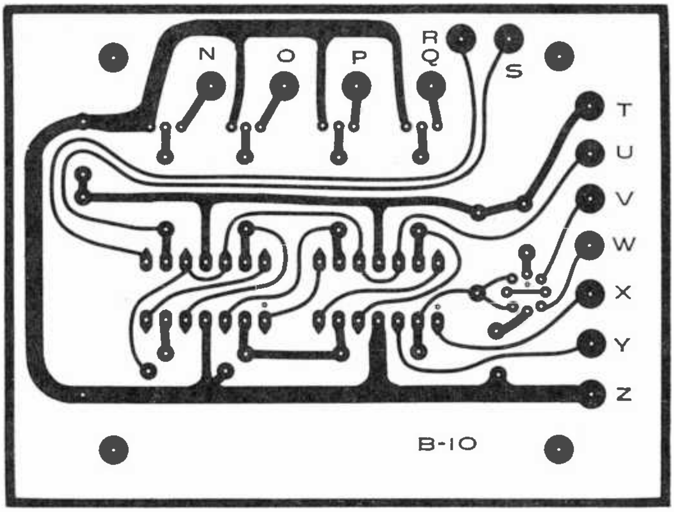



Fig. 3. In actual size printed circuit board etching guide, lettered contacts indicate off-the-board component connections.

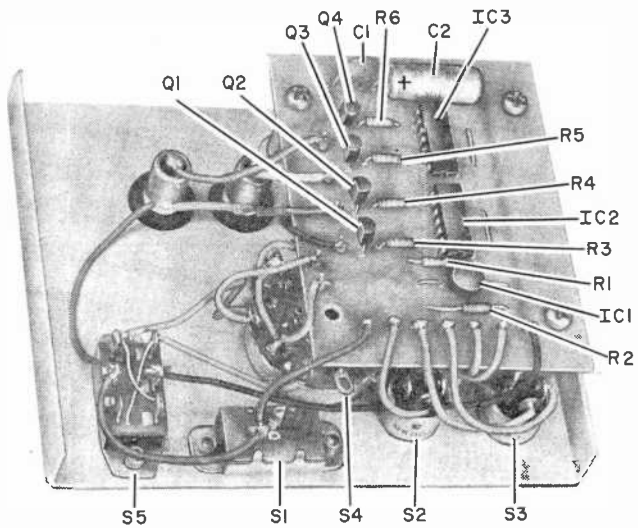



Fig. 4. When mounting integrated circuits on board, make sure indexing dot on IC1 is to left and notches of IC2 and IC3 are to bottom as shown in photo.

## HOW THE SHIFT REGISTER WORKS

**CLEAR:** With the clear command fed in, the register automatically resets to indicate 0000, regardless of the previous states. This operation empties the register, preparing it for its next use.

**ENTER:** The register places a selected 1 or 0 into the first stage on a shift command. All other 1's and 0's in the register then move one stage to the right. This is how a register is "filled" or "loaded."

| | |
|---|---|
| Start with | 0000 |
| Enter a 1 | 1000 |
| Enter a 1 | 1100 |
| Enter a 0 | 0110 |
| Enter a 0 | 0011 |

With each digit entry, a shift command must be initiated.

**RECIRCULATE:** The register shifts the word one stage to the right with each command received, with the last stage passing its 0 or 1 back to the first stage. This condition "marches" out a word bit by bit for outside use. When finished, the word ends up in its initial position if you shift exactly the number of stages in the register. This is how a word can be used but still retained.

| | |
|---|---|
| Start with | 0011 |
| Shift to get | 1001 |
| Shift to get | 1100 |
| Shift to get | 0110 |
| Shift to get | 0011 |

The binary word has gone "once around," one bit at a time appearing at the farthest right stage for outside use.

**COMPLIMENT:** This is a "trick" that is sometimes used to change a register into a counter. To compliment a register, the opposite of what is in the last stage gets passed back to the first stage, with all other stages passing their 0 or 1 one position to the right as usual. Eight shift commands are required to get the register back to where it started in a four-stage register.

| | |
|---|---|
| Start with | 0011 |
| Shift for | 0001 |
| Shift for | 0000 |
| Shift for | 1000 |
| Shift for | 1100 |
| Shift for | 1110 |
| Shift for | 1111 |
| Shift for | 0111 |
| Shift for | 0011 |

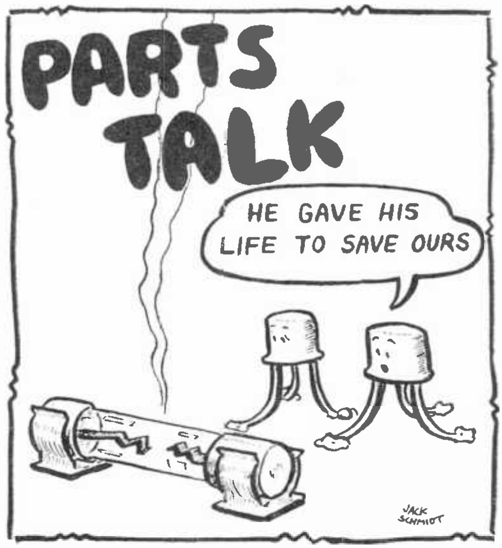
At this point, the register is back to where it started, taking eight shift commands to get it there. Hence, a divide-by-eight counter, called a "walking ring counter," is obtained.

board is shown in Fig. 4. When mounting components on the board, notice that *IC1* is identified by a flat and color dot near lead 8, while *IC2* and *IC3* are identified by a dot-and-code notch. Also take careful note of the lead orientations of transistors *Q1-Q4*. Use fine-grade solder and a small pencil soldering iron.

The lamps mount on the dialplate by press fitting them into 3/4" rubber grommets as shown in Fig. 4. The hookup wires are soldered directly to the contacts on the lamps, saving the price of individual lamp sockets. Next, the circuit board mounts on the front panel with the aid of three spacers. (Note: bend the lugs of *S4* so that they do not interfere with or touch the circuit board.

Once the components are mounted on the front panel and the circuit board is in place, interconnect with hookup wire, referring back to Fig. 2 as needed. Then mount the assembly in the vinyl-clad metal box provided with the kit of parts, or mount it in an aluminum utility box with dimensions at least 5" × 4" × 3½", and construction is complete.

When using the shift register, bear in mind that the circuit requires 3.6 volts at 700 mA, with less than 700 mV of ripple peak-to-peak. Any good bench supply will do. —30—



# SUPER FLASH

## WORLD'S BRIGHTEST INCANDESCENT LAMP FLASHER

BY THOMAS COUCH

FLASHING LIGHT systems are one of the most popular types of projects found in electronics experimenters' publications. But wait a minute! No matter how many flashers you may have seen or built, you are in for a surprise when you build the "Super Flash". It uses only a 117-volt, 6-watt lamp, but the amount of light emitted is practically blinding! In fact, an ordinary D26 Christmas-tree lamp was found to deliver slightly more than 500 foot candles in one flash. Because of this extreme brightness, it is recommended that the Super Flash *not* be used indoors where a person might stare at it at close range.

Although this new approach to flashers was designed for use with a disabled vehicle on a dark roadway, it can also be used as a boat light, a pier or dock indicator, or a sure-to-be-seen obstruction light.

**Construction.** The circuit for the Super Flash is shown in Fig. 1. The prototype was built in a 5″ × 4″ × 3″ metal enclosure, though any type of construction can be used. If you use the metal enclosure, drill a hole in one end large enough to accommodate the two-pin bayonet socket. If you are going to use the Fresnel lens, also drill the four holes required to mount the lens retainer ring.

The two power transistors are mounted in sockets, each socket supported by a pair of insulated standoffs. The two sockets and the transformer are mounted on one long wall as shown in the photograph. Arrange the sockets so that the terminals are facing you and are accessible.

The dual potentiometers, along with a two-lug terminal strip (non-grounded) are mounted on the other half of the chassis. Arrange these parts so that,

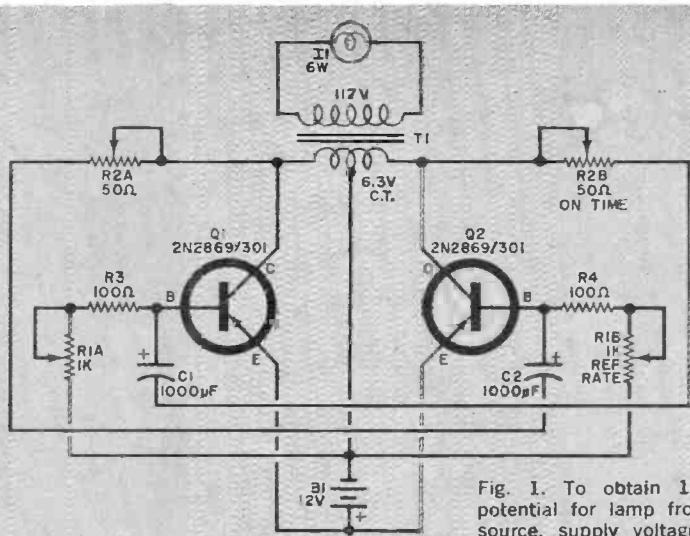
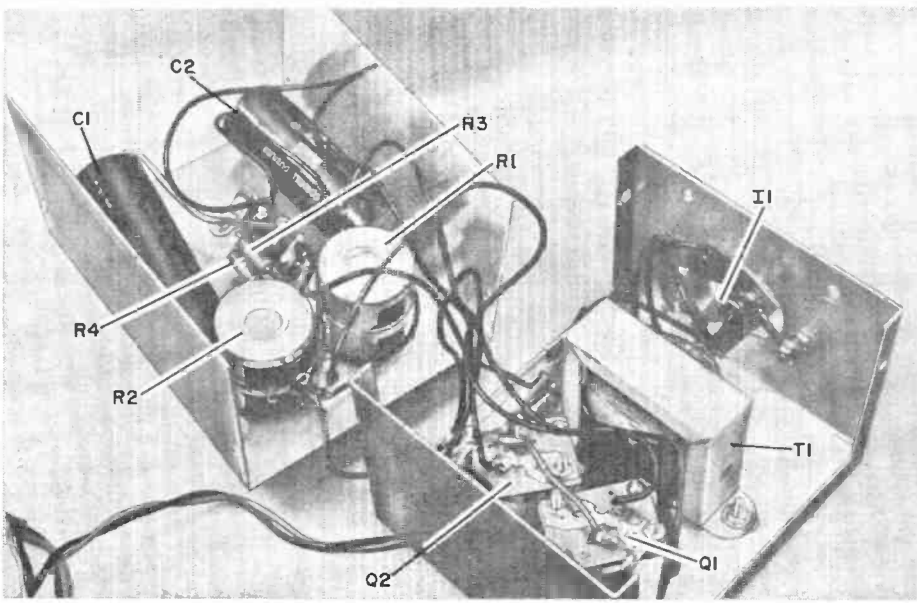



Fig. 1. To obtain 117-volt driving potential for lamp from 12-volt d.c. source, supply voltage is converted to a.c. via oscillator and stepped up.

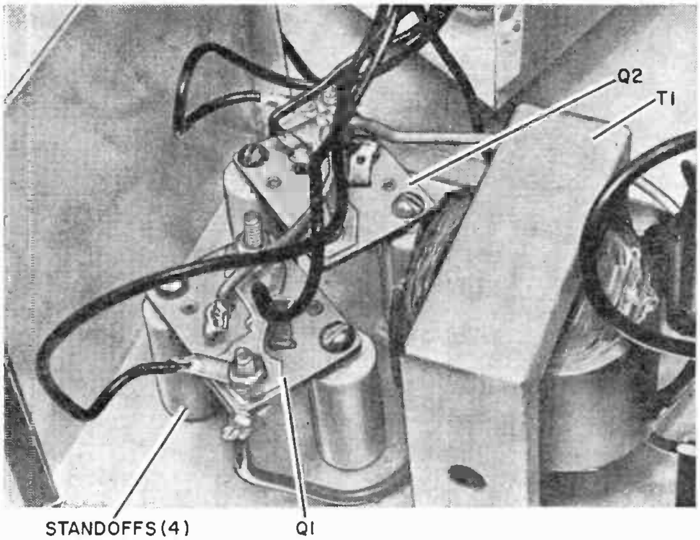
## PARTS LIST

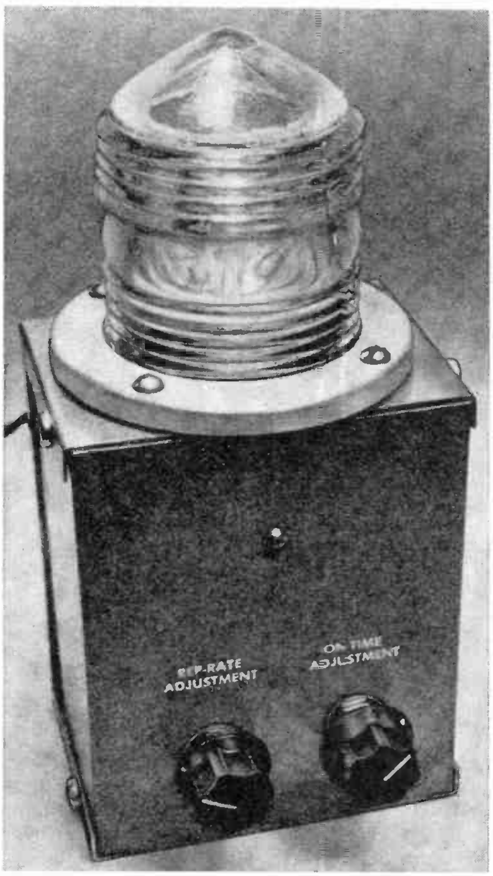
*C1,C2—1000-μF, 50-volt electrolytic capacitor*
*I1—117-volt, 6-watt incandescent lamp, Chicago Miniature 6S6, or similar*
*Q1,Q2—2N2869/301 power transistor*
*R1—1000-ohm, linear-taper, dual potentiometer*
*R2—50-ohm, linear-taper, dual potentiometer*
*R3,R4—100-ohm, 1-watt resistor*
*T1—Filament transformer, 117-volt primary, 6.3-volt, 6-amp CT secondary (Chicago Stancor P-3064 or similar)*
*Misc.—5" x 4" x 3" metal enclosure, 2-pin bayonet socket, power transistor socket (2), insulated standoff with mounting hardware (4), terminal strip, length of twin-conductor lead with cigarette-lighter attachment, Fresnel lens (optional).*
*Note—A clear Fresnel lens, with gasket and retaining ring, is available at #2826 for $5.00 from Gordon S. Anderson, Mfg. Co., Mabbittsville County Rd., RD #1, Millbrook, NY 12545.*




Due to simplicity of circuit, point-to-point wiring, using stranded hookup wire, is best for assembling project. Mount controls on front, lamp and lens assembly to top of chassis box.

With aid of standard phenolic sockets and insulated spacers, mount transistors to rear of chassis below transformer T1 as shown.




The Fresnel lens assembly bolts to the top of the chassis box with four sets of #6 machine hardware.

when the two halves of the metal enclosure are fitted together, the potentiometer metal shells do not contact the transistor socket terminals.

Once these parts have been assembled, wire the circuit in accordance with Fig. 1. Note that *T1* is wired "backwards." That is, the center-tapped low-voltage winding is used as the primary, while the 117-volt winding is used as the secondary. To avoid component damage, make sure that no part of the electrical circuit is connected to the metal chassis.

Power for the Super Flash is obtained from an external 12-volt vehicle battery capable of delivering 2 amperes. A length of two-conductor cable is terminated in a conventional cigarette-lighter plug. Be sure that the proper connections are made to the plug. On a negative-ground vehicle system, the center pole of the cigarette lighter is positive.

If you want to test the flasher on your workbench, use a low-impedance 12-volt d.c. power supply capable of delivering 2 amperes.

Insert the 6-watt lamp in the socket and mount the Fresnel lens. Do not use a lamp with a power rating any higher than 6 or 7 watts as the load may keep the circuit from oscillating.

With the lamp installed, connect up the power. Do not stare at the lamp when it is operating as a very bright flash of light

(*Continued on page* 86)

# BUILD THE ADD-ON SQUARER

## NO OVERSHOOT AND 70-NANOSECOND RISE/FALL TIME

BY JAMES BONGIORNO

WITH THE QUALITY of audio equipment and the "know-how" of the serious audio experimenter constantly improving, better test gear (usually meaning ultra-low distortion) is a must. One of the primary tools in this area is the audio sine-wave generator. Although most audio generators have characteristics that greatly exceed those of even a few years ago—many enthusiasts have built the "Ultra-Low-Distortion Sine-Wave Generator" (POPULAR ELECTRONICS, October 1969)—there is one aspect in which there is room for improvement. This is in the generation of good clean square waves, which are essential for proper audio testing.

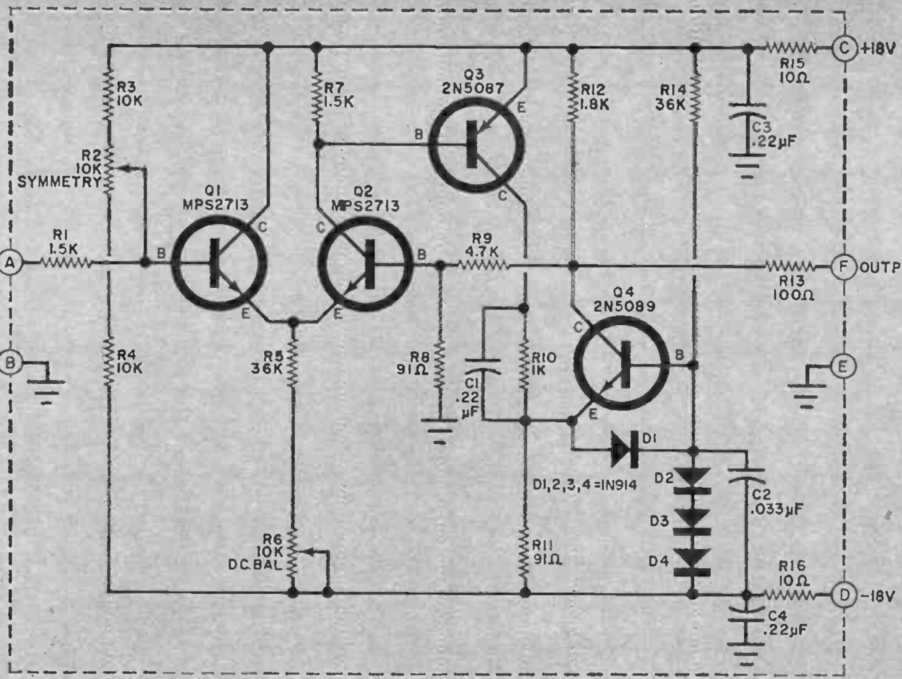
Of course there are all types of squaring circuits that can be permanently coupled to the output of sine-wave generators, permitting a choice in the type of output. The big drawback to this approach, however, is that some form of regenerative Schmitt trigger is used to create square waves from sine waves. Unfortunately, although the square waves are good, large switching transients are produced back in the sine-wave generator so that the sine waves have disturbances that appear as spikes or notches when that type of output is being used.

The "Add-On Squarer" described here is a new approach to squaring circuits in that no disturbances are reflected into the sine-wave source. In addition, the circuit has essentially no overshoot, ringing, or transistor storage time; and the symmetry remains constant up to about 1 MHz. Rise and fall times have also been improved and are approximately 70 nanoseconds each. If desired, rise and fall times can be improved further by the use of faster transistors and a minor resistance change. As is, the circuit will satisfy the most critical of audio experimenters, and the same circuit can be used to trigger most logic circuits as well.

The output of the Add-On is short-circuit proof and has no triggering offset or hysteresis. It triggers as the input sine wave goes through zero.

**About the Circuit.** The Add-On is basically a d.c. operational amplifier (see Fig. 1) having positive rather than negative feedback. There are, however, two distinct differences between this circuit and other regenerative feedback systems. First, none of the stages will saturate under any condition. This insures an absolute minimum of overshoot and ringing. Second, there is no storage time so that rise and fall times of 70 nanoseconds can be achieved. Incidentally, you will need a top-quality laboratory scope to measure such fast rise times.

Since the output stage is non-saturating, loading does not have any effect on the quality of the output square waves—only on the amplitude. The Add-On will




## PARTS LIST

*C1,C3,C4—0.22-μF Mylar capacitor*
*C2—0.033-μF Mylar capacitor*
*D1-D4—1N914 or similar diode*
*Q1,Q2—Transistor (Motorola MPS2713)*
*Q3—Transistor (Motorola 2N5087 or 2N3906)*
*Q4—Transistor (Motorola 2N5089)*
*R1,R7—1500-ohm*
*R3,R4—10,000-ohm*
*R5,R14—36,000-ohm*
*R8,R11—91-ohm*
*R9—4700-ohm*
*R10—1000-ohm*
*R12—1800-ohm*
*R13—100-ohm*
(All resistors ½-watt, 5%)
*R2,R6—10,000-ohm PC-type trimmer potentiometer*
*R15, R16—10-ohm, ½-watt, 10% resistor*
*Misc.—Small heat sinks for Q3 and Q4.*
*Note—An etched and drilled G-10 glass epoxy circuit board is available for $4.25 postpaid from Lambert Laboratories Ltd., 48 Washington St., Westfield, N.Y. 14787. Residents of New York state add sales tax.*

Fig. 1. Basically a d.c. operational amplifier, the circuit can change states in less than 70 nanoseconds—much faster than most scopes can display. Besides high-quality audio testing, the pulses can be used with many digital circuits.

deliver 15 volts peak-to-peak into an essential open load and will trigger with any input signal of a half a volt or more.

The circuit will trigger and deliver a symmetrical output waveform up to approximately 1 MHz.

**Construction.** A foil pattern for a printed circuit board for the Add-On is shown in Fig. 2. If you do not use a PC board, make sure that you follow the physical placement of the components as shown in Fig. 3 as closely as possible to insure clean, fast waveforms. Wire the circuit as shown in Fig. 1.

If you want to further reduce the rise and fall times, use a faster switching transistor for *Q3* and *Q4* and raise the value of *R8* to about 200 ohms. The only critical transistor in the circuit is *Q3*, and you must use the one specified (or a faster one). Small heat sinks may be used on *Q3* and *Q4*.

If you suspect that you have fluctuating line voltage and you want to insure the quality of the square-wave output, remove *R5* and *R6*, and substitute the circuit shown in Fig. 4.

**Calibration.** After applying power to

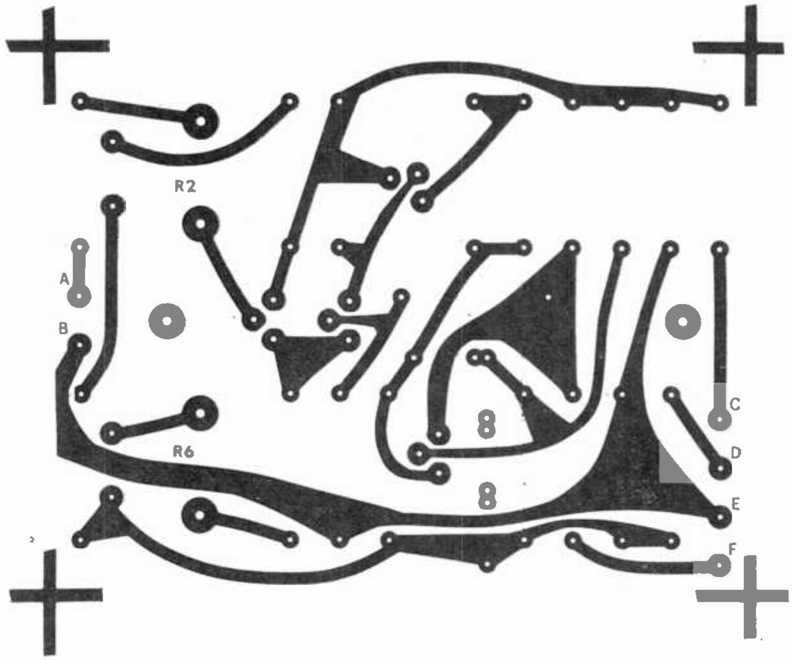



Fig. 2. Actual size printed circuit foil pattern. The marks at the corners are for board dimensions. The two mounting holes are shown along the center line.

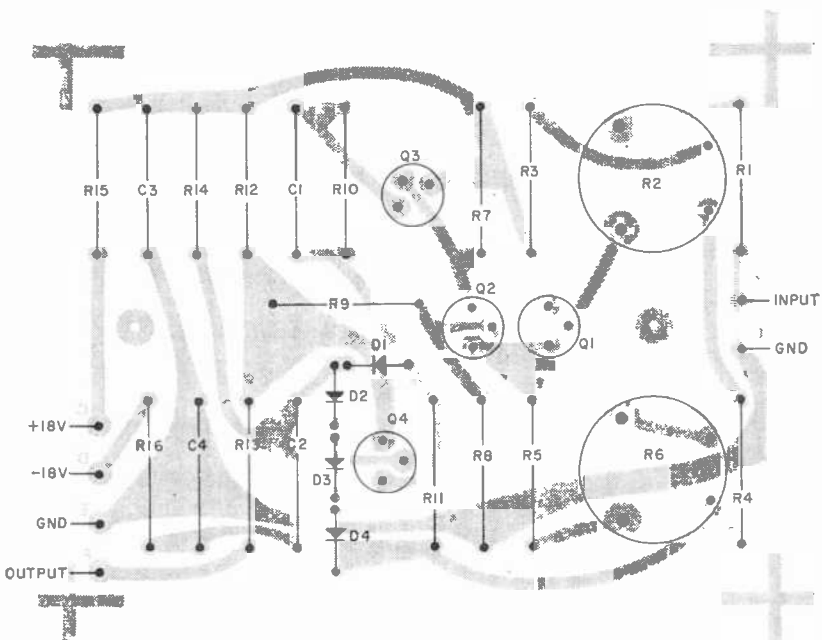



Fig. 3. When installing the components, make sure that the semiconductors are properly installed. This figure also shows external connections to be made.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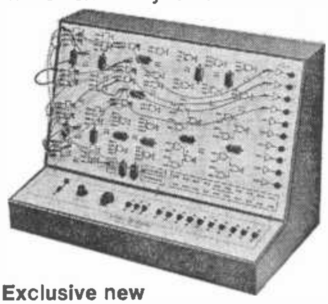

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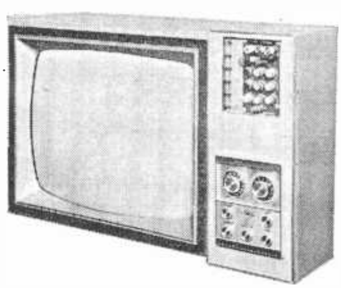

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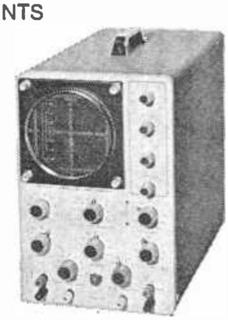

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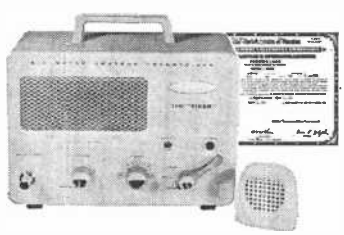

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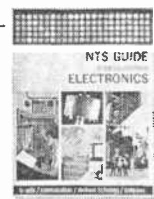


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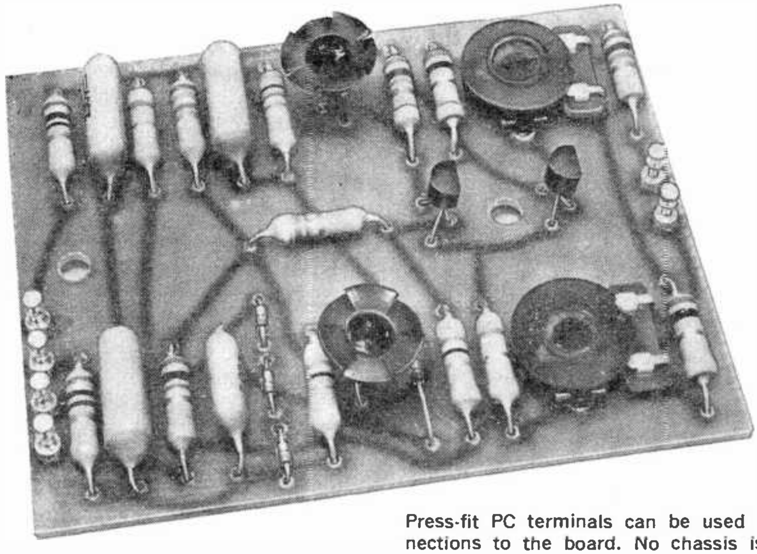


Press-fit PC terminals can be used to make connections to the board. No chassis is shown here because board is designed to be mounted in an existing single-wave generator and get its d.c. power either from the generator supply or a built-in source of +18 and −18 volts. The squarer can be switched in through a switch on the front panel.

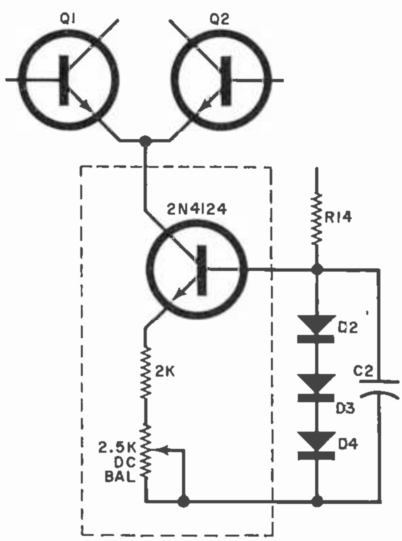



Fig. 4. This optional circuit is used in case of severe power-line fluctuations. It helps stabilize the output.

the circuit, wait at least one minute to allow charges to build up on the capacitors. The d.c. balance control, *R6*, is the key to making the unit work properly. Once *R6* is adjusted, it should not have to be reset unless you have a badly fluctuating line voltage.

After the unit has been on for a couple of minutes, apply a 10-kHz sine wave to the input and mechanically center *R2*. Connect an oscilloscope to the output and adjust *R6* until a swing of 15 volts peak-to-peak is obtained. If you can't get 15 volts, slightly lower the value of *R5*. Having made this initial adjustment, let the unit sit for about 5 or 10 minutes to allow all voltages to settle. If the bottom of the visible square wave starts to show some slight tilt, adjust *R6* to make it square. The unit is now calibrated and should remain stable.

When using the Add-On to test systems where rise and fall times are important, use an absolute minimum of connecting cable since cable capacitance has a distinct effect on these sharp transients.

The Add-On Squarer makes an ideal companion to the Sine-Wave Generator mentioned above. It can be built within the same cabinet and can use the same +18- and −18-volt power supply. —30—

# DESIGN YOUR OWN PRINTED CIRCUITS

## FROM DIAGRAM TO BOARD IS SIMPLER THAN YOU THINK

**BY ALEXANDER W. BURAWA**
**Associate Editor**

THE PRINTED CIRCUIT board undoubtedly ranks among the most important developments in the history of electronics. The PC method of construction, compared to point-to-point wiring, has many advantages and they become more apparent with increasing circuit complexity. The PC board reduces construction and assembly time (and generally costs), virtually eliminates wiring errors, is easy to trace and troubleshoot, and provides neater, more compact, lighter weight modular assemblies.

Unfortunately, many experimenters and hobbyists avoid using the PC board for a misguided reason—they think that designing their own is beyond their capabilities. The fact is, however, that designing a printed circuit board is a great deal easier than designing a circuit. All you have to do is master a few simple techniques. With a little practice, the techniques outlined here will allow you to design PC boards that are every bit as professional as those produced commercially.

Discussion in this article is purposely limited to the techniques that can be employed by *anyone* interested in electronics. The materials required are basic dime-store items: tracing and opaque paper, a straight-edge rule with sixteenth-inch divisions, pencils, a compass, and a protractor. Three optional items that really save time and paper are graph paper with ten divisions/inch, a large sheet of heavy-duty clear acetate, and a grease pencil.

**Preliminary Layout.** Many electronic components are manufactured in standard sizes. So, it is to your advantage to make up a template that shows mounting hole locations and minimum area required for these components. If you wish to make such a template, you can copy the drawing shown in Fig. 1. Put it on heavy clear acetate and carefully perforate the acetate at the hole locations.

Now, assume that the circuit you want to mount on a PC board is the one shown in Fig. 2. First, decide which of the components will *not* be mounted on the board. Break the connecting lines to these components, and insert a letter or numeral designation at the breaks. Examples of components that should not be mounted on a PC board are primary controls and switches (because of their frequency of use), power relays and heavy transformers (because of their weight), and high-power or high-current semiconductors (which generate excessive heat). These components should be mounted on a strong accompanying chassis that is capable of quickly conducting away excessive heat.

Next, redraw the schematic diagram

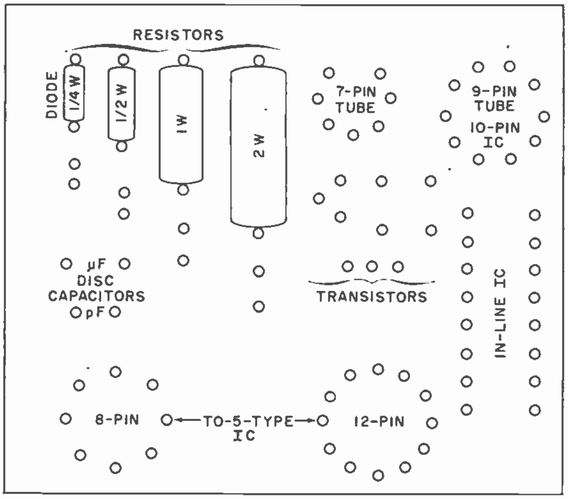



Fig. 1. Template guide, shown actual size, gives minimum hole spacing for most commonly used components. Most signal and low-current diodes fit into ¼-watt resistor slot; other silicon diodes fit into ½- or 1-watt resistor slots. Eliminate one dot in upper right drawing for nine-pin tubes.

so that only the conductor pattern, as viewed from the *underside* of the board, remains (see Fig. 3). If possible, keep the input-to-output flow from right to left, and route the ground or signal reference conductor so that it encircles the circuit. Make sure you include a dot or circle for *each* connection to be made to the pattern (including the connections for the off-the-board components). *Never* have more than one component lead connected to a given point in the conductor diagram. Then letter in the schematic part number between the connection points, preferably on a tracing paper overlay to avoid confusion. Identify polarities of electrolytic capacitors and diodes, lead orientation for transistors and the indexing tabs or dots and pin numbers of IC's.

Bear in mind that, to avoid the need for jumper wires to complete a circuit, you can route conductors between connection points of resistors, large capacitors, and most diodes. *Never* route conductors between transistor leads. And try to limit the number of conductors inside the pin outlines of IC's to a maximum of three side-by-side, and then only for the conductors specifically related to the IC. If a jumper is unavoidable, plan it so that it does not bridge a component; route it around components as necessary, or even on the underside of the board.

Once you are satisfied that your conductor pattern layout is correct, a good idea is to "breadboard" your circuit exactly as laid out to determine whether or not you will have to deal with feedback, crosstalk, hum and noise, etc. If the design is troublesome, now is the time to find out; otherwise what you do from here on will be fruitless.

If you experience any of the problems enumerated above, you have two choices: you can start fresh with an alternate conductor pattern design; or, you can try the less drastic step of shielding sensitive components or assemblies with metal barriers, or isolating troublesome circuits on separate circuit boards. In very extreme cases, a combination of the two methods might be called for, such as in the two channels of a stereo preamplifier that are first mounted side-by-side on a single PC board. If metal shields are used, when they are mounted in place with either hardware or solder they must touch only the common ground or signal reference conductors. They must *not* touch conductors that are not common to each other.

Once you are satisfied that the circuit will operate as designed, you can proceed to make the full-size drawing of the etching guide you will use to make the PC board.

**Making the Etching Guide.** Tape down on your work surface a clean sheet of graph paper. Then over this, tape a sheet of good quality tracing paper. Vellum is best—it is expensive but well worth it since it does not crack or tear easily and readily takes a pencil line.

Now, make sure you have several pen-

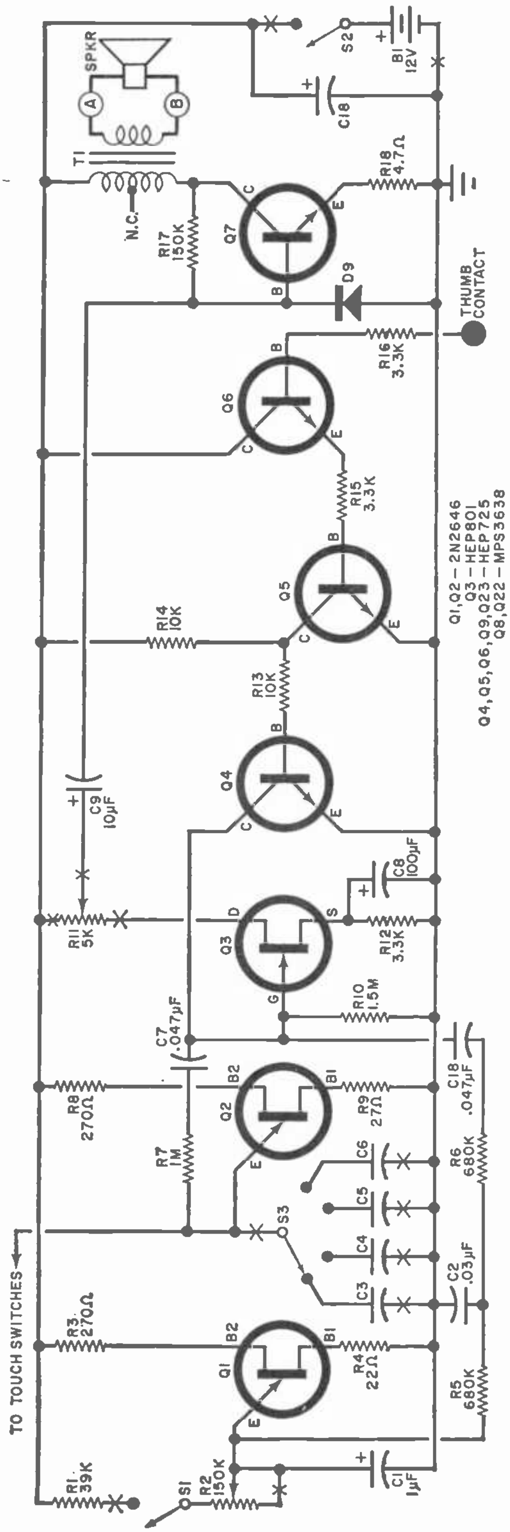



Fig. 2. Shown at left is sample circuit. Off-the-board components are shown by small X marks; you can break lines at these points and insert letters.

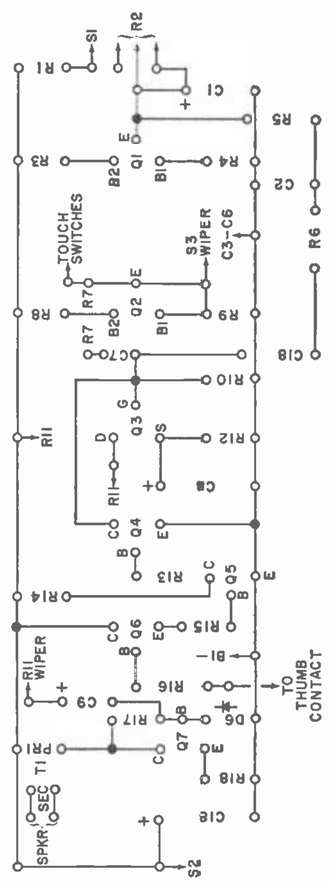
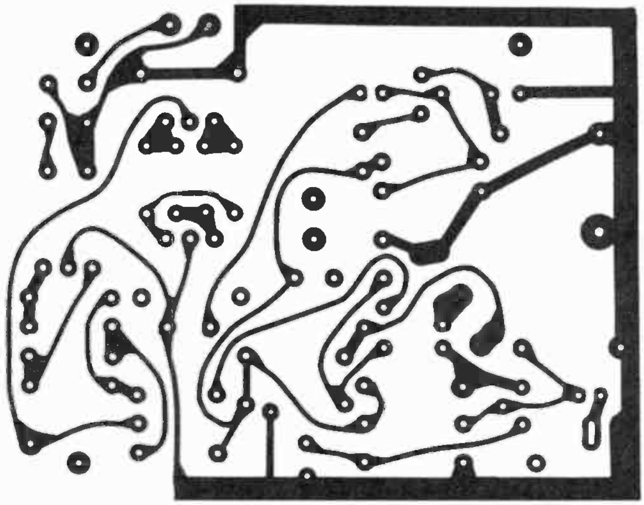


Fig. 3. Drawing above is conductor pattern diagram of sample circuit shown at left.

cils, your rule, component sizing template, and protractor handy. By consolidating your materials close at hand, you will work faster and more efficiently and make fewer errors.

Begin your etching guide layout by striking the top and right border lines perpendicular to each other and about 6" long. If you have succeeded in routing the ground or signal reference conductor around all other conductors, strike two more lines, each spaced ¼"-⅜" in from and parallel to the border lines. If not, make these new lines at least ⅜" in from the border lines to allow for circuit board mounting without the hardware touching the foil.



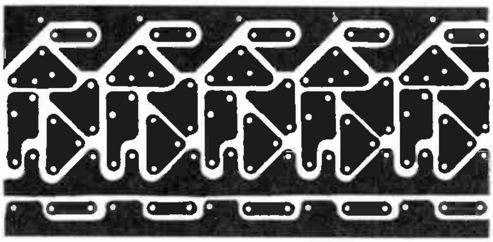


Fig. 4. Examples of both minimum-width conductor (above) and "area etch" (left) etching guides are shown. Note differences in amount of copper (blacked-in portions) in guides.

Now, using your template and/or rule, start filling in hole locations and foil patterns in the same sequence as in your conductor pattern diagram. Condense the areas on which the components are to be mounted for maximum space utilization. However, do not be afraid to assign a component more space than it requires if you want to preserve symmetry of the layout or to prevent thermal problems.

The foil pattern can be any thickness from 3/32" to as wide as you want, within the limits of the circuit board size required. Another basic rule to remember is to space conductors no closer together than 1/16" (except for inline IC's, where spacing can be as small as 1/32" between the two rows of pins). If the conductors are to be less than 1/8" wide, plan to have solder pads that are a

(*Continued on page* 98)

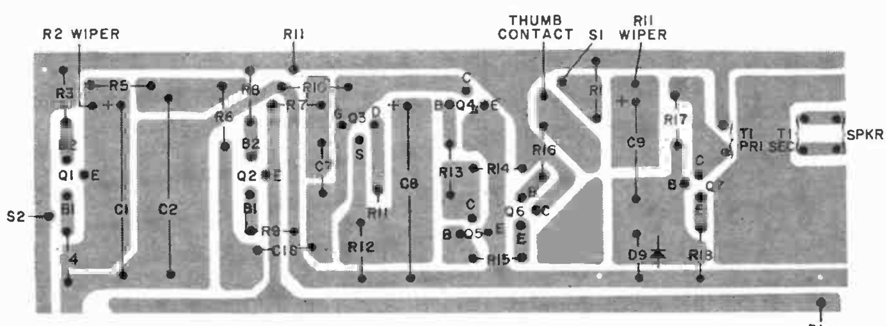



Fig. 5. Viewed from conductor side of board, foil pattern is in grey. Area etch technique was used here, but minimum-width conductor would have served just as well.

# 500/50-kHz FREQUENCY STANDARD

## ACCURATE CALIBRATION FOR YOUR RECEIVER

BY NEIL JOHNSON

THE CRYSTAL CALIBRATOR is the most versatile test instrument available to hams and SWL's for accurately checking the calibration of their receivers. Most available crystal calibrators operate on a fundamental frequency of 100 kHz with multiple markers obtained from the 100-kHz spaced harmonics of the fundamental.

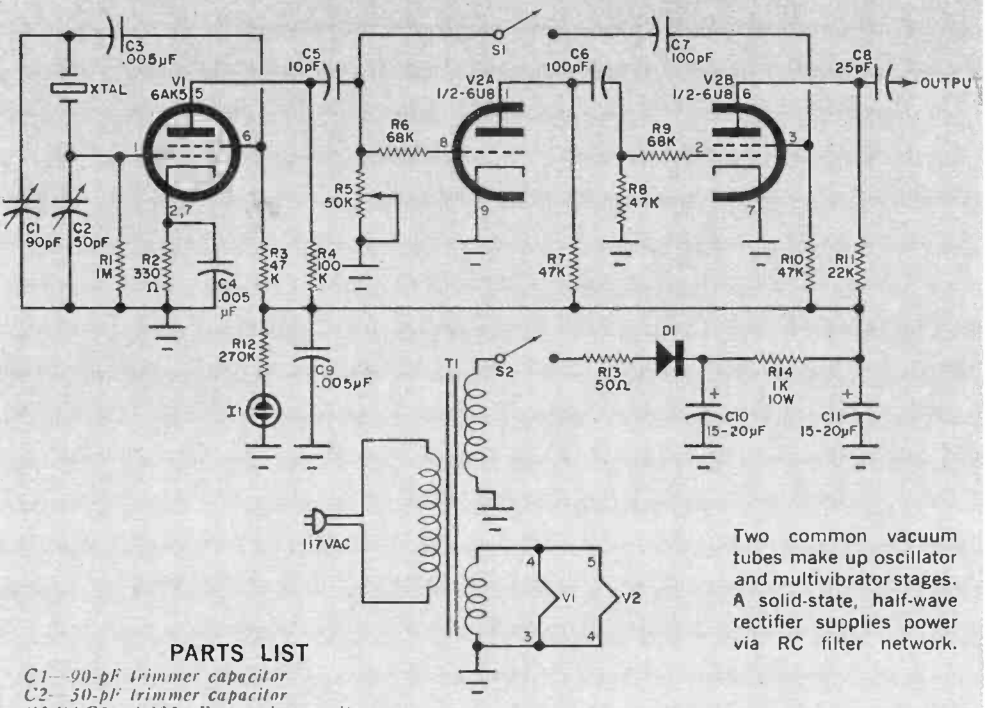
The main problem here is that the markers are inflexibly placed at predetermined intervals. So if you have to set your receiver dial in the HF range between 20 and 30 MHz where the markers are close together, it is often difficult to determine whether your receiver is set to 20.1 or 20.2 MHz. Conversely, on the low end of the spectrum, the markers may be too far apart for adequate coverage. Therefore, if you could obtain a frequency standard capable of delivering markers at both 50- and 500-kHz intervals, you might have a more useful instrument. The secondary "Frequency Standard" described here is designed with that philosophy in mind.

**About the Circuit.** The "Frequency Standard" is basically a conventional crystal calibrator with one major advantage—it can split the fundamental frequency as desired. The crystal oscillator stage (*V1* in schematic diagram) employs a tetrode vacuum tube in an electron-coupled configuration. This type of design provides good frequency stability so that changes in output loading have little effect on the input circuit.

There are no reactive elements in either the plate or screen-grid circuits. As a result of eliminating any trace of a resonant load, the fundamental frequency and its harmonics are free to appear at the output of the stage.

Stages *V2A* and *V2B* serve a dual purpose. With *S1* open, they act as a straight amplifier. By closing *S2*, a feedback loop from the screen grid of *V2B* to the grid of *V2A*, through *C7* and *S1*, connects the two stages in a multivibrator configuration. Again, the use of a tetrode for *V2B* allows either high- or low-impedance loads to be connected to the frequency standard with no ill effects on the circuit.

The typical multivibrator, being basically an unstable circuit, is excited with a crystal-stabilized signal from *V1*. With




Two common vacuum tubes make up oscillator and multivibrator stages. A solid-state, half-wave rectifier supplies power via RC filter network.

## PARTS LIST

*C1—90-pF trimmer capacitor*
*C2—50-pF trimmer capacitor*
*C3,C4,C9—0.005-μF ceramic capacitor*
*C5—10-pF ceramic capacitor*
*C6,C7—100-pF ceramic capacitor*
*C8—25-pF ceramic capacitor*
*C10, C11—15-20-μF, 250-volt electrolytic capacitor*
*D1—1N3195 diode*
*R1—1-megohm*
*R2—330-ohm*
*R3,R7,R8,R10—47,000-ohm*
*R4—100,000-ohm*
*R6,R9—68,000-ohm*
*R11—22,000-ohm*
*R12—270,000-ohm*
*All resistors ½ watt*
*R5—50,000-ohm, linear-taper potentiometer*
*R13—50-ohm, 5-watt resistor*
*R14—1000-ohm, 10-watt resistor*
*S1,S2—S.p.s.t. slide or toggle switch*
*T1—125-volt, 100-mA power transformer with 6.3-volt filament winding*
*V1—6AK5 vacuum tube*
*V2—6U8 vacuum tube*
*XTAL—500-kHz crystal with matching socket (see text)*
*Misc.—Metal utility box; 7-pin and 9-pin tube sockets; hookup wire; solder; hardware; etc.*

*R5* set at approximately mid-range, an uncontrolled oscillation of about 50 kHz is obtained. However, by injecting the 500-kHz signal from *V1* into the multivibrator, a very stable 50-kHz signal appears at the output.

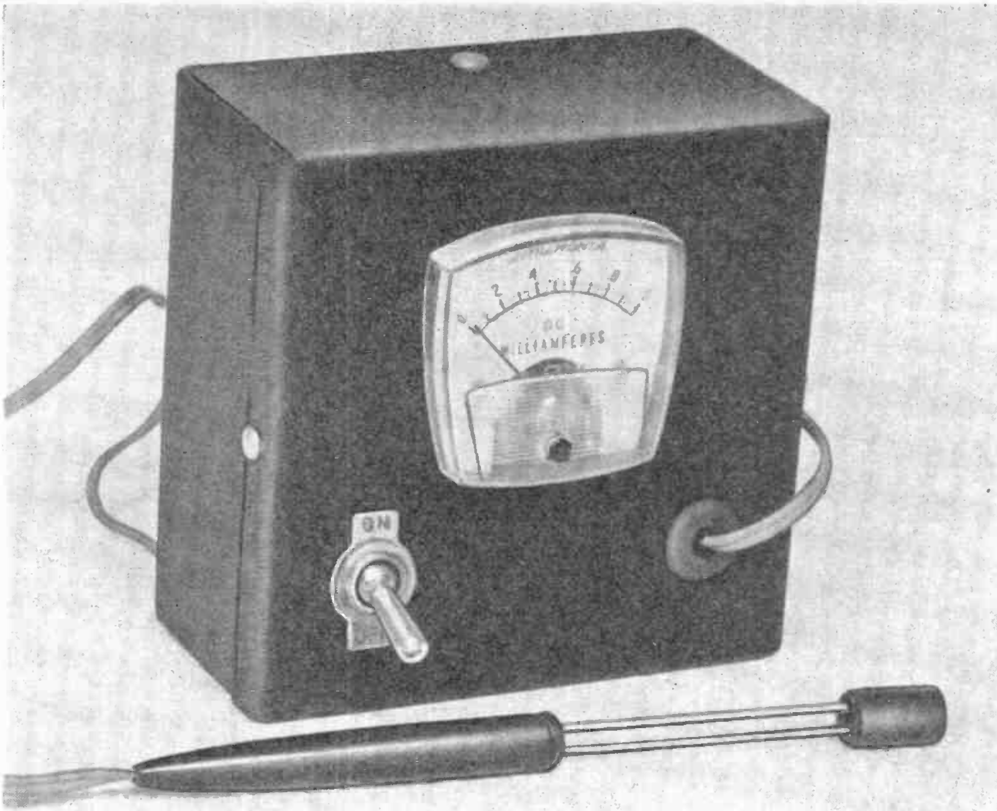
The frequency standard also features an instant-on type of design. Switch *S2* in the power supply controls only the B+ to the three stages. Heater power is applied at all times when the line cord is plugged into an a.c. outlet.

**Construction.** Because of the relative simplicity of the circuit, almost any method of assembling and mounting it inside an appropriate size cabinet will do. The cabinet, however, should be metal and vent holes should be drilled in it at the rear and top to provide adequate convection cooling for the tubes.

Switches *S1* and *S2* should be easily accessible and clearly marked to show which positions they are set to and the functions they perform. For *S2*, you have the added convenience of indicator lamp *I1* to indicate when the B+ is applied to the plates of *V1* and *V2*.

When selecting the crystal, try to obtain one that is right on 500 kHz. If you buy from surplus parts suppliers, it is worth noting that the FT-241 variety are generally too far off frequency—especially on the harmonics—for your purpose. A better choice would be the HC-6U

(*Continued on page* 98)




# BUILD A PHOTOGRAPHIC WASH TESTER

FOR BETTER DEVELOPING AND PRINTING

BY ANDRE BROSNAC

AFTER a hypo bath, photographic film and paper require a thorough wash in running water to remove any residual sodium thiosulfate (the hypo chemical). There are several ways of checking the wash water to make sure that the cleansing process is complete. Some of these are complicated and some are too expensive; but now you can build your own photographic wash tester which gives good indication of the amount of hypo left in the wash water, at a cost of only $8 or less.

The principle of the wash tester's operation is simple and is based on the fact that the electrical conductance of the wash water increases with increasing strength of hypo in the wash. A comparison of meter readings for the wash water and for plain tap water enables the photography buff to determine exactly when the wash is complete.

**The circuit** (see Fig. 1) of the photographic wash tester is very simple, consisting of a series circuit loop. It is self-powered by battery *B1*. Power is applied and removed by switch *S1*. Meter *M1* is the visual indicator, and resistor *R1* is used to limit the flow of current around the loop to a safe value.

When the probe is immersed in the wash and *S1* is closed, *M1*'s pointer will deflect upscale by an amount proportional to the amount of hypo solution in the bath. If the hypo concentration is high, the pointer deflects to a high upscale position. As the solution becomes less and less concentrated, the meter pointer will move downscale until it reaches the preset reference.

**The first step** in assembling the wash tester is to machine the chassis box. Then mount the meter movement, power switch, terminal strip, battery holder, and rubber grommet as shown in Fig. 2.

Referring to Fig. 1, wire together the

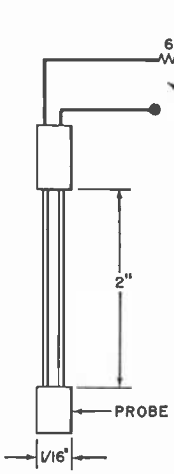



Fig. 1. Tester is simple series d.c. loop. Probe is homemade with wire and epoxy cement.

## PARTS LIST

*B1—1.5-volt C cell*
*M1—0-1-milliampere meter movement*
*R1—680-ohm, ½-watt resistor*
*S1—S.p.s.t. slide or toggle switch*
*1—4" x 4" x 2" metal chassis box*
*2—3½"-long 0.04"-0.06"-diameter stainless or galvanized steel rod for probe elements*
*Misc.—C-cell battery holder; old "BIC Click" ball-point pen; 4' length of two-conductor speaker cable; fast-setting epoxy potting compound; rubber grommet; ¼"-diameter neoprine tubing; #6 hardware; hookup wire; solder; etc.*

chassis mounted components. Make sure that no component interferes with the others and that the meter movement is connected with the proper polarity.

Next, assemble the sensor probe as follows. Cut a ½" length of ¼"-inner-diameter neoprene tubing to size. Seal one end with masking tape. Then insert

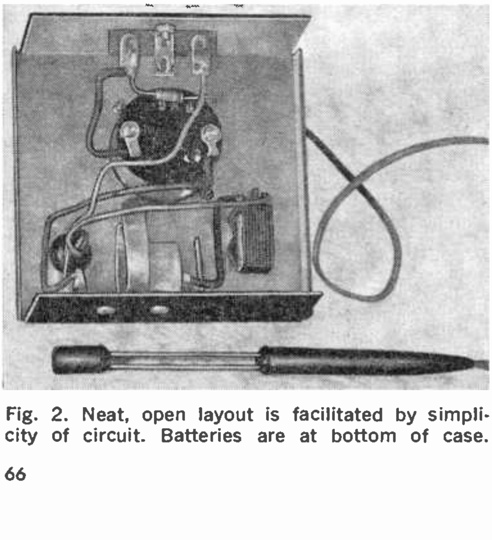
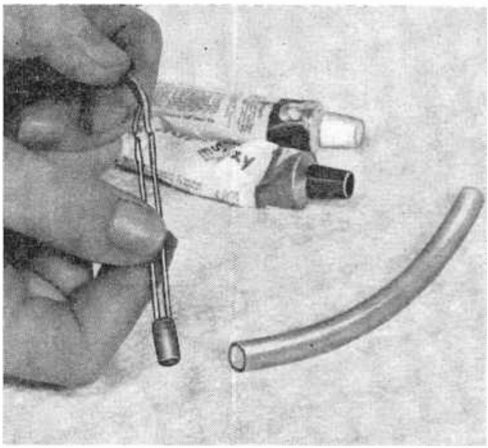


Fig. 2. Neat, open layout is facilitated by simplicity of circuit. Batteries are at bottom of case.



Taped-end neoprene tubing serves as the form when assembling the probe elements with hard-set epoxy.

the 3½"-long sensor rods (see Parts List) into the tubing, keeping them spaced 1/16" apart. Pour epoxy potting compound into the tubing and allow sufficient time for the compound to set. Then peel off the neoprene tubing.

Solder one end of a two-conductor cable to the free ends of the sensor rods. Seal this end of the sensor assembly with epoxy potting compound as described above.

Remove and discard the ink cartridge, return spring, operating button, and bottom half of an old ballpoint pen. Feed the free end of the two-conductor cable through the top half of the pen shell, and epoxy cement the sensor probe element assembly to the shell.

Finally, connect the free ends of the sensor cable to the appropriate points in the circuit. Assemble the chassis box, and the tester is ready to use.

**To use the wash tester,** first immerse the sensor probe in plain tap water. Set power switch *S1* to the ON position. Wait about 45 seconds, and mark the position on the meter face where the pointer comes to rest. The mark represents the reference point for your tests.

Now, as you use the tester to monitor your wash, continue to wash the film or paper with the probe immersed in the wash water until the meter pointer deflects to your mark. At this point, the wash will be complete, and you can proceed to the next step in your processing. —30—

# the Product Gallery

## REVIEWS AND COMMENTARY ON ELECTRONIC GEAR AND COMPONENTS

### VERTICAL SWL ANTENNA (Mosley SWV-7)

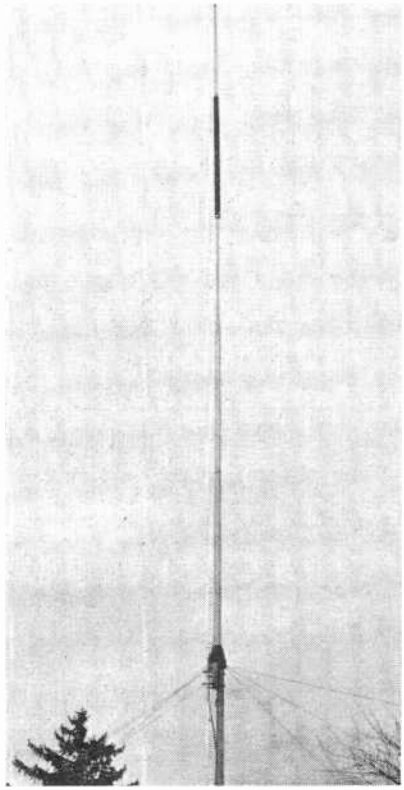
ABOUT A YEAR AGO, the Editor of POPULAR ELECTRONICS (who considers himself to be an active SWL) asked Mosley Electronics about the possibility of their redesigning a vertical ham-band antenna to cover the international shortwave broadcasting bands—one that would be a counterpart to the excellent Mosley SWL-7 horizontal antenna. The response was encouraging and it eventually resulted in Mosley's developing an entirely new SWL antenna—the SWV-7 ($33.71).

This new antenna is a center-loaded vertical with an overall height of 13 feet above the supporting base insulator. It tunes (resonates automatically) to the center of the 11-, 13-, 16-, 19-, 25-, 31-, and 49-meter broadcasting bands. It is designed to be used either at ground level (if the soil conductivity is right) or on a rooftop in conjunction with seven radials of different lengths.

The SWV-7 makes use of the very sturdy Mosley base insulator and is sold with a length of pipe that may be used to support the antenna at ground level or on a roof. Assembly of the vertical section is very simple and, from all appearances (we have had it installed for the month of February), it will withstand considerable weathering without ill effects. In fact, a conductive paste is supplied to insure good electrical contact between the vertical rod sections.

We have not had the opportunity—nor the properly cleared area—to mount the SWV-7 at ground level. In the rooftop installation, a triangular 5-foot high TV antenna tower was used as a support. Unfortunately, in a case such as this, the user must supply his own radials (7 of them) varying in length (from 9 to 38 feet) and position them around the base insulator. The radials are necessary to make the SWV-7 resonate in the proper bands. You can tune without them, but a bad mismatch is set up and the signals are degraded by 5 to 9 S-units.

Installing the radials is not the world's easiest job; but with patience, and by placing the supporting tower at the proper spot on the roof, you can run the radials to the eaves (using egg insulators where necessary) without too much trouble. Coaxial feedline must also be supplied by the installer/user and should be a good grade of RG-59/U (75-ohm) cable.



Only thirteen feet tall, the new Mosley SWV-7, antenna is center-loaded with coils tuned to the 11-, 13-, 16, 19-, 25-, 31, and 49-meter bands. In our tests, the SWV-7 was centered on the peak of roof supported by a triangular TV tower and 5 ft steel tube. The 7 wire radials are seen here spreading out over the rooftop toward the eaves. The SWV-7 out-performed all other SWL antennas.

The results obtained by tuning the bands with the vertical SWV-7, when compared with those using the horizontal SWL-7, were quite amazing and firmly reinforced our frequently stated recommendation that every SWL should use two different types of receiving antennas. This is particularly necessary because of the ever-changing angles at which incoming signals arrive—sometimes high, sometimes very low. No one antenna

| RECEPTION REPORTS | | |
|---|---|---|
| Station | SWL-7 | SWV-7 |
| 11,710 (R. Australia) | S8 | S9+6 dB |
| 11,725 (RFE, Lisbon) | S7 | S9+10 dB |
| 11,760 (Havana) | S6 | S9+10 dB |
| 15,060 (R. Peking) | S3 | S4 |
| 15,070 (BBC, London) | S7 | S8 |
| 15,110 (Moscow) | S6 | S9+4 dB |
| 15,205 (VOA, Wooferton) | S6 | S8 |
| 17,710 (Moscow) | S7 | S8 |
| 17,820 (R. Canada) | S8 | S6 |
| 17,919 (Cairo) | S3 | S2 |
| 21,490 (Moscow) | S6 | S8 |
| 21,645 (Paris) | S9+4 dB | S9+10 dB |
| 25,730 (Norway) | S4 | S5 |
| 25,750 (BBC, London) | S5 | S8 |

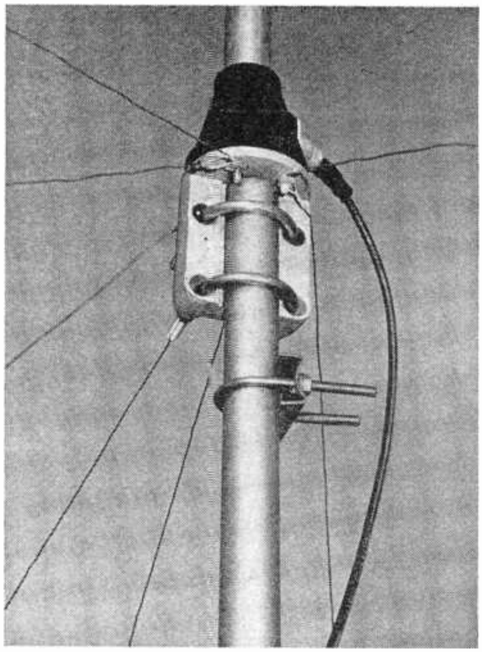
can really suffice for adequate SWL DX'ing.

Some sample reports showing the differences in reception with the two antennas are given in the Table. Results on the 31- and 49-meter bands were equally impressive. In some directions and on most signals, the vertical outperforms the horizontal by an average of 4 S-units!

However, the vertical does have some peculiar characteristics—particularly in that the lobe pattern (directivity) of the antenna favors the azimuth of the matching radial for that band. Of course, with a vertical, the listener shouldn't expect directivity; but it is there, nevertheless. Also, the SWV-7 operates much more efficiently as a broadband antenna than the SWL-7 and is usable without a balun on 41, 60, 90, and 120 meters where it tunes as if it were two unequal, random lengths of wire.

All-in-all, we are happy with the SWV-7, but we would caution the installer/user about the problems involved in putting up the radials and the extra money required (about $12.00).

**Circle No. 91 on Reader Service Page 15 or 97**

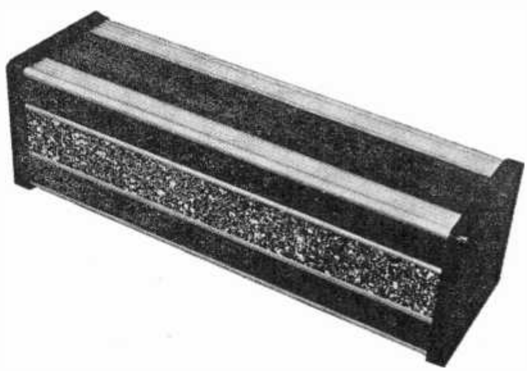


The SWV-7 antenna uses the "proven-in-practice" sturdy Mosley insulated mounting. Seven radial wires are attached to the bolts holding the insulator to the metallic support that is clamped to the steel mast. A 75-ohm coax feedline is attached to the opposite side of the insulator via a special connector. The "extra" clamp below the insulator doesn't belong to this setup—it was a leftover from another antenna mounting experiment.

## ULTRASONIC ALARM
### (Delta Products DeltAlert)

THE USEFULNESS of an ultrasonic alarm system to protect a fixed-volume area should not be underestimated. If you are unfamiliar with the operation of such alarms, we suggest that you write Delta Products (use the Reader Service Number on page 69) for a colorful brochure that carefully explains the operation and application of ultrasonic alarms.

Recently, a member of the staff of POPULAR ELECTRONICS had the opportunity of

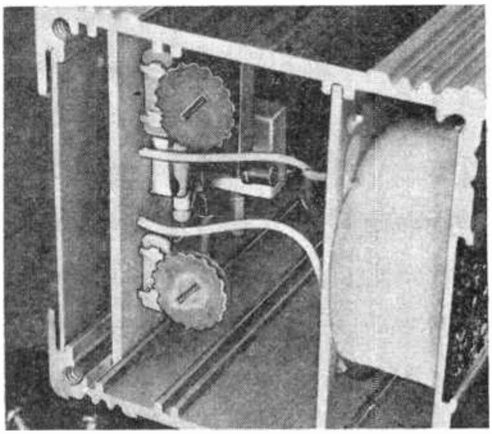


conducting an extensive test of the DeltAlert over a period of several weeks while valuable equipment was being stored in a two-car garage. In the area and volume of the garage, the DeltAlert worked to perfection. Sitting unobstructively on a steel storage shelf, the DeltAlert "flooded" the garage with ultrasonic sound and any motion such as entering from the house or opening the overhead swinging doors immediately set off the alarm (a Thomas Industries Audibell).

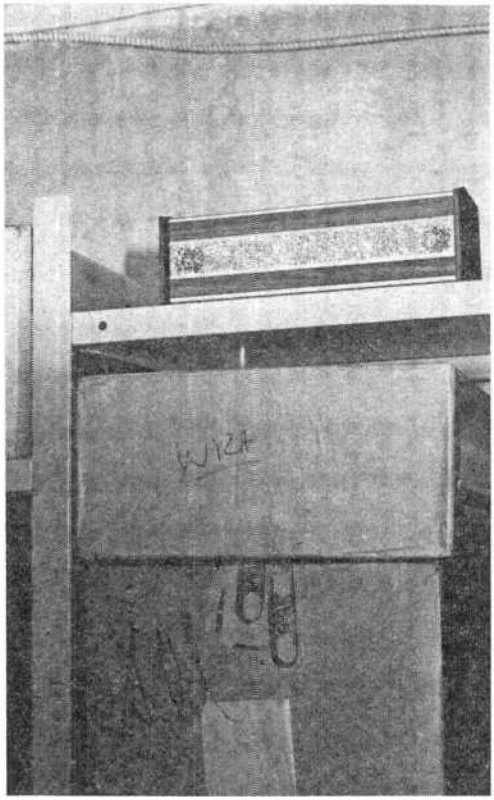
The DeltAlert is sold complete (except for alarm) for $59.95 and is ready to be installed. It has a 10-second delay after it is turned on to permit the operator to leave the protected area. Should any motion disturb the ultrasonic "flooded" area, the alarm is sounded and the period that the alarm is activated may be preset to last from 15 seconds to less than 2 minutes. After the preset interval, the DeltAlert re-cycles and either remains quiescent or re-sounds the alarm for an additional period.

The workmanship on the DeltAlert is top quality and there is no doubt that this alarm will operate efficiently for many months without an adjustment of the sensitivity (or range of detection) control. In an enclosed area, where there should be no abnormal motion (or forcible entry), we highly recommend the ultrasonic alarm.

Circle No. 92 on Reader Service Page 15 or 97



Two controls, for sensitivity (top) and time interval, are conveniently located just inside one end of the chassis. Sensitivity is easily set by connecting a lamp to the normal alarm outlet and walking back and forth through ultrasonic field. Time interval depends on the type of alarm used.



Unobtrusively set on a storeroom shelf, DeltAlert ultrasonic alarm fans 35-kHz energy out at a horizontal angle of about 100° and vertical angle of 40-45°. Used in this storeroom (a 2-car garage), it immediately sensed any "foreign" movement and energized a loud alarm bell for thirty seconds.

## METAL/MINERAL LOCATOR (Caringella TRL-1)

THE BOYS who carried mine detectors during World War II won't believe the evolution that has transpired in such devices when they see the Caringella TRL-1. Compared to those old heavyweights, the TRL-1 weighs only 1 lb 9 oz (including the one-piece earphone). In kit form ($29.95), it is easy and foolproof to build in just about two hours. It can safely be recommended to an electronics novice as a very first project—it's just about impossible for it not to work, as long as the builder follows the wiring instructions.

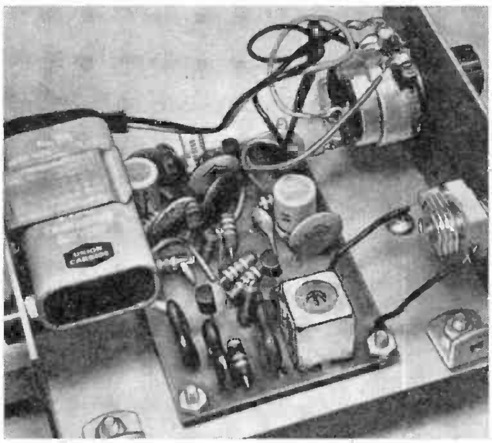
The TRL-1 is a FET-circuit, beat-frequency type of metal-mineral locator. The presence of metal or mineral in sand or common earth changes the pitch of the low-frequency beat note heard in the earphone. The unit operates from a single 9-volt battery and the audio beat note has sufficient volume to override the ambient noise picked up by the uncovered ear.

# tpg
## CONTINUED

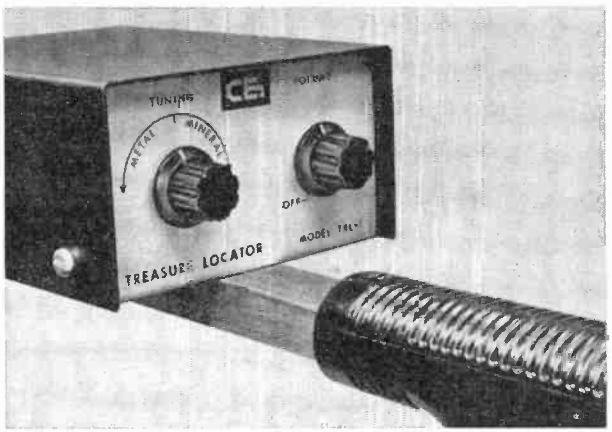
We started this review by mentioning the WW II mine detector for the simple reason that the TRL-1 is not the most sensitive metal/mineral locator we have tested. It will not respond to very small metallic objects, but will note the presence of something the size of a land mine that might be 6 to 9 inches under the ground. Objects smaller than the size of a coffee can lid can only be detected if they are near ground level (maybe 1 or 1½ inches under) and the soil is very dry. Without trying it, we suspect that the TRL-1 would be great fun on a dry sandy beach.

Circle No. 93 on Reader Service Page 15 or 97

The metal/mineral locator is very light in weight and easy to use. Angle of search coil plane may be changed to suit convenience of user. Support pole is in two pieces and can be folded up into a relatively small package to fit in car trunk.



Most of electronics package is on a PC board. Use care in soldering in the 5 transistors (3 FET's). Assembly of board took your reviewer about 1½ hr.




Knob at left (above) controls beat note frequency and offers some indication of "type" of detected substance. Other knob controls volume and on/off switch. Earpiece connection is on back of the box.

Search coil (left) is a double-sided piece of copper-clad fiberglass PC board. Top side has a coil etched out of the copper. On the bottom is a continuous band of copper connected to coax shield.

# BURNING OUT YOUR CIRCUITS WITHOUT REALLY TRYING

BY ERROL J. QUEEN

THE AGE OF SEMICONDUCTORS brought with it the many advantages of subminiaturization, cool operation, and improved performance in everything from sophisticated FM tuners to electronic light dimmers. Diodes and transistors are not without problems, however; as I recently discovered.

I am an audio-visual enthusiast and take great pains to put on semi-professional slide shows for friends and relatives who visit us frequently. A Kodak Carousel projector is connected through a Sound Synchronizer to a transistorized tape deck and amplifier. The Synchronizer unit receives trip signals from one track of the stereo tape, in turn changing the slides in coordination with prerecorded commentary and music. Colored lamps light the projection screen prior to the show's beginning; and by means of a light dimmer, the room lights and colored spots are slowly dimmed as the first slide comes on.

**Recently,** in redecorating our family room, I made the mistake of having acrylic wall-to-wall carpeting put in. I was unaware of its highly electrostatic nature, particularly on cool winter evenings. Sparks can play havoc with apparatus containing semiconductors.

When my wife or I walked across the room and then touched any metal surface, an intense spark was created. While not dangerous because of the infinitesimally low current, the voltage was probably near 100,000 volts with sparks as long as an inch and a half. We even found that we were able to locate metal surfaces behind the wall plaster (such as plumbing and conduits) by walking about and probing with a finger until a spark jumped into the wall. My wife insisted that perhaps there were treasures buried beneath the floor and asked that I crawl along the carpeting as a human treasure locator!

**In all seriousness,** the electrostatic nature of acrylic was such that within a week I saw sparks fly into my FM tuner, lamp dimmer, and FM-AM clock radio. Each in turn suffered semiconductor damage, which was costly and emotionally disconcerting. At that point, I felt I would have to make a serious decision—sell the carpeting at a tremendous loss, or sell the semiconductor equipment at a loss of dollars and pleasure. I searched the catalogs and concluded that tube-type tuners and clock radios were rapidly becoming a thing of the past—what with their problems of size, heat dissipation, and lack of demand.

**My problems** were finally resolved when I called in the firm which sold the carpeting. They recommended one of several available sprays, which, when applied, reduce the charge buildup on such fibers. Powders are also available for the same purpose. They can be brushed into the rug, with the excess vacuumed up immediately.

If you own or plan to buy transistorized radios, amplifiers, tuners, tape decks, light dimmers, or other appliances, make sure your carpeting is static-free. —30—

I made an excellent human treasure locator!

# ENGLISH LANGUAGE NEWS BROADCASTS FOR THE MONTH OF MAY

**Prepared by ROGER LEGGE**

### TO EASTERN AND CENTRAL NORTH AMERICA

| TIME-EDT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|
| 7:00 a.m. | Stockholm, Sweden | 15.315 |
| 7:30 a.m. | Melbourne, Australia | 9.58, 11.71 |
| 8:00 a.m. | Peking, China | 11.685, 15.095 |
| 8:15 a.m. | Montreal, Canada | 9.625, 11.72 |
| 12 Noon | London, England | 21.61 |
| 5:30 p.m. | Hilversum, Holland | 11.73, 15.425 |
| 7:00 p.m. | Montreal, Canada | 9.625, 11.945, 15.19 |
| 7:45 p.m. | Tokyo, Japan | 15.445, 17.825 |
| 8:00 p.m. | London, England | 6.11, 9.58, 11.78, 15.14 |
| | Moscow, U.S.S.R. | 11.87, 11.90, 15.15 |
| | Sofia, Bulgaria | 9.70 |
| | Tirana, Albania | 7.30, 9.50 |
| 8:30 p.m. | Johannesburg, South Africa | 5.98, 9.705, 11.875 |
| | Stockholm, Sweden | 11.915 |
| 8:50 p.m. | Brussels, Belgium | 6.125 |
| | Vatican City | 11.725, 15.285, 17.81 |
| 9:00 p.m. | Berlin, Germany | 9.73, 11.89 |
| | Budapest, Hungary | 9.833, 11.91, 15.16 |
| | Havana, Cuba | 9.525 |
| | Madrid, Spain | 6.14, 9.76 |
| | Peking, China | 15.06, 17.715 |
| | Prague, Czechoslovakia | 7.345, 9.54, 11.99, 15.365 |
| | Rome, Italy | 11.81, 15.41 |
| 9:30 p.m. | Berne, Switzerland | 9.535, 11.715, 15.305 |
| | Cologne, Germany | 6.075, 9.735 |
| | Melbourne, Australia | 15.17, 17.775 |
| 10:00 p.m. | Cairo, Egypt | 9.475 |
| | Hilversum, Holland (via Bonaire) | 11.73 |
| | Lisbon, Portugal | 6.025, 11.935, 15.125 |
| | London, England | 6.11, 9.58, 11.78 |
| | Moscow, U.S.S.R. | 9.70, 11.87, 15.15 |
| | Oslo, Norway (Sunday) | 11.85 |
| 10:30 p.m. | Beirut, Lebanon | 15.285 |

### TO WESTERN NORTH AMERICA

| TIME-PDT | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|
| 8:00 a.m. | Tokyo, Japan | 9.505 |
| 9:00 a.m. | Stockholm, Sweden | 15.315 |
| 6:30 p.m. | Melbourne, Australia | 15.17, 17.775, 21.74 |
| | Tokyo, Japan | 15.235, 17.825, 21.64 |
| 7:30 p.m. | Johannesburg, South Africa | 5.98, 9.715, 11.875 |
| 8:00 p.m. | Madrid, Spain | 6.14, 9.76 |
| | Moscow, U.S.S.R. | 9.70, 11.90, 15.15 |
| | Peking, China | 15.095, 17.673, 21.735 |
| | Prague, Czechoslovakia | 7.345, 9.54, 11.99, 15.365 |
| | Seoul, Korea | 15.43 |
| | Tokyo, Japan | 17.785 |
| 8:30 p.m. | Berlin, Germany | 9.73, 11.84, 15.45 |
| | Stockholm, Sweden | 11.705 |
| | Tirana, Albania | 6.20, 7.30 |
| 9:00 p.m. | Budapest, Hungary | 9.833, 11.91, 15.16 |
| | Havana, Cuba | 9.525, 11.76 |
| | Lisbon, Portugal | 6.025, 11.935, 15.125 |
| | London, England | 6.11, 9.58, 11.78 |
| | Moscow, USSR (via Khabarovsk) | 15.14, 15.18, 17.775 |
| | Sofia, Bulgaria | 9.70 |
| | Tokyo, Japan | 17.785 |
| 9:30 p.m. | Kiev, U.S.S.R. (Mon., Thu., Sat.) | 11.90, 15.15 |
| 9:45 p.m. | Berne, Switzerland | 9.72, 11.715 |
| | Cologne, Germany | 6.145, 9.545 |
| 10:00 p.m. | Havana, Cuba | 11.76 |
| | Hilversum, Holland (via Bonaire) | 9.715, 11.73 |
| 11:00 p.m. | Moscow, USSR (via Khabarovsk) | 15.14, 15.18, 17.775 |
| | Tokyo, Japan | 15.105 |
| 11:30 p.m. | Havana, Cuba | 11.93 |

# OPPORTUNITY MIRROR

### Thoughtful Reflections On Your Future

Third in a Monthly Series, BY DAVID L. HEISERMAN

## Preparing a Resume

*I notice that most "help wanted" ads request a resume from the applicant. I have never prepared one. What information should I include in a resume?*

● Your resume should be as brief and factual as possible, but do not leave out any important or interesting information about yourself that might help you get the job. The following items must be included in your resume:

1. Full legal name.
2. Home address and telephone number.
3. Personal information. (Date of birth, marital status, and number of dependents.)
4. Educational background. (Name and location of your high school and any college, technical school or military school you have attended and the amount of time spent at each. Describe the major courses you studied and indicate any certificates, diplomas, degrees, or honors you have received. Detail any home study courses you have completed and name the schools and describe the courses.)
5. Work experience. (List your last employer first and then the names and addresses of all previous employers showing the date you started working and the date you left each employer. Also include the name of the immediate supervisor at your last place of employment. Describe the kinds of work you performed for each employer and the titles of the positions held. Name any special equipment you have worked on—military or civilian. Lastly, give an honest reason for your leaving each job.)
6. Military and draft status, including any military experience. (Show dates, duties and rank.)
7. Special interests. (Detail your hobbies and favorite pastimes.)

Don't be afraid to prepare one master resume and to send copies (Xerox or other) of your resume to different prospective employers. However, be sure to attach a personal note to each prospective employer telling who you are and why you are submitting the resume.

## Sams Photofacts

*I work in a TV service shop and we have a complete file of Sams Photofacts. I use at least three different folders of schematics and maintenance data every day. In the years that I've worked at the service shop I've never discovered how Sams develops these valuable folders. Is it true that errors are occasionally put in the schematics to circumvent the equipment manufacturers' copyrights?*

● Since 1948, Howard W. Sams & Company has been publishing complete circuit schematics, parts lists, troubleshooting hints, and maintenance tips on just about every TV, radio, and phonograph made in the United States. These folder packets of information are available at a modest price from most of the large electronics retailers and are considered the bibles of the TV and radio service industry.

It is not true that errors are intentionally introduced. In fact, Sams is very careful to avoid errors of any kind. According to Les Nelson, Director of the Photofact division of Howard W. Sams, all of the schematics are original and not copies of the circuits distributed by the manufacturer.

It seems hard to believe, but Sams develops the schematics the hard way—by tracing the circuit on working models of the equipment. Sams has a staff of about 60 technicians who trace out the schematics, take voltage readings, photograph oscilloscope waveforms, and develop maintenance and alignment techniques. Sams also has an expensive staff of draftsmen, photographers, and artists to put together the Photofact folders.

Most manufacturers are so pleased with

the services provided by Sams that new working models of home entertainment electronic equipment are loaned to the Sams laboratory as soon as the first models are off the production line.

Electronics technicians and draftsmen interested in more information about job opportunities with Howard W. Sams should write to: Mr. Frank Wallace, Personnel Department, Howard W. Sams & Company Inc., 4300 West 62nd Street, Indianapolis, IN 46206.

Frank Wallace tells us that he is especially interested in hearing from people who have completed training at a two-year technical school, and have had several years experience in home entertainment manufacturing or servicing.

### Teaching Electronics

*I am a senior in high school and have always had a great interest in electronics. I also have a ham radio license. I would like to teach electronics, but my school counsellor hasn't been able to find any material on how to prepare for a career in this particular field. He has information about science and the industrial arts, but nothing on electronics. Is there anything different about the kind of training an electronics teacher must have?*

● I assume that you do not want, or intend, to teach electronics in high school. Very few high schools offer any courses in electronics. Those few schools that do use their regular science teachers, or hire a part-time electronics teacher. Generally speaking, electronics in high school is usually at a hobby level.

In order to teach electronics full time, you should be shooting for a teaching job in a vocational school or a two-year technical college.

Teachers at accredited vocational schools and technical colleges must have college degrees in the subjects they teach. Since you want to teach electronics, your counsellor should find you a good university where you can study electrical/electronic engineering.

If you don't want to teach at the vocational level, you must get a college degree in education and according to the rules of the various educational colleges, a prospective teacher must "minor" in a secondary subject that he can also teach. Unfortunately, electronics is not one of the minors offered by any of the usual education colleges. If you want to teach electronics in high school, you will probably find it necessary to have a minor in science.

Even with a degree in education and a minor in science, you should have formal electronics training. Let your counsellor help you select a home study course in electronics technology.

### Electronic Organ Repair

*Here is a case where the tail may be wagging the dog! I have been working as a digital circuit design technician for six years. Last Christmas I bought my family the large Heathkit electronic organ. I became so entranced by organ circuits that I am seriously considering getting into the electronic organ repair business. However, is there such a thing?*

● The electronic organ manufacturers that we have talked to all tell us that they hire organ repairmen and technicians who can meet two principal qualifications: a good solid background in electronics, and at least a one-finger ability to play the instrument.

However, the electronic organ repair business is very specialized and it is doubtful that you can make it a going business just by yourself. Each organ is a different design and it would appear to us that your best bet would be to try part-time electronic organ servicing in behalf of a large music store or organ dealer's service shop.

If the shop thinks you are qualified, they may have you tag along with an experienced technician. Then, they'll probably ask you to go to a full-time factory school for a week or so—with pay, of course.

At these factory schools the instructors will tell you about the circuits used in their organs and how to cure the most common bugs and defects.

From that point on, you will be a specialist in that particular brand of electronic organ. And, you can expect to spend at least a week each year back at the factory brushing up on new circuits and maintenance tricks. If you happen to get a job with one of the larger companies you'll also be spending several days a year at regional seminars.

The career opportunities in electronic organ repair appear to be very good at the present time. Organ sales are rising steadily and there is a demand for top-notch repair technicians. At the same time we cannot disguise the fact that the complexity of organ electronics is increasing at an alarming rate. Organ dealers are paying top wages to attract and keep electronics technicians who feel at home with modern solid-state computer-type circuits.

If you don't want to get too involved, you might contact the Niles Bryant School, 3631 Stockton Boulevard, Sacramento, California 95820 concerning a home study course on electronic organ repair.

# SOLID STATE

By LOU GARNER, Semiconductor Editor

## OPTOELECTRONICS—A GROWING FIELD

OPTOELECTRONICS is rapidly emerging as a full-fledge technology which, one day, may rank with microwaves, telemetry, instrumentation, etc. in terms of applications and numbers of individual specialists. An interdisciplinary field involving both optical and electronic techniques, it offers rich rewards to the serious experimenter.

With light as the common denominator, optoelectronics employs devices in four principal classes: sources, directors, modifiers, and detectors (or sensors). The former include units as simple as the common incandescent bulb and as exotic as high-power lasers. Light directors include lenses, prisms, and reflectors, while typical modifiers are filters, polarizers, and modulators. The detector category covers specialized units ranging from photodiodes to light multipliers, photo-FET's, and high-gain photo-transistor Darlington amplifiers. Although some of these devices have been available for years, the field's rapid expansion lately has been due, in large part, to the development of a variety of new semiconductor optoelectronic components, principally light sources and sensors.

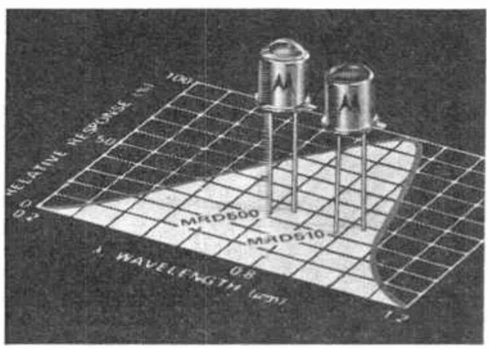
Two major manufacturers have recently introduced low-cost plastic encapsulated light-emitting diodes (LED's) suitable for hobbyist applications. Motorola's MLED600 and Monsanto's MV50 are basically similar in that both are gallium arsenide-phosphide diodes and they emit visible red light at about 700-750 foot-lamberts, require approximately 40 mA for maximum output, operate on low voltages (up to 2.0 volts) and have response times on the order of a nanosecond. With extremely long service lives (perhaps as much as 100 years), the two devices are more expensive than standard pilot bulbs but they are competitive with special long-life incandescent lamps.

The experimenter or circuit designer may choose from a number of commercial semiconductor light sensors, including photovoltaic (solar) cells, photodiodes, and even multi-stage units such as photosensitive IC amplifiers. While most devices are available with a broad range of optical and electrical specifications, no single unit may have characteristics that are ideal for a specific application.

Light communications systems, switching or logic circuits, and pulsed laser beam detectors require sensors with ultra fast response times. A good choice for these applications would be one of Motorola's newly introduced *pin* photodiodes, types MRD500 or MRD510. These devices have a typical response time of only 1 nanosecond. Both units are similar except for packaging. The MRD500 has a convex lens which provides a narrow field of view and a typical radiation sensitivity of 1.8 $\mu A/mW/cm^2$, while the MRD510, equipped with a flat-glass window for a wide field of view, has a sensitivity of 0.4 $\mu A/mW/cm^2$.

If overall sensitivity, rather than response time, is the critical parameter in a specific project, the experimenter/designer might select from GE's 2N5777-80 series of light sensors. Suitable for alarms and control circuits, these devices are low-cost *npn* planar silicon photo-sensitive Darlington amplifiers packaged in a clear epoxy. Depending on type, sensitivities range from 0.25 $mA/mW/cm^2$ to 1.0 $mA/mW/cm^2$.

Solid-state light emitters and matching detectors are combined in some optoelectronic devices. Illustrated schematically in Fig. 1, Monsanto's MCT 1 is typical, consisting of a gallium arsenide LED and an *npn* silicon phototransistor closely coupled




Motorola photodiodes have response times of only 1 nsec and are sensors for switching circuits.

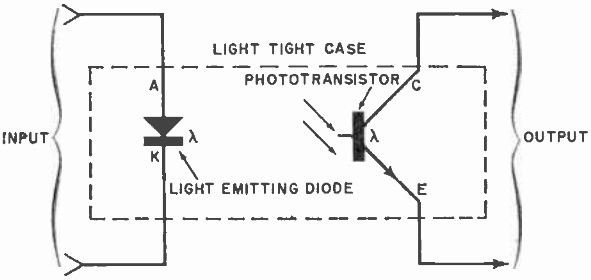



Fig. 1. Light emitting diode and phototransistor are combined in a TO-5 case. For use as high-speed switch, device has an input-output isolation resistance of about 100,000 megohms.

in a package no larger than a TO-5 transistor case. Used principally as high-speed, solid-state switches and signal couplers, these devices have input-output isolation resistances on the order of 100,000 megohms! In operation, input signal currents are converted into light radiation by the LED which is directly coupled to the photosensitive detector and, in turn, controls the unit's output current. With light as the only coupling medium, there is no electrical connection between the input and output circuits.

**Readers' Circuit.** Useful as a tuning indicator as well as for measuring relative signal strength, an S-meter can be a valuable accessory on any receiver used by the ham, SWL, or communications buff. Wishing to add such an instrument to his inexpensive short-wave set, reader W.J. Kreamer, WA2ZLR (10 Manning Ave., Troy, N.Y. 12100) devised the circuit shown in Fig. 2. Suitable for virtually all tube-type receivers, the project can be assembled in a few hours.

Emitter follower *Q1*, in conjunction with isolation resistor *R1*, provides a high input impedance to minimize receiver a.v.c. circuit loading. Resistor *R2* serves as *Q1*'s emitter load and *R3* as a current-limiting interstage coupling resistor. Transistor *Q2* and its emitter resistor *R5* form one of the lower arms of a bridge circuit, with *R8* serving as the matching lower arm and *R4* and *R7* forming the upper arms. Meter *M1*, shunted by sensitivity control *R6*, is used to measure bridge unbalance.

In operation, a change in the receiver's a.v.c. voltage resulting from changing r.f. signal strength, is amplified by *Q1* and applied to *Q2*, causing a corresponding change in bridge balance and hence in *M1*'s reading. The higher the a.v.c. voltage, the greater the meter (current) indication, and vice versa.

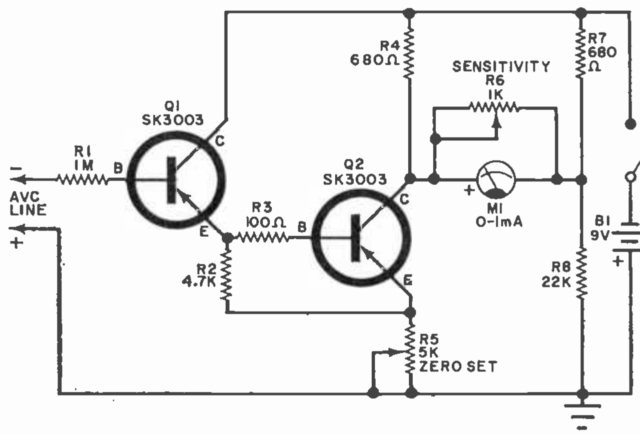
All components needed for the project are available through regular distributor outlets. The transistors are general purpose *pnp* types, and, except for linear potentiometers *R5* and *R6*, all resistors are ½-watt types.

Any construction technique may be used for assembling the S-Meter, for neither parts placement nor the wiring arrangement should be critical. The circuit can be wired on a small piece of perf board mounted directly on the meter, using the terminal studs for support.

The S-meter is installed by connecting its input terminals to the receiver's negative a.v.c. bus and circuit ground, as indicated in the diagram. If space is available, the instrument can be mounted directly in the re-

(*Continued on page* 95)

Fig. 2. Easy-to-build homemade S-meter is a valuable accessory on any receiver used by ham or SWL.



# AMATEUR RADIO

By HERB S. BRIER, W9EGQ
Amateur Radio Editor

## NEW USE FOR SMOG!

AS EXPERIENCED VHF operators know, when an atmospheric temperature inversion occurs—that is, when a layer of warm, damp air flows over cool air close to the ground—VHF radio signals are diffracted or bent back to the earth many miles beyond their normal, "line-of-sight" range. The same atmospheric condition compounds the air-pollution-smog problems in our cities, because the dense upper layer of air prevents the air pollutants spewed out by our cars, chimneys and factories from floating away into space. So the next time your city is under a smog alert, rejoice! Get on the 50-MHz and higher frequency amateur bands and work stations you have never worked before. The other operators will be tolerant of your cough. Isn't progress wonderful?

But cheer up. All is not lost, even if you do not have smog. Each year around the first of May, as regular as spring, the VHF spectrum suddenly erupts into a raging cacophony of strong signals from distances of 600 to 2400 miles. The phenomenon ("sporadic E") may last only a few minutes or for hours on end and will repeat itself many times before the summer is over.

Sporadic E propagation ("short skip") results from unpredictable, intense radiations from the sun that ionize small patches within the ionosphere. These patches reflect back to the earth signals that leak through the normal ionosphere into space.

Short skip is especially exciting to 50-MHz operators, because it permits many of them to work 20 or 30 states and a neighboring country or two during the summer months. Sporadic E propagation affects all frequencies from 3.0 to 100 MHz and higher. Thus, short skip openings are frequent summer occurrences on the 14-, 21-, and 28-MHz

AMATEUR STATION OF THE MONTH

Mike Flenz, WB9ANR, 805 Maple St., Neenah, WI 54956, divides his time between 40- and 15-meter AM phone and CW with a Heathkit DX-60B transmitter and HR-10B receiver in conjunction with either a 40-meter horizontal dipole or an inverted-V dipole. We are sending WB9ANR a 1-year subscription to POPULAR ELECTRONICS for winning this month's Amateur Station Photo Contest. You can enter by sending a clear (black and white) photo of yourself at the controls of your station along with some details about your amateur career, to Amateur Photo Contest, c/o Herb S. Brier, W9EGQ, POPULAR ELECTRONICS, P.O. Box 678, Gary, IN 46401.

# HAMS ON FILM

The ARRL has recently produced a 27-minute color film telling the story of amateur radio today. Covering the activities of some typical hams (including some novices and a pretty female ham), field days, and emergency operation, the film includes some shots of the fantastic station used by Barry Goldwater to illustrate phone patch conversations between servicemen overseas and their families. There are also some interesting sequences showing ham TV in operation.

The film is narrated by Arthur Godfrey (K4LIB), Barry Goldwater (K7UGA) and Bill Leonard (W2SKE), and is recommended for active hams, would-be hams and anyone else interested in amateur radio. Watch your local TV station listings to see when it is to be broadcast, or contact a ham club for details.

amateur bands, as they scramble the commercial, point-to-point services operating between 30 and 50 MHz and substitute strange TV signals for the regular stations on many receivers tuned to TV channels 2 through 6.

**Sporadic E in Europe.** In England and Europe, the 70-MHz (4-meter) band replaces the 50-MHz amateur band. In spite of the fact that many U.S. 50-54-MHz amateurs believe that they must stick as close as possible to 50 MHz to take advantage of "short skip," there are many inter-European 70-MHz, sporadic E contacts. Gibralter to England (1000 miles), England to Iceland (1200 miles), and contacts with Spain, Hungary, Poland, Russia, Sweden, etc., are reported regularly in England's "Radio Communications" and "Short-Wave Magazine." In fact, last May, HG5AIR, Hungary, worked a couple of English stations via 144-MHz sporadic E propagation. Denmark and Swedish amateurs were hearing Italian and

(*Continued on page* 92)

Bruce Oliver, WA6CAA, Modesto, Calif., has worked all states and 23 countries with an ancient Harvey-Wells TBS-50 transmitter and Gonset G-63 receiver plus a Gotham 3-band Quad and a dipole.

# SHORT-WAVE LISTENING

By **HANK BENNETT**, W2PNA/WPE2FT
Short-Wave Editor

## SCATTERED NOTES FROM OUR DESK

THE 1970 COMMUNICATIONS HANDBOOK contained a couple of errors in the listings of radio clubs. On page 145, the Newark News Radio Club is listed as having a yearly dues fee of "(about) $10.00". The North American Shortwave Association (NASWA) listing shows its yearly dues to be $1.00. In reality the dues of both organizations are $5.00 per year and in each case this entitles members to 12 bulletins per year, third-class mail. Both clubs will mail their bulletins first class (for faster service) but the fee for this is higher. Finally, the address for NNRC should be 215 (not 25) Market St., Newark, N. J. 07101.

Over the years we have mailed out over 6000 copies of leaflet K (Time and Standard Frequency Stations). One of the various versions of this leaflet has a listing for JAQ56, Tokyo, Japan. If you have this particular leaflet, delete this station from the listing since it has closed all operations according to the Midwest DX Club, to whom we send our thanks. (For information on this club please write directly to David Alpert, 6636 Davis St., Morton Grove., Ill. 60053).

Again referring to leaflet K, we have an updating on some of the other material as supplied by Bill Orr, W6SAI, Menlo Park, Calif. The Chinese station, BPV, Shanghai, is now listed as using 9351 kHz. Under USSR listings, add RTA, Novosibirsk, on 4996, 9996 and 14,996 kHz. Also add RKM and RID, Irkutzsk, both of whom use the same transmitter, on 0554, 10.004 and 15,004 kHz. Bill mentions that the transmissions are sporadic and not on at all hours; but, he adds, all of these stations have been heard recently in the U. S. Meanwhile we're endeavoring to learn if the station that we have listed, RWM, is still in operation. The last schedule that we had shows 5000 kHz in service at 0500-0800 and 1700-0600; 10,000 kHz at 1300-1600; and 15,000 kHz at 0100-0400 and 0830-1306.

Congratulations are in order for Jim Young, WPE6ENA, of Wrightwood, California. Jim not only retains his position of first place on our DX Honor Roll, he does so in a most impressive manner. He is the first DX'er on our roles to achieve the distinction of having obtained QSL's from over 300 countries (305 to be exact). The proud holder of a 300 Country Letter of Certification, the first one that we've issued, Jim also has DX Awards for all 50 states, the 12 Canadian areas, and all 40 world radio


Powerful HCJB, Quito, Ecuador, is offering four different—and all colorful—QSL cards this year. This one, two boys on a donkey on a banana plantation, is available through June. Send 3 IRC's or equivalent U.S. stamps or money, with your report, which must be as complete as possible, especially with regard to frequency—within 5 kHz.

zones, for a total score of 402. This places him well ahead of his nearest contender. The four runners-up as we go to press are Chuck Edwards, WPE4BNK, Fort Lauderdale, Fla., with a total of 292, Mark Connelly, WPE1HGI, Arlington, Mass., with 252, Charles Matterer, WPE6DGA, San Leandro, Calif., with 242, and Paul Kilroy, WPE3FOB, Washington, D. C., with 232.

Using an Allied A-2515 receiver with a total of 140 feet of antenna wire, Michael Skinner, Columbus, Ohio, WPE8JVR, has now verified 47 countries.

### CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports were as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to Short-Wave Listening, P. O. Box 333, Cherry Hill, N. J. 08034, in time to reach us by the fifth of each month. Be sure to include your WPE identification and the make and model number of your receiver.

**Albania**—*R. Tirana* has two new channels in use: 6165 kHz at 0300 s/on with "Govorit Tirana" ID, and on 7060 kHz at 0000-0028, dual to 9780 kHz, in English to N.A. This latter xmsn is scheduled for one half-hour later but is being heard now at this earlier time. The foreign service outlet on 1394 kHz is being heard from 1630-1830 in four 25-minute xmsn's in various languages, but no English; s/on is with Tirana's two-trumpet IS; s/off is with the *Chinese* ("The East is Red") anthem.

**Australia**—*R. Australia,* Melbourne, is on 11,930 kHz at 1800-1820 in English to Africa and Pacific, on 11,840 and 9540 kHz to the Pacific in English at 1800, and on 6155 kHz, beam not yet determined, at 1940-2000 with pop music. VLI6, Sydney, is also heard on 6090 kHz around 1000-1200 with music and news and around 1445 with horse racing announcements.

**Austria**—*R. Austria,* Vienna, was noted on 21,670 kHz at 0700-0755 with no ID but the IS of "The Blue Danube" was given often. The station can also be easily recognized on 7245 kHz at 0345-0400 with the same IS.

**Bolivia**—CP70, *R. Grigota,* Santa Cruz de la Sierra, is on 4824 kHz and heard in Spanish after 2200 but badly QRM'ed by stations on 4823 and 4825 kHz. . . CP84, *R. Los Andes,* Tarija, 4775 kHz, was logged at 0337-0406 with continuous music and time checks.

**Botswana**—*R. Gaberones* has been heard on 4844 and 3356 kHz at 0358 with a cowbell IS, anthem at 0400 and to past 0430 with light music, including some U.S. pop tunes, and possibly a newscast around 0425. The languages are English and vernaculars.

**Cape Verde Islands**—*R. Clube de Cabo Verde* has moved from 3960 kHz to 3883 kHz and is scheduled at 2100-2300. Reports go to C.P. Box 26, Praia, Ilha de Santiago, Cape Verde Islands.

**China**—Chinese stations logged lately include Kweiyang, 3260 kHz, in Chinese at 1343-1444, and Chengtu, 3245 kHz, in Chinese at 1454 to past 1500 with music to 1459 and a time check on the hour.

**Denmark**—The latest schedule that we have from Copenhagen shows Danish xmsn's ONLY as 0945-0950, 1130-1155, 1330-1345 and 1730-1815 to Greenland, 1200-1245 and 0100-0145 to N.A., 1400-1445 to S. Asia, 1830-1915 to Africa and 2100-2145 to South America. All xmsn's are on 15,165 kHz except for the 0100-0145 xmsn to N.A. on 9520 kHz. Another 15,165 kHz is listed at 0730-0815 to "Fjernøsten." No reports will be answered unless written in Danish. A "DX-Window" memory card with a photo of the "DX-Window Gang" can be obtained by sending one IRC to Danish Short-Wave Club, DK-2670 Greve Strand, Denmark.

**Ecuador**—*R. Pastaza,* Puyo, 3315 kHz, was heard at 0301-0308 in Spanish with L.A. music. . . HC4FA, *La Voz de Manabi,* Portoviejo, 5990 kHz, is noted at 1158-1215 with continuous Spanish talking. . . HCOS4, *La Voz del Rio Carrizal,* Calceta, 3570 kHz, has listener's requests after 0100. . . HCDY4, *R. Iris* Esmeraldas, has moved up to 3381 kHz. Only a 2000 watt unit, it is heard fairly often.

**England**—London was logged with a sideband xmsn (possibly a feed to Cyprus) on 9318 kHz at 1845 in Arabic, 2015 in Eastern European languages, 2145 with World Service, 0030 in Indian languages, and at 0315 in Persian.

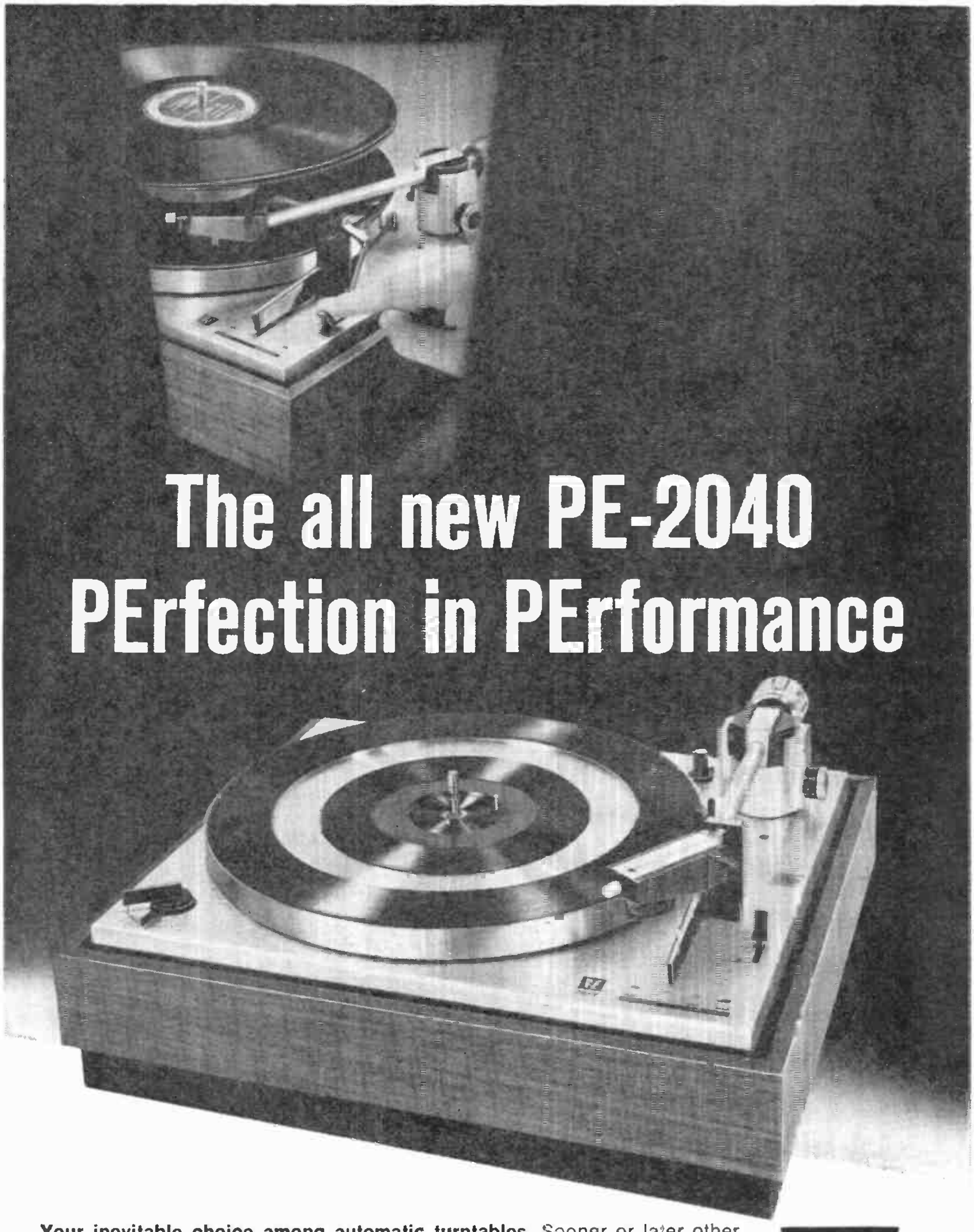
John Wheeler, WPE5FFS, San Angelo, Texas, has a Hallicrafters Sky Champion and a U.S. Navy RCH-2. The small box between receivers is a homemade antenna switching unit. And it's all very compact.

**Ethiopia**—ETLF, Addis Ababa, is fair on a new frequency of 11,910 kHz at 1930 with multi-lingual announcements, including English.

**France**—We have a report from Georgia listing reception of *France Inter,* Allouis, on 164 kHz (long-wave) at 0045. This on a Zenith Trans-oceanic 3000-1 receiver. Long-wave listeners might do well to check this band from time to time.

**Ghana**—*R. Ghana,* Accra, is on 21,645 kHz as logged at 1510 with dance music and in English in their External Service.

(*Continued on page* 90)




**Your inevitable choice among automatic turntables.** Sooner or later other automatic turntables will incorporate the exclusive features *now* available on the new PE-2040: Dial-a-Matic vertical tracking angle adjustment for all records . . . Independent, ultra-gentle, fingertip cueing control . . . Fail safe stylus protector . . . Automatic record scanner . . . Single lever control for all modes of operation . . . Continuous record repeat. These are just some of the exclusive features. Stop by at your PE dealer for the complete story and a demonstration of PErfection in PErformance. PE-2040—$145.00; PE-2038—$115.00.

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CIRCLE NO. 35 ON READER SERVICE PAGE

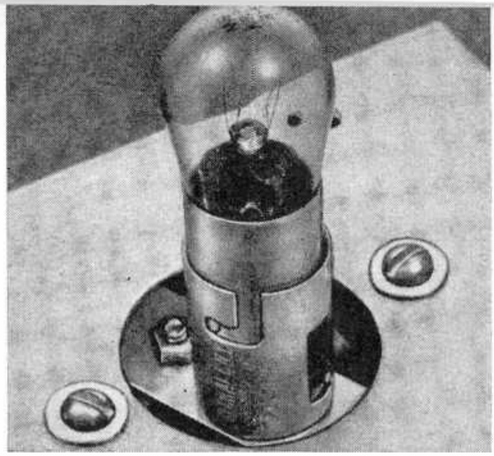
## SUPER FLASH

(*Continued from page* 50)

is developed. Since the ability of the human eye to see a signalling device such as this is directly proportional to the amount of time that the lamp remains on, the on time can be set by adjusting dual potentiometer *R2*. Dual potentiometer *R1* is adjusted to determine the flashing rate.

Almost any type of 6- or 7-watt, 117-volt lamp can be used with the Super Flash. However, don't use a Christmas-tree lamp that has its own built-in thermal flasher since it has a mind of its own about when it will go on and off. The best type of lamp (such as a 6S6) to use is that normally used on appliances where quite a bit of mechanical vibration is normally expected.

You may wonder why the lamp doesn't burn out rapidly. At each flash, the lamp is subjected to a considerable overvoltage and would indeed burn out if the duration of the power were for an appreciable length of time. The flashes are so short, however, that the lamp has a chance to cool down between them. The brightness of the flash is due to the fact that a lamp rated at 117 volts delivers an increase in light of approximately 30% for every additional volt above its rating. The current consumption of the Super Flash is low because the circuit draws no current when the lamp is not flashing. -30-



Ferrule of bayonet socket protrudes through a hole in top of box and is fastened with machine screws.

## ABOUT YOUR SUBSCRIPTION

Your subscription to POPULAR ELECTRONICS is maintained on one of the world's most modern, efficient computer systems, and if you're like 99% of our subscribers, you'll never have any reason to complain about your subscription service.

We have found that when complaints do arise, the majority of them occur because people have written their names or addresses differently at different times. For example, if your subscription were listed under "William Jones, Cedar Lane, Middletown, Arizona," and you were to renew it as "Bill Jones, Cedar Lane, Middletown, Arizona," our computer would think that two separate subscriptions were involved, and it would start sending you two copies of POPULAR ELECTRONICS each month. Other examples of combinations of names that would confuse the computer would include: John Henry Smith and Henry Smith; and Mrs. Joseph Jones and Mary Jones. Minor differences in addresses can also lead to difficulties. For example, to the computer, 100 Second St. is not the same as 100 2nd St.

So, please, when you write us about your subscription, be sure to enclose the mailing label from the cover of the magazine—or else copy your name and address exactly as they appear on the mailing label. This will greatly reduce any chance of error, and we will be able to service your request much more quickly.

# OPERATION ASSIST

*Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information, write him directly—he'll appreciate it. If you need help, send a postcard to Operation Assist,* POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name and model number of the unit. If you don't know both the maker's name and the model number, give year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Do not send an individual postcard for each request; list all requests on one postcard. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

**Hickok** Model 530 tube tester. Instruction manual and last available roll chart needed. (Marion H. Traylor, P.O. Box 432, Norris TN 37828)

**Heathkit** Model FM-2 tuner. Assembly manual needed. (Bill Swafford, 119 Stallsville Rd., Summerville, SC 29483)

**Admiral** Model T1807-N TV. Schematic needed. (Tim Behal, 508 7th Ave., Durant, IA 52747)

**Atwater-Kent** Model 35 radio. Schematic and operating instructions needed. (Phil Knobel, 16 Apple Tree Ln., Walpole, MA 02081)

**Europhon** Model ES 59 Italian made six tube AM-FM-SW. Manufacturer's name and address needed. (Thomas J. Miller, 103 E. Poplar St., Wenonah, NJ 08090)

**Precision Apparatus** Series 920 Electronamic Tube and Set Tester. Operating instructions and schematic needed. (James Gwathmey, 950 Aster Ave., El Cajon, CA 92020)

**Heathkit** Model A-9C Amp. Operating manual and schematic needed. (Jamie Cass, 173 Dufferin Ave., Belleville, Ont., Canada)

**Atwater Kent** Model 70 BC receiver. Eight tubes, UY-227, UY-224A, UX-280, UX-245. Need schematic, source of parts and tubes. (C. A. Bugbee, 185 Jobin Dr., Manchester, NH 03103)

**Heathkit** Model 0-7 oscilloscope. Construction and operating manuals needed. (Jeff Bonar, 7850 Whitsett Ave., N. Hollywood, CA 91605)

**Dumont** Model OBL-I oscillograph. Instruction manual and schematics needed. (Lete Connelly, 7350 Graham Rd., Hazelwood, MO 63042)

**Arvin** Model 741T radio chassis RE 352. Schematic and tuning information needed. (Justin De Vault, 610 Foxx St., Johnson City, TN 37601)

**Hallicrafters** SX 24. Schematic and manual needed. (Paul Knickerbocker, 7750 Highgate Ln., La Mesa, CA 92041)

**Hammarlund** HQ-140X. Schematic needed. (K. Youngblood, 2801 NW 151 St., Opa-Locka, FL 33054)

**Hallicrafters** Model S120. Schematic needed. (Robert Henry, Box 258, Toronto, OH 43964)

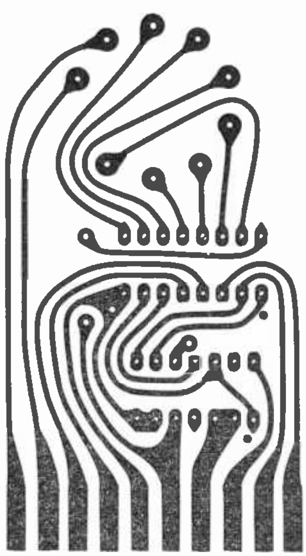
# OUT OF TUNE

"One-Step Motion Detector" (March 1970). The following information on testing the unit was inadvertently omitted from the article: The slugs in *L1* and *L2* should be flush with the top of the cans. Coil *L3* slug is set about ⅛" in from the top. Temporarily connect a 1000-ohm resistor between point A and the center of the transmitter phono plug. Connect an a.c. voltmeter (or scope) between the transducer side of this resistor and ground. Adjust *L3* slug with a non-metallic tuning tool until a dip is noticed on the readout. Remove the resistor and reconnect the lead. Coils *L1* and *L2* are used as r.f. chokes.

"Build Security 1" (March 1970). In the Parts List on page 29, *R6* should be a 5000-ohm potentiometer, not 500 ohms. The schematic diagram is correct.

"The Touch-A-Tone" (March 1970). The electrolytic capacitor shown in Fig. 1 near *S2* is *C19*, not *C18*. Also, in Fig. 2, the capacitor labeled *C17* at lower left should be *C19*.

"Numitron Readout" (March 1970). The foil pattern on page 75 is incorrect. Use the one below.



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CIRCLE NO. 3 ON READER SERVICE PAGE

# SHORT-WAVE LISTENING

(*Continued from page* 84)

**Guatemala**—TGNA, Guatemala City, has English at 0300-0430 (0100-0430 Sundays) on 5955 kHz. This is dual to medium-wave TGN on 720 or 730 kHz, depending of whether you read their QSL card or their schedule. Does anyone know for sure which frequency they use?

**Honduras**—HRVC, *La Voz Evangelica de Honduras,* Tegucigalpa, operates on 4820 and 1380 kHz at 1100-0400 in Spanish, 1500-1600 and 0300-0400 in English. Reports go to Apartado 270. . . HRN, *La Voz de Honduras,* Tegucigalpa, has been running substantially later than its normal s/off time, usually to about 0300 with L.A. music, news, and long strings of commercials. Because of its unusual frequency (5875 kHz) it is one of the easiest stations to hear from this country.

**Indonesia**—Indonesian stations noted on the West Coast recently: *R. Samarinda,* YDY, 3294 kHz, at 1420-1432 with South Sea music. . . *R. Pontianak,* 3346 kHz, at 1209-1435 with light music and some South Sea music. . . *R. Djakarta,* YDD, 3277 kHz, at 1200-1248 with local news and native music; language used on all three was Indonesian.

**Ireland**—Anyone needing this country should look for *Shannon Aeradio* on 5559 kHz with aero weather for Ireland and European airports at 0430, 0500 and 0530. Tune just before the times shown and you may hear Gander Radio in Newfoundland.

**Malawi**—The current schedule for Malawi Broadcasting Corp. is 0345-0605 (Sunday from 0335) on 3380 kHz, 0620-1445 on 5995 kHz, and 1500-2105 (Saturday to 2305) on 3380 kHz. All reports go to P. O. Box 453, Blantyre. Programming is mostly in native language but they do have some English commercials.

**Mauretania**—*R. Nouakchott* is on 7245 kHz at 0805-0907 and later, dual to 9610 kHz, with Arabic chanting and announcements and some guitar music, and a French ID at 0900.

**Morocco**—Rabat is fair to good on 6170 kHz in all-Arabic from 2215 with chanting.

**Mozambique**—Lourenco Marques opens at 0300 on 3265 kHz with usual format of time checks, lively pop music and commercials. It may not be heard daily due to propagation conditions.

**New Zealand**—*R. New Zealand,* Wellington, is good at 0600-0845 in English to the Pacific Islands on 11,780 and 9540 kHz, and at 0900-1045 to Australia on 11,830 and 9520 kHz.

**Niger**—*R. Niamey* was heard on 3260 kHz at 0529 with an anthem, s/on anmt's and an ID in French; to 0631 s/off with African music and anmt's in several African languages.

**Papua and New Guinea**—VL8BM, Port Moresby, is on the air on 11,880 kHz with 10 kW on Monday to Friday at 0100-0200 and 0430-0530. This station has been heard with a special news broadcast to regional stations during the 0500-0530 xmsn. . . VL9CG, *R. Goroka,* 2410 kHz, is heard at times in Pidgin with U.S. pop music; best listening time has been 1030-1100.

**Peru**—OBX70, *Onda Imperial,* Cuzco, is on 5058 kHz, slightly above its listed frequency, where it is noted with Andean music and many anmt's in Spanish from 0100.

**Philippines**—*Voice of the Philippines,* Manila, was noted briefly on 9580 kHz at 0900-0945 in English but they were soon QRM'ed out.

**Rwanda**—*Deutsche Welle,* Kigali, has African news and a program preview in English at 1725-1730 s/off on 11,965 kHz.

**Seychelles**—*R. Seychelles,* Victoria, opens at 2325 on 15,440 kHz with news from Manila at 2330. We also have a report that they are operating daily except Saturday from 1400 s/on in English, and from 1430-1530 s/off in French.

**South Africa**—The All-Night Service from Johannesburg in English and Afrikaans can be heard on 7150 kHz at 2300-0100 with variety music, public service anmt's and commercials. This same channel is also logged in a non-commercial service at 0300-0400 with light music and anmt's in English and Afrikaans. . . *R. RSA* has replaced 11,875 kHz with 15,250 kHz, dual to 21,480 kHz, at 1800 to Europe. . . *Springbok Radio* is excellent on 7190 kHz at 0430 with news on the hour and half hour. It is scheduled from 0300-2200 and, from the standpoint of commercials, they are completely sold out of time.

**Spain**—*Radio Nacional Espana,* Madrid, has been found on 11,705 kHz, an unlisted frequency, dual to 11,800 kHz at 0210-0225. They list their English schedule as being 0100-0345 daily except Sunday on 6140 kHz (100 kW) and 9760 kHz (20 kW).

**Tanzania**—*R. Tanzania,* Zanzibar, considered to be an excellent DX catch, is on 3339 kHz from 0330 s/on. The IS, before s/on, seems to be a group of musical chords, possibly on a percussion instrument. Programming is mostly Moslem or Arabic chants; there may be a newscast in Swahili around 0400. Reports indicate a rapid fade-out on this with the signal rarely being heard after 0400-0410.

**Togo**—Lome, 5047 kHz, is good and consistent on the West Coast at 0530 s/on with African and western pop music, news, and native language programming.

### SHORT-WAVE CONTRIBUTORS

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Roger Chambers *(WPEØFKK)*, Salina, Kans.
Mike Carrick *(WPEØFLX)*, Omaha, Nebr.
Arthur Burke *(WPEØFOJ)*, Topeka, Kan.
John Stap *(WPEØFQA)*, Colorado Springs, Colo.
Mark Schwing *(WPEØFRB)*, Aurora, Colo.
David Szafranski *(WPEØFRQ)*, Colorado Springs, Colo.
Marvin Robbins *(WPEØMW)*, Omaha, Nebr.
Jack Perolo *(PY2PE1C)*, Sao Paulo, Brazil
D. L. Thomas *(VE3PE2IR)*, Burlington, Ont.
Doug Stark *(VE3PE2OY)*, London, Ont.
Edward Swynar *(VE3PE2RT)*, Oshawa, Ont.
Anthony D'Agostino *(VE3PE2SD)*, Hamilton, Ont.
Les Hughes *(VE7PE1EH)*, S. Burnaby, B. C.
Charles Richardson *(VK3PE1P)*, Horsham, Victoria, Australia
Lloyd Berman, Van Nuys, Calif.
Rick Cosby, Chicago, Ill.
Dana Friend, Medfield, Mass.
Mark Hogarth, Bronx, N. Y.
Harold Honnold, Modesto, Calif.
Jerry Kapenzynski, Fountanville, Pa.
Bud Kelly, Champaign, Ill.
Patrick Marineau, Marinette, Wis.
Carla Mills, St. Paul, Minn.
Tommy Najman, Montreal, Que.
Bob Roeder, El Cerrito, Calif.
Michael Stasiak, Baltimore, Md.
Jon Weiner, Beachwood, Ohio
Sweden Calling DX'ers Bulletin, Stockholm, Sweden

**Vatican City**—We can always depend on reports of new frequencies being placed in service by *Vatican Radio:* 6175 kHz at 0100 in English, and 11.845 kHz at 2328-2346 s/off in Spanish to the Americas. Programming is Church news and a brief period of Mexican folk music.

**Venezuela**—YVMO, *R. Lara,* Barquisimeto, is now on 4800 kHz and noted at 2330-0000 in Spanish with L.A. music, commercial anmt's and much musical fanfare. . . YVKD, *R. Cultura,* Caracas, is up to 5060 kHz (from 5050 kHz) and heard after 2300 in Spanish. From this it would seem that reports of a *R. Litoral* on this frequency may be in error. . . *R. Barquisimeto,* 9510 kHz, has a time check, then news in Spanish at 1115-1200.

### SHORT-WAVE ABBREVIATIONS

anmt—Announcement
GMT—Greenwich Mean Time
ID—Identification
IRC—International Reply Coupon
IS—Interval Signal
kHz—Kilohertz
kW—Kilowatts
L.A.—Latin America
N.A.—North America
QRM—Station interference
R—Radio
s/off—Sign-off
s/on—Sign-on
xmsn—Transmssion

## AMATEUR RADIO

(*Continued from page 82*)

Spanish 144-MHz amateurs at the same time.

**FCC and Related News.** Effective in March, the Federal Communications Commission shifted the 2-meter exclusive CW (code) assignment from the 147.9-148-MHz range to 144-144.1 MHz. The latter frequencies are used for almost all 2-meter CW "moon-bounce" and other international CW experiments.

At the same time, the FCC shifted the 10-meter F1 (RTTY) teleprinter assignment out of the phone segment of the band to the 28-to-28.5-MHz CW segment. Now on the FCC docket are two proposals to permit Technicians to operate on 10 meters and one by W9HTF to reserve portions of the 7- and 14-MHz phone bands, exclusively for Extra class licensees, possibly with a 50-kHz increase in the width of the 14-MHz phone band.

Coincident with the FCC's final implementation of the Incentive Licensing program last November, a group of Southwestern amateurs began campaigning on 75-meter phone to force the Commission to rescind the program—especially the portion limiting the phone frequencies available to Conditional and General class licensees. They appointed Senator Barry Goldwater (Arizona), K7UGA/K3UIG, to be their Washington spokesman. But they neglected to check first with Barry. When the Senator learned of this unilateral action, he ordered them to cease associating him with their activities. In addition, Barry informed the

Using a homebuilt 500 milliwatter, Tom Varnecky, WA3CPH, Johnstown, Pa., transmits television on 432 MHz. He's worked 27 states on 50 and 144 MHz.

group that he approved of the Incentive Licensing Program.

By the way, Barry took a slow-scan television camera with him on his last trip to Southeast Asia and used it to transmit TV pictures from Vietnam across the Pacific to the United States via MARS (Military Affiliate Radio System) stations. Feeding the output of a slow-scan television camera unit into its microphone jack converts any phone transmitter into a TV transmitter. The received signals may be seen on a conventional receiver fitted with an SSTV receiving unit or recorded on a standard tape recorder for later viewing.

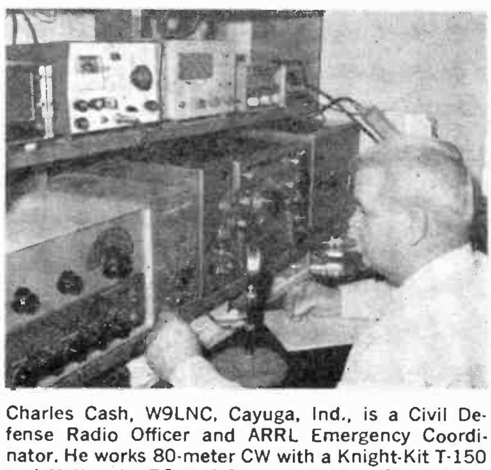
Joe K. Winner, WB8AST, Beckley, W.Va. operates with an Eico 50 watter plus Mosley CM-1 receiver.

## NEWS AND VIEWS

**Chuck Elquist, W6JIF/6,** Grass Valley, Ca., has a "gopher"; at least he did while he was operating KR6FB, Okinawa, last year. KR6FB, operated by off-duty military personnel, is used mostly to keep phone-patch skeds back to the States. According to Chuck's buddy, Dick Eymar—not a ham—he was the station "Gopher"—go for coffee, go for this, and go for that. Operating seven days a week. KR6FB averages about 40 "patches" a day, and after 4000 of them, is still going strong. But Chuck and Dick are now back in the states, running phone patches with Okinawa from the opposite end of the circuit. W6JIF uses a Swan 500-C transceiver and a Mosley TA-33 beam atop a 60-foot tower. Try Rte #1, Box 569, Grass Valley, Ca. 95945, if you want to reach Chuck by mail . . . **A. Edw. Terpening, W4VCY, M.E.,** 838 Darlington Rd., Tarpon Springs, Fla., 33589, Public Relations Director of the Gold Coast Amateur Radio Club, is another who believes that the way to encourage new amateurs is to help prepare them for their examinations. He conducts free amateur classes at his home each Saturday morning and afternoon . . . As a result of Dave, WAØQYS's "doubt" that Vermont existed in January "News and Views," **Arthur Greenleaf, WA1EQI, RFD #2, Montpelier, Vermont 05602,** President of the Central Vermont Amateur Radio Club, W1BD, offers to arrange skeds with CVARC members for anyone needing Vermont for a new state or other reasons. Art reports that the club has many members, both male and female, active on all bands and modes; consequently, there should be no difficulty in meeting any reasonable request. We suggest including a stamped reply envelope with your note to WA1EQI.

**Jeff Crawford, WAØZRT,** P.O. Box 197, Sidney, Iowa 51652, started his amateur career with a General class ticket; and four months later, qualified for an Advanced class license. He usually works 10 and 15 meter phone or 20 meter CW in the daytime and 75 meter phone at night. He transmits and receives on a Galaxy GT-550 CW/SSB transceiver via a Mosley TA-33, tri-band beam and presumably a 75-meter dipole. Jeff has worked all states but still lacks QSL cards from four of them; he also has worked 76 countries. Probably his most thrilling contact was working Senator Barry Goldwater using his K3UIG call letters in Washington, D.C. . . . **Murray Cutler, W9EHQ,** 338 South Geneva Ave., Bellwood, Illinois 60104, has spent 99% of his 9-year amateur career on 50-MHz AM until very recently. On 50 MHz, he uses a modified Knight-Kit T-150 transmitter and a Knight-Kit R-100 receiver aided by a Tecraft 6-meter converter. The antenna is two, stacked Cushcraft, 5-element beams mounted on a 10-foot tripod tower on the roof of his house, putting the antenna 50 feet above the ground. This equipment has worked 25 states. Murray operates 6-meter mobile with a Lafayette HA-460 transceiver. The latest addition at W9EHQ is 2-meter FM mobile with a Varitronics FDFM-2S transceiver. Murray is also a recording buff with a sound-proof studio, nine turntables and recorders, six amplifiers, all tied together in elaborate remote-control and mixing networks . . . **Bob Pie-Guz Guzenski, WB2EZU,** 585 Chapman Parkway, Hamburg, N.Y. 14075, got started in amateur radio "rather late in life" 22 months ago. Guz pretty well proves his contention that you do not need high power by posting a record of 195 countries worked with the Heathkit SB-400 SSB/CW transmitter and SB-301 receiver. His antenna farm sprouts a 3-element, tri-band beam (brand unknown), 30 feet high, and dipoles for 80 and 40 meters. WB2EZU recommends that prospective amateurs join the local amateur radio club . . . **Susi Christen, HE9AOE,** is a long way from her home in Switzerland. She is a pretty coed at Jackson State University, International House, J.S.U., Jacksonville, Ala. 36265. (The half-tone picture she sent isn't sharp enough to reproduce.) Susi operates 144 MHz with a 500-milliwatt, homebuilt transmitter feeding an 11-element beam. Receiving gear includes a National HRO, a surplus BC-946, and a homebuilt converter.

73, *Herb, W9EGQ.*



Charles Cash, W9LNC, Cayuga, Ind., is a Civil Defense Radio Officer and ARRL Emergency Coordinator. He works 80-meter CW with a Knight-Kit T-150 and National HRO and 2 meters with a Clegg 99'er as well as with a Heathkit Two-er transceiver.

## SOLID STATE

(*Continued from page* 80)

ceiver's cabinet, but an "outboard" mounting can be used if necessary or preferred. Here, a small sloping front meter cabinet or other small chassis can be used for housing the unit, with circuit connections made through a short length of shielded microphone cable. After installation, *R5* is adjusted for a "0" meter reading with zero input signal (receiver antenna terminals shorted) and *R6* for a full-scale reading on the strongest station that can be received.

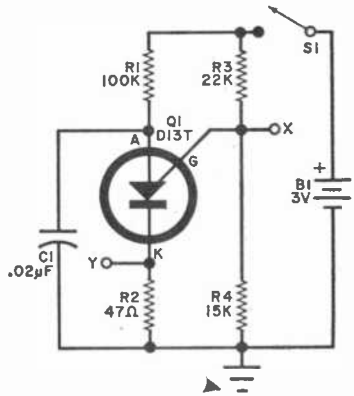



Fig. 3. Low-voltage oscillator circuit using programmable unijunction transistors has many uses.

**Manufacturer's Circuit.** Abstracted from GE's application notes on its type D13T programmable unijunction transistor, the low-voltage oscillator circuit shown in Fig. 3 may be used in a number of projects. Typically, it can be incorporated in digital "clocks," timers, sweep circuits, signal injectors, test equipment, electronic musical instruments and industrial controls. Extremely simple, it can be breadboarded for experimental tests in less than an hour.

Essentially a relaxation oscillator, the design features a familiar *RC* timing circuit. In operation, *Q1* is initially in a non-conducting state. Capacitor *C1* is charged slowly through *R1* until its voltage reaches *Q1*'s anode-cathode breakdown voltage, as pre-established by the device's gate potential, determined by voltage-divider *R3-R4*. At this point, *Q1* "fires" (*i.e.,* switches to a conducting state), discharging *C1* through *R2,* and developing a narrow positive-going pulse across this registor (point Y). At the same time, a negative-going pulse appears across *R4* (point X). With *C1* discharged, *Q1* switches back to its non-conducting state and the action repeats. Operating power is furnished by *B1*, controlled by switch *S1*.

With neither layout nor lead dress critical, the oscillator may be assembled on a small chassis, or perf board, or on a suitable etched circuit board, as preferred. Its basic operating frequency (or repetition rate) is approximately 1 kHz with the parts specified in Fig. 3. Within moderate limits, however, this frequency may be lowered by using a larger-valued capacitor for *C1* and raised by using a smaller value.

**Device Developments.** TRW Semiconductors Incorporated (14520 Aviation Blvd., Lawndale, CA 90260) has announced a new series of 3-GHz transistors designed for operation on a 28-volt d.c. source. The series includes four devices with output power ratings ranging from 300 mW for type PT6669 to 5 watts for type PT6636. Featuring a stripline package design, the new units can furnish from 3 to 6 dB gain, depending on type.

At a lower frequency level, and perhaps of more immediate interest to advanced amateurs, Motorola Semiconductor Prod-



ucts, Inc. (Box 20924, Phoenix, AZ 85036) has introduced a group of *npn* silicon r.f. power transistors capable of providing up to 12 watts output in the 450-to-470-MHz band. While intended for use as power amplifiers in the UHF FM bands used primarily for police, taxicab and industrial communications, the new transistors, types 2N5644 through 2N5646, are suitable for applications in equipment operating up to 520 MHz. The three new devices are supplied in ⅜" ceramic stripline opposed-emitter packages with wide, low-inductance leads. Designed for operation on 12.5-volt d.c. power supplies, the entire family features a balanced-emitter construction which is very resistant to damage from mismatched loads or detuning.

Motorola has also announced the development of a new monolithic IC tuning indicator circuit designed for use in color-TV and FM receivers. Requiring only the addition of a miniature lamp bulb, the device is used to compare input voltages furnished by the receiver's ratio detector. If these voltages are equal, the lamp is turned on, if unequal, indicating the need for retuning, the lamp is switched off. Identified as type MC1335, the new IC is encased in an eight-lead dual in-line plastic package and requires a 20-volt d.c. power supply.

An experimental field-effect transistor capable of handling up to 40 watts has been developed by research scientists at Japan's Semiconductor Research Institute. This power capability was achieved by departing from customary FET construction and developing an entirely new internal configuration. Several techniques were used. First, breakdown voltage was raised by using a thick *n*-type intrinsic semiconductor layer between the source and drain electrodes. Second, current flow was spread over the entire wafer area by using a lattice-shaped *p*-type gate region, with the gate channel length reduced to minimize internal voltage drops and depletion layer spreading. Although the initial units have only a 200-volt, 200-mA capacity, theoretical studies reveal that kilovolt, multiamp units are feasible if fabrication techniques can be refined and improved. With further work, then, *kilowatt FET*'s may be within reach.

Two new low-cost bridge rectifiers have been announced by the Amperex Electronic Corporation (Semiconductor Division, Slatersville, RI 02876). These units, types BY164 and BY179, are plastic-encapsulated assemblies made up of four silicon double-diffused diodes. The BY164 provides 1.2 amperes output at 54 volts, while the BY179 is specified at 1.0 ampere output at 255 volts.

*—Lou*

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## PRINTED CIRCUITS

*(Continued from page 62)*

minimum of 1/8" in diameter wherever a hole is to be drilled to avoid breaking the foil during drilling.

There are two methods of making an etching guide. The first employs a minimum-width conductor pattern that leaves large areas of the board etched (without copper foil). The second method, known as "area etch," provides for a minimum amount of copper foil to be removed from the board; in some cases, the foil left on the board is not connected to a current-carrying conductor. Examples of both methods are shown in Fig. 4.

When you have finished laying out your etching guide, black-in the conductor pattern, leaving small white dots where holes for component leads, hookup wire, and hardware are to pass through the circuit board. Make these holes *small* since their only purpose is to serve as guide markers for drilling.

Your completed etching guide should look like the one shown in Fig. 5. Note that the guide employs the "area etch" technique. The minimum-width technique could just as easily have been employed.

From your etching guide, you can now determine exactly how large a copper-clad board is needed for your project. A good idea is to add about 1/8" to the length and width dimensions for safety. After all, it is better to have a slightly oversize board that can be trimmed than an undersize board that will not fill your requirements. -30-

## FREQUENCY STANDARD

*(Continued from page 64)*

crystal mounting with matching socket.

You might have to experiment with grid resistors *R6* and *R9* to find the optimum values for proper operation of the multivibrator circuits. But the values shown in the schematic diagram and specified in the Parts List will be adequate in most cases. If not, start with the values specified and work from there.

**How To Use.** With both switches set to the off position, plug the line cord into an a.c. outlet. The heaters of both tubes should begin to glow. Now, close *S2*, leaving *S1* open, and tune your receiver to WWV on 2.5, 5, 10, or 15 MHz. Loosely couple the output of the frequency standard to your receiver's antenna and adjust *C1* to approximately midrange. Vary *C2* until the output of the frequency standard zero beats with the WWV signal. If necessary, touch up *C1* to obtain zero beat.

Remove the antenna lead from your receiver, and connect the output lead of the frequency standard in its place. Tune your receiver across the 3.5-4.0-MHz band; you should hear two markers, one at each end of the band. Now, close *S1* and again tune across the 3.5-4.0-MHz band, listening for markers. If you do not hear eleven markers (one at 3.5 MHz and every 50 kHz apart as you go up the band), adjust *R5* until you do. Since the setting is somewhat broad, adjust *R5* midway between its upper and lower drop-off settings. -30-

# NEW PRODUCTS

(*Continued from page 24*)

equipment. The UHD delivers high output, extended frequency response, broader dynamic range, and a signal-to-noise ratio impossible to achieve with conventional tapes. The HD has a consistent output, broad frequency response, wide dynamic range, and a better signal-to-noise ratio than tapes comparatively priced. Both tape types are available in cassette and 5" and 7" open-reel configurations.

Circle No. 88 on Reader Service Page 15 or 97

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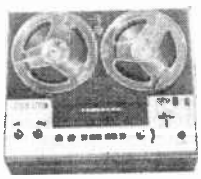
The first in a new series of *Tandberg of America, Inc.*, tape recorders is the three-speed solid-state Model 6000X stereo deck. With the 6000X, it is possible to obtain professional quality recordings even at the lower speeds. The compact deck features four precision-gapped mumetal screened heads with Crossfield design for superior record frequency response, signal-to-noise ratio, and dynamic range. Available in quarter- and half-track models, the 6000X has peak-reading VU meters for record and playback levels; automatic overload protection; independent microphone/line record level controls for each channel; pushbutton control for electrical functions; single-lever tape transport control; hysteresis synchronous motor; stereo mixing, cueing, and special effects.



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A system that can virtually eliminate auto theft and can be adapted to any lock has been introduced by *HR Enterprises Inc.* The heart of the system is "Kode-Kee," a patented device that replaces the standard ignition locking mechanism with a combination of electrical impulses. A toggle or proximity switch, located on the dash board, takes the place of a key. Only the right combination of impulses, right and left, will permit the car to start. Because of the infinite variety of combinations, no two systems are alike, eliminating the fear of a master key being used. A built-in alarm hookup automatically sounds the car's horn if an attempt is made to bypass the Kode-Kee by short circuiting the starter. Two optional items—a gasoline shut-off system and an anti-towing device—complete the system.

Circle No. 90 on Reader Service Page 15 or 97

## LIBRARY

(*Continued from page* 16)

cuits and mechanisms used to achieve modulation, without providing much theory on why this modulation is necessary. This book attempts to rectify the oversight. The text is broken up into five sections: Communication; Signal Transmission in Electrical Networks; Amplitude Modulation; Angle Modulation; and Pulse Modulation. A working knowledge of calculus is required for understanding this book.

*Published by Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York, NY 10017. Soft cover. 274 pages. $3.95.*

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*by John D. Lenk*

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*Published by Tab Books, Blue Ridge Summit, PA 17214. 288 pages. $7.95 hard cover, $2.95 soft cover.*

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# POPULAR ELECTRONICS

## MAY 1970

## ADVERTISERS INDEX



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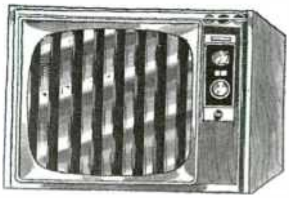

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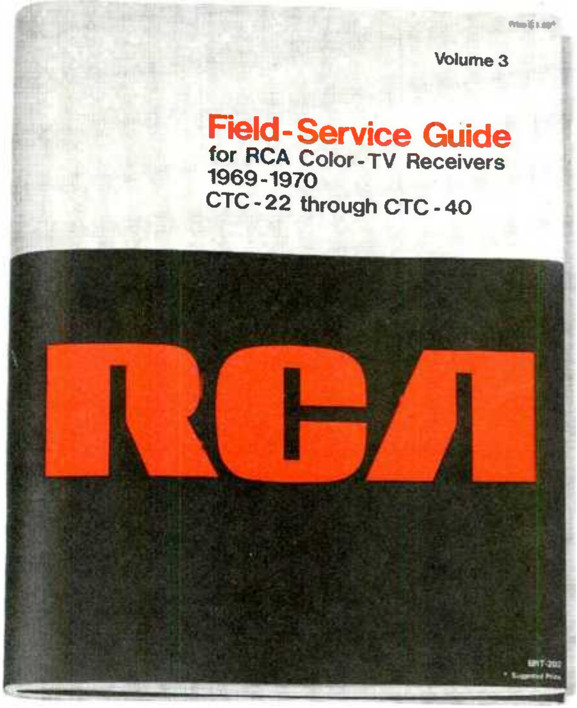


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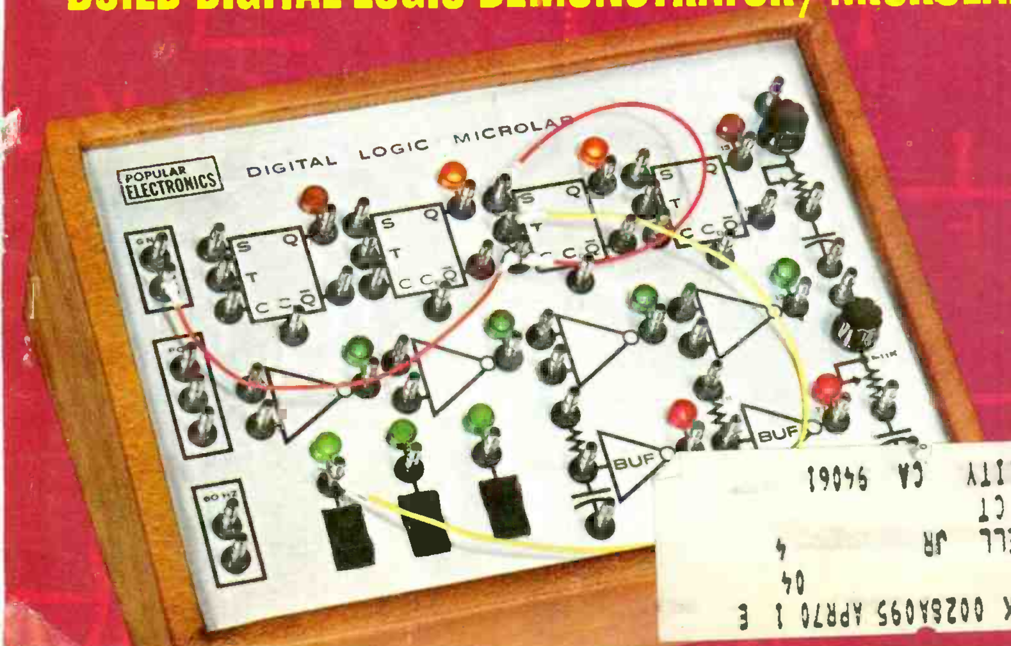

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VOLUME 32 NUMBER 4 APRIL 1970

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE


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CIRCLE NO. 6 ON READER SERVICE PAGE

# letters FROM OUR READERS

## TAPE RECORDING, LITERATURE ON

I am in the process of building my own recording studio with the intention of going into this business (eventually) on a professional basis. However, I am appalled by the lack of books or literature on professional tape recording. Certainly, there must have been something published on this subject. Where is it hidden?

R. STODDARD
Kansas City, Mo.

*Reader Stoddard has a good point. To our knowledge, the last definitive book published about magnetic tape recording is now 6 years old. However, there is some information in a later book by Alec Nisbett entitled "The Technique of the Sound Studio" (Sagamore Publishing Co., 980 Old Country Rd., Plainview, NY 11803, $10.50).*

## KUDOS

As a guitarist, I appreciate the fun and savings that result from such projects as the "Treble Boost" (December 1969) and "Waa-Waa" (February 1970).

Keep up the good work.

A. P. TETON
Wilmette, Ill.

Just finished the "Capacitance Meter" (October 1969) and am very pleased with its performance. I used a 4½" meter and calibrated the unit with 2% capacitors. It it now almost twice as good as my friend's capacitance bridge that cost him twice the money to build.

ROBERT LIEBMAN
Flushing, N. Y.

## LOW-FREQUENCY STATIONS

A friend tells me that there are radio stations operating on frequencies below 20 kilohertz. I find this hard to believe, since down at those frequencies you would start hearing radio directly through your own hearing.

B. R. HALL
Clearwater, Florida

*You are confusing radio waves and sound waves. Radio waves travel at the speed of light. Sound waves do not and although the frequencies seem to be similar, there are two different things involved. There are ra-*

## LETTERS (*Continued from page 8*)

*dio stations below 20 kHz. They include: NLK, 18.6 kHz; NAA, 17.8 kHz; GBR, 16.0 kHz; and various Omega navigational-aid stations between 10.2 and 13.6 kHz.*

### DIGITAL READOUT CLOCK

After reading your February 1970 issue, I am very much interested in building a numeric glow-tube readout clock. How about some plans? You can certainly come up with a good idea.

J. WRIGHT
Gardenia, Calif.

*We are working on a numeric readout clock using some of the new low-cost decade readouts. Frankly, however, we have held back on this project because of the complexity and the cost. We feel that $250.00 is too much for a clock, especially since we are convinced that the same job can be done for under $90.00 when the prices of the new decade readouts start coming down—due to mass production. Soon, very soon.*

### QUADRASONICS—TELL ME MORE

Your January 1970 article on "Quadrasonics" was great; but who is Peter Scheiber, the inventor of the new method of recording and playback?

W. A. COOKE
Wayne, Pa.

*Peter Scheiber and his associate, Thomas Mowrey, of Audiodata Company, are discussed in some detail in our companion magazine* Stereo Review, *January 1970, page 68. You can find it at your library or order a copy from Ziff-Davis Service Division, 595 Broadway, New York, NY 10012. Include 75¢ with your order.*

### THE HECK WITH CHANNEL 9

I think that the REACT proposal about the use of channel 9 in the Citizens Band for emergency use is fine—but, thoroughly impractical.

As a country doctor, I have used CB for 8 years and have been frustrated by the illegal "skip" conversations. I have written the FCC and my U.S. senators, to no avail.

If the FCC is unable to enforce its own existing rules, what good is another rule going to be to anyone?

R. L. MOLLENHAUER, MD
Sonoma, Calif.

*In our opinion, editorially speaking, Dr. Mollenhauer has hit the nail on the head. The idea of using channel 9 is great—in theory—but it is difficult to believe that the present crop of idiot CB'ers will respect a ruling that might be made for their own good.*

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Lavender Electronics
522 East 4th Street
**CALIFORNIA**
Canoga Park
Sandy's Electronic Supply
21305 Saticoy St.
Hollywood
Pacific Radio Exchange, Inc.
1351 Cahuenga Blvd.
Yale Radio Electric Co.
6616 Sunset Blvd.
San Francisco
Hauer Electronic Supply
281 Ninth St.
South Gate
Mac's Electronics
3351 Tweedy Blvd.
Temple City
G&M Wholesale Electronics
5651 N. Rosemead Blvd.
Thousand Oaks
Sandy's Electronic Supply
369 Hampshire Rd.
**COLORADO**
Team Electronics
Denver
Burstein-Applebee of Colorado
800 Lincoln St.
**CONNECTICUT**
Hartford
Sceti Electronics, Inc.
78 Maple Avenue
**GEORGIA**
Albany
Specialty Distributing Co.
428 Roosevelt Avenue
Athens
Specialty Distributing Co.
230 Epps Bridge Road
Atlanta
Specialty Distributing Co.
763 Juniper Street, Northeast
Augusta
Specialty Distributing Co.
1541 Fifteenth Street
Brunswick
Specialty Distributing Co.
2812 Carrie Street
Columbus
Specialty Distributing Co.
1112 Brookhaven Blvd.
Macon
Specialty Distributing Co.
539 Arch Street
Marietta
Specialty Distributing Co.
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Savannah
Specialty Distributing Co.
612 East Broad Street
Valdosta
Specialty Distributing Co.
916 Marion Street
**ILLINOIS**
Team Electronics
Chicago
Allied Radio Corp.
100 North Western Ave.
Howard Electronic Sales, Inc.
4573 Archer Avenue
North Central Electronic Supply Co.
3412 W. Bryn Mawr Avenue
Crest Hill
Mainline Supply Co., Inc.
804 Theodore Street
Peoria
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Badger Electronics, Inc.
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Electronic Supply of Anderson
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H. A. Williams Co.
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H. A. Williams Co.
1003 Washington St.
Evansville
Ohio Valley Sound, Inc.
20 E. Sycamore St.
Ft. Wayne
Ft. Wayne Electronic Supply, Inc.
3606 East Maumee Ave.
Indianapolis
Graham Electronic-Glendale, Inc.
6101 North Keystone Ave.
Graham Electronic Supply, Inc.
133 S. Pennsylvania St.
Jeffersonville
Moakler Electronics
500 E. Chestnut
Lafayette
Lafayette Radio Supply, Inc.
408 East North St.
Muncie
Muncie Electronic Supply, Inc.
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H. A. Williams Co.
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Vincennes
Ohio Valley Sound, Inc.
902 Main Street
**IOWA**
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Burlington
Union Supply Company
231 S. Third St.
**KANSAS**
Team Electronics
Topeka
Acme Radio Inc.
135 Kansas Avenue
Wichita
Radio Supply Company, Inc.
115 Laura
**KENTUCKY**
Louisville
The Collins Company
829 S. Floyd Street
Owensboro
Ohio Valley Sound, Inc.
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Peerless Elec. Equip. Co.
1815 S. 7th St.
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Ralph's of Lafayette, Inc.
601 N. 3rd St.
Baton Rouge
Ralph's Radio Electronic Supply
1732 Plank Road
Lafayette
Ralph's of Lafayette, Inc.
3004 Cameron St.
Metairie
Pelican Supplies, Inc.
3321 Division St.
Shreveport
Industrial Electronic Supply, Inc.
2422 Southern Ave.
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**MAINE**
Portland
Commercial Distributors
8 Somerset Street
**MARYLAND**
Hagerstown
Allegheny Electronics, Inc.
1301 Potomac Avenue
Mt. Rainier/Hyattsville
Lafayette Radio Electronics
3191 Queens Chapel Road
**MASSACHUSETTS**
Boston
A. W. Mayer Co., Inc.
895 Boylston Street
DeMambro Radio Supply
1095 Commonwealth Avenue
Lynn
Land Electronics Supply Co.
9 Franklin Street
New Bedford
C. E. Beckman Co.
11-35 Commercial Street
**MICHIGAN**
Adrian
Wedemeyer Electronic Supply Co.
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Ann Arbor
Wedemeyer Electronic Supply Co.
213-217 North 4th Ave.
Detroit
Radio Specialties Co., Inc.
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Radio Supply & Engineering Co.
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Radio Supply & Engineering Co.
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Radio Supply & Engineering Co.
15200 Wyoming Ave.
Rissi Electronic Supply Co.
14405 Wyoming Ave.
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990 W. Eight Mile Road
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Shand Electronics, Inc.
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Wedemeyer Electronic Supply Co.
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Electronic Supply Co. of Pontiac, Inc.
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**MISSOURI**
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Show-Me Electronics, Inc.
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Springfield
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**NEBRASKA**
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Mytron Electronics Corp.
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Paramus
Lafayette Radio Electronics
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Totowa
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New York
Dale Electronics Corp.
244 West 14th St.
Lafayette Radio Electronics
71 West 45th Street
Scarsdale
Lafayette Radio Electronics
691 Central Avenue
Syosset, L. I.
Lafayette Radio Electronics
111 Jericho Turnpike
Westbury, L. I.
Adelphi Electronics, Inc.
30 Jericho Turnpike
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Freck Radio & Supply Co., Inc.
38 Biltmore Ave.
**NORTH DAKOTA**
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Summit Road & Reinhold Drive
Cleveland
Fox Audio Center
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Fox Radio Parts Co.
4314 Lee Road
Dayton
The Stotts-Friedman Co.
108 North Jefferson St.
Elyria
El-A-Co.
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Lima
Hutch & Son
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Mansfield
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Shelborne Electronics
169 N. Pennsylvania Ave.
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# ELECTRONICS library

QUIET

## 101 TV TROUBLES FROM SYMPTOM TO REPAIR

*by Art Margolis*

This invaluable "cause-and-cure" guide to the solution for virtually any color and monochrome TV receiver trouble is a handy reference that will lead the reader right to the cause of the trouble in a matter of minutes. All the reader needs to do is analyze what he sees and hears, look up the symptoms in the book, and follow the clear and simple steps to a speedy trouble cure. Troubles are broken down into five basic categories in the text: brightness, contrast, sweep, color, and sound. Each category lists specific troubles relating to the symptom.

*Published by Tab Books, Blue Ridge Summit, PA 17214. 223 pages. $7.95 hard cover, $4.95 soft cover.*

## RADAR DESIGN PRINCIPLES

*by Fred E. Nathanson*

Written for the engineer or senior technician engaged in all phases of modern radar engineering, this book is a comprehensive survey of all types of current radars and ancillary equipment. It covers all the latest techniques. The book's 14 detail-packed chapters provide a wealth of information covering the relationship between radar and its environment, performance, computations, detection processes, target details, effects of weather and artificial interference, etc. The text is complete, containing mathematical analyses, the most applicable curves and graphs, and includes a detailed bibliography and reference sections for readers who require more detail than is given in the discussions.

*Published by McGraw-Hill Book Co., 330 West 42 St., New York, NY 10036. Hard cover. 626 pages. $22.50.*

## INTRODUCTION TO NONLINEAR NETWORK THEORY

*by Leon O. Chua*

This is the first undergraduate book to cover both the theory and techniques for the analysis and synthesis of practical large-scale, or nonlinear, circuits regardless of the component used. Emphasis in the text is on the methods used—not the single individual component. Hence, students can adapt any newly developed electronic component by analyzing

*(Continued on page 114)*

# POPULAR ELECTRONICS READER SERVICE PAGE

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TAKE ONE

# new literature

*To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15 or 115.*

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Just recently made available by *New-Tronics Corp.* is the company's twenty-page 1970 "Hustler" CB catalog, No. NT-1470. Printed in three colors, the catalog contains the company's full line of CB antenna and accessory equipment. More than 80 models are detailed for complete coverage of every antenna requirement ranging from 25" center-loaded short antennas to power-gain base station arrays.

Circle No. 75 on Reader Service Page 15 or 115

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Two full-color booklets describing the automatic turntables in the two separate Garrard lines for 1970 have been issued by *British Industries Co.* The first, titled "Component Series," lists eight turntables, describing the features of each in full detail. The other booklet, "Module Series," focuses the accent on the "mod." The four automatic turntables listed and described in the second booklet are ready to plug into other components for immediate use; they are pictured in typical setups.

Circle No. 76 on Reader Service Page 15 or 115

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The 1970 edition of *Tab Books'* catalog describes more than 125 current and forthcoming books on electronics. The 16-page illustrated catalog's listing covers such subject areas as schematic/servicing manuals; broadcasting; basic electronics technology; CATV; electric motors; electronics engineering; television; etc. Among the new and forthcoming titles in the catalog is the newly revised 1970 edition of "Popular Tube/Transistor Substitution Guide." Prices are given for each book listed.

Circle No. 77 on Reader Service Page 15 or 115

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Whether you use a microphone for tape recording, professional and amateur performing, or for PA applications, you will want a copy of *RCA's* new "Starmaker Microphones for the Art of Performing" catalog. Listed in the four-color, 12-page catalog are microphones for every need—including communications. Each microphone is fully described, and its list price is given.

Circle No. 78 on Reader Service Page 15 or115

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# New SAMS Books for every electronics interest

New 18th Edition of the famous E & E

## RADIO HANDBOOK

by WILLIAM I. ORR, *W6SAI*. Completely updated edition of the famous communications handbook which is the electronics industry standard for engineers, technicians and advanced amateurs. Explains in authoritative detail how to design and build all types of radiocommunications equipment. Includes SSB design and equipment, RTTY circuits, latest semiconductor circuits and IC's, as well as special-purpose and computer circuitry. Order **24020**, *only*..**$13.50**

New 13th Edition of the famous

## TUBE SUBSTITUTION HANDBOOK

Lists over 12,000 direct substitutions. A complete guide to substitutions for receiving, picture tube, miniature, industrial, and communications types; includes foreign tubes. Tells how and when to substitute.
Order **20769,** Twin-Pak (regular size for bench use; pocket-size for caddy) *both for only*.............................**$2.25**
Order **20768,** shop edition, *only*.....**$1.75**

### Color-TV Waveform Analysis

This book provides both the theoretical and the practical knowledge of waveform analysis essential for profitable and efficient color TV servicing. It begins with the rf and i-f sections, and proceeds through the video-amplifier, bandpass-amplifier, color-sync, color-demodulator, and matrix circuits.
Order **20763**, *only*.......................**$3.50**

### 101 Q & A About Hi-Fi and Stereo

A practical and useful reference book explaining the essential facts about hi-fi and stereo, with important help on troubleshooting and maintenance. The six sections of the book cover: high-fidelity systems; amplifiers; tuners; record and tape players; maintenance and troubleshooting procedures. Order **20753**, *only*............**$3.50**

### SWL Antenna Construction Projects

Provides detailed information on how to construct 35 different antennas for improved short-wave reception. Explains basic antenna principles and then presents the construction projects which fall into six basic classes of design.
Order **20766**, *only*.......................**$2.95**

### Color-TV Trouble Clues, Vol. 3

by HOWARD W. SAMS EDITORIAL STAFF. Helps speed diagnosis of color-TV troubles. Tells how to get right to the heart of the problem, how to make positive checks, how to use meaningful clues for quick troubleshooting.
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### Record Changer Servicing Guide

Provides a complete understanding of record changers, how they operate, and the various systems employed. With detailed instructions on how to track down troubles encountered in record changers and how to repair them in the fastest and most effective way. Order **20730**, *only*..**$3.95**

### Electronic Organs—Vol. 2

Explains the fundamental principles of electronic organs, including theory, development, features and operation. Shows in block diagram and schematic illustrations what is inside an organ.
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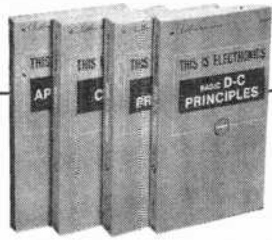
### Auto Radio Servicing Made Easy

2nd Ed. Explains the circuitry of both new and old auto radios, covering each of the tube and transistor stages. Provides step-by-step troubleshooting and repair details; explains how to eliminate noise and interference, and how to make proper adjustments. Order **20719**, *only*......**$3.95**



## THIS IS ELECTRONICS Series

by ITT EDUCATIONAL SERVICES, INC. These books provide a remarkable introduction to electronics, imparting to any reader a clear understanding of the basics of this vital technology. All topics are completely covered and readily mastered.

### Vol. 1. Basic D-C Principles

Covers electronics—past and present; electronic components and symbols; matter and electricity; current, voltage, and resistance; series and parallel circuits; conductors, semiconductors, and insulators; resistors; and sources of d-c power.
Order **20657**, *only*...................**$5.95**

### Vol. 2. Basic A-C Principles

Covers alternating voltage and current; capacitors and capacitive reactance; magnetism and electromagnetism; electrical measuring instruments; and inductors and inductive reactance.
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### Vol. 3. Circuits

A-c and d-c principles and components are used to illustrate how vacuum tubes and semiconductors operate. Various amplifier and oscillator circuits of both tube and transistor types are fully described.
Order **20759**, *only*...................**$6.95**

### Vol. 4. Applications

This volume explains how amplifier and oscillator circuits are used in actual applications. Explains principles of modulation, broadcast receiver fundamentals, a-m and f-m receiver circuits, etc.
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*4-Vol Set*. Order **20761**, *only*........**$23.50**

### Amateur Radio Incentive Licensing Study Guide

Fully explains the new incentive licensing which affects both newcomers and old-timers. Covers all the new FCC Regulations and band allocations. Includes sample exams for Novice, Technician, Conditional, and General- Advanced- and Extra-Class licensing. Order **24004**, *only*....**$2.75**

## HOWARD W. SAMS & CO., INC.

Order from any Electronic Parts Distributor, or mail to Howard W. Sams & Co., Inc., Dept. PE-4
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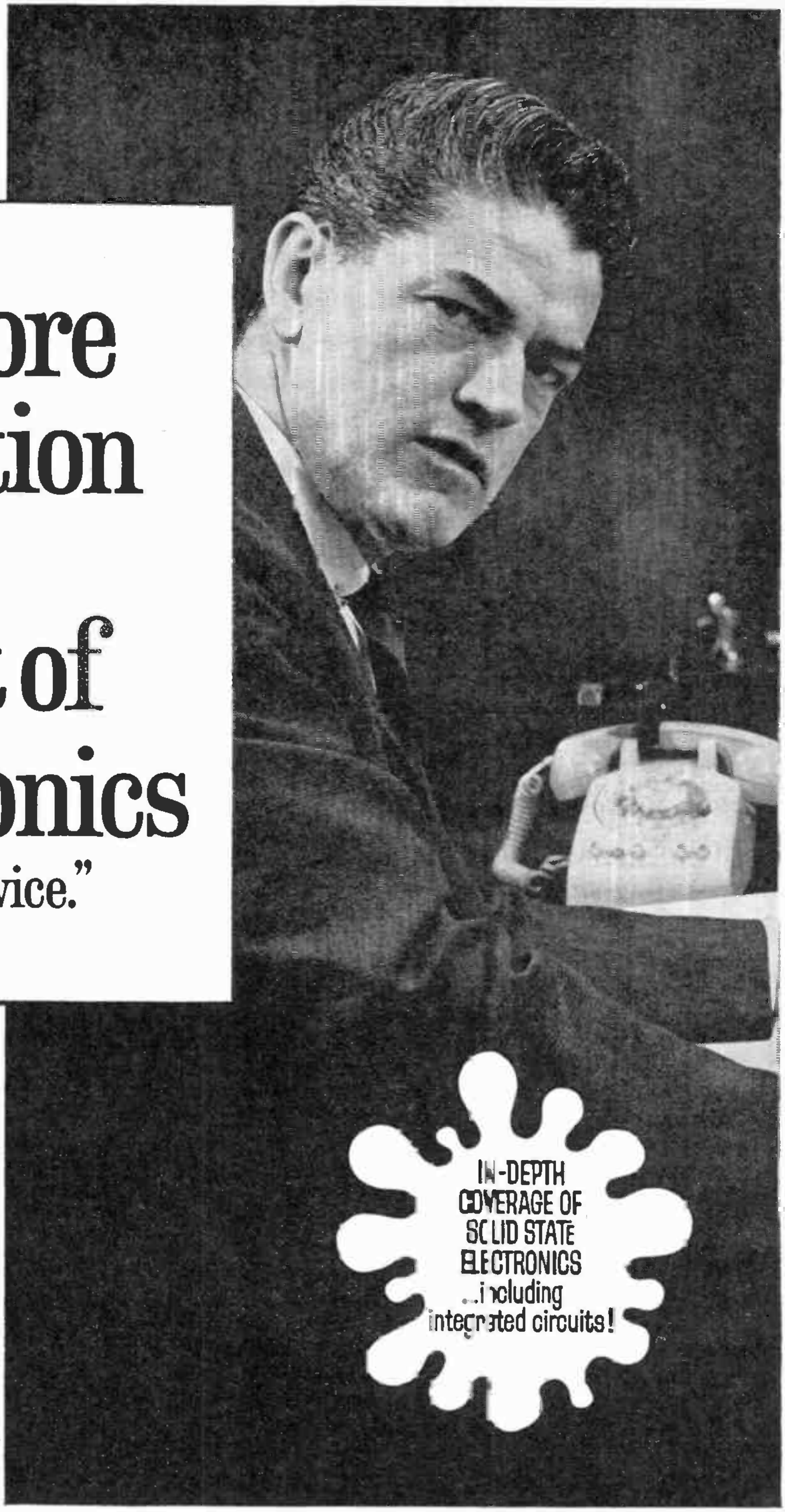
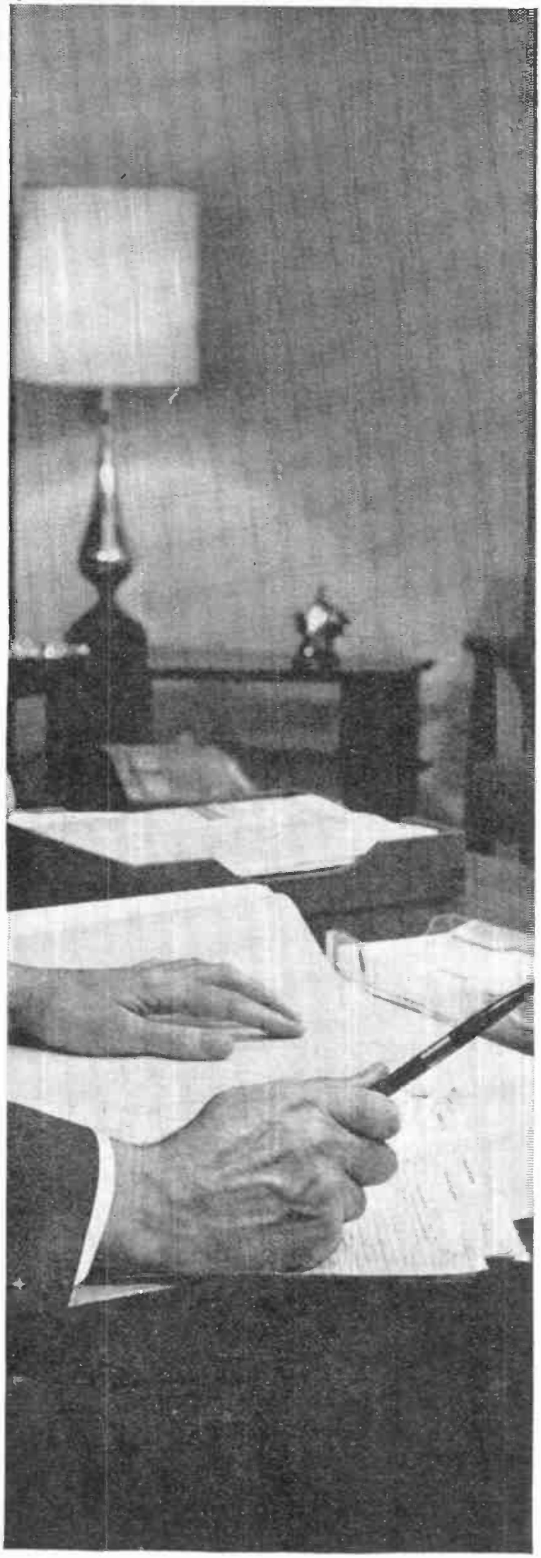
CIRCLE NO. 23 ON READER SERVICE PAGE

"Get more education or get out of electronics

...that's my advice."





# NEW PRODUCTS

*Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15 or 115.*

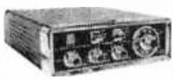
## LOW-COST VHF-FM RADIOTELEPHONE

The first low-cost VHF-FM marine radiotelephone to be made available to the average boating public is being marketed by *Simpson Electronics, Inc.,* as the Model T. The 6-watt Model T comes as a complete pretuned package, including antenna, mount, and crystals for four channels to meet minimum boat-equipment budgets. Featured are a push-button channel selector, quality carbon microphone with coil cord, internal speaker, and epoxy-glass printed circuit board. The Model T operates from 12-volt d.c. supplies with negligible current drain. Overall dimensions of the radiotelephone are 8½" wide x 10¾" deep x 2¾" high.

Circle No. 79 on Reader Service Page 15 or 115

## HI/LO BAND VHF FM MONITOR RECEIVER

*Fanon Electronics'* new Hi/Lo Band FM-VHF Monitor Model APO-50HL receiver zooms the listener right into the moment of action. The listener can monitor fire and police calls, accident reports and emergency broadcasts, hear official business communications, and keep abreast of the latest weather developments. The monitor has a built-in 117-volt a.c. power supply, but it can also be used in a 12-volt d.c. mobile setup. Six high-band frequencies from 150-175 MHz and six low-band frequencies between 25 and 50 MHz are provided with all channels crystal controlled. The solid-state design incorporates IC's. Featured are an exclusive r.f. peaking coil for maximum receiver sensitivity, and adjustable squelch, and a tone control that allows the user to emphasize the highs or lows.



Circle No. 80 on Reader Service Page 15 or 115

## PORTABLE PA SYSTEM

Capable of being heard up to 600 yards away over crowd ambient noise, *The VP Company's* Model VP280 public address system is just the thing for bazaars, rallies, club meetings, guided tours, etc. The portable PA system is completely self-contained. It is line-independent, operating from batteries; weather proof; and lightweight. The circuit design of the VP280 is all solid state, including the use of integrated circuits designed to provide a long trouble-free life. Output power is 5 to 9 watts r.m.s. Two speakers are built in, one or both of which can be switched into operation by a switch on the microphone. A power on/off switch is also located on the microphone housing, while a volume control is located on the side of the amplifier's housing.

Circle No. 81 on Reader Service Page 15 or 115

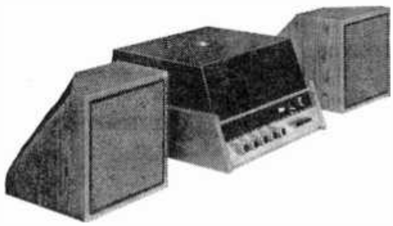
## AMATEUR LINEAR AMPLIFIER

A pair of Eimac 3-500Z's as a grounded-grid final are used in the new Model SB-220 linear amplifier available from *Heath Company* to provide 2000 watts PEP input on SSB and 1000 watts on CW and RTTY. The SB-220 requires only 100 watts of driving power for full output. A pretuned broadband pi-input delivers maximum efficiency and low distortion throughout the 80-10 meter amateur bands. Features of the SB-220 include a built-in solid-state 120/240-volt a.c. power supply and circuit breaker protection. A zener diode regulates operating bias and reduces zero signal plate current for cooler operation and longer tube life. Double shielding provides maximum TVI protection, and an open layout permits the fan in the PA compartment to move large volumes of air for really cool operation. The kit can be assembled in about 20 hours.

Circle No. 82 on Reader Service Page 15 or 115

## ADVANCED INTEGRATED MUSIC SYSTEM

The company's first integrated or "compact" system, the Landmark 100, is now available from *Electro-Voice, Inc.* A complete music



system, including an AM/stereo FM tuner and record changer, the Landmark 100 incorporates "Acoust-Array" speaker systems and a "Servo-Linear" motional feedback circuit in the amplifier. Each speaker system has three full-range loudspeakers and a tweeter

# IF YOU WANT TO GET MAXIMUM PERFORMANCE FROM YOUR CB RADIO, MAIL IN THIS COUPON.

**Pearce-Simpson**
A Division of GLADDING Corporation
P.O. Box 800, Biscayne Annex
Miami, Florida 33152 Dept. PE-4

*Send me complete information on your full line of base and mobile antennas, from 18 to 105 inches, in fiberglass or stainless steel.* ☐ *I want to get more out of my CB Radio.*
☐ *I am looking for a new radio and want the right antenna.*

Name ..........................................

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City ..........................................

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You bought a real "talk" radio. You paid anything from about $50 to $500 for it. You expected great range. Clear reception.

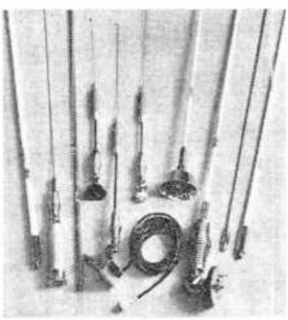
But you're just not getting the results you thought you would. So you blame your radio.

Don't.

Your radio's probably fine. But what about the antenna? You might think all antennas are the same. They're not.

Pearce-Simpson offers a complete line of Talking Antennas. From 18 to 105 inches. In fiberglass or stainless steel. Base station and mobile. And every one is backed by the Gladding Corporation, first in outdoor recreation since 1816.

There's one that will give your radio the talk power it's missing.



Every Pearce-Simpson antenna is designed with the lowest possible Standing Wave Ratio in its class—which means all the power you put into it goes where it's supposed to—to the man who is listening—not right back into your set.

How do we know so much about antennas? Because we build radios. And because we build better radios than anyone else, we know that a bad antenna can hurt the performance of even the best radio. So we designed antennas just as good as our radios.

If you want to find out what antenna is best suited to your radio, fill in the coupon. Get our catalogue of Pearce-Simpson Talking Antennas.

And make your good radio a great radio.

## The Talking Antennas by Pearce-Simpson

Pearce-Simpson, a Division of Gladding Corporation. First in outdoor recreation since 1816. GLADDING

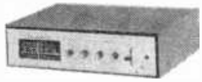
CIRCLE NO. 20 ON READER SERVICE PAGE

## PRODUCTS *(Continued from page 22)*

in a relatively small truncated cube enclosure, to achieve multi-directional sound and balanced stereo throughout the listening room. The tuner features a FET front end with four IC's in the i.f. and multiplex sections. The Servo-Linear feature corrects for any distortion produced in the loudspeakers by sampling the actual movement of the cones and comparing the motions with the input signal. It then corrects the difference by applying negative feedback.

Circle No. 83 on Reader Service Page 15 or 115

### PAGING RECEIVER



A versatile paging receiver that can be used in the home, office, or small industry is currently being marketed by *Radio Shack* as the Model MTA-20. A monaural FM receiver, 15-watt audio amplifier, and a microphone input circuit make up the receiver. The paging receiver's front panel carries receiver tuning, tone and volume, and standard hi-fi FM/phono/tape switch controls, plus an electrically silent spring-return paging switch and microphone jack. Located on the rear panel are a paging volume control, switched power outlet, connections for four loudspeakers, and auxiliary and magnetic phono inputs. The audio frequency range of the receiver is 20-20,000 Hz.

Circle No. 84 on Reader Service Page 15 or 115

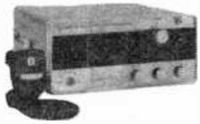
### CASSETTE "CIRCULATOR"

The *Norelco* Model CC6 cassette "circulator" is a snap-on device that gives to cassette tape players the features of an automatic record changer—plus a little more. A simple but ingenious device with no moving parts, the CC6 makes possible 12 hours of non-stop, no-repeat playback and then recycles. It can be loaded with four to six cassettes, automatically flips over each for second-side play, and restacks the cassettes for replay. Functionally styled in tinted plastic and standing only 5" high, the CC6 is simply snapped into place for instant use. The CC6 is compatible with Norelco cassette player Models 2401, 2401A, and 2502; Bell & Howell Models 332 and 337; and Ampex Micro Models 90 and 95.

Circle No. 85 on Reader Service Page 15 or 115

### VHF MARINE RADIOTELEPHONE

The new *COMCO Communications Co.* Model 610 VHF marine radiotelephone features a unique dual front-end receiver which provides full sensitivity on both simplex and duplex



channels and optimum selectivity and intermodulation rejection at sea and in big city harbors. Designed for operation in the uncrowded VHF portion of the marine band, the 610 has an output of 25 watts for dependable ship-to-ship communications up to 30 miles and ship-to-shore up to 50 miles. Twelve channels permit full-range operation. The use of transistor and IC circuitry assures maximum reliability and minimizes heat, space, and battery drain requirements. Special circuitry prevents damage if battery polarity is reversed or the transmitter is keyed with a shorted antenna or no antenna at all.

Circle No. 86 on Reader Service Page 15 or 115

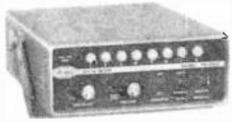
### ADVANCED AM/STEREO FM RECEIVER

Contained in the *Pioneer Electronics U.S.A. Corp.* Model SX-990 AM/stereo FM receiver are features of interest to sophisticated hi-fi buffs. The receiver's push-pull output can supply 100 watts (IHF) of clear audio power across an 8-ohm load. Bass and treble controls are provided, but the user has the option of a completely flat response. Two pushbutton filters are featured: low-pass provides an 8-dB cut at 50 Hz and high-pass 7.5 dB at 10 kHz. A switchable loudness contour provides 12 dB of boost at 50 Hz and 9 dB at 10 kHz, with the volume control set at −40 dB. Harmonic distortion is maintained at less than 0.5% at 1000 Hz for rated output. Frequency response is ±3 dB 10-100,000 Hz. The FM tuner has a usable sensitivity of 1.7 μV and a 62-dB signal-to-noise ratio. In the multiplex section, a time-switching demodulator, with automatic stereo selection, is used to provide left-right channel separation of 42 dB at 1000 Hz.

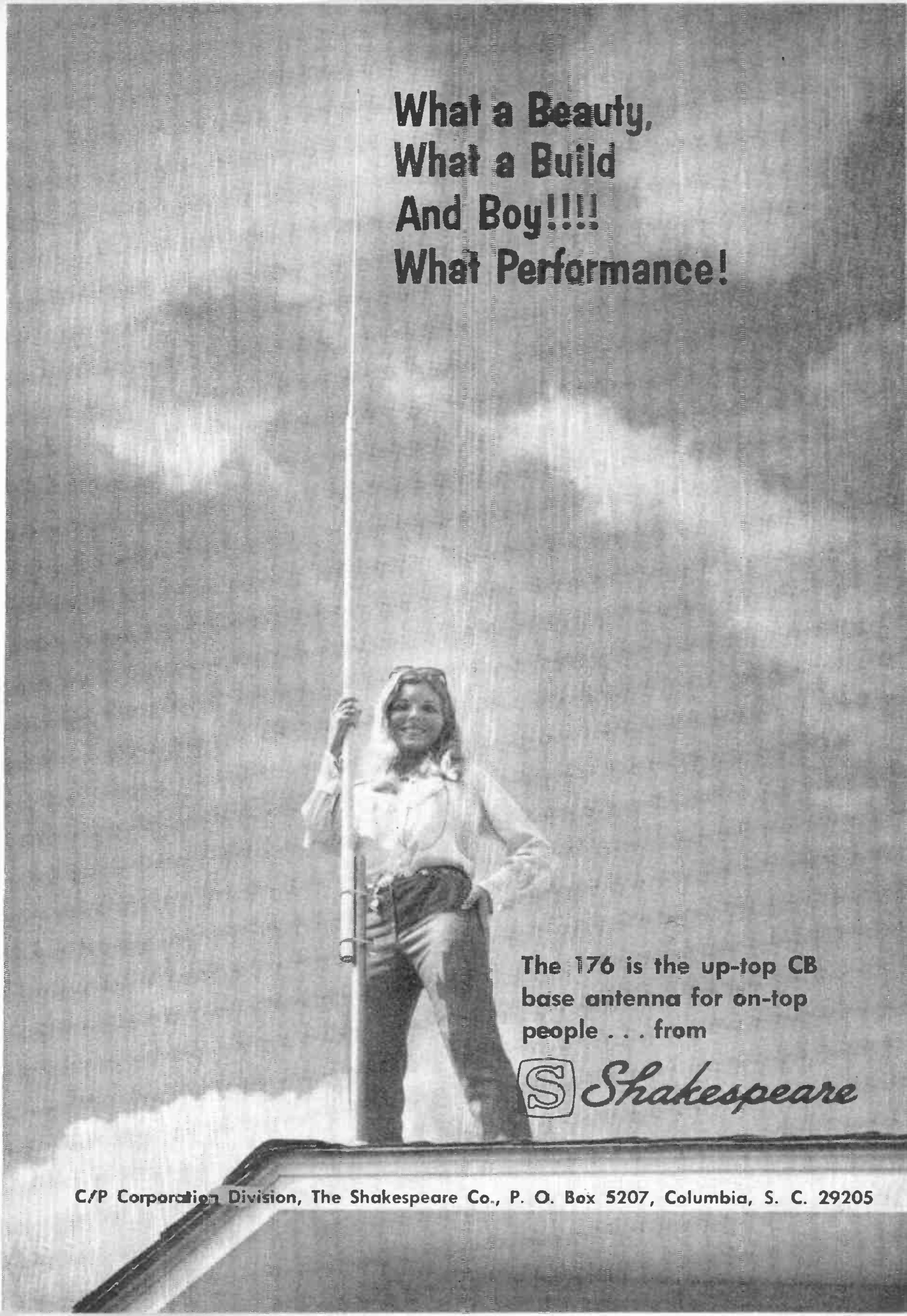
Circle No. 87 on Reader Service Page 15 or 115

### AUTO-SCAN FM MONITOR RECEIVER

A choice of low- or high-band monitoring facilities on the emergency and public service bands, an automatic scanning feature, and a dual-purpose power supply are available with the *Sonar Radio Corp.'s* "Auto-Scanner" FM monitor receiver series. Available are the Model FR-2514 (25-50 MHz) and Model FR-2515 (150-175 MHz). The receivers automatically scan and lock onto any of eight programmed channels. A priority channel signal will lock to the exclusion of all other signals. A carrier delay allows the operator to hear mobile callbacks to eliminate lost information. Also, manual selection is accomplished by a slow-scan facility. The receivers have dual limiter Foster Seeley discriminators, quadruple-

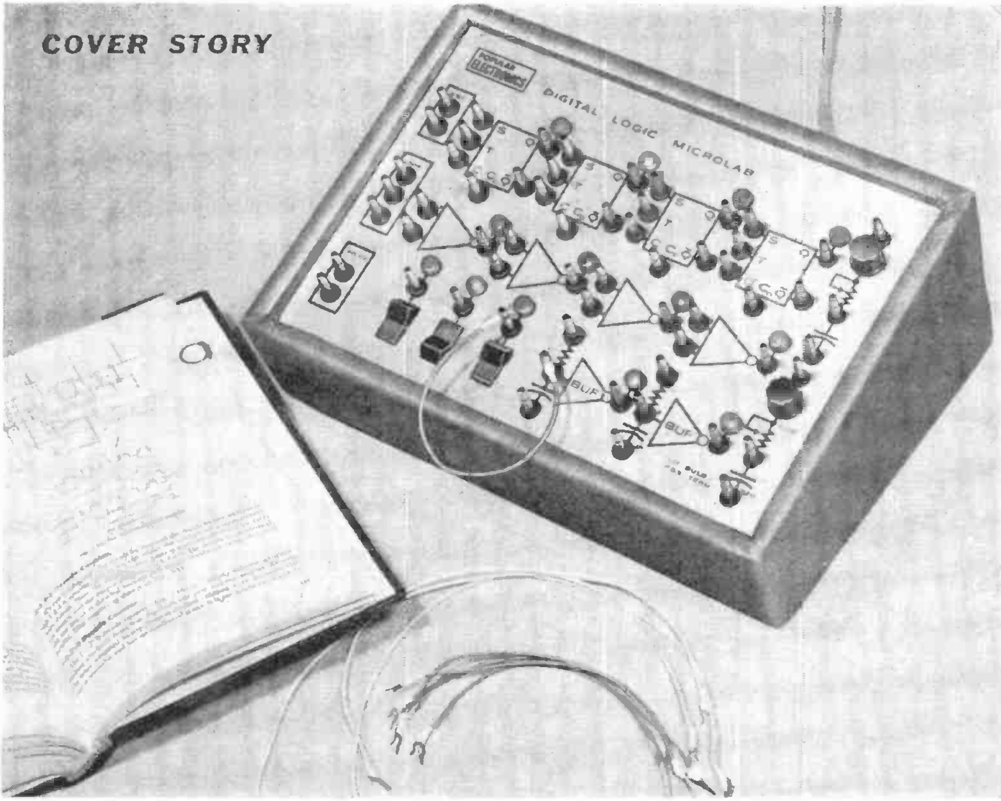


*(Continued on page 116)*



What a Beauty,
What a Build
And Boy!!!!
What Performance!
The 176 is the up-top CB base antenna for on-top people . . . from
Shakespeare
C/P Corporation Division, The Shakespeare Co., P. O. Box 5207, Columbia, S. C. 29205

COVER STORY




# BUILD THE Digital Logic Microlab

LEARN HOW DIGITAL CIRCUITS WORK—THE EASY WAY

BY DON LANCASTER

DIGITAL LOGIC is involved in a great number of experimental projects and in instruments used daily in the laboratory. Despite the fact that digital logic circuits are so commonplace, the principles involved are not always too well understood. To remedy this situation, you will want to build a "Digital Logic Microlab"—an advanced breadboarding device that lets you quickly and painlessly verify all the basics of digital logic. It will serve as a teaching aid for yourself and others; and it is an excellent science fair project.

The Microlab can also serve as a universal digital test and debugging instrument, providing such functions as bounceless contacts, state checkers, monitors, precision one-shot time gates, synchronizers, and cycling oscillators. Although the Microlab is designed to use resistor-transistor logic (RTL), to make it compatible with the majority of projects described in POPULAR ELECTRONICS, it can easily be adapted to work with diode-transistor logic (DTL), transistor-transistor logic (TTL) or Utilogic® (Signetics Corp.) systems.

The Microlab includes four JK flip-flops, four two-input gates, two buffers, and three bounceless mechanical switches and can be used in over 100 basic logic experiments (see page 35). Each logic block has its own pilot-light readout to indicate the state of its output and the power supply and ground connections for

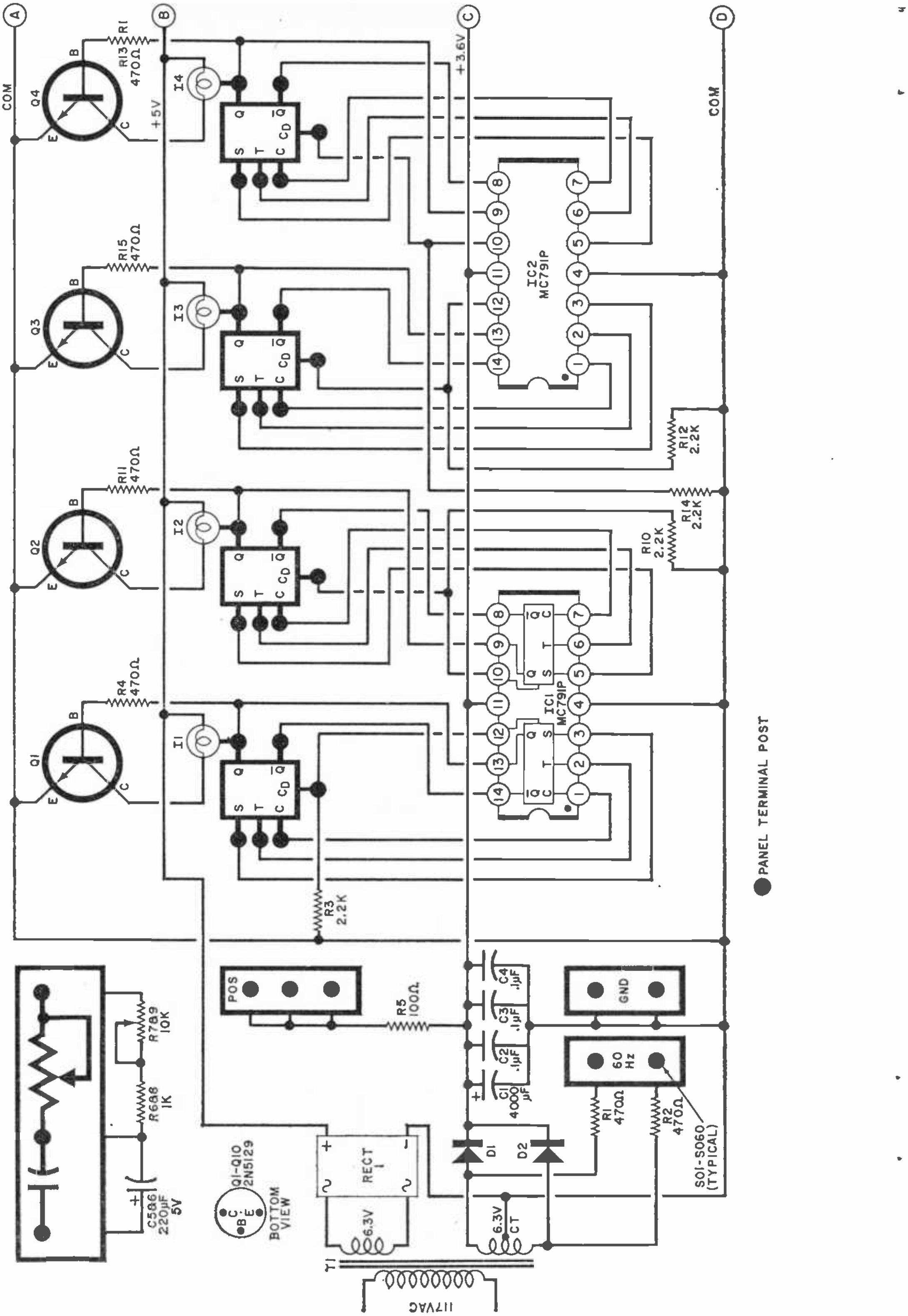
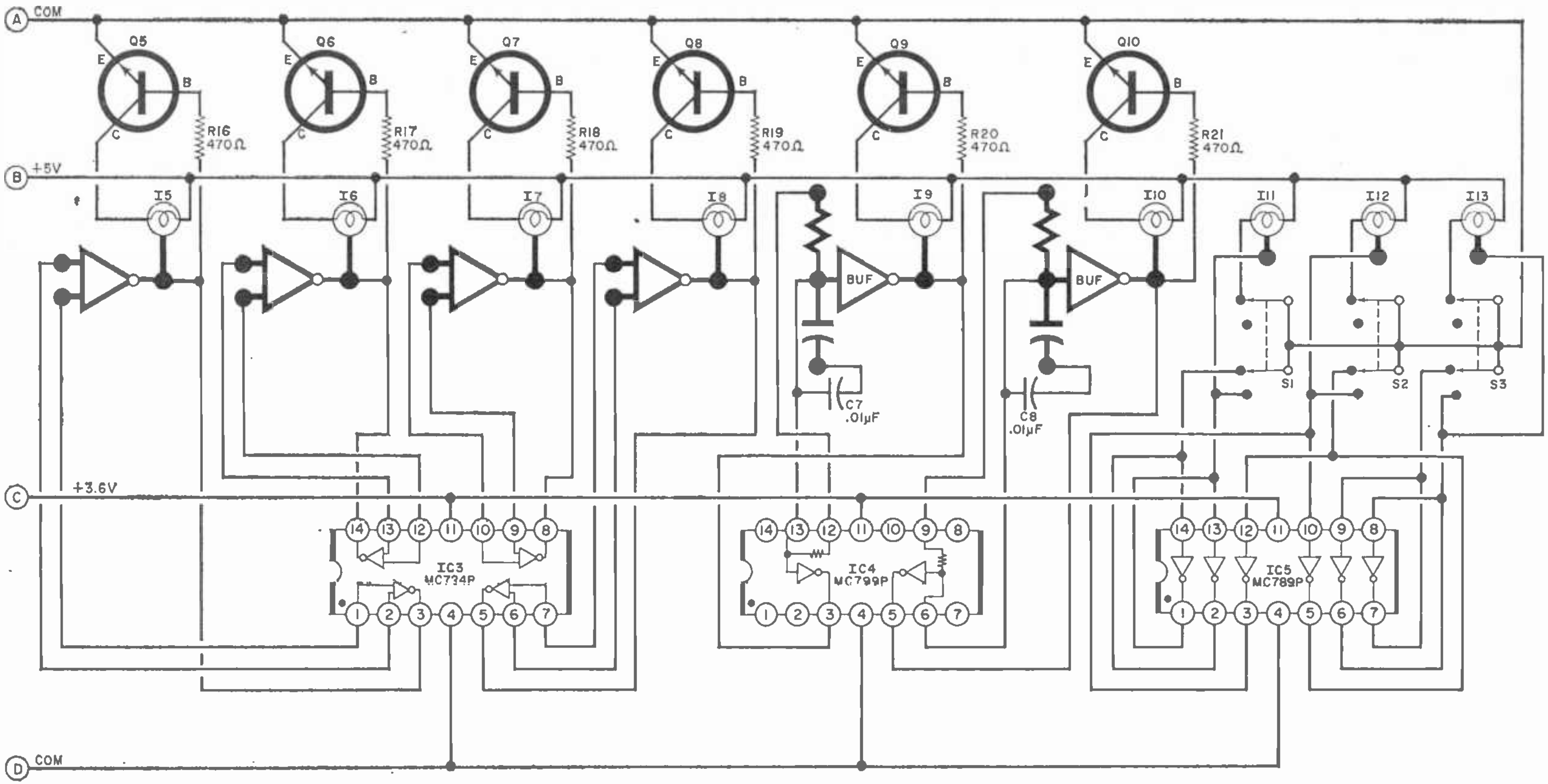

A
B
C
D
COM
COM
Q1
Q2
Q3
Q4
R1
R13 470Ω
R15 470Ω
R11 470Ω
R4 470Ω
+5V
+3.6V
I1
I2
I3
I4
IC1 MC791P
IC2 MC791P
R12 2.2K
R14 2.2K
R10 2.2K
R3 2.2K
PANEL TERMINAL POST
POS
R5 100Ω
C1 4000 µF
C2 .1µF
C3 .1µF
C4 .1µF
GND
60 Hz
R1 470Ω
R2 470Ω
SO1-SO60 (TYPICAL)
D1
D2
RECT 1
6.3V
6.3V CT
T1
117VAC
Q1-Q10 2N5129
BOTTOM VIEW
R789 10K
R688 1K
C586 220µF 5V

Fig. 1. Complete schematic diagram of Microlab is shown here in two parts; points A, B, C, and D in each half connect to their respective letters. Logic, schematic, and post designations on the front panel—not circuit board—are shown in bold lines. These lines refer to functions inside the IC's and outboard connections.



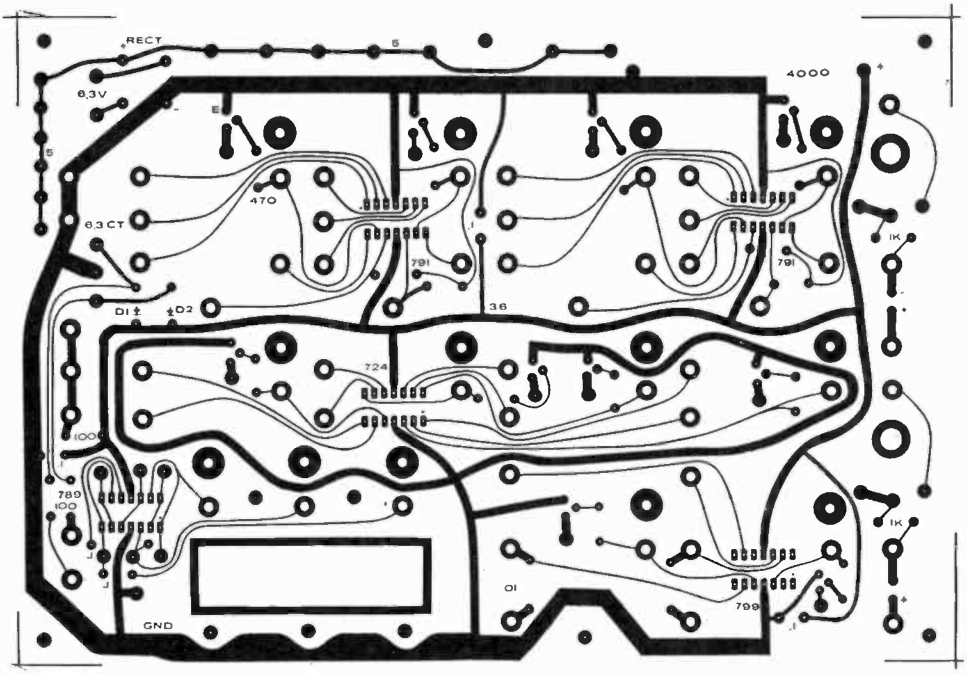



Fig. 2. Foil pattern etching guide is shown here half-size. The best method of obtaining a full-size guide is to use photographic blow-up. However, board is available from the source specified in Parts List if you prefer not to make your own.

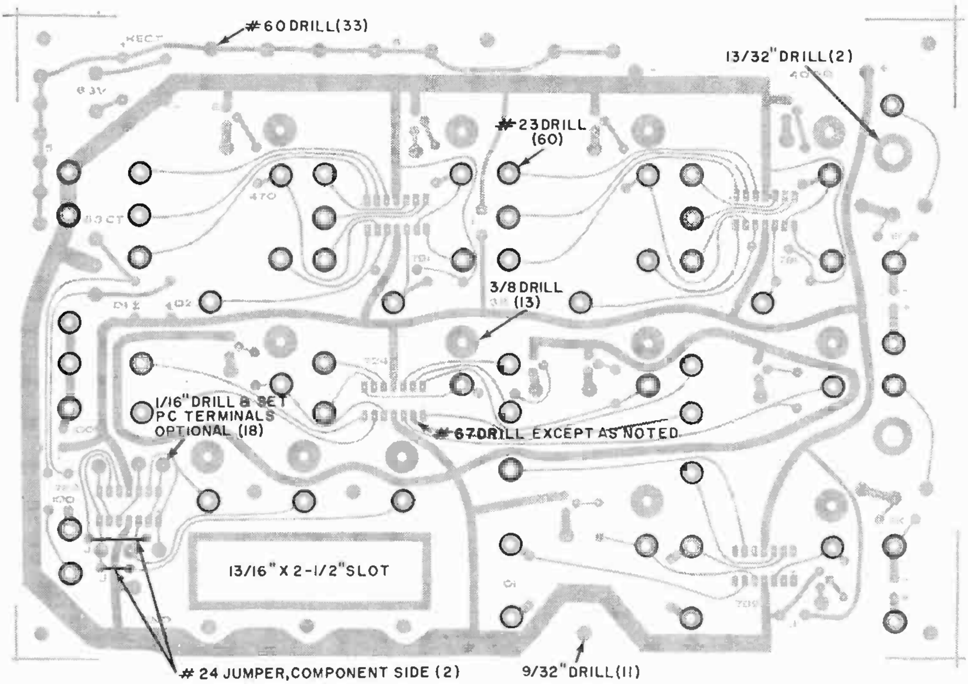



Fig. 3. Circles around solder pads indicate locations of terminal posts. Slot at bottom is to provide clearance for switches. Note jumpers at lower left of illustration.

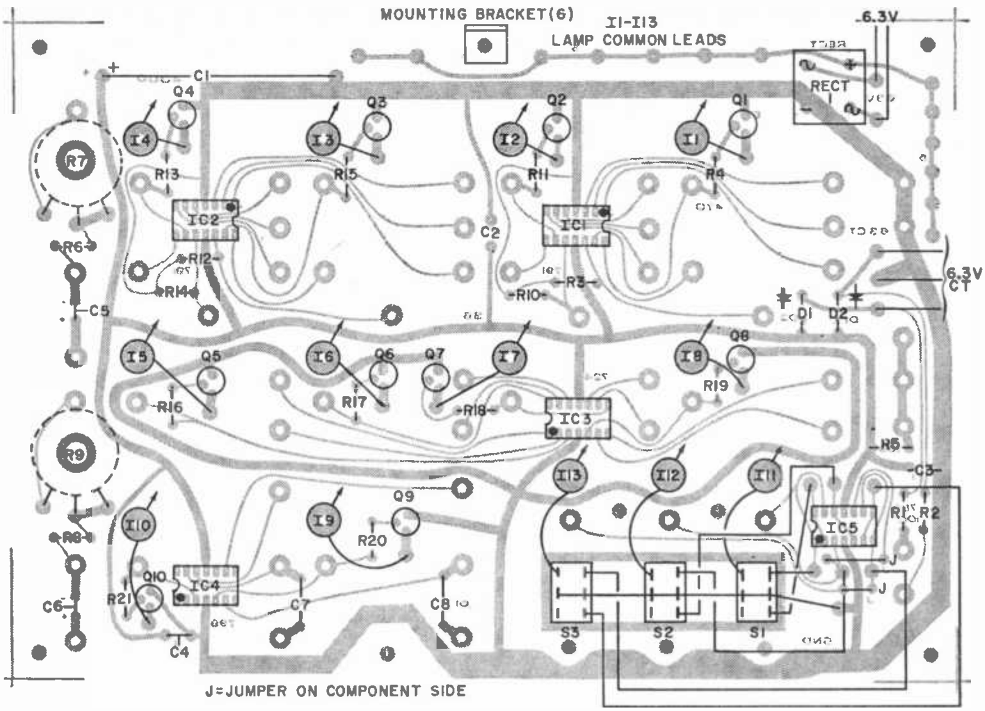



Fig. 4. Be extremely careful when mounting components on circuit board to observe proper lead orientations. Terminal ends of S1-S3 pass through slot in board (lower right) and terminals connect to appropriate points in circuit via wire.

each block are permanently installed and properly bypassed. In using the Microlab, all you do is make the logic connections using simple "zip" leads that require no soldering and are easy to attach and remove.

Three types of input signals are available on the front panel: a constant-value positive voltage, the 60-Hz power line that can be properly conditioned for driving the logic blocks, and three conditioning actuators that may be used as either

## PARTS LIST

*C1—4000-µF, 6-volt electrolytic capacitor*
*C2-C4—0.1-µF, 10-volt disc ceramic capacitor*
*C5,C6—220-µF, 6-volt electrolytic capacitor*
*C7,C8—0.01-µF, 50-volt Mylar capacitor*
*D1,D2—1-ampere, 25-volt silicon power diode (1N4001 or similar)*
*I1-I13—5-volt, 50-mA pilot lamp and color-coded lens (3 green, 4 blue, 2 red, 4 orange)*
*IC1,IC2—Dual JK flip-flop (Motorola MC-791P)*
*IC3—Quad two-input gate (Motorola MC724P)*
*IC4—Dual buffer (Motorola MC799P)*
*IC5—Hex inverter (Motorola MC789P)*
*Q1-Q10—Transistor (National or Fairchild 2N-5129, available from New Jersey Semiconductor, 20 Commerce St., Springfield, NJ 07081)*
*R1,R2,R4,R11,R13,R15-R21—470-ohm, ¼-watt resistor*
*R3,R10,R12,R14—2200-ohm, ¼-watt resistor*
*R5—100-ohm, ¼-watt resistor*
*R6,R8—1000-ohm, ¼-watt resistor*
*R7,R9—10,000-ohm, linear potentiometer*
*RECT1—1-ampere, 25-volt diode bridge assembly*
*S1-S3—D.p.d.t. rocker switch*
*T1—Filament transformer, secondaries: 6.3 volts at 0.5 amperes, 6.3 volts center-tapped at 0.5 amperes; or two separate transformers.*
*Misc.—Match-drilled dialplate; 5-ferrule terminal posts (Southwest Technical #TP-7563-3GD or similar, 60 required); vinyl grommets (60); vinyl-clad wood case; heat-shrinkable tubing (2 ft); red lead wire (15 ft); yellow lead wire (9 ft); plated hair pin cotters (Southwest Technical PHPC-43, 80 required); ½-inch knobs (2); line cord; wire nuts (2); mounting brackets with hardware (6); switch bracket and hardware; epoxy cement; #24 solid wire; sleeving; ¼" nylon nuts or other insulated spacers (7); PC terminals (18, optional); solder, etc.*
*Note—The following are available from Southwest Technical Products, Box 16297, San Antonio, TX 78216: etched and drilled printed circuit board #997, $10.50; complete kit of all parts including front panel and vinyl-clad case #997-K, $26.75; 240-page experimenter laboratory manual #B-1, $5.25; all prices postpaid. All individual parts are also available.*

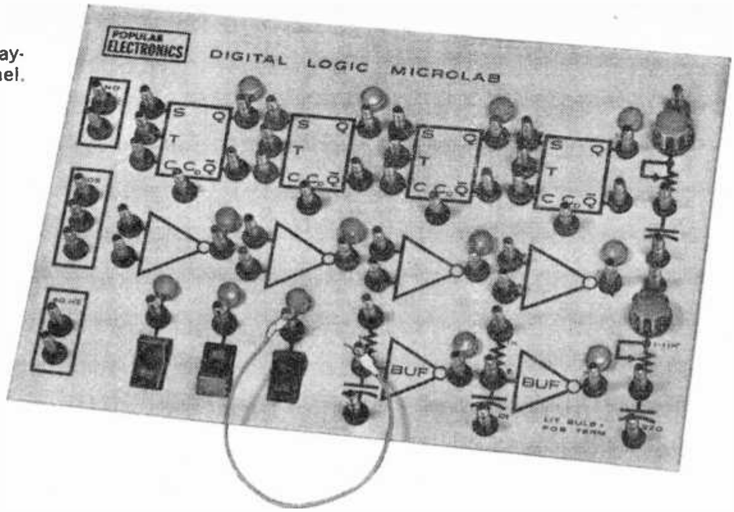



Fig. 5. Photo shows how to layout and label the front panel.

pushbuttons or slide switches. The latter are bounceless and can drive all logic blocks. If desired, certain blocks may be interconnected to form oscillators for driving or test purposes.

Another important feature of the Microlab is that, if you are going to use it as a teaching aide, the entire instrument is "student proof" in that no possible combination of panel connections, however wrong, can damage the circuits. You can build the Microlab for $20 to $30 using the printed circuit boards and complete kits mentioned in the Parts List for Fig. 1. A 240-page experimenter's manual is also available.

**What Do the Logic Blocks Do?** In general logic blocks perform "yes-no" decisions based upon the presence or absence of "yeses" and "nos" at their inputs. Each block follows a predetermined set of rules and always does the same thing in response to a particular set of input conditions.

There are four types of logic blocks in the Microlab: *two-input gates, buffers, counting flip-flops* (called JK flip-flops by the computer people), and *inverters,* the latter being inside the unit. The principal components in the blocks are RTL integrated circuits. The outputs of each block are either grounded or at some positive potential (between 1.5 and 3.6 volts), depending on the presence or absence of similar positive or grounded conditions on the inputs.

*Two-Input Gate.* The logic rule for the two-input gate states that, if both inputs are grounded, the output is positive; and if either one or both of the inputs is made positive, the output is grounded. If you call ground a "yes" and positive a "no", the two-input gate is a NAND gate. On the other hand, if you call positive a "yes" and ground a "no", you have a NOR gate. The choice is up to you. By combining these gates, all the remaining logic functions can be generated. Two-input gates may also be used to form flip-flops and perform decoding and decision logic.

*Buffer.* A buffer is an inverting high-power one-input gate and is used where lots of output drive is needed. Its logic rule is simple: if the input is positive, the output is grounded; and vice versa.

A capacitor and resistor are also connected to the buffer's input. If you connect the buffer normally, you simply leave both these components floating. If you connect the resistor to positive and the input to the capacitor, a sudden positive-to-ground transition on the input will produce a brief positive output pulse lasting only several microseconds. This type of pulse is used to reset counting chains or to recognize the beginning, but not the duration, of some event.

Although such an arrangement is seldom used, the resistor can be grounded and a sudden ground-to-positive transition applied to the capacitor. In this case the buffer's output is normally positive and goes to ground briefly for a few microseconds.

Buffers are used as amplifiers to increase drive capability and as reset pulse generators for counters; or, when used in pairs, they may be cross-coupled to form an oscillator or latch.

*Counting Flip-Flop.* This is the most complex of the logic blocks in the Microlab. Each flip-flop has two outputs, called Q and $\bar{Q}$, and four inputs, S, T, C, and $C_D$. The Q and $\bar{Q}$ outputs are complementary. This simply means that, if one is positive, the other is grounded, and vice versa. The inputs are used to make the flip-flop's outputs either change states or stay the way they are.

The $C_D$ input is called a direct input. It is normally left grounded or unconnected. If it is made positive, the flip-flop will immediately go to the state where Q is grounded and $\bar{Q}$ is positive. This is used to initially set the states on a number of flip-flops or to reset a flip-flop. After such a resetting, the $C_D$ input must be returned to ground to allow the other inputs to function.

Inputs S, T, and C are normally used together and are called *clocked* inputs. No matter what happens to the S and C inputs, nothing happens to the outputs until the T input suddenly changes from positive to ground. The rules are as follows:

1. If both S and C are grounded, the output changes state when the T input suddenly goes from positive to ground.
2. If S is grounded and C is positive, and the T input suddenly goes from positive to ground, the outputs are ground at Q and positive at $\bar{Q}$.
3. If S is positive and C is grounded, and the T input suddenly goes from positive to ground, the outputs are positive at Q and ground at $\bar{Q}$.
4. If both S and C are positive, nothing happens when the T input goes from positive to ground.

The clocked nature of the JK inputs permits us to set up what the flip-flop is going to do before it actually does it. This is the key to the operation of counters, registers, sequencers, synchronizers, and many other circuits which use clocked flip-flops.

*Inverter.* The inverter—there are six inside the Microlab—is a low-power buffer. A positive input produces a ground at the output and vice versa. The six inverters are used to make the three conditioning switches bounceless so that they properly drive the T inputs of the flip-flops. Conditioning is accomplished by cascading two inverters to form a set-reset latch whose output is a fast-rise square wave, independent of any contact bounce and noise.

**Construction.** The Microlab is built in three major parts: a large printed circuit board on which are mounted all of the parts except the power transformer, a front panel that displays the logic symbols and makes available the required connections, and a sloping-front vinyl-clad cabinet.

The schematic is shown in Fig. 1. Since the PC board is so large, a *half-*

## HOW IT WORKS

The Microlab contains five IC's, a dual power supply, and some discrete components. One power supply provides +3.6 volts of filtered, bypassed d.c. for the logic circuits; a current-limited positive voltage reference for the front panel; and a split-phase, current-limited 60-Hz reference. The other supply provides 5 volts of full-wave rectified but unfiltered d.c. to drive the state-indicating pilot lights. Either a single tapped transformer or two filament transformers may be used.

The logic circuits in each IC are brought out to the front panel. For instance, *IC1* and *IC2* are dual JK (counting) flip-flops. Each of the four independent flip-flops is brought out to its own symbolic terminal grouping on the front panel. Resistors are added to the $C_D$ inputs so that they may be safely left unconnected.

Each logic block has its state indicated by a pilot light driven by an *npn* silicon transistor having a base-current limiting resistor. When the output terminal is positive, the lamp lights.

The four two-input gates in *IC3* are also brought out to symbolic terminals on the front panel; as are the two buffers in *IC4*. The 1000-ohm resistors shown in the inputs are internal to the IC, while two capacitors are added as shown. These are useful for pulse and reset generation and for cross-coupling of two buffers to build a high-frequency oscillator.

Hex inverter *IC5* is used to form three bounceless actuators in conjunction with *S1, S2,* and *S3*. This permits direct driving of the T inputs of the flip-flops without erratic triggering. An extra contact on each switch directly controls a pilot light when the post output is positive, saving three driver transistors and three resistors.

Two networks on the right side of the front panel complete the circuit. Each of these consists of a potentiometer, a fixed resistor, and an electrolytic capacitor. They are used with the two-input gates to form either a monostable multivibrator (one network) or an astable low-frequency oscillator (two networks) adjustable over a 10:1 range from several cycles per second to a cycle every second or so. The values have been selected for optimum visual demonstration of logic and count sequences.

*size* foil pattern is shown in Fig. 2. If you make your own board, match drill it to the front panel so that all 60 terminal posts are correctly registered—within the play of the rubber grommets that insulate the board from the panel if the latter is metal.

Using Fig. 3. as a guide, press fit each terminal post into place on the foil side of the board, making sure that each post is vertical to the board. Press the posts down so that the first ferrule is in contact with the board. Solder them in place. After soldering, turn the board over and either stake or cement (with epoxy) each post in place. Mount the other components in accordance with Fig. 4, using a low-power iron and fine solder. Note that not all of the IC's are mounted the same way. Follow the notch and dot code on each IC body to position it correctly.

The three switches are mounted ¼″ below the component side of the board on a suitable standoff bracket. L-brackets are then attached to the component side of the board as shown. These brackets will be used to support the PC board assembly on the case.

Prepare the front panel as shown in Fig. 5. Be sure that the holes in the panel align with the appropriate components—terminal posts, switches, and potentiometers. Drill holes for and mount the 13 pilot light lenses. In the prototype, orange lenses were used for the four IC displays, blue for the two-input gates, red for the two buffers, and green for the three switch indicators. These lenses press fit into place and can be glued for extra security. The holes for the terminal posts should have enough leeway to permit the installation of ¼″ grommets. (As noted in the Parts List, a front panel can be purchased.)

Before attaching the PC board to the front panel, wire up the pilot lights. Check that you have enough lead length on each lamp so that it can be fitted into place before mating the board with the front panel. Place a couple of ¼″ insulating spacers (nylon nuts are fine) over a few of the terminal posts to keep the board from contacting the metal front panel.

Ease the front panel and PC board together slowly, starting by aligning each grommet on its post and applying only enough pressure to register against the grommets. As you ease the two components together, apply pressure to each grommet every time around. After several "rounds" of pressure, the board and front panel can be seated together perfectly. The operation is simple; but, if you hurry, a grommet may pop out. If you ever want to separate the board from the panel, simply reverse the procedure (see Fig. 6).

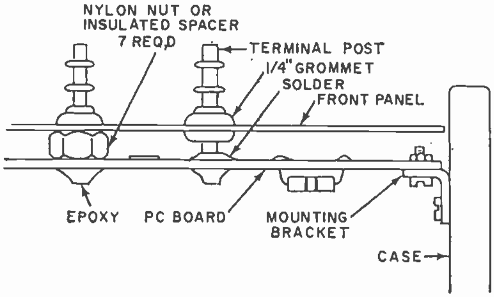



Fig. 6. Nylon spacers prevent circuit board from shorting against metal front panel. Rubber grommets keep terminal posts from contacting panel.

The supporting case is made from wood or particle board and may be covered with vinyl if desired. The PC board and front panel assembly is fitted into the case and secured with wood screws through the L-brackets. The power transformer is then attached to the cabinet interior as desired and wired to the board. Though they are not really necessary, an optional on-off switch and fuse may be added at this time.

**Making the Zip Leads.** The wires used to make connections on the front panel are called "zip" leads. Each is made of a length of insulated wire (size is not critical but #22 is good), two ⅜″-long pieces of heat-shrinkable tubing, and two 5/32″-diameter plated hair pin cotters. Unplated hair pin cotters, such as GC Electronics #7378, may be used if they are cleaned carefully before soldering.

For general experimenting, about 40 leads (perhaps 30 red ones 6″ long and 10 yellow ones 10″ long) will be required. To make a zip lead, cut the wire to the proper length and strip ¼″ of insulation from each end. Slip a piece of heat-shrinkable tubing over each end and solder a hair pin cotter to each end. Then

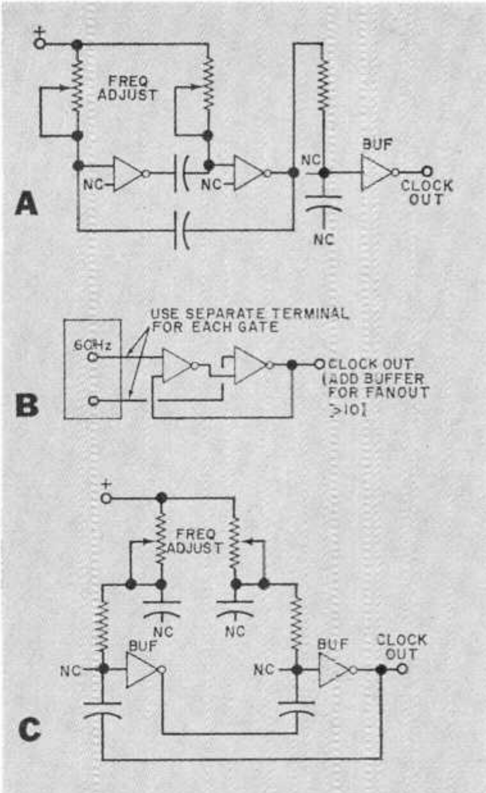
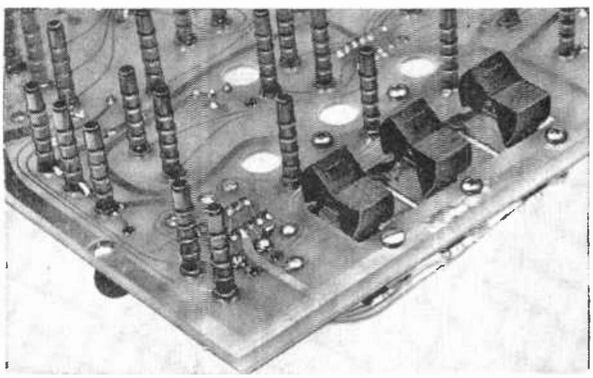



Fig. 7. Clock circuits you can use to automatically cycle your logic experiments include: (A) visual rate, (B) 60-hertz, and (C) high-frequency audio configurations.

slip the tubing over the joint and heat it to shrink it in place. You can do a very neat shrinking job by holding the tubing lightly against the ceramic portion of a screw-in-element soldering iron and rotating slowly.



Terminal posts insert through foil side of board, soldered to foil, and exposed to component side.

## OVER A HUNDRED CIRCUITS YOU CAN BUILD WITH THE MICROLAB

**GATES AND BUFFERS:**
Buffer amplifier, positive pulser, negative pulser, high- or low-frequency astable; logic demonstrators—2-input OR, NOR, AND, NAND, EXOR, EXNOR, positive or negative logic, 3-input OR, NOR, AND, NAND, positive or negative logic, 4-through-8-input OR, NOR, positive and AND/NAND negative logic; binary encoder and decoder; inverter demonstrator.

**TYPES OF MULTIVIBRATORS:**
RS flip-flop; set-reset latch; edge trimmer latch; monostable multi-, high-, or low-frequency, buffered or load-isolated; half monostable; reset pulse generator; astables, including load isolated, sure start, symmetric, VCO, and negative recovery types; frequency doublers and quadruplers; risetime improvers; squaring circuits; linear amplifier modification.

**COUNTERS, REGISTERS, AND SCALERS:**
Binary up or down counters, modulo 2,4,8, and 16; synchronous binary 2,4, and 8; shift registers, 1,2,3, and 4 bit; shift register counter, modulo 3,7, and 15; walking ring counters, 2,4,6, and 8, including protected 6 and 8; odd length walking ring counters, 3,5, and 7; factored counters, 2,4,6,8,9,10,12,14, and 16; halfway addition counters, 3,5,6,7,9,10,11,12, 13,14,15; pseudo-random counter sequencers 7 and 15; even-odd reduction modulo 3, 5, and 9; bucket brigade counters, open ended or closed, modulo 1,2,3, and 4; decoded counters, 2,3,4, and 5.

**OTHER CLOCKED FLIP-FLOP CIRCUITS:**
Sequential pass-ons, 1,2,3, and 4; divide-by-two synchronizer; gated divider; straight synchronizer; one-and-only-one; sequencer; demonstrators, JK, T, D, and RS; type D registers, rings, binary dividers, and sequential passons; disallowed state 2/6 and 2/8 demonstrators.

**DECIMAL COUNTERS:**
Modulo 10 minimum; inverted M-10-Min; 1-2-4-8; 1-2-4-5; excess 3; 1-2-2'-4; 1-1'-2-5 biquinary ring; quibinary ring; halfway addition modulo 10.

**DIGITAL TEST INSTRUMENTS, ETC:**
Bounceless pushbuttons; 60-Hz power line clock; visual rate clocks; audio high-frequency clock; state indicators; 0.1-second time base; synchronized 0.1-second time base; power line zero-crossing detector; synchronizers; buffer interface; contact conditioner; heads/tails machine; electronic die; pseudo and random number generators; gated oscillator; counter prescaler; reset pulse generator; signal injector; audio oscillator; electronic siren, doorbell, or panic alarm.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CIRCLE NO. 9 ON READER SERVICE PAGE

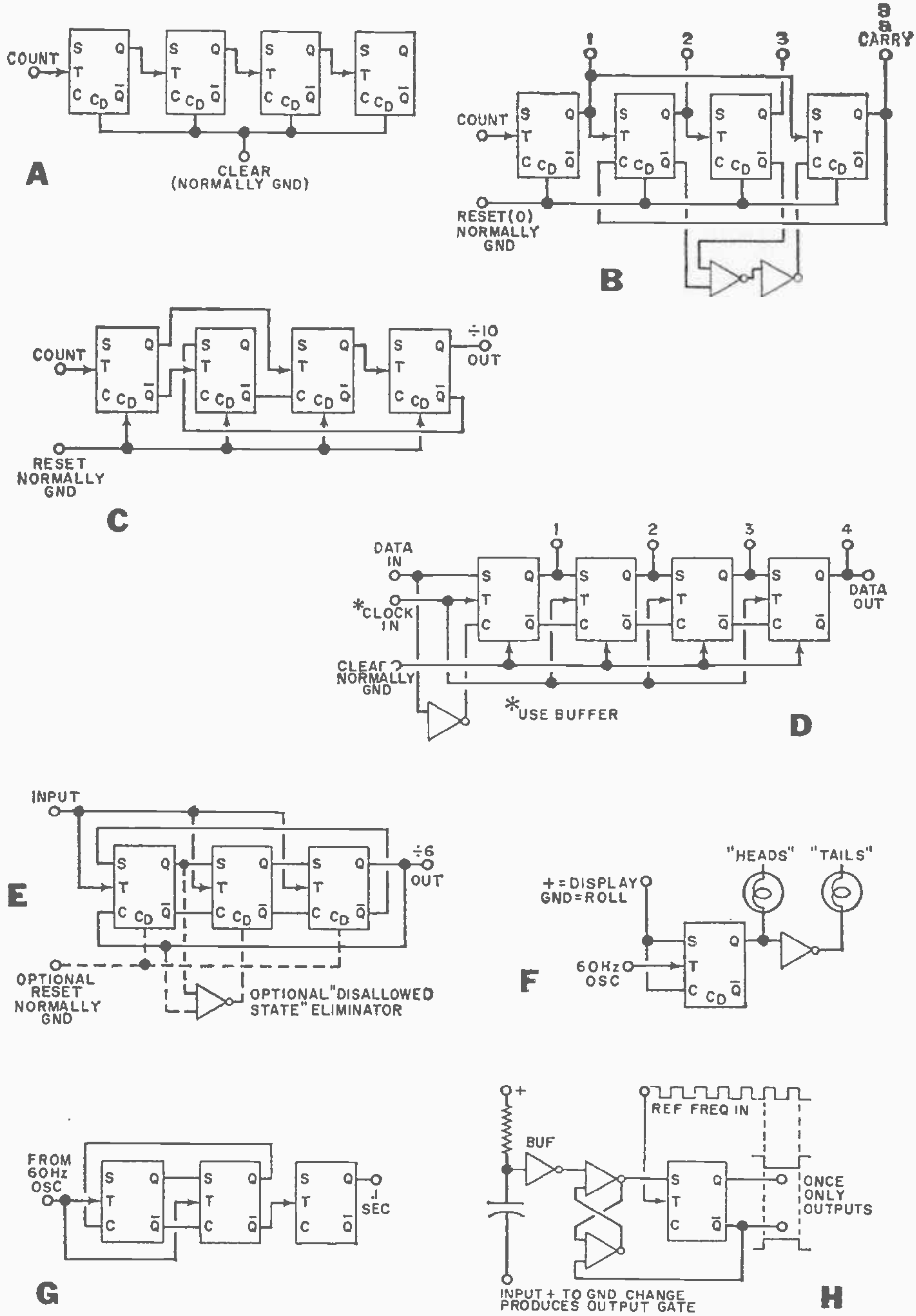



Fig. 9. Some popular digital logic demonstration circuits you can set up are: (A) divide-by-16 binary ripple counter; (B) "1-2-4-8" BCD divide-by-ten counter; (C) "modulo-10 minimum" divide-by-ten scaler; (D) four-stage shift register; (E) divide by six walking ring counter; (F) heads-or-tails "honest odds" coin flipper; (G) 0.1-sec time base (square-wave generator); and (H) "one-and-only-one" synchronizer.

**How to Use.** The manual prescribed in the Parts List gives many of the experiments you can perform with the Microlab. Many of the drawings are in logic block form and ready for instant breadboarding. Generally, you set up an experiment using a logic diagram and the zip leads and then put the circuit through all its possible states in one of several ways.

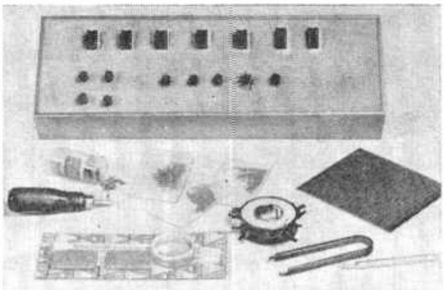
For instance, you can use the positive and ground reference posts and, by changing zip leads, cycle the circuit. Or you can use the actuators, either as slide switches or by rocking them with two fingers, as pushbuttons.

For automatic experimenting, you can drive the circuit from one of the "clocks" shown in Fig. 7. Figure 7A shows how to use the two *RC* networks to build a variable low-frequency oscillator that can cycle an experiment at an easy-to-watch, adjustable rate. Figure 7B shows how to build a 60-Hz power-line driven oscillator, which is useful for time bases, heads-tails and random-number circuits, and other cases where you want to cycle the logic faster. Finally, Fig. 7C shows how to create a high-frequency oscillator by cross-coupling the two buffers. This high-speed cycling circuit is most useful when you have an oscilloscope to observe the resulting waveforms or are cycling or testing an external digital instrument.

Several small numbers appear next to terminals on the front panel. These tell you either how much drive is available if the terminal is an output or how much drive is needed if the terminal is an input. For instance, the two-input gate has 13 units of drive available at its output and needs 3 units of drive at either of its inputs. With this gate, you can drive, say, two T inputs (5 units each) and an S input (3 units); but three T inputs (totalling 15) would be too much. Any time you run out of drive capability, run the output through a buffer. Either buffer output is powerful enough (77 units) to drive every input on the board simultaneously. Each of the three switches can put out 13 units of drive power. Use a buffer if you simultaneously (synchronously) drive all four T inputs.

Figure 8 shows some of the more popular digital demonstration circuits. Figure 8A is a binary ripple counter that counts to 16 and then repeats; B is a 1-2-4-8 decimal or divide-by-10 counter; C is a modulo-ten minimum-hardware decimal counter; D is a four-stage shift register; E is a walking-ring divide-by-six counter useful in digital clocks and as an electronic die; F is an honest-odds, heads-or-tails coin flipper; G is a 0.1-second time base and square-wave oscillator; H is a one-and-only-one synchronizer that can be used with the time base to get one precise 0.1-second gate under random command every time you flip the switch; I is a divide-by-3 counter; J is a divide-by-five counter; and K is a 15-state pseudo random-sequence generator.

—30—



### A DIGITAL LOGIC BREADBOARD

Sometimes, the digital logic experimenter would like to put together a circuit consisting of a mixture of 14- or 16-pin in-line IC's, round IC's, some transistors, etc. Obviously, he wants to avoid the constant soldering and unsoldering of IC or transistor leads, since this usually results in component damage.

To help this experimenter, the Vector Electronic Corp. (12460 Gladstone Ave., Sylmar, CA 91342) has a number of logic experimentation kits available. For example, the Model 29X ($59.75) consists of a 4½" x 14" perforated board supported on all sides by a 2" aluminum extrusion. The sockets provided include ten for 14-pin in-line IC's, two four 16-pin in-line IC's, four for TO-5 transistors (four-lead type), four for 8-lead and two for 10-lead round IC's, and ten 12-hole mounting pads to adapt round IC's to a square hole.

Although primary connections are made through vinyl covered clip leads (50 provided), the kit also includes a mixture of other types of wire connectors used to make up your own test leads. In addition, there are an IC extractor tool, 200 small clip terminals for external component mounting, all required hardware, a couple of small perforated boards, and extra copper wire including 20 feet of the solder-through type. The board can be made without a single solder joint. Once a circuit has been confirmed, the board can be "cleaned off" to await the next project.

# Electronics Geography Quiz

BY THOMAS HASKETT

ANYONE who works, studies, or experiments in the field of electronics will sooner or later associate certain cities with well-known electronics manufacturing facilities. For instance, what electronics manufacturer do you think of when Harrison, N.J. is mentioned? RCA Electronic Devices, of course. While there may be other smaller companies there, chances are you thought of the one most well-known.

This little quiz is divided into three parts: Easy, Difficult, and Very Difficult. Even a duffer should be able to get 9 or 10 of the Easy ones. If you do that well on the Difficult, you're pretty well-informed about locations; and if you get 10 or more in the third category, you're an expert on Electronics Geography. See how well you can do—and no fair peeking at the advertisement in this magazine. Match the cities on the left with the companies on the right. Note that for some cities, a group of manufacturers is listed.

(*Answers on page* 104)

### PART I: EASY

| | | |
|---|---|---|
| 1 G | Harrison, N.J. | A. R.L. Drake |
| 2 ___ | Benton Harbor, Mich. | B. Edmund Scientific |
| 3 ___ | Brooklyn, N.Y. | C. Bogen |
| 4 ___ | Skokie, Ill. | D. Ohmite |
| 5 ___ | Indianapolis, Ind. | E. Sencore |
| 6 ___ | Orchard Park, N.Y. | F. Allied Radio |
| 7 ___ | North Adams, Mass. | Belden |
| 8 ___ | Owensboro, Ky. | B & K Mfg. |
| 9 ___ | Paramus, N.J. | Switchcraft |
| 10 ___ | Chicago, Ill. | G. RCA Electron. Div. |
| 11 ___ | Addison, Ill. | H. Heath Co. |
| 12 ___ | Bluffton, Ohio | I. Xcelite |
| 13 ___ | Buchanan, Mich. | J. Eico |
| 14 ___ | Barrington, N.J. | Sonar |
| 15 ___ | Miamisburg, Ohio | K. Sprague |
| | | L. Howard W. Sams |
| | | P.R. Mallory |
| | | M. Triplett |
| | | N. Electro-Voice |
| | | O. G.E. Tube Div. |

### PART II: DIFFICULT

| | | |
|---|---|---|
| 1 ___ | Waseca, Minn. | A. H.H. Scott |
| 2 ___ | Newark, N.J. | B. ITT Semiconductor |
| 3 ___ | Hicksville, N.Y. | C. Amperex |
| 4 ___ | Evanston, Ill. | D. Astatic |
| 5 ___ | Malden, Mass. | E. 3M Co. |
| 6 ___ | Conneaut, Ohio | F. Delco Radio |
| 7 ___ | Rockford, Ill. | G. E.F. Johnson |
| 8 ___ | Redwood City, Calif. | H. Shure |
| 9 ___ | W. Palm Beach, Fla. | I. Ampex |
| 10 ___ | Kokomo, Ind. | J. Acoustic Research |
| 11 ___ | Peoria, Ill. | K. Winegard |
| 12 ___ | Maynard, Mass. | L. GC Electronics |
| 13 ___ | Burlington, Iowa | M. Blonder-Tongue |
| 14 ___ | Cambridge, Mass. | N. James Millen |
| 15 ___ | St. Paul, Minn. | O. Rohn Towers |

### PART III: VERY DIFFICULT

| | | |
|---|---|---|
| 1 ___ | Cleveland, Ohio | A. Hewlett-Packard |
| 2 ___ | Quincy, Ill. | B. Tektronix |
| 3 ___ | Cedar Rapids, Iowa | C. Grommes |
| 4 ___ | Beaverton, Ore. | D. New-Tronics |
| 5 ___ | Liberty Corner, N.J. | E. Energy Conv. Dev. |
| 6 A | Palo Alto, Calif. | F. Pearce-Simpson |
| 7 ___ | El Segundo, Calif. | G. Jackson Instru. |
| 8 ___ | Troy, Mich. | H. Measurements Inc. |
| 9 ___ | Santa Ana, Calif. | Ballantine Labs. |
| 10 ___ | Boonton, N.J. | I. International Rect. |
| 11 ___ | Miami, Fla. | J. Squires-Sanders |
| 12 ___ | Spartanburg, S.C. | K. Langevin |
| 13 ___ | Franklin Park, Ill. | L. Gates Radio |
| 14 ___ | Dayton, Ohio | M. Turner Microphone |
| 15 ___ | Garden City, N.Y. | Collins Radio |
| | | N. Reeves Instrument |
| | | O. Quietrole |

# The FRISKY FOUR SPEAKER SYSTEM

*Small speakers give top response*

BY DAVID B. WEEMS

THE IDEA OF USING several small loudspeakers in a single enclosure to obtain full-range sound was popularized by the "Sweet Sixteen" system described in POPULAR ELECTRONICS in January 1961. That system consisted of 16 inexpensive replacement-type speakers and utilized close coupling to achieve a fair bass range response.

In the years since the Sweet Sixteen appeared, there has been a revolution in small speaker design. Now some small speakers have a free air resonance that is from one to four octaves below that of the common replacement-type speakers of the same diameter. When a single low resonance speaker can surpass the bass response range of several replacement types, there is little advantage in using a large number of speakers for good bass response, unless you have some special application in mind.

For conventional direct radiator systems, it is probably easier and less expensive to obtain full bass response with a single woofer. Hence, the number of small speakers used in a system should be limited to a figure which will keep the total cost less than the combined price of a large woofer, mid-range speaker, and tweeter.

The "Frisky Four" speaker system

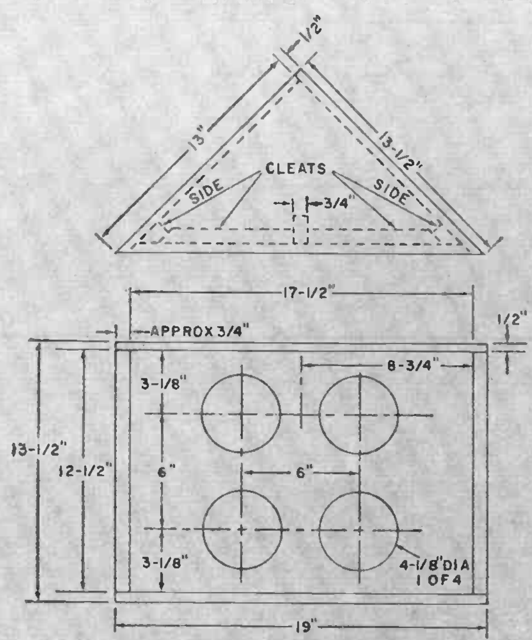



Fig. 1. Due to small size and triangular configuration, enclosure can be almost entirely assembled with nails only.

### BILL OF MATERIALS

*4—Loudspeakers (No. XS-510, $3.50 each from McGee Radio Co., 1901 McGee St., Kansas City, Mo. 64108)*
*1—17½" x 12½" piece of ½" plywood for speaker mounting board*
*1—13½" x 12½" piece of ½" plywood for side*
*1—13" x 12½" piece of ½" plywood for side*
*1—13⅝" x 13⅝" piece of ½" plywood, cut diagonally from corner to corner to make top and bottom plates*
*1—38" length of 1" x 2" pine for side cleats and brace*
*1—30" length of ¾"-square pine for top and bottom cleats*
*1—72" length of ¾" molding for trim*
*1—Two-lug screw-type terminal strip*
*14—#8 x 1" flathead wood screws*
*3—Plastic furniture glides or rubber bumper tacks*
*13—#8 x 1¼" flathead wood screws*
*16—#8 x ½" pan-head sheet metal screws*
*Misc.—Finishing nails (see text); wire brads; glue; gasket material (see text); grille cloth; sound-absorbent material; speaker cable; solder; etc.*

described here employs four $3.50 speakers. The price tag makes sense, especially for speakers with rolled-edge suspensions and large (10-oz) magnet assemblies. And four speakers can be housed in a small enclosure that saves space as well as money. Frisky Four somewhat describes the transient response of the speaker system's nimble little cones.

**About the System.** The enclosure (see Fig. 1), designed to use a room corner for better air loading on the cones, aids the bass response. Another advantage to the triangular enclosure configuration is the absence of parallel walls; internal reflections are reduced and structural rigidity is improved, permitting simplified construction.

Working together, the speakers and enclosure produce good sound. The system is particularly good for use with low-power amplifiers because its efficiency at low volume levels conserves audio power.

A typical location for the system in your listening room is on a corner table. If such is not available, there are many other possibilities, such as the upper corner of the room. The enclosure can be hung on the wall like a framed picture or even supported by a pole lamp. However, the junction of two walls and the ceiling is an ideal location for maximum bass response. One enclosure in each of two adjacent ceiling corners will give very good stereo coverage. An alternate possibility is a floor corner, but make sure the sound path is not blocked by furniture.

**Construction.** Assembly of the enclosure is quick and easy due to the use of finishing nails and glue on the sides, top, and bottom. Such construction techniques, though not suitable for a large enclosure, are quite adequate for a small box enclosure.

Referring to Fig. 1, cut the sides, top, and bottom plates, and the speaker mounting board to the dimensions given. Notice also that you will have to make several 45° miter cuts, one at the front edge of each side, one at each end of the speaker board, and one for each of the side cleats. To save time, the angled edges of the side cleats can be made with one pass of the saw. Simply set your saw at 45° and rip the length of a 1″ × 2″ pine stud into two strips of equal thickness. The lengths can be trimmed to the proper dimensions later.

Strike a line on the inside surfaces of the top and bottom plates, spaced ½″ in from the front edges, to show the location of the inside surface of the speaker board. Then begin assembling the enclosure by joining the sides at the rear corner. Make sure that the longer wall overlaps the shorter one. Put glue on the surfaces being joined. Then set the shorter side in a vise, or have someone hold it upright on a solid surface, while you drive in the six-penny finishing nails. Wipe off excess glue after nailing.

Now, glue and nail the top and bottom plates to the walls as shown in Fig. 2. Cut the side cleats to the proper lengths. Glue and nail or screw the cleats in place as in Fig. 3. Three-penny finishing nails are adequate for anchoring these cleats in place if C-clamps are used to apply pressure while the glue sets. Otherwise, you will have to substitute 1″ flathead wood screws.

The positions of the side cleats are defined by the lines on the inside surfaces of the top and bottom plates. Seat the cleats behind the lines, leaving space between each cleat and the line to allow for the compressed thickness of the gasket material you plan to use.

Cut a length of 1″ × 2″ pine to exact length for the center brace. Locate the brace behind the lines the same distance as the side cleats. Then glue and nail it in place by driving two six-penny nails through the top and bottom plates and into the butt ends of the brace.

Trim four ¾″-square lengths of pine to the exact lengths to fit between the


Fig. 2. Liberal bead of white glue between joined members helps to rigidize enclosure and provides air seal. Finishing nails anchor members together.

Fig. 3. Side cleats are miter cut at 45° angles; then glued and nailed to sides, ½" in from front.

brace and side cleats, cutting one end of each to 45° as shown in Fig. 4. Glue and nail or screw the cleats to the top and bottom plates. Then sand and stain the enclosure shell.

Assuming that you have already made the speaker cutouts as shown in Fig. 1, now you must drill about thirteen 11/64" guide holes for mounting the speaker board. Locate a vertical row of three holes about 1¼" in from each mitered outside edge of the speaker board, and a vertical row of three holes down the center of the board. Then drill one hole between each vertical row, top and bottom. Mark each guide hole location. Then set the speaker board temporarily in place to check for possible positioning errors. When you are satisfied, remove the speaker board, and apply a coat or two of flat black paint to its front surface and the insides of the cutouts.

Remove sawdust and other debris from your work surface. Set the speaker board face down, and mount the speakers with #8 × ¾" pan-head screws as shown in Fig. 5. Then, referring to Fig. 6, wire together the speakers. (Note: When wiring the speakers, set the enclosure shell nearby so that you can route the cable that connects the parallel wired pairs *behind* the center brace.)

Now, check the speaker polarity by momentarily touching the contacts of a D cell to the free ends of the wiring. All speaker cones in the system should move in the same direction at contact. Any that move in the opposite direction should be desoldered and the leads transposed and resoldered. Connect the bat-

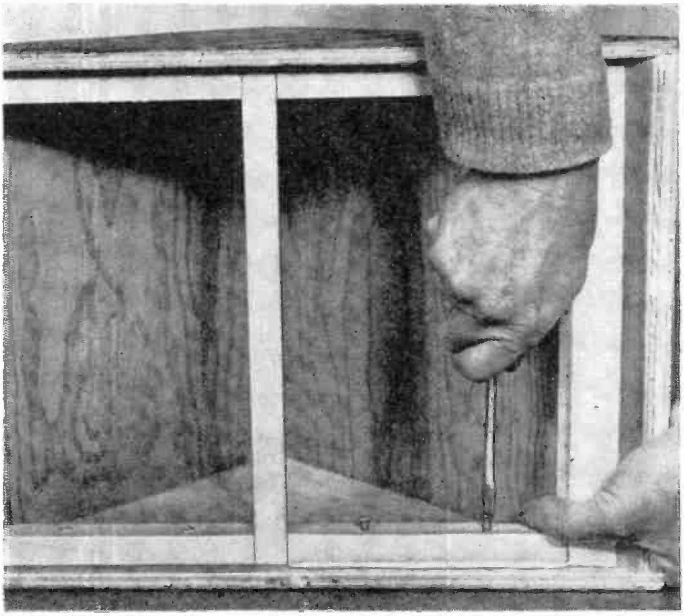


Fig. 4. Front cleats are mounted on top and bottom plates between center brace and sides.

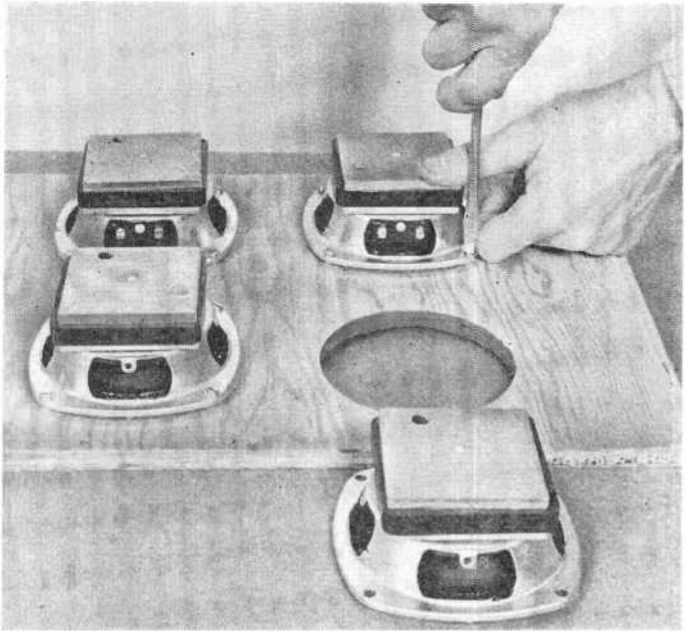


Fig. 5. Fasten loudspeakers to speaker mounting board with #8 x ½" pan-head sheet metal screws.

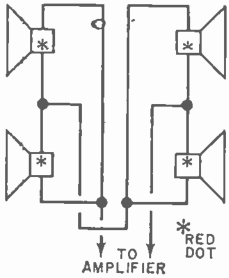



Fig. 6. Parallel-series speaker hookup is required to preserve uniformity and standard impedance. Note carefully red dot orientations. When properly wired, system connects to 8-ohm output.

tery again so that the cones move *outward*; code the wire touching the positive terminal of the battery.

Due to the angled fitting and large area of the speaker mounting board as compared to the small volume of the enclosure, air leaks might present a problem. To obviate any such problems, a gasket should be used. It can be adhesive-backed foam rubber, thin cork, or felt. Or you can run a bead of silicone rubber caulking compound along the outer surfaces of the cleats; this method provides a positive seal even for loose-fitting parts, but it makes access to the speakers difficult—if not impossible.

Another point to seal is the exit hole for the speaker cable. One method is to use a two-lug screw-type terminal strip, located at the center of the bottom plate of the enclosure. Mark and drill two ¼" holes to accept the solder lugs. Then use the drill bit to ream out one side of the holes so they are large enough to accept both solder lug and screw end. Pass the speaker cable through the holes and solder them to the lugs. Code the screw terminal connected to the wire previously coded. Then glue and screw the terminal strip down, and attach three plastic furniture glides or rubber bumper tacks about 2" from each corner of the bottom plate.

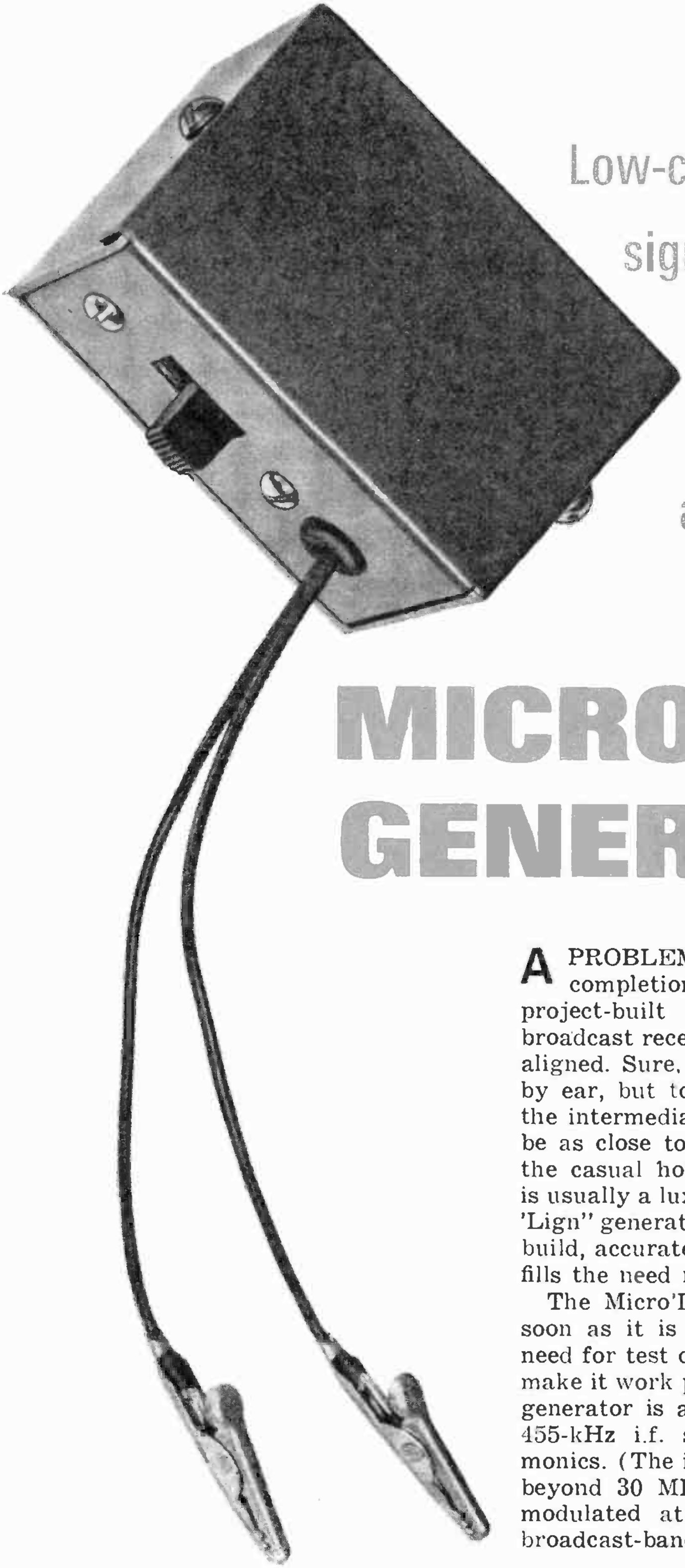
Stuff the enclosure with fiberglass or other sound absorbent material. Begin by lining the top, bottom and sides. Then loosely fill the empty space in the middle with glass wool or cut-up pieces of fiberglass wool.

Attach the speaker board with about four evenly spaced screws and give the system a test run at normal listening volume. You can experiment at this stage by removing or adding stuffing until the sound reproduction meets with your approval. Then install the speaker board with #8 × 1¼" flat-head wood screws.

Tack or staple a 12½" × 18" piece of grille cloth over the front of the enclosure. Then select a decorative molding to cover the raw edges of the wood and staples or tacks. Cut the molding to size, stain and finish it to match the enclosure shell, and use small wire brads to affix it in place.

If you are an apartment dweller, limited to low volume levels, you will like the Frisky Four. Some systems, particularly those with large speakers, must be driven at high levels in a large room for maximum enjoyment. This is not a matter of efficiency but of final sound intensity. The Frisky Four, however, sounds good at a low level in a small room like those in apartments. Try one and see for yourself. —30—

BY MICHAEL S. ROBBINS



Low-cost signal source for a.f./i.f./r.f.

# MICRO'LIGN GENERATOR

A PROBLEM often encountered upon completion of a kit- or magazine project-built radio receiver for AM broadcast reception is getting it properly aligned. Sure, you can tune the receiver by ear, but to get it to track properly, the intermediate frequency (i.f.) should be as close to 455 kHz as possible. For the casual hobbyist, a signal generator is usually a luxury. However, the "Micro-'Lign" generator, an inexpensive, easy-to-build, accurate a.f./i.f./r.f. signal source, fills the need nicely.

The Micro'Lign is "on frequency" as soon as it is assembled so there is no need for test or calibration equipment to make it work properly. The output of the generator is a 500-Hz audio tone and a 455-kHz i.f. signal, both rich in harmonics. (The i.f. harmonics are usable to beyond 30 MHz.) The 455-kHz output, modulated at 500 Hz is used in AM broadcast-band work for i.f. alignment, and modulated signals at 910 kHz and 1365 kHz are for r.f. alignment. The 500-Hz signal is also useful for troubleshooting the audio stages of a receiver or other audio circuits.

**How It Works.** The r.f. oscillator (*Q3* circuit in Fig. 1) is a variation of the Hartley or Colpitts circuit, but it uses a Clevite Transfilter, *XTAL,* in place of the usual coils and capacitors. The Transfilter is a piezoelectric device consisting of a plated ceramic disc. The disc has natural mechanical vibration modes which can be induced by applying a voltage to the plated terminals.

Transistor *Q3* amplifies the signal produced by the vibrating disc in *XTAL* and feeds it back in the proper phase to sustain oscillations. Initial oscillations are caused by the sudden application of voltage to the circuit when power switch *S1* is closed. The Transfilter oscillator then produces the 455-kHz "r.f." signal and its harmonics.

Audio for amplitude modulation is produced by the astable multivibrator circuit consisting of transistors *Q1* and *Q2*. A voltage divider made up of resistors *R1* and *R2* is used to supply audio and the oscillator voltage from *B1* to *Q3*. The use of the divider insures that *Q3* will oscillate even on the audio half-cycles when *Q1* is cut off.

**Construction.** To keep construction simple, it is suggested that you use a printed circuit board for parts mounting. You can make your own board from the full-size etching guide provided in Fig. 2, or you can buy one already etched and drilled from the source given in the Parts List.

In assembling the circuit, notice that all components, with the exception of the Transfilter, mount on the top of the

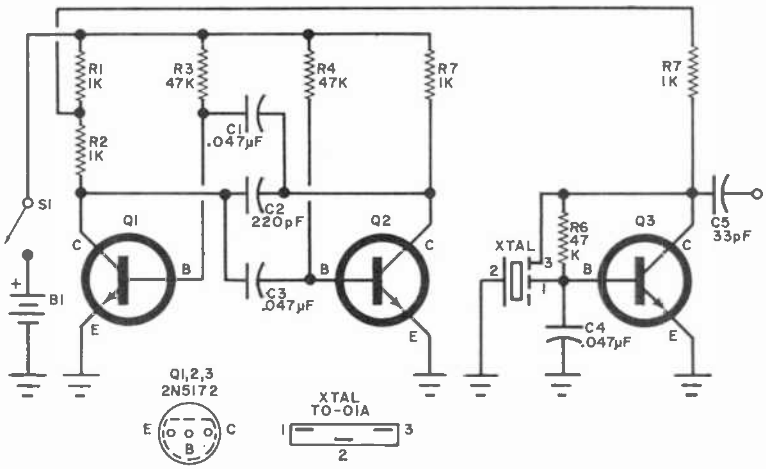



Fig. 1. Generator consists of crystal-controlled r.f. oscillator Q3 and Q1/Q2 multivibrator which provides amplitude modulating signal.

## PARTS LIST

*B1—9-volt transistor battery*
*C1,C3,C4—0.047-μF, 10-volt disc capacitor*
*C2—220-pF disc capacitor*
*C5—33-pF disc capacitor*
*R1,R2,R5, R7—1000-ohm, ¼-watt resistor*
*R3,R4,R6—47,000-ohm, ¼-watt resistor*
*S1—S.p.s.t. printed-circuit-type slide switch*
*XTAL—Transfilter (Clevite Corp. No. TO-01A)*
*1—2¼" x 1½" x 1⅜" chassis box (LMB No. M00, available from Newark Electronics—No. 91F1105—or similar)*
*Misc.—Printed circuit board; battery connector; miniature alligator clips (2); hardware; hook-up wire; solder; etc.*
*Note—A complete kit of parts (including Transfilter, battery, printed circuit board, chassis box, and all components) is available for $7.95, postpaid, from Kits Industries, Inc., 16774 Schoenborn St., Sepulveda, CA 91343. Clevite Transfilter is available from Semiconductor Specialists, Inc., P.O. Box 66125, Chicago, IL 60666, or from Kits Industries for $1.75. Printed circuit board is available separately from Kits Industries for $2.*

circuit board (see parts placement photo in Fig. 2). The transfilter mounts on the foil side of the board. It must be mounted as close as possible to the board and carefully soldered with a miniature soldering iron.

The ground connection can be made to the chassis by soldering it to a #6 solder lug mounted between the switch tab and chassis.

The slide switch holds the small circuit board in place inside the chassis box by bolting the switch to the front of the box after bringing out the signal and ground leads from the board as shown in the photo on the first page of this article. This allows you to mount the battery directly behind the circuit board. Then place a piece of sponge rubber or other insulating material between the battery and bottom of the circuit board. Finally, solder alligator clips onto the output leads, and assemble the box.

**How To Use.** Connect the output lead clips of the Micro'Lign together to form a loop, and place the loop near the ferrite rod antenna of an AM broadcast receiv-

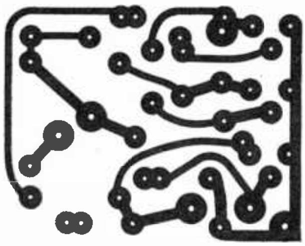
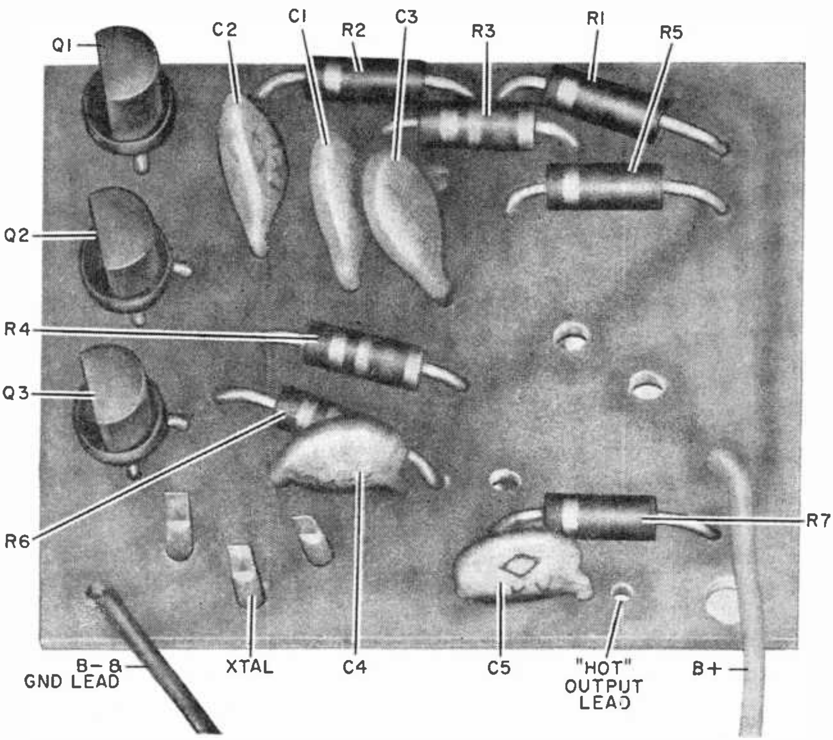
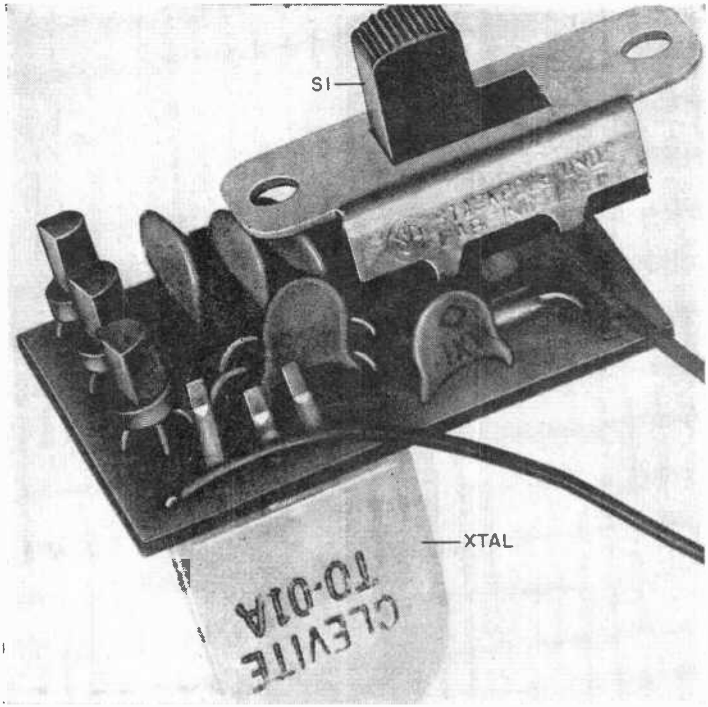


Fig. 2. Actual size printed circuit etching guide is shown at left. Photo below shows component placement (except S1) on board.






Special Clevite Transfilter must be seated on circuit board from foil side; switch S1 mounts on top (component side) of board.

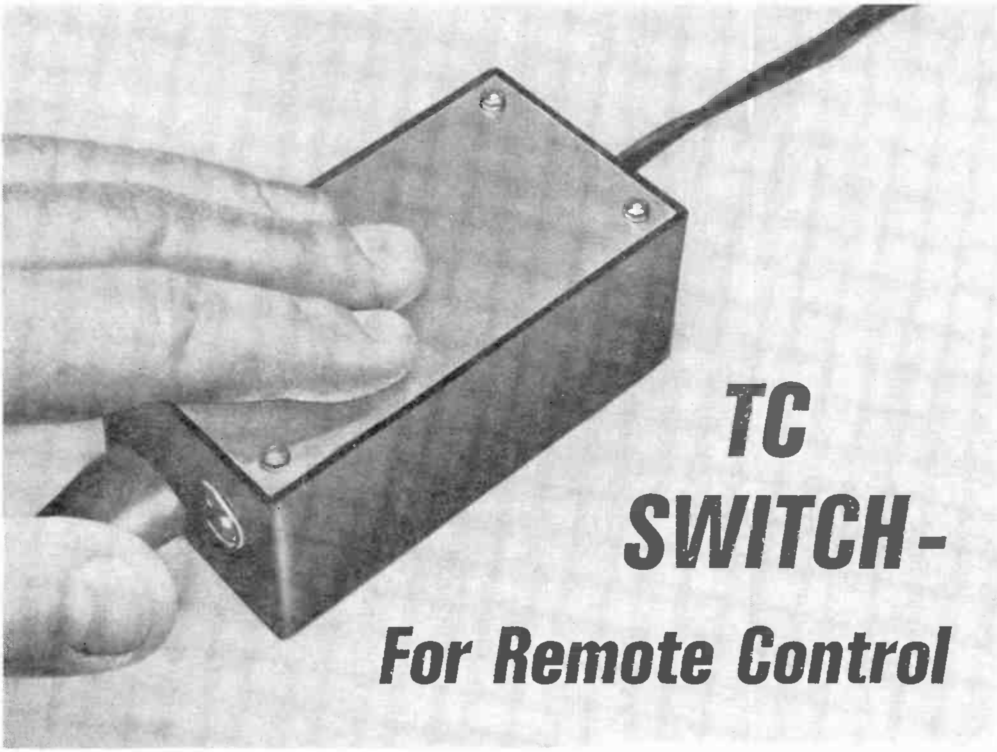
er. Tune the receiver to its lowest frequency (535-540 kHz, if the dial markings go that low). Turn on the receiver.

With the receiver volume turned up, you should hear the 500-Hz tone coming from its speaker. However, if you do not hear the tone, or the tone is too low in volume, move the Micro'Lign's loop closer to the antenna; if too loud, move the loop farther away. Now, adjust the i.f. transformer slugs to obtain the loudest note. Move the Micro'Lign away from the receiver until the note volume diminishes, and adjust the slugs again for maximum volume. Do this until you hear no perceptible change in the level of the note.

After peaking the i.f. transformers, turn off the Micro'Lign. Tune in a station at the low end of the receiver dial and adjust the oscillator coil slug and the setting of the station selector until you hear the broadcast on the correct dial setting. Now, tune in a station at the top end of the receiver dial, and adjust the oscillator trimmer capacitor and the setting of the station dial until the station comes in at the proper dial setting. Repeat this procedure at the low and high ends of the dial until no further change is noted.

Again, turn on the Micro'Lign. Tune in the generator's signal at 910 kHz on the receiver dial. Move the Micro'Lign away from the receiver until you can barely hear the signal. Adjust the antenna trimmer capacitor for maximum volume level.

The Micro'Lign can also be used as a signal injector for troubleshooting the audio and i.f. stages in both tube and transistor type receivers. It can even be used to trace troubles in high quality amplifiers. -30-



# TC SWITCH- For Remote Control

ONE TOUCH, IT'S ON—ANOTHER, IT'S OFF

BY JACK BECHTOLD

WHEN YOUR "lazy streak" gets the upper hand and convenience is the most important thing in the world, that's when you want a "Touch Control Switch." With this handy device you can turn off the television without getting out of bed; you can start the coffee to perking without moving from the dining table; and you can turn on the lights when you come in the house with your arms full of packages.

The Touch Control Switch can be located any place where a wall outlet is available. The appliance or light to be controlled is then plugged into the TC Switch and can be turned on or off with a simple touch of the finger, wrist, elbow, etc. The touch plate can be located remote from the TC Switch itself to make control even more convenient and versatile.

**About the Circuit.** The circuit of the TC Switch is composed of five main sections—detector, pulse shaper, switch memory, switch, and power supply. Alternate touches of a metal plate toggle on and off a triac, gated by a flip-flop circuit. The system operates around a multifunction integrated circuit (*IC1* in Fig. 1) which consists of an inverter, two inverter/buffer stages, and a J-K flip-flop.

Referring to the schematic diagram, when the user touches the touch plate, he creates the equivalent of small capacitance *Cb* which forms a series circuit with *C3* to provide a voltage divider across the a.c. line. As soon as the potential across *C3* exceeds the firing voltage of *I1*, *SCR1* triggers into conduction (the SCR is very sensitive, requiring only a few microamperes to trigger it). As long as contact is made with the touch plate, *SCR1* remains conducting on the positive alternations of the a.c. line, producing a low-voltage, half-wave rectified train of pulses across *R4*.

The pulse shaper section generates a

single trigger pulse from the first pulse across *R4*. The positive-going part of this first pulse passes through *D1* and *C4* and appears as a single pulse across *R6*. This pulse then passes through *D2* and is shaped by the inverter and one of the inverter/buffers in *IC1*. This pulse is then used to trigger the switch memory section. Resistor *R5* prevents *C4* from discharging quickly thus permitting only one trigger pulse each time the plate is touched.

The switch memory section is comprised of the flip-flop portion of *IC1* and another inverter/buffer. The flip-flop is operated in the toggle mode with alternate trigger pulses setting and resetting it.

The switch section, consisting of *Q1*, operates as follows: When the flip-flop is in the set state, the output of the inverter/buffer is high, permitting *Q1* to conduct and supply power to the load connected at *SO1*, the a.c. receptacle. In the "reset" state, no gate current is provided for *Q1* or the load. Since a d.c. voltage is used to gate *Q1*, the triac triggers into conduction very early in the line current cycle. This is essentially zero-crossing switching which generates very little radio-frequency interference (RFI), but *C2* is in the circuit as an added suppressor of RFI.

Low voltage for *IC1* is provided from the a.c. line through *C1* and *D3*, where *C1* stands in for a dropping resistor as a result of its capacitive reactance. Diode *D4* serves as a discharge path for *C1*, and *C6* is the filter to provide a fairly uniform level of d.c. from the rectified a.c. pulses.

**Construction.** The circuit of the TC Switch is best assembled on a printed

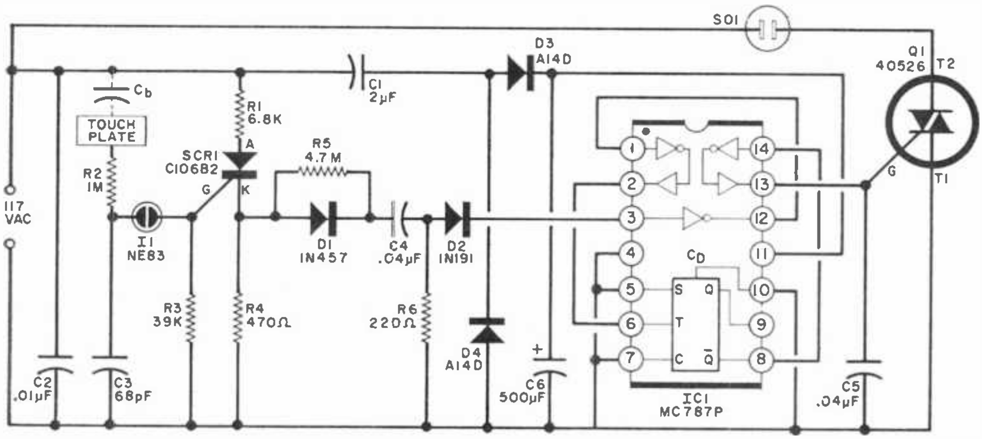




Fig. 1. In the schematic diagram, Cb is the operator's body capacitance when contacting metal touch plate.

## PARTS LIST

*C1—2-μF, 200-volt non-polarized capacitor*
*C2—0.01-μF disc capacitor*
*C3—68-pF disc capacitor*
*C4, C5—0.04-μF, low-voltage capacitor*
*C6—500-μF, 6-volt electrolytic capacitor*
*D1—1N457 diode*
*D2—1N191 diode*
*D3,D4—1-ampere rectifier (G.E. A14D or similar)*
*I1—NE83 neon lamp*
*IC1—Integrated circuit (Motorola MC787P)*
*Q1—Triac (RCA 40526, see text)*
*R1—6800-ohm*
*R2—1-megohm*
*R3—39,000-ohm*
*R4—470-ohm*
*R5—4.7-megohm*
*R6—220-ohm*
All resistors ½-watt
*SCR1—Silicon controlled rectifier (G.E. C106B2)*
*SO1—Chassis-mounting a.c. receptacle*
*Misc.—Bakelite case with aluminum cover (see text); a.c. line cord with plug; Wakefield No. NC209 finned heat sink for Q1; ⅜" spacers (4); 4-40 hardware (6 sets); heat-shrinkable tubing and epoxy potting compound (optional, see text); bare and insulated hookup wire; solder; etc.*

*Note: The following are available from Consumer Electronic Specialties, Inc., Box 326, S. Vineland, NJ 08360: PC board, \$2; kit of all parts \$13.50, postpaid. NJ residents add sales tax.*

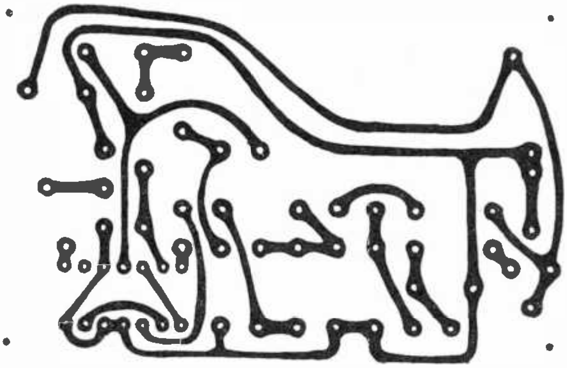
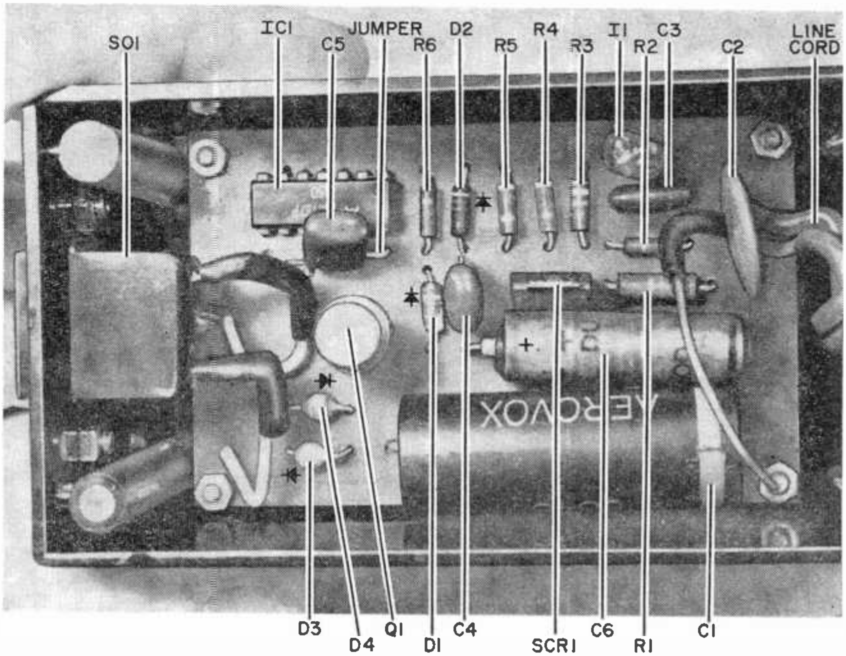


Fig. 2. Full-size etching guide is shown at left. Photo below shows component locations on circuit board and box ends.




circuit board (see Fig. 2 for etching guide and part location photograph) and mounted inside a plastic case that is equipped with an aluminum cover. The metal cover will then serve as a convenient touch plate.

Be very careful when soldering into place the solid-state components to prevent heat damage. Use a low-power soldering iron (not more than 40 watts) and a clip-on heat sink. Also, before mounting *Q1* slip on the finned heat sink specified in the Parts List.

After assembling the circuit, make the rectangular cutout and drill a ¼" hole at opposite ends of the plastic case for the a.c. receptacle and line cord entry, respectively (see Fig. 3). Now feed the free end of the line cord through the hole, tie a strain relief knot in it, and solder the conductors to the appropriate points on the circuit board. Then solder 2" lengths of hookup wire to the appropriate circuit board holes for the a.c. receptacle. Use ⅜"-long spacers and 4-40 hardware to mount the circuit board on the bottom of the case.

Next, mount the a.c. receptacle in place. Cut the leads coming from the circuit board to the appropriate lengths, strip the ends, and solder them to the lugs on the receptacle.

There should be an uninsulated lead still left to connect. This lead goes to the touch plate via one of the hold-down screws used to secure the aluminum cov-

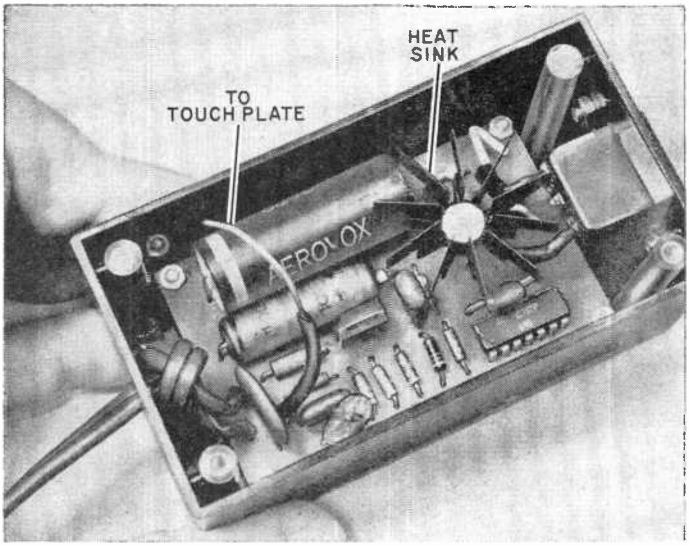



Fig. 3. Heat sink slips onto Q1's case; bare wire end goes to cabinet's metal cover plate.

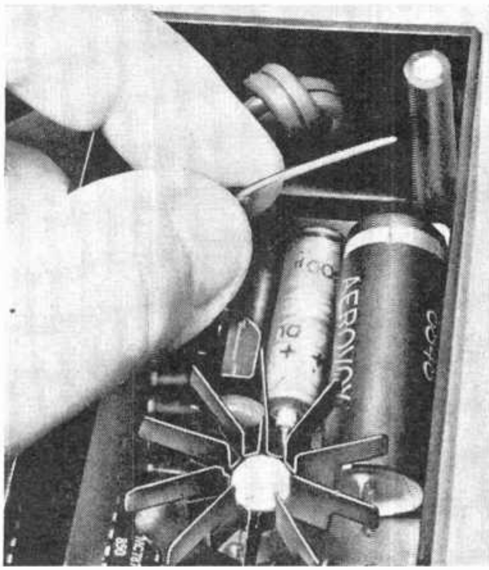



Fig. 4. Bare wire can be either wrapped around cover holddown screw or clamped in screw receptacle.

er. Cut this lead to a length of 3" and route the wire to the nearest screw hole, making sure it does not touch any other component or lead (see Fig. 4). Slip on the case cover, and secure it with the screws supplied.

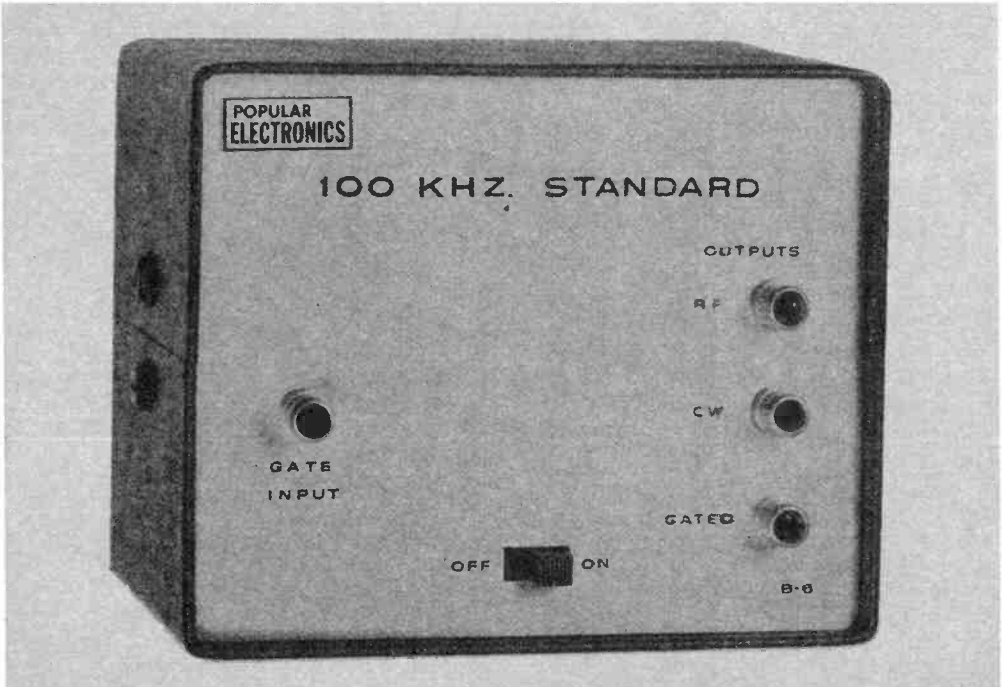
**How To Use.** Before using the TC Switch, it is a good idea to keep in mind that full line voltage is present at various points in the circuit. For this reason, it is recommended that you not operate the circuit with the cover of the case removed; if you must, exercise extreme caution. You can obviate any possibility of shock hazard if you epoxy encapsulate the entire circuit board before mounting and slipping heat-shrinkable tubing over the lugs of the a.c. receptacle.

Connect the lamp or appliance you wish to control to the TC Switch via the a.c. receptacle, turn on the appliance, and plug in the line cord of the touch switch. If the appliance immediately goes on, touch the metal plate on the touch switch; the appliance should go off. In the event that the lamp or appliance does not turn on immediately as the line cord is plugged in, touch the touch plate to turn it on. If nothing happens, reverse the line cord at the wall outlet.

For proper operation of the TC Switch, alternate touches of the metal plate should turn the appliance on and off.

The TC Switch, with the parts specified, will handle a maximum load of 150 watts. If you want to control an appliance with a greater drain, you can substitute a higher power triac for *Q1,* The RCA 40485, for instance, safely handles loads up to 720 watts (be sure to use the appropriate heat sink).

Instead of using the aluminum cover of the case as a touch plate, a remote touch plate can be used. This permits you to use a wall plate, mounted on a commercial wall box. However, make the distance between the project and remote touch plate as short as possible. -30-




# Build The 100-kHz Standard

## STABLE, ACCURATE SOURCE OF REFERENCE SQUARE WAVES

BY DON LANCASTER

A STABLE, accurate source of 100-kHz reference square waves has many applications—most of which are adequately filled by the "100-kHz Standard" described here. For the ham or SWL, it is a must for receiver calibration, providing a "birdie" every 100 kHz and, if desired, it can be adjusted to zero beat against WWV for optimum accuracy.

For general experimental and laboratory work, the Standard can be used as a top-notch calibrator for oscilloscopes and r.f. generators, since it has a very accurate frequency and excellent rise time (about 12 nanoseconds) for probe compensation.

In work involving digital IC's, the unit is a handy high-frequency clock source. For example the frequency can be divided to obtain ultra-precise time gates for an electronic counter. Or, the gate input can be used to start and stop the gate output making available a train of 10-$\mu$sec pulses that can be fed to the counter to measure the velocity of a bullet and perform other experiments in the laboratory.

**About the Circuit.** The 100-kHz standard employs a crystal and a single integrated circuit (*XTAL* and *IC1* in Fig. 1) in a very simple circuit. Three outputs are provided: CW (*J3*) for 100-kHz square waves all of the time; RF (*J2*) for wide-spectrum narrow (10-$\mu$sec) period spikes for receiver calibra-

IC EXPERIMENTER'S CORNER

NO. 3 of 5

tion; and GATED (*J4*) for the 100-kHz square waves only when a separate GATE INPUT (*J1*) is grounded. Application of +1-4 volts d.c. to the GATE INPUT removes the output signal.

In addition, an internal trimmer capacitor, *C5*, is provided to allow shifting the frequency approximately 100 Hz on either side of the crystal frequency to provide compensation for crystal tolerance, variations in supply voltage and temperature, and zero beating with WWV. A buffer stage between the oscillator and the outputs insures minimum constant loading.

Integrated circuit *IC1* consists of four two-input gates, two of which are biased into the class A region to act as linear amplifiers with resistors *R1* and *R2*. These amplifiers are cross-connected to each other through capacitors *C3* and *C4* and the crystal to form a feedback loop.

A third gate and *R3* provide an isolating buffer stage. The output of this gate goes to *J3* directly, and to *J2* through capacitor *C6* to provide only the sharp leading and trailing edges for the calibrator output.

The fourth gate is the only one in which the second input is used. This stage is used for gating the CW output

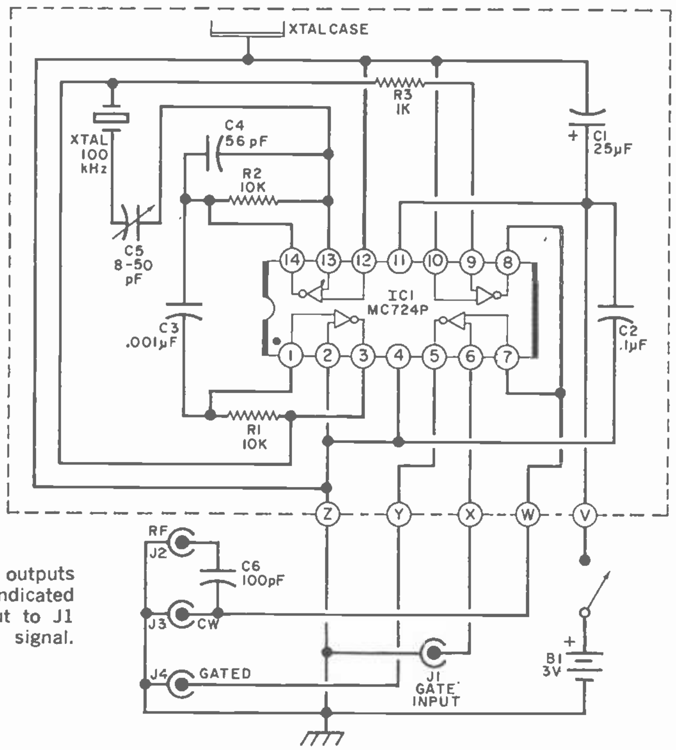



Fig. 1. Separate outputs are available, indicated near J2-J4. Input to J1 removes output signal.

## PARTS LIST

*B1—1.5-volt D cell (2)*
*C1—25-μF, 6-volt electrolytic capacitor*
*C2—0.1-μF disc capacitor*
*C3—0.001-μF, 50-volt Mylar capacitor*
*C4—56-pF mica capacitor*
*C5—8-50-pF screwdriver-adjustable trimmer capacitor*
*IC1—Quad two-input-gate integrated circuit (Motorola MC724P)*
*J1-J4—Phono jack*
*S1—S.p.s.t. switch*
*XTAL—100-kHz parallel resonant crystal, specified into 32-pF load*
*Mis.—Printed circuit board (see text); crystal holder and rivets; hardware for C5 if needed; 5" x 4" x 2½" vinyl-clad case; Keystone No. 176 battery holder; #6 hardware; hookup wire; solder; etc.*
*The following items are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216: etched and drilled printed circuit board No 173C for $9.85; complete kit of parts, including pre-punched case, but less batteries, No. 173b $2.15; postpaid in U.S.*

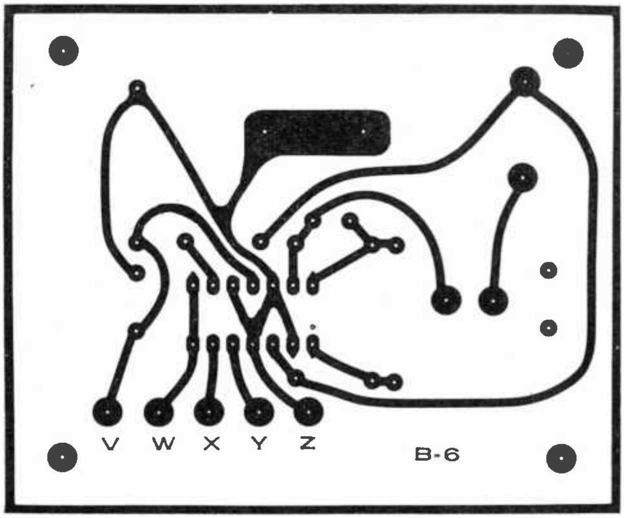



Fig. 2. Full-size printed circuit etching guide at left should be copied exactly as shown. Exercise caution to avoid short circuits between close proximity IC pin solder pads.

and, in turn, provide a gated output signal.

The crystal specified is a 100-kHz parallel-resonant type into a 32-pF load. When *C5* is set to 32 pF, the operating frequency will be the same as the characteristic frequency of the crystal. Increasing the capacity of *C5* decreases the crystal's operating frequency, and vice versa. This feature allows the user to "pull" the oscillator frequency to exactly 100 kHz.

**Construction.** A printed circuit board is recommended for this project. You can buy one already etched and drilled (see Parts List), or you can make your own by carefully following the etching guide provided in Fig. 2.

The first step in assembling the circuit is to rivet the crystal clip to the component side of the PC board in the appropriate location. Then mount the components on the board as shown in Fig. 3. Use a low-power, small tip soldering iron to solder the leads of *IC1* to the foil pattern, and apply heat just long enough to get the solder to flow.

Next, mount the circuit board to the front panel with #6 hardware and four ½″-long spacers. Interconnect the jacks, switch, and circuit board.

For a housing, you can use either the pre-punched vinyl-clad one specified in the Parts List or a 5″ × 4″ × 3″ metal

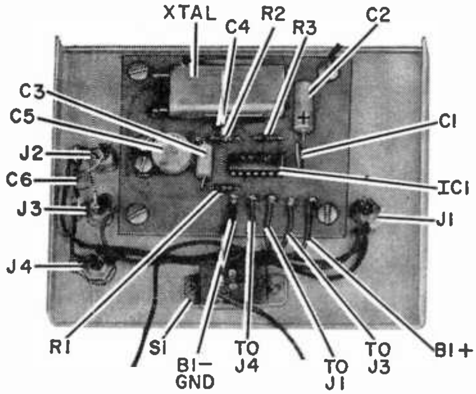
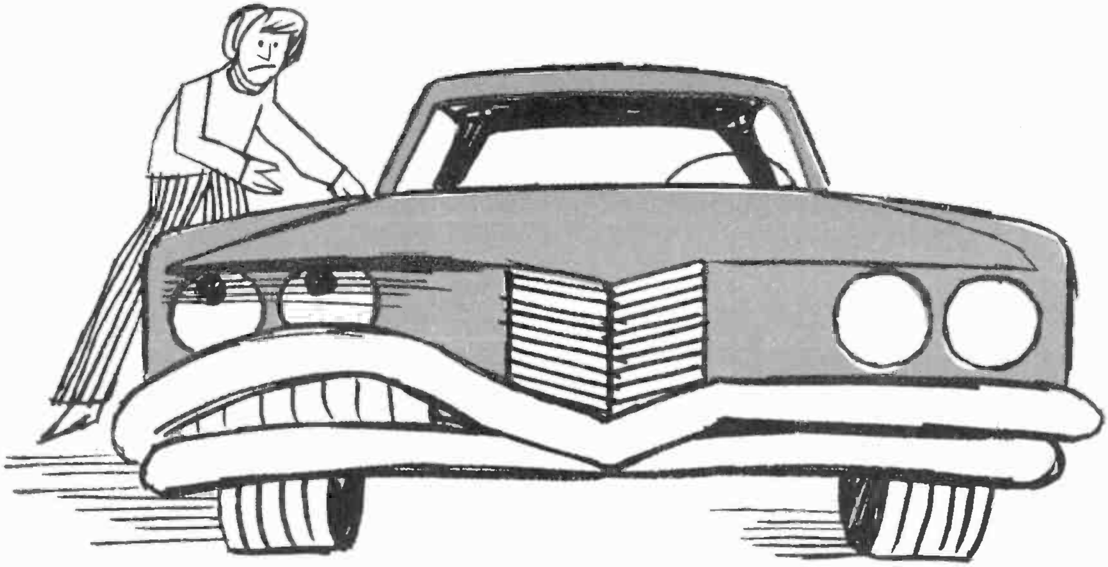



Fig. 3. Photo shows component locations on circuit board and front panel. Notch on IC1 is to left.

utility box. In either case, the batteries should be mounted to the rear of the case, and an access hole to *C5* should be drilled. (Note that both sides of *C5* must be "floating," precluding the use of a conventional panel-mounting variable capacitor; so do not attempt to substitute this component.)

**How To Use.** Calibration of the 100-kHz Standard is needed only for very exacting applications since the normal operating frequency of the standard will usually be well within a 99.9-100.1-kHz range. To calibrate, use either an electronic counter or a communications receiver tuned to a high-frequency WWV transmission. Adjust *C5* with an insulat-

*(Continued on page 105)*



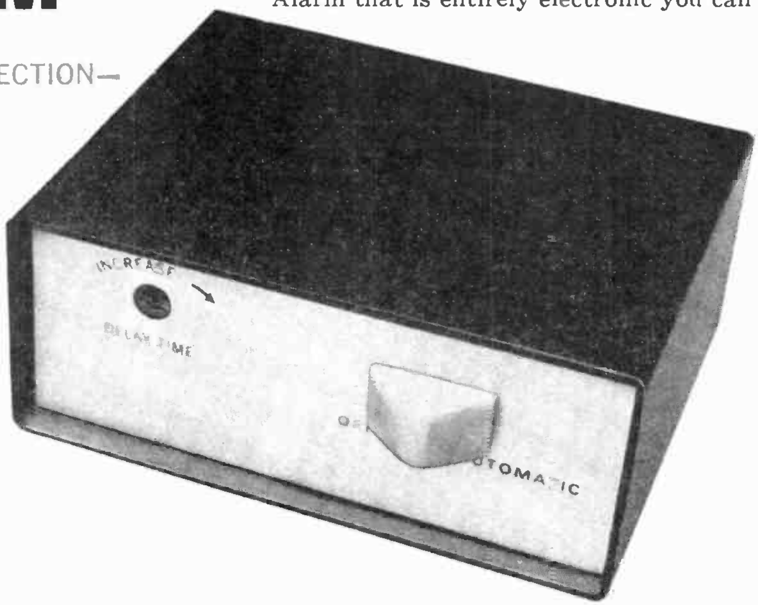
# *Automatic* VEHICLE BURGLAR ALARM

OVERALL PROTECTION—WITHOUT AN EXTERNAL KEY SWITCH

BY GEORGE MEYERLE

IF YOUR CAR is stolen, there are automobile rental agencies which will give you special rates until the insurance pays off. That's some comfort; but these days most people should prefer a burglar alarm system to prevent theft in the first place. Most of these alarm systems require an external lock in a hole drilled somewhere in the car frame—and that leads to trouble due to dirt and ice in the lock or the fact that you lose or forget the key.

With an automatic Vehicle Burglar Alarm that is entirely electronic you can



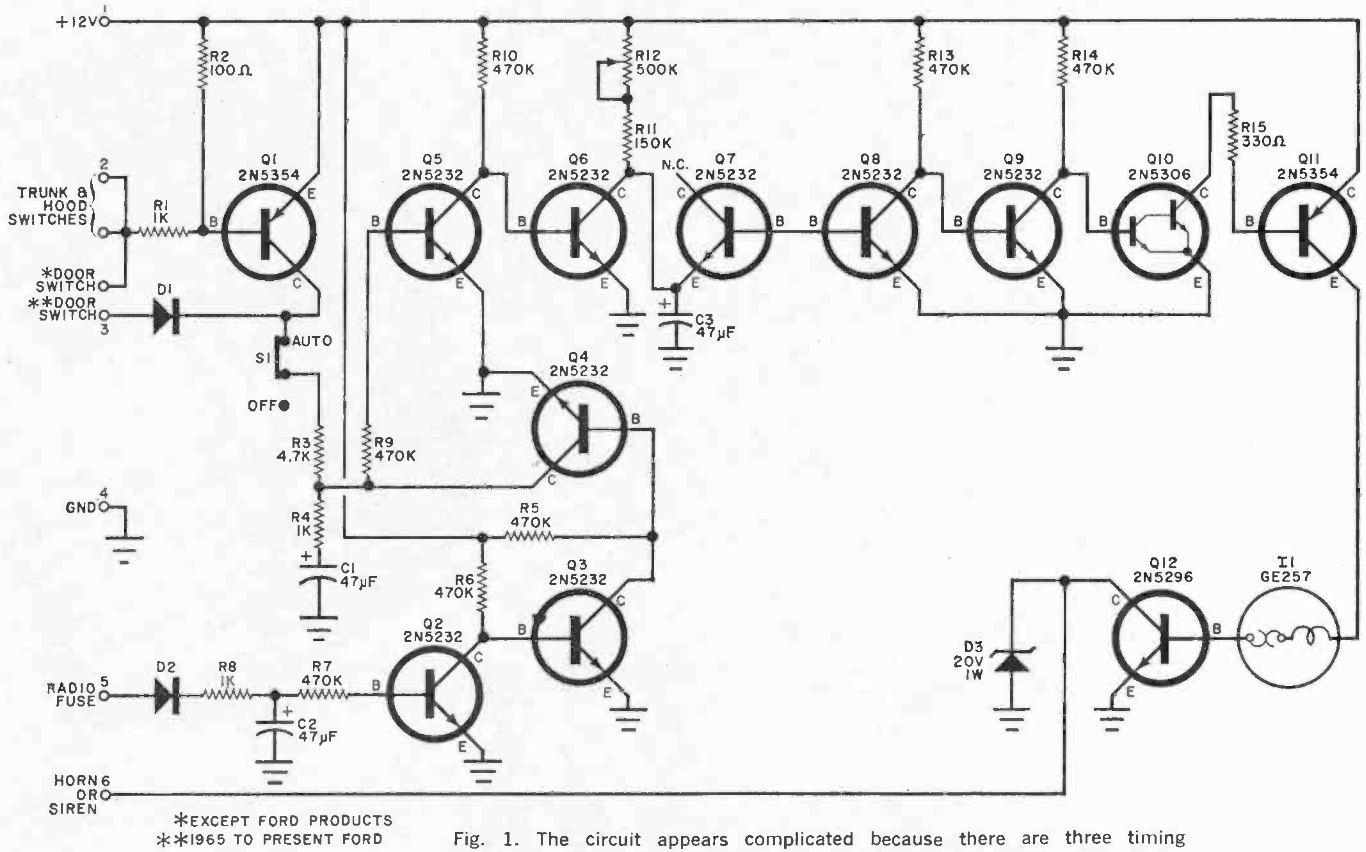



Fig. 1. The circuit appears complicated because there are three timing circuits as well as a multi-transistor power driver for the vehicle horn. If you desire siren operation, substitute a 220-ohm, 1-watt resistor for I1 and use the output line to operate a suitable relay, that in turn operates the siren.

protect your car easily and completely without the use of an extra key. Once it is installed, you can forget about it and rest assured that the car, plus the contents of the hood and trunk, are protected by a loud, persistent alarm system.

Hidden in the glove compartment, the alarm arms itself two minutes after the ignition key is turned off. This gives you sufficient time to get out of the car and close all the doors. When you return and open the doors, you have 10 to 45 seconds (depending on how you set the controls) to put the key in the ignition switch and turn it either to the ignition or accessories position before the alarm circuit is activated. Wired directly to the courtesy light circuit, the system operates when the car doors are opened. Other, optional switches are mounted under the hood and trunk covers to protect those areas.

If the alarm should sound before you get the key in the ignition, it will shut off as soon as the key is inserted. For the alarm, you can use either the vehicle horn or an optional siren. With the horn the alarm does not operate continuously, but "beeps" about once per second.

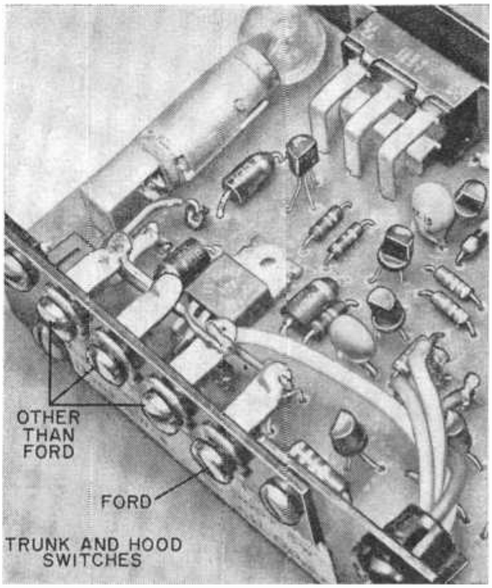


Fig. 2. The prototype was arranged for both Ford and non-Ford products. If you build your own, use only the terminals required and leave the others off. Three other-than-Ford lugs are in parallel.

### PARTS LIST

*C1-C3—47-μF, 15-volt tantalum electrolytic capacitor (Sprague 150D or similar)*
*D1,D2—50-volt, 1-ampere silicon diode*
*D3—20-volt, 1-watt zener diode*
*I1—Thermal flash lamp (GE257 or similar)*
*Q1,Q11—2N5354 (GE)*
*Q2-Q9—2N5232 (GE)*
*Q10—2N5306 (GE)*
*Q12—2N5296 (RCA)*
*R1,R4,R8—1000-ohm*
*R2—100-ohm*
*R3—4700-ohm*
*R5-R7,R9,R10,R13*
*R14—470,000-ohm*
*R11—150,000-ohm*
*(All resistors ¼-watt)*
*R12—500,000-ohm, printed circuit potentiometer*
*R15—330-ohm, ½-watt resistor*
*S1—S.p.s.t. slide or toggle switch*
*Misc.—Metal cabinet, insulated color-coded leads, barrier strip (three lug), solderless splice connectors (2), fuse connectors (2), normally closed spring-loaded switch (2, optional), horn relay for Ford products, siren (optional), mounting hardware.*
*Note—The following are available from Metrotec Industries, 1405 Northern Blvd., Roslyn, N.Y. 11576: printed circuit board, $1.75; PC board and all electronic components, $12.95; complete kit including all hardware, fuse connectors, solderless splices, decal, two remote switches, and metal cabinet, $17.50; wired and tested unit with 2-year guarantee, $29.95; trunk and hood switches, 50¢ each; horn relay for Ford products after 1965, $1.50; heavy duty siren, $17.95. New York state residents, add 5% sales tax.*

The alarm sounds for about two minutes and then automatically stops. If the trouble has not been corrected—door, trunk or hood closed—the alarm starts again. If the condition has been corrected, the alarm remains off and rearms itself for further protection. This feature prevents needless public annoyance and battery drain and may also prevent a passerby from cutting a wire to make it stop. All he has to do is close the open door, hood, or trunk.

The circuit is designed so that, if you don't use the hood protection switch and a thief uses a jumper on the ignition circuit, the alarm will sound when he opens the door and tries to drive the car. The alarm will also sound, after the slight delay, even if a protected area is opened for a fraction of a second and then closed immediately.

A switch on the alarm chassis can be used to disable the system but it will not shut off the alarm once it has been set off by an intruder. The alarm system is designed to operate with any 12-volt negative-ground system. It is not temperature sensitive and standby current is only 250 microamperes.

**Construction.** The circuit of the automatic burglar alarm is shown in Fig. 1.

*Second in a series...*

# Can you solve these problems in electronics?

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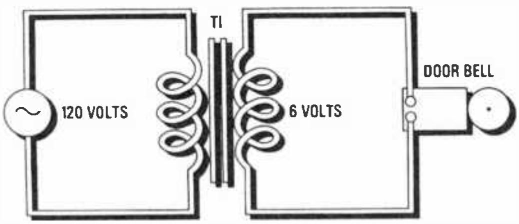
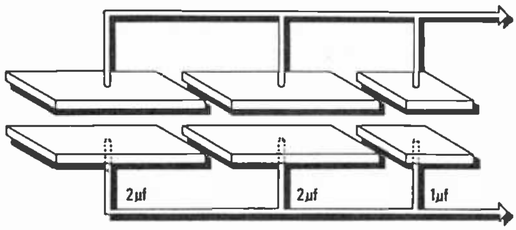
This one is quite elementary.




**In this door bell circuit, which kind of transformer is $T_1$ — step-up or step-down?**

Note: if you had completed only the first lesson of *any* of the RCA Institutes Home Study programs, you'd easily solve this problem.

This one is more advanced.




**What is the total capacitance in the above circuit?**

Note: you'd know the solution to the problem if you'd taken only the first two lessons in RCA's new Communications Electronics Program.

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*Answers:* Step-down. 5 μf

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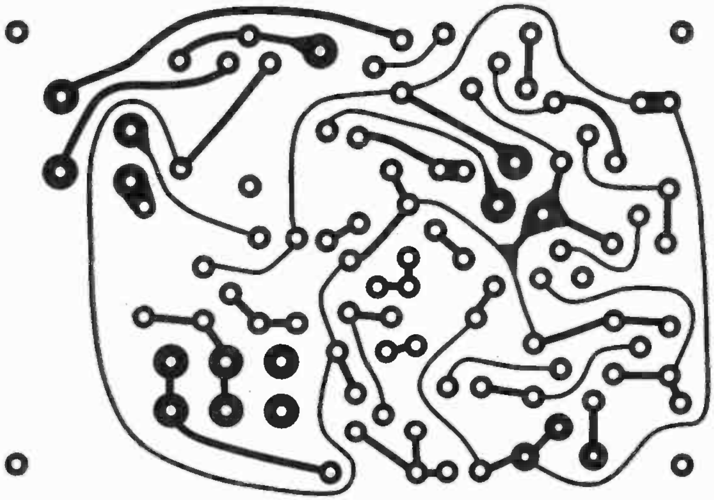
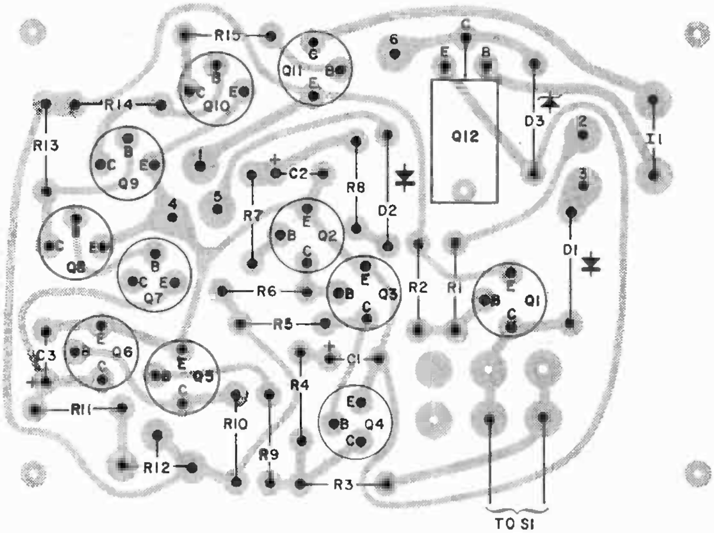


Fig. 2. Actual size foil pattern for the alarm. It can be easily duplicated with some reasonable care.

Fig. 3. Install the components as shown here. Be sure the semiconductors and the electrolytics are correctly installed and watch for solder bridges.




A printed circuit board (Fig. 2) should be used in the construction. (See Parts List if you want to buy one already etched and punched.) Mount the components on the board as shown in Fig. 3.

Install the board in a suitable metal enclosure with switch *S1* on the front panel. Drill a hole for screwdriver adjustment of potentiometer *R12*. Also drill a hole and put a grommet in it for the wires to the car's electrical system. These wires should be color-coded and about 5 feet long. Wires are connected to terminals 1, 4, 5, and 6 on the board. Also connect a wire to terminal 3 if your car is a Ford product. If it is not, mount a three-lug barrier strip on the back of the alarm chassis and connect the three lugs in parallel to terminal 2 on the circuit board. (See Fig. 4, A and B)

**Installation.** The alarm may be placed in the glove compartment with a small hole in the bottom or rear of the compartment for the leads. Connect the lead from terminal 1 to any point that is always at 12 volts, whether or not the ignition is on. This can be on the clock, cigarette lighter, turn indicator, dome light, battery, etc. The lead from terminal 4 is secured to any point that is in electrical contact with the vehicle chassis

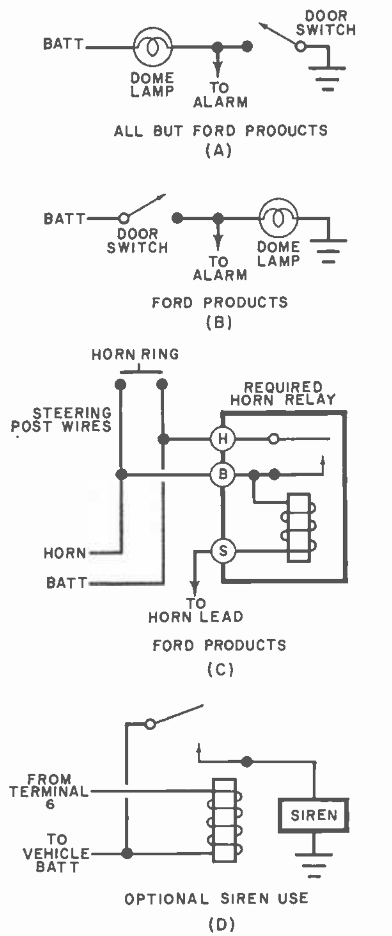



Fig. 4. Top three drawings illustrate differences between Ford and non-Ford products. Bottom illustration shows how optional siren can be driven by a relay.

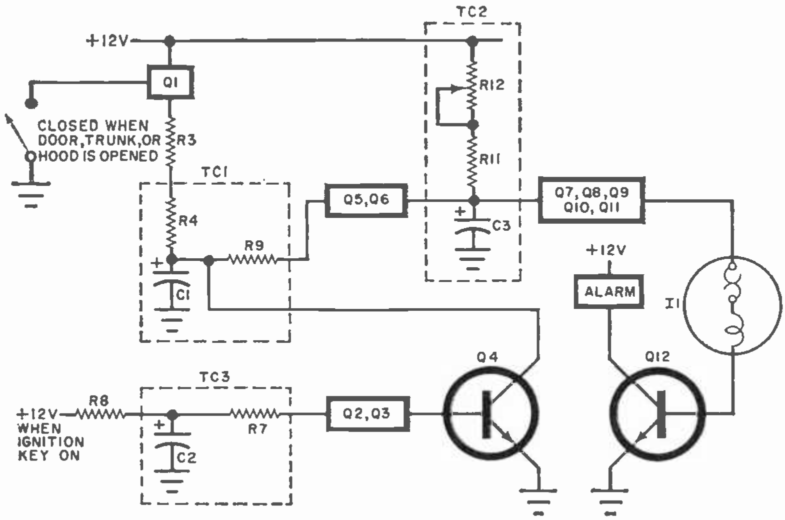
(ground). Connect the lead from terminal 5 to either side of the fuse that supplies the radio (or any other accessory that is powered only when the ignition key is in either the ignition or accessory position).

Connect terminal 6 to the horn. If the car is not a Ford product, the horn sounds only when this wire is grounded. You can use a length of test lead with one end connected to the chassis and the other end terminated in a pin or needle to find the wire that will make the horn sound. If you have a Ford product, an additional horn relay must be used, wired as shown in Fig. 4C.

If the car is not a Ford product, connect one lug of the barrier strip (terminal 2 of the board) to the lead coming from the dome or courtesy lights. The other two lugs on the barrier strip are used to make connections to the switches on the hood and trunk. These switches should be installed so that they close when the hood or trunk lid is opened. To install the switches, locate a spot where the lid comes close to the metal chassis when the lid is closed. Use good-quality insulated wire to connect these switches to the barrier strip on the alarm. Secure the wires so that they do not interfere with other vehicle wiring and operation. Do not hook up the dome light or remote switches to the barrier strip at this time.

In Ford products, the door switches are not grounded on one side. Therefore connect these switches to terminal 3 on the board and ignore the barrier strip. If you want hood and trunk protection in Ford


Although designed for automobiles, the burglar alarm can be fitted to a boat by installing hood or trunk switches on various access doors. Anyone entering such a protected area causes the boat's horn to blast an alarm signal.




## HOW IT WORKS

All of the protected-area switches are open when the doors, trunk and hood are closed. When any one of these areas is opened, the associated switch closes. The base of transistor *Q1* is automatically grounded and the transistor is turned on. The time constant of timing circuit *TC1* is about 2 minutes. While *TC1* is discharging, *Q5* and *Q6* are turned on and timing circuit *TC2* is energized. Its time constant is made variable from about 10 to 45 seconds. As soon as this shorter time constant is reached, alarm drivers *Q7* through *Q11* supply base current to power transistor *Q12* through thermal flash lamp *I1*.

As long as base current is flowing in *Q12*, the alarm sounds. The flash lamp has a built-in thermal circuit breaker that opens the filament circuit after the filament has reached a predetermined temperature. When the breaker opens, the current to the lamp and *Q12* is interrupted and the alarm stops. After a very short time—about one second—the filament cools off and the breaker closes to remake the circuit. This cycle repeats producing a "beeping" of the horn or alarm.

After about 2 minutes when the time constant of *TC1* has been reached, if the protected area has not been closed and all switches returned to open, the alarm system continues to operate. If the protected area has been closed in the meantime, *TC1* stops charging and the system is reset, ready to operate again if any switch is closed.

When the operator gets into the vehicle, he has the time determined by the setting of *R12* (10 to 45 seconds) to insert the ignition key. When this is done, timing circuit *TC3* charges up and transistors *Q2*, *Q3* and *Q4* are turned on. This drains the charge off of *TC1*. When the ignition key is removed, *TC3* starts its discharge of about two minutes. After that, *TC1* is ready to be charged up again.

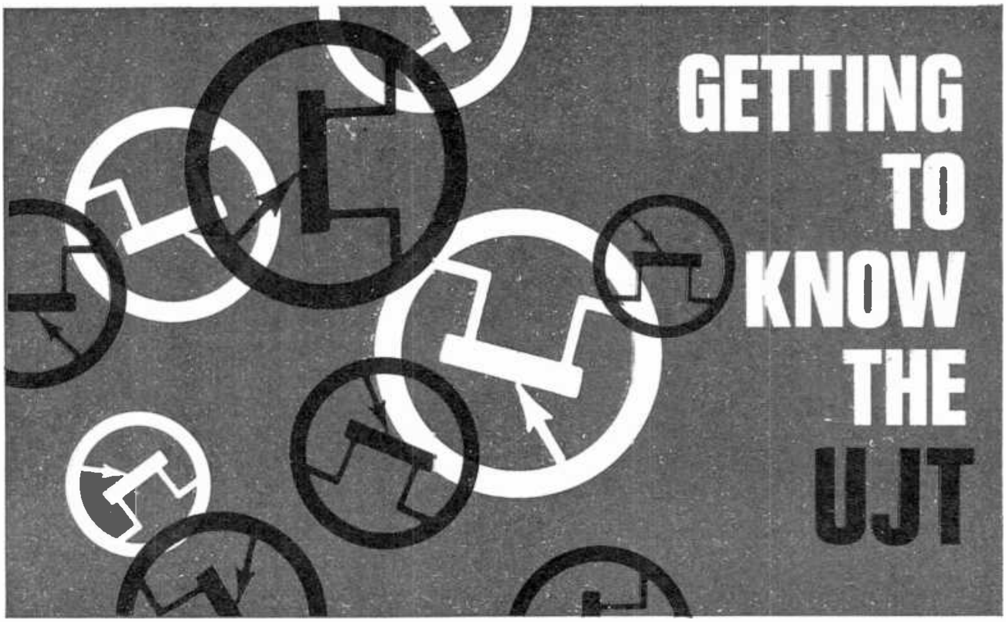
products, wire these switches to the barrier strip (terminal 2) connectors.

When all wiring is complete, recheck everything to make sure it is correct. Close the trunk and hood lids and use an ohmmeter to make sure that the normally open switches are open when the lids are closed and closed when the lids are open.

With all doors closed, connect the door, hood, and trunk switches to the alarm. Insert the key in the ignition and momentarily turn on the accessories. Turn the ignition off and wait at least two minutes. The alarm is now armed as it would be in normal use. If any protected area is opened now, even for a fraction of a second, the alarm should sound after 10 to 45 seconds. To stop the alarm, turn the ignition on momentarily. Using a small screwdriver, adjust potentiometer *R12* to get the desired off time between triggering and sounding of the alarm.

If you require an unlimited amount of time with the doors, trunk or hood open, place the key in the ignition and turn it

*(Continued on page 73)*




## AN ALL-ROUND SIGNAL GENERATOR: SAW-TOOTH, SQUARE-WAVE, SINE-WAVE

**BY FRANK H. TOOKER**

ALMOST EVERYONE who has an interest in electronics is aware of the existence of a device called the unijunction transistor, or UJT. (If he remembers it from its very beginning, he might recall that it was originally referred to as a "double-base diode.") The UJT is used most often in circuits requiring a positive-going spike pulse and, occasionally, as a generator of sawtooth waveforms.

However, the UJT is actually much more versatile than these two uses would imply. It can also be used to generate square waves and, believe it or not, sine waves having quite pure waveforms. It behooves the serious electronics experimenter to learn more about all of these uses—and to do so, he will need to know more about the UJT itself.

**How the UJT Works.** The UJT can be represented by a circuit approximation consisting of two resistances in series, with a diode connected at their junction as in Fig. 1. (Also shown in the figure is the accepted schematic symbol and base diagram for the UJT. Note that in both cases the leads are identified as E, B1, and B2 for emitter, base-1, and base-2.) The resistance approximation is a *passive* representation of the UJT. In simple terms, this means that a pair of resistors and a diode connected as shown will *not* operate as a unijunction transistor. The approximation is simply a means by which operation of the UJT can be explained.

In the majority of applications, the

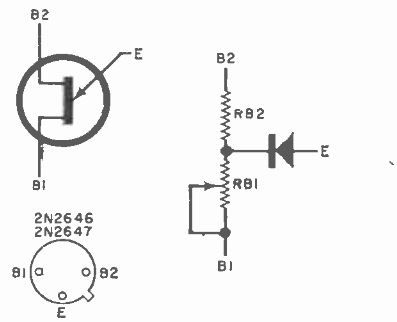



FIGURE 1

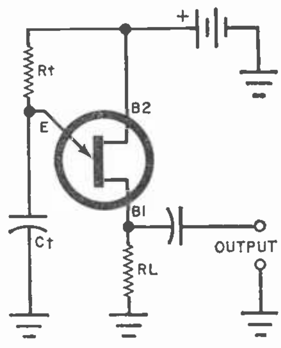



FIGURE 2

emitter is the control electrode of the UJT. The magnitude and polarity of a potential applied to the emitter determine whether or not the UJT will fire. With the emitter circuit open (diode nonconducting), resistance *RB1* is maximum, and the sum of *RB1* and *RB2,* called interbase resistance, is between 5000 and 10,000 ohms for the 2N2646 and 2N2647 (two typical, useful UJT's).

Resistance *RB1* is shown variable because current flow in the emitter circuit causes a decrease in the ohmic value of this resistance. The greater the current flow, the lower the resistance. Hence, a UJT exhibits negative resistance, a characteristic that can be thought of as amplification. What actually happens inside the UJT is that current flowing into the E-to-B1 circuit "pulls" current carriers from the B2 area, increasing the circuit's conductance.

The supply voltage, usually applied through a series resistor, is connected across the interbase resistance, B1 to B2, with B2 positive with respect to B1. To fire the UJT, a positive potential (called the peak-point voltage) is applied to the emitter.

The ratio of *RB1* to the interbase resistance is called $\eta$ (Greek eta), or the intrinsic standoff ratio. The peak-point voltage is this ratio times the supply voltage plus the potential hill of the diode (about 0.5 volt). Thus, the voltage required for firing the UJT varies as the supply voltage is varied, and in the same direction.

**UJT Relaxation Oscillators.** The schematic diagram in Fig. 2, or some variation of it, is probably familiar to most experimenters. It is the one most commonly used circuits for relaxation oscillators by circuit designers.

Referring to the diagram, capacitor *Ct* charges up through resistor *Rt* at a rate determined by the *RC* time constant of these two components. The larger these values, the slower the charging rate. During the charging interval, the emitter junction is reverse biased, and the only current flowing in the emitter circuit is due to leakage (similar to the $I_{co}$ of a bipolar transistor). Emitter leakage for the 2N2646 is a maximum of 2 $\mu$A, and for the 2N2647, only 0.2 $\mu$A.

When the potential across *Ct* reaches the value of peak-point voltage for the particular UJT being used in the circuit, the emitter junction goes suddenly into conduction. Using the UJT approximation shown in Fig. 1, *RB1* promptly drops to a much lower value and *Ct* in Fig. 2 discharges abruptly through load resistor *RL*, producing a spike pulse of voltage across the output terminals.

Capacitor *Ct* does not discharge to zero potential. Rather, it is discharged to a value determined by the series resistance between the emitter and ground and the magnitude of the discharge current. The actual value to which *Ct* discharges is termed the "valley voltage." When *Ct* discharges to this value, the emitter junction of the UJT becomes reverse biased again; then *Ct* begins to recharge, and the cycle repeats. The charge-discharge action of *Ct* produces a sawtooth waveform signal.

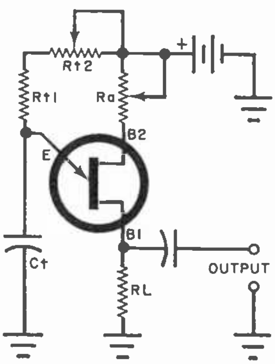



FIGURE 3

**When It Doesn't Work.** The operation of a UJT relaxation oscillator involves more than just raising the potential across timing capacitor *Ct* to the firing level. A certain value of current, called the "peak-point emitter current," is required to fire the unijunction transistor. This current must be supplied through timing resistor *Rt* (see Fig. 2). If the current through *Rt* is too low, capacitor *Ct* will charge to a value that is below the peak-point voltage, and operation will cease. The UJT will not fire. This need for sufficient emitter current becomes important when *Rt* must have a large value to operate the UJT at a very low repetition rate.

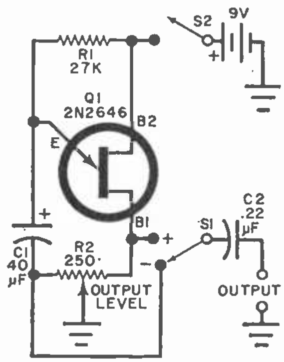



**FIGURE 4**

The peak-point emitter current for the 2N2646 is about 5 µA; for the 2N2647 it is only 2 µA. It is important to bear in mind that even though the 2N2647 is 2.5 times better than the 2N2646, if an electrolytic capacitor is used in the circuit, the leakage current of the capacitor has the same effect as an identical increase in the peak-point emitter current of the UJT. Consequently, care must be exercised in choosing a capacitor with the lowest leakage or the value of the 2N2647 might be lost.

Characteristics vary from one UJT to another, even for those with the same type number. Thus, if the relaxation oscillator is to have a definite repetition rate, the value of timing resistor *Rt* should be made adjustable to allow you to "trim" the circuit to the desired frequency or repetition rate.

The circuit shown in Fig. 3 has trimming facilities. Varying the resistance of either *Ra* or *Rt2* varies the interbase voltage, thereby altering the peak-point voltage and, thus, the repetition rate. The value of potentiometer *Ra* in such a circuit should be limited to a maximum of 5000 ohms.

**Negative-Pulse Generator.** Pulses obtained at the B1 terminal of a UJT are positive-going. Negative-going pulses can be obtained from the B2 terminal when a resistor is connected between B2 and ground. Negative pulses can also be obtained from a resistor connected in series with the lower end of the timing capacitor.

The circuit shown in Fig. 4 provides a choice of either positive or negative pulses, depending on the setting of *S1*. Adjusting the setting of level control potentiometer *R2* adds resistance to one of the two circuits, while it subtracts an equal amount of resistance from the other circuit. So, when *R2* is set for maximum amplitude of a negative output pulse, resistance in the positive side of the circuit is zero, and vice versa. This gives the circuit maximum efficiency, providing maximum pulse amplitude in either direction.

The repetition rate of the circuit with the component values shown is about one pulse in every two seconds. This rate was selected to provide a useful instrument for checking experimental hookups

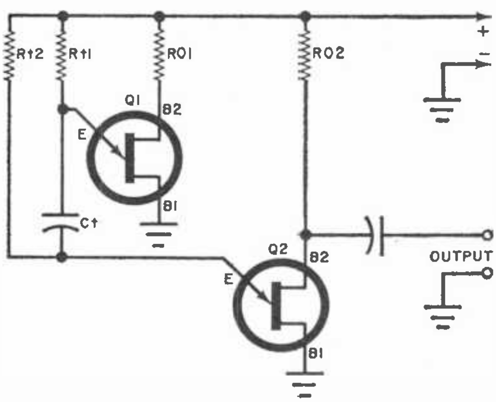



**FIGURE 5**

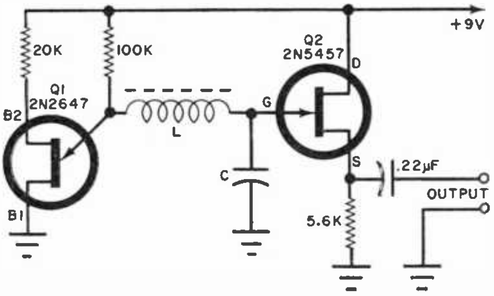


FIGURE 6

of JK flip-flops, SCR's, SCS's, and other pulse-operated devices.

**Square-Wave Generator.** The circuit of a square-wave generator (actually a dual-UJT multivibrator) is shown in Fig. 5. This circuit generates excellent square waves within the frequency range of efficient operation of the unijunction transistors.

When the power is applied to the dual-UJT circuit, both emitters are made positive with respect to ground through resistors *Rt1* and *Rt2*. One UJT fires promptly, bringing both ends of the timing capacitor, *Ct,* to a value well below the peak-point voltage. This UJT remains conducting while *Ct* charges through the timing resistor of the other UJT circuit.

As soon as the second UJT's emitter becomes sufficiently positive with respect to ground, it suddenly conducts, driving the first UJT negative and causing it to stop conducting. With the second UJT conducting and the first cut off, *Ct* starts charging in the opposite direction, through the timing resistor of the first UJT. Now, when the emitter of the first UJT becomes sufficiently positive, it fires, and the second UJT cuts off. The alternate-stage fire/cutoff cycle is self repeating whenever power is applied to the circuit, and the output of the system is a train of rectangular pulses.

**Sine-Wave Generator.** Sine waves are produced by allowing a UJT circuit to charge and discharge a capacitor through an inductance. When the charge-discharge period is equal to the resonant frequency of the *LC* circuit, sine waves are generated across the capacitor. A schematic diagram of a UJT sine-wave generator is shown in Fig. 6.

The tuned circuit of the generator is made up of inductor *L* and capacitor *C*. Field effect transistor *Q2* operates as a source follower to prevent loading down the tuned circuit; this stage is not otherwise essential to the operation of the oscillator as a sine-wave generator. The circuit shown has operated well up to 50,000 Hz.

The output of the sine-wave generator is obtained across *Q1*'s source resistor. The waveform here is cleanest when the ratio of inductance to capacitance is high.

**Modulate a Relaxation Oscillator.** A UJT relaxation oscillator can be frequency modulated by applying the modulating signal across a resistor in the B2 circuit as shown in Fig. 7. The waveform of the modulating signal can be sine, sawtooth, square, triangular, or irregular.

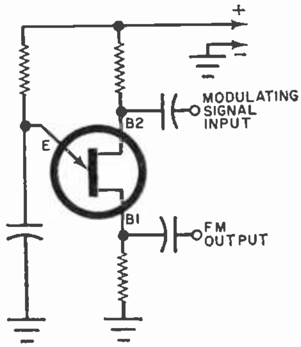


FIGURE 7

A practical example of a modulated UJT oscillator is shown in Fig. 8. This circuit is known as a "bell-tone" oscillator. In operation, *Q2* and its associated components make up a relaxation oscillator which, when unmodulated, has an operating frequency of about 700 Hz. Unijunction transistor *Q1* and its associated components make up a low-frequency astable multivibrator. The wave-form of the *Q1* setup is not as good as that of the circuit in Fig. 6, but it

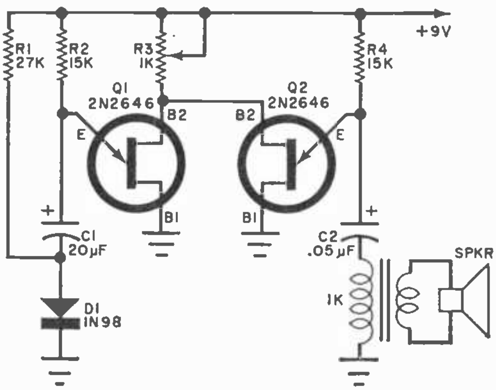


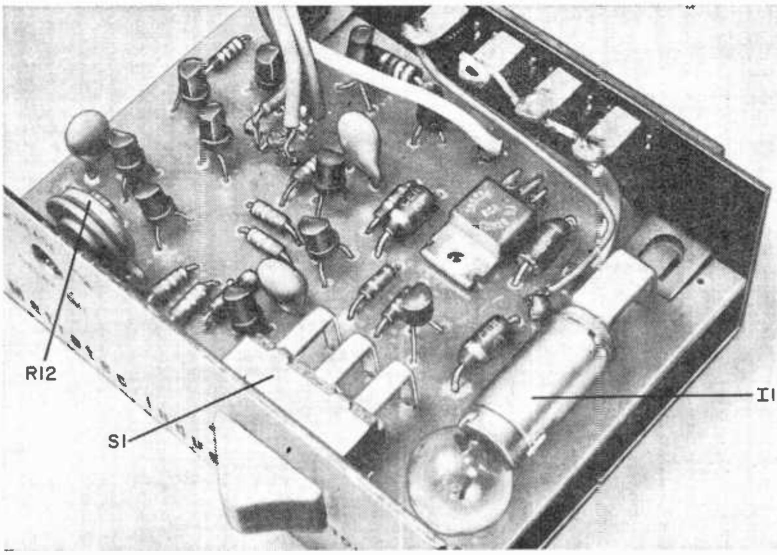

FIGURE 8

serves the purposes of the bell-tone oscillator well.

In the multivibrator, *C1* charges through *R2*, while diode *D1* is maintained in a forward conducting state by the charging current and the current through *R1*. When *Q1* fires, reverse bias is applied to *D1*, and the diode appears as an open circuit. Transistor *Q1* remains conducting while capacitor *C1* discharges through resistor *R1*. At the end of this interval, *D1* begins conducting again, *Q1* cuts off, and the cycle repeats. The result is a rectangular signal across *R3*.

Since the B2's of *Q1* and *Q2* are tied together, each time *Q1* fires, its B2 signal decreases the interbase voltage of *Q2* and causes an increase in *Q2*'s operating frequency. As *Q2* conducts and cuts off, the pitch of the sound heard from the loudspeaker rises and falls sharply, giving the sound a distinct bell-like quality. The speaker is preferably a small one, such as a 3" replacement type, to provide "tinny" reproduction. When working with the circuit, adjust potentiometer *R3* to obtain the most pleasing sound. -30-

## AUTOMATIC VEHICLE BURGLAR ALARM/*CONT. FROM P. 68*




When mounting the PC board in the metal chassis, make sure that you can gain screwdriver access to R12 so that delay time can be externally adjusted as desired. If you have no need to vary this time, the chassis hole can be eliminated.

on. Then turn *S1* to the off position. Return the switch to the automatic position to re-actuate the alarm.

To use a siren or optional horn, replace *I1* with a 220-ohm 1-watt resistor and wire the circuit as shown in Fig. 4D. -30-

PARTS/METHODS/IDEAS/GADGETS/DEVICES

# tips & techniques

## PERMANENT MARKING PEN RENEWS WORN OUT DIAL MARKINGS

After years of service, the dial markings and numerals on some radio receivers and other electronic gear become worn out and faded, and the enamel cracks and falls out of the marking grooves. It is a messy and sometimes impossible job to clean some cabinets—notably plastic types—without causing further damage to the markings. However, in the case of white and ivory cabinets on which black enameled markings need refurbishing, it is a simple matter to restore them with a black permanent marking pen (such as the Sanford "Sharpie" shown in the photo). The points of such pens are just the right size to fit the grooves, and the ink is permanent and waterproof. Before using the marking pen, make sure the dial is clean and free of oil and grease.

—*Art Trauffer*

## MINIATURE KNOBS FOR STANDARD SIZE POTENTIOMETERS

Most miniature potentiometers are available only with a linear taper; so it is often necessary to substitute a standard size pot when a log taper is required. If you are designing your project with the mini look, that standard pot will stick out like a sore thumb—unless you use a Harry Davis Co. Type 1450 miniature knob (available from Allied Radio Corp., catalog No. 47A4134). And if you need a position locator dot on the knob, you can apply a professional-looking one in just three steps. First, use the tip of a heated nail to mark the desired location of the dot. Next, enlarge the dot mark with the tip of a 3/32" drill (make it shallow). Finally, use a toothpick to deposit one drop of white model airplane dope in the hole. When the dope dries, put the knob on the shaft.

—*Donald R. Hicke*

## CLASSIFY SOLID-STATE COMPONENTS WITH IDENTIFICATION "PLATES"

Once you have identified and tested unmarked transistors, diodes, and IC's, the next step is to record the data directly on the device. Unfortunately, grease pencil and graphite pencil markings rub off too easily, and paper tags tied or taped to the devices often clutter up a spare parts box or become dislodged in the shuffle. The easy way out of your dilemma is to paint one of the surfaces of the device with liquid typing error cover-ups, such as "Sno-pake" or "Liquid Paper," and record the data on the coating with India ink or a ballpoint pen. These coatings apply quickly and dry almost instantly. They are particularly useful as identification "plates" for recording *n* and *p* types and betas for transistors, peak-inverse-voltage ratings for diodes, and IC functions. And, the coatings actually improve the heat radiating properties of the solid-state devices.

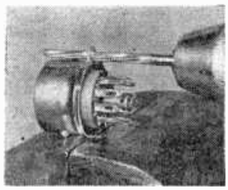
—*John Brosemer*

## MAKE NUT STARTER TOOLS FROM HEAT-SHRINKABLE PVC TUBING

Anyone who has ever built an electronic kit or has had to fasten machine hardware in an almost inaccessible area of a chassis knows how handy and useful a nut starter can be. Unfortunately, nut starters are available only in the most common sizes—#4, #6, and #8. Consequently, for miniature hardware, you are still faced with the problem of fumbling with hardware in blind places. But with a length of scrap irradiated polyvinyl chloride ("heat-shrinkable" PVC) tubing, you can fashion your own nut starters for virtually any size hardware. All you need do is select a size tubing that just fits the hardware. Insert the nut at one end of the tubing, flush with the tubing's edge. Apply heat until the tubing shrinks snugly around the nut. —*Stephen E. Maziarz*

## SAFELY ENLARGE HOLES IN THIN SHEET METAL

It is practically impossible to use a twist drill to enlarge a hole in sheet metal without tearing the metal or producing an eccentric hole. To do the job safely and neatly, the most satisfactory small hole enlarger available is the taper pin reamer (obtainable from most machine tool dealers and some well-stocked hardware stores). These reamers can be obtained in a variety of sizes, but the most useful for the electronic equipment builder are the #4/0, #2/0, and #1 sizes. With just these three sizes, you will have a continuous range from 0.0869" to 0.198", which permits enlarging holes in tube socket saddles, solder lugs, etc., to clear #4, #6, and #8 machine screws. Reaming is best done by hand with a pin drill or screw-tap check; do not use an electric drill.



—*Robert F. Lewis,* K7YBF/W8MQU

# DEHUMMING SMALL RECEIVERS

PERK UP YOUR SHORT-WAVE LISTENING

BY RONALD L. IVES

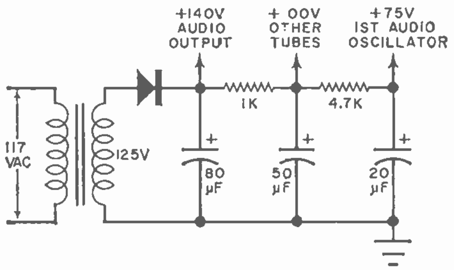
DO YOU LISTEN to the short-wave bands through a veil of a.c. hum? Such hum troubles are commonly generated in the d.c. power supply. Though a comparative rarity, hum can also originate in the filament circuit. Efficient d.c. filtering and a simple redesign can drastically reduce this a.c. hum to a very low level.

Most power supplies in modestly-priced or inexpensive shortwave receivers use a half-wave rectifier and a "brute-force" filtering circuit. A few receivers do use a full-wave rectifier, but on occasion even these receivers are subject to certain a.c. hum problems.

Troubles in a.c. hum can also be caused by a cold solder connection and before delving into the circuit of the receiver itself, it is always best to check the tubes for heater-to-cathode leakage.

And, while you have the receiver open, carefully inspect underneath the chassis for any evidence of corrosion or leakage around the filter capaciters.

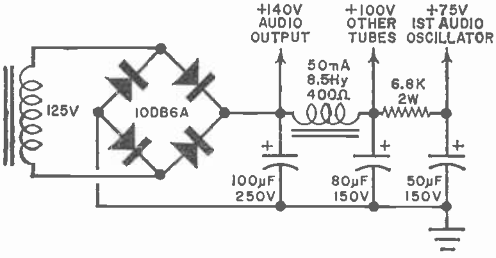
**Reducing Rectifier Hum.** Hum that can be traced back to the rectifier can be reduced by two expedients. If the receiver is small and inexpensive, the most effective method of reducing the hum is to replace the half-wave rectifier with a packaged bridge rectifier. The typical half-wave rectifier seen in many low-cost



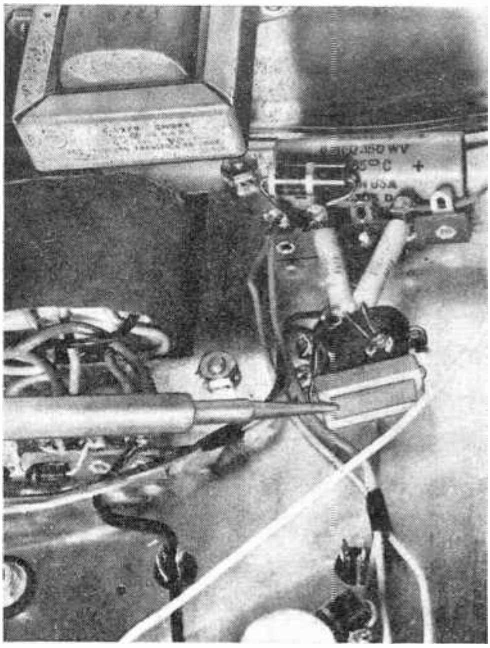

Half-wave rectification and RC filtering are hallmarks of most inexpensive receiver power supplies.

receivers is shown in Fig. 1. The circuit for a modified full-wave bridge rectifier is shown in Fig. 2. Choose the specific rectifier to have a rated input voltage (rms) slightly higher than the nominal output voltage of the power transformer.

This substitution will change the a.c. hum ripple frequency from 60 Hz to 120 Hz and will thereby double the effectiveness of each filter component. Check the results after the substitution and, if the




Full-wave bridge rectification and LC filtering remove most of the a.c. ripple from the d.c. output.



Pointer shows filter resistor to be removed and replaced with filter choke mounted to side of chassis.

hum level is now tolerable, the job is done.

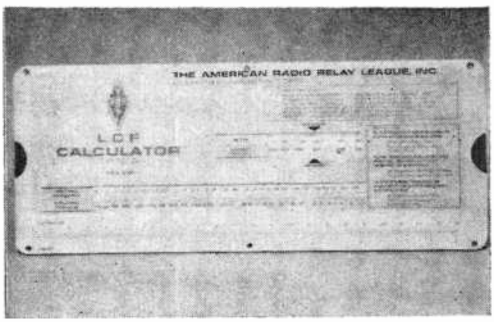
Further hum reduction might be obtained by increasing the capacitance of one or all of the active filter elements. Try shunting the electrolytic filter capacitors, one at a time, with other capacitors of equivalent value. Note the results and if the tests indicate that larger value filter capacitors are called for, they should be installed up to the point of space limitations.

Oddly enough, many short-wave receivers use a resistive element in the filter in preference to an inductance whose higher reactance would vastly increase the effectiveness of filtering. A 1-henry filter choke has a reactance at 120 Hz of about 750 ohms. A tremendous reduction in a.c. hum is possible through the substitution of a choke having an inductance in excess of 7.5 henrys for the resistor. For most small receivers, a Stancor C-2318 (12 H at 30 mA) or C-1515 (30 H at 50 mA) or the equivalent of other manufacturers will be more than adequate.

Replacement of the resistive filter element by an inductive element (choke) has another advantage. Audible hum consists not only of the fundamental ripple frequency, but also of its harmonics, of which those at 240 and 360 Hz are possibly more important. Obviously, a resistive filter element has the same reactance at all frequencies. An inductive filter element, however, has a reactance proportional to the frequency and a 1-H choke which has a reactance of 750 ohms at 120 Hz has a reactance of about 1500 ohms at 240 Hz and 22,500 ohms at 360 Hz. —30—

## MODERNIZED "TYPE A" L/C/F CALCULATOR

The American Radio Relay League recently released a modernized "Type A" Calculator, a slide-rule-like device used for solving inductance, capacitance, and frequency problems. The calculator can be used for frequency-to-wavelength conversions; determining inductance and capacitance; finding resonant frequency; and calculating coil size for a particular inductor (and its number of turns/in. for a given length and diameter). Inductance scales range from 0.1 to 1500 μH, capacitance from 3 to 10,000 pF, and frequency from 300 kHz to 100 MHz. Priced at $2, the Type A Calculator can be obtained from ARRL, 225 Main St., Newington, CT 06111.



# the product gallery

## REVIEWS AND COMMENTARY ON ELECTRONIC GEAR AND COMPONENTS

### SEMICONDUCTOR CURVE TRACER (EICO Model 443)

Until fairly recently, the only semiconductor curve tracers available on the market were for the transistor industry. The average solid-state circuit experimenter had to make do with his ohmmeter and/or transistor tester. Now, however, there is available a curve tracer adapter or add-on that converts virtually any existing oscilloscope into a semiconductor curve tracer. And, considering the versatility of the curve tracer, it behooves the experimenter who buy transistors on the surplus market (usually without knowing types, power-handling capabilities, or gain) to have such an instrument handy.

The EICO Electronic Instrument Co., Inc., (283 Malta St., Brooklyn, NY 11207) Model 443 Solid-State Semiconductor Curve Tracer sells in kit form for $79.95 and factory wired for $119.95. It has the ability to convert most scopes into versatile instruments that can trace a family of curves for any transistor, whether its characteristics are known or not, display PIV and forward voltages of diodes, test for d.c. gain and linearity, and test for current leakage.

We built the kit version of the 443, and like most test instrument kits in which the functions are tied together through inter-related multi-deck rotary switches, assembly time was long—about 20 hours from start to finish—but well worth the effort. The assembly manual provided with the kit is well-written with separate assembly charts for each strip.

There are several features of the 443 worth mentioning. An epoxy-glass printed circuit board is used in the electronic portion of the instrument. All of the parts and components are of excellent quality. The power cord is a three-conductor "safe" type; a feature which is good to see on any type of electronic equipment, particularly test equipment. We particularly like the low silhouette design of the cabinet and the sloping front panel that gives easy access to all controls. The instrument can be set up with two transistors, allowing the user to select and compare the two with the flip of a switch—which comes in handy when you want to find two transistors with identical characteristics.

Supplied with the 443 are a pair of banana-plug clips that allow rectifiers to be tested safely without bending leads, and a calibrated graticule for 5" oscilloscopes. An operating manual, also included, outlines all calibration and testing procedures that can be performed with the 443 curve tester adapter.

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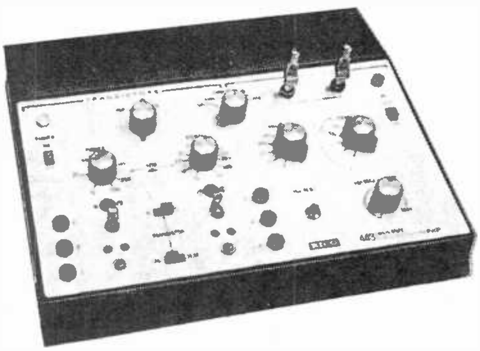
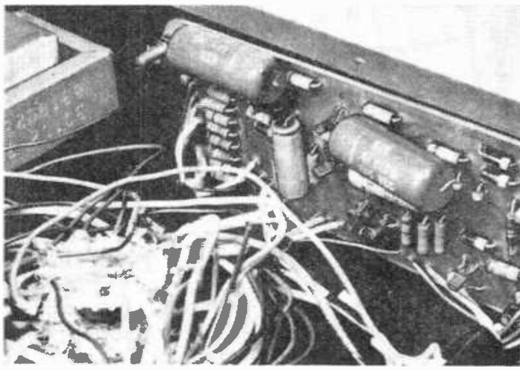
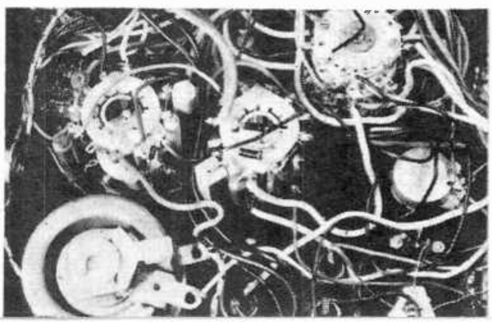
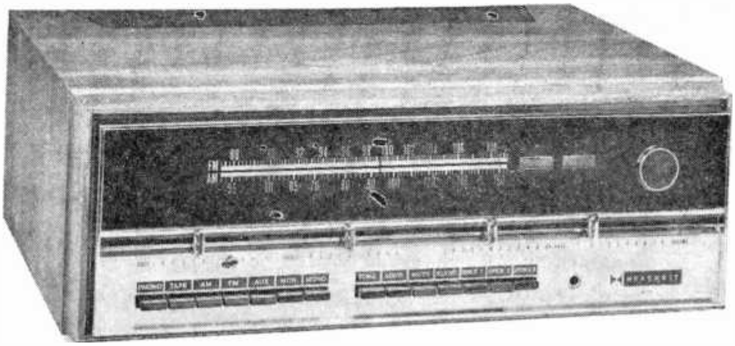






All functions in the curve tracer are tied together through a fairly complicated switching arrangement. Inside, the finished kit (photo at left) appears to be nothing but wiring and more wiring. The electronic portion of tracer is mounted on a printed circuit board which is held in place by the vertical and horizontal binding posts (above).



## MEDIUM-POWER STEREO RECEIVER (Heathkit Model AR-29)

HOW DOES a company that is reputed by the experts and hi-fi purists to be the maker of the world's finest top-of-the-line stereo receiver (AR-15) outdo itself? Simple (or so it seems)! It proceeds to make the world's finest medium-power, medium-price stereo receiver. This is exactly what the Heath Company (Benton Harbor, MI 49022) has done with its Model AR-29 receiver. For features and styling, the AR-29 is, in our opinion, a triumph of modern technology. It sells in kit form for only $285, plus $19.95 for an oiled pecan (?) cabinet.

**It is difficult** to focus on any one feature that makes the AR-29 the best receiver in its class. For example, there are such innovations as a built-in test circuit (a hallmark of Heath); IC's and mechanical filtering in the FM i.f. section; plus plug-in circuit boards that save a lot of wiring time and reduce the chance of wiring errors.

High-Q toroids, a Heath exclusive, give better performance than transformer-type, multi-stage i.f. designs or crystal filters. A new "blend" function in the AR-29 attenuates any on-station FM hiss and high-frequency noise, while a "mute" function eliminates between-station noise on FM without affecting tuner sensitivity.

Some other features worth mentioning include a switching arrangement that allows the user to select either left and right stereo channels, or left, right, and center stereo outputs. A built-in rod-type AM antenna, housed in a unique plastic swivel assembly, can be positioned for the best AM reception. The output stages of the amplifier section are short-circuit proof. And input level controls are provided for each channel and source, allowing the user to preset levels with respect to each other so that, when switching inputs, the level remains constant.

The front-panel controls are functionally realistic. Sources, outputs, and modes of operation are easily switched in and out as desired, facilitated by two banks of pushbutton switches. The power control is also a pushbutton switch. Four slide controls provide bass, treble, balance, and volume settings, and a single control knob lets the user tune either AM or FM stations.

The dial window features a "Black Magic" panel that presents a toned-down black face when the receiver is turned off. Turned on, the front panel springs into life with a cool green tint. The AR-29 has a quiet distinction that will fit into any decor, especially when housed in its handsome cabinet set off by the chrome, black, and white of the front panel.

**We built the kit,** and your reviewer can honestly state that it was a pleasurable hobby activity. Assembly time will be contingent upon your experience in kit building, but it is safe to say that you should allow between 15 and 25 hours for the job depending on your kit building experience.

The kit is laid out in an orderly fashion. The builder tackles first the seven printed circuit boards, each of which refers to a different numbered box (the only exception is the output amplifier box; both boards and their components are packed in the same box). Assembling the circuit boards takes up the lion's share of construction time. But if you pace your work and allow for frequent rests, the job can be made reasonably easy.

Chassis construction, due to the plug-in feature of the boards and the use of wiring harnesses, is minimal. This portion takes place at the very end of assembly, and when you get to it, you know you are just about finished.

Once the kit is assembled, and before the circuit boards are plugged in, resistance checks must be made. Then each board is plugged into place individually and in a given sequence, and voltage checks are made. Both tests are performed with the AR-29's built-in test circuit.

Finally, hum injection tests, FM adjustments, and multiplex adjustments are performed—all without the aid of or need for special tools or equipment.

The assembly/operating manual that comes with the kit bears the usual Heath mark of excellence. The manual's thickness is deceptively formidable, but a large part of it is devoted to testing and troubleshooting procedures, theory of operation, etc. All construction procedures, testing information, and adjustment techniques are clearly outlined.

You don't have to live with the AR-29 to know you have a good receiver. Turn it on and tune along the dial and listen to how stations drop in and stay solidly in place in both FM and AM. Listen to your best tapes and records and you will find that the reproduction is crisp and natural—even the deepest bass tones. You will know right away that the Heathkit AR-29 *is* the best medium power receiver you have ever heard or are likely to hear.

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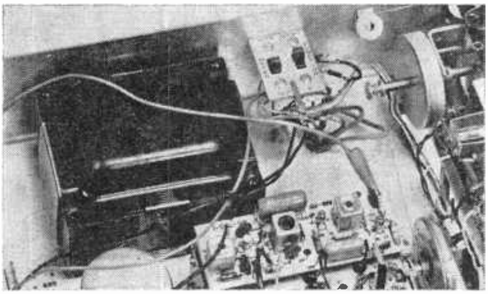
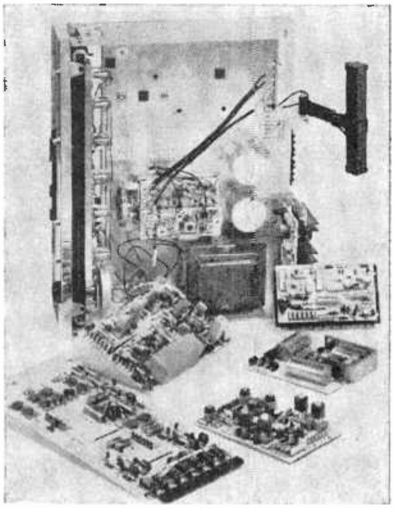


Special test circuit (switch bracket shown at top center and meter on front panel) is built in to eliminate the need for outboard test equipment. Assembly/operating manual details test procedures.



Unique plug-in circuit boards greatly reduce assembly time. Clockwise from bottom left are input preamplifier, FM i.f., audio output, power supply, and multiplex circuit boards. Control pre-amp circuit board is mounted behind front panel, and at center of chassis, AM r.f. board and AM/FM tuner.

## TECHNICAL SPECIFICATIONS (Heathkit Model AR-29)

**FM Section:**
88-108 MHz tuning range
10.7 MHz i.f.
20-15,000 Hz $\pm 1$ dB frequency response
1.5 $\mu$V typical sensitivity
Greater than 70 dB selectivity
90 dB image and i.f. rejection
50 dB AM suppression
1.5 dB capture ratio
0.5% or less harmonic distortion
0.4% or less i.m. distortion
Greater than 60 dB hum and noise
Greater than 90 dB spurious rejection
40 dB minimum at 1000 Hz channel separation
55 dB or greater 19 kHz and 38 kHz suppression
55 dB typical SCA suppression

**AM Section:**
535-1620 kHz tuning range
455 kHz i.f.
20 $\mu$V at 1400 kHz with external antenna; 300 $\mu$V at 1400 kHz with built-in rod antenna sensitivity
Greater than 40 dB (alternate channel) selectivity
60 dB at 600 kHz, 45 dB at 1400 kHz image rejection
50 dB i.f. rejection
Less than 2% harmonic distortion
35 dB hum and noise

**Amplifier Section:**
50 watts into 8-ohm load dynamic power output/channel (65 watts into 4 ohms; 30 watts into 16 ohms)
35 watts into 8-ohm load continuous output power/channel (35 watts into 4 ohms; 25 watts into 16 ohms)
Less than 5 Hz to greater than 30 kHz power bandwidth for constant 0.25% THD
Greater than 50 damping factor
2.2-mV phono; 180-mV tape, auxiliary, and tape monitor input sensitivities
155 mV phono; greater than 10 volts tape, auxiliary, and tape monitor input overload
−65 dB minimum hum and noise
50 dB minimum channel separation
4-16 ohms output impedance
50 ohms tape output impedance
49,000 ohms, RIAA equalized, phono; 100,000 ohms auxiliary, tape, and tape monitor input impedances

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CONTINUED

### FOUR-TRACE PRE-AMP KIT
### (Phase Corporation)

OSCILLOSCOPES are wonderful tools to have around when one is trying to follow a waveform around a complex circuit. However, with a conventional single-trace scope, you can only look at one waveform at a time. In most multi-stage circuits, there is a definite relationship between the waveforms within each stage; and this you just can't see with a single-trace scope. This is particularly true of digital circuits where accurate time-related waveforms are an essential.

With the need for a multiple display on a single-trace scope in mind, the Phase Corporation has introduced its Model A1KC Four Trace Pre-Amp ($34.95 for the basic kit). Powered by its own 9-volt battery, the device accepts up to four independent inputs, passes them through a four-stage FET-transistor switch, and delivers a composite signal to the single-trace scope where it appears as four independent traces. Each input has its own gain control and can be positioned as desired on the scope CRT through independent centering controls. A sync signal for the scope sweep is derived from the signal appearing at the input to channel 1.

The actual switching is performed by a pair of multivibrators that gate each stage sequentially. If you find that the display "breaks up" due to the input signal being harmonically related to the switching frequency, a built-in slide switch is provided to change the gating frequency. This approach also makes the Pre-Amp applicable for conventional audio work as well as for discrete pulses.

Each channel of the Pre-Amp has an input impedance of 1 megohm and a bandwidth of 1 MHz, while the composite output is 0.5 volt, peak-to-peak. The circuit contains 4 FET's (high-impedance input stages), 9 transistors, and 2 diodes, all mounted on a single PC board. The kit goes together easily and is simple to adjust and get to working properly. An assembled and tested unit in a custom cabinet is available for $54.95.

After using the Four Trace Pre-Amp with a conventional single-trace scope, this reviewer can say that it is an extremely handy piece of test equipment that can save a lot of time and effort when building or troubleshooting almost any multistage circuit.

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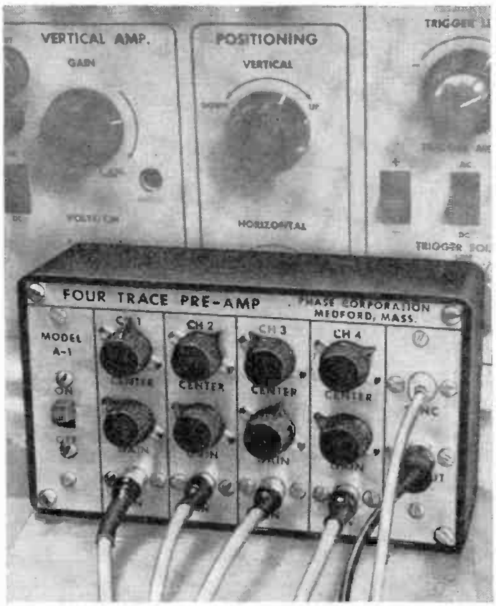
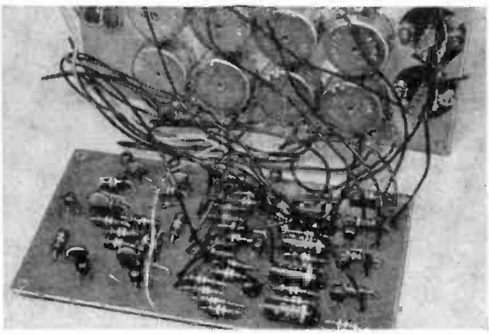



Four coaxial cables terminated in alligator clips are used to connect channels to multiple inputs. One output cable goes directly to vertical input on single-trace scope, while the other provides the scope with sync from the signal at channel 1.

The Four-Trace Pre-Amp is constructed on a PC board, with controls and jacks mounted on metal front panel. Complete pre-amp, with battery, fits compactly within plastic case that is provided.



## RCA INTEGRATED CIRCUIT KITS

ONCE SEMICONDUCTORS became an important part of electronics, several companies started to market various types of transistors in blister-type packages for the electronics experimenter. Some went even further and included a printed circuit board and all other components required to make a complete project. Such packages are now quite common and can be found at just about all parts distributors.

Now that we are in the age of integrated circuits, several companies are following the same procedure with low-cost integrated circuits. Thus IC's are available on a fairly wide basis, either singly or in combinations.

RCA (Harrison, N.J.) has now taken one more step, packaging complete IC projects. Four basic projects are now available: Mike Preamplifier (KC4000, $5.95); Two-Channel Mixer (KC4001, $6.50); Audio Oscillator (KC4002, $4.95); and 500-mW Oscillator-Amplifier (KC4003, $8.95). With other circuits to be announced in the future, each project is complete with IC, printed circuit board, and all components—including solder—to build the project. The only things not supplied are batteries and a soldering iron and, in the case of the amplifier, the loudspeaker.

A detailed brochure, packed with each project, explains exactly what the project is and how to use it, illustrates the circuit, includes a parts list, and discusses soldering techniques (especially those for IC's) and methods of construction. A photograph of the completed project, calling out all components, is also included.

We assembled the four projects and found that they went together very easily and worked the first time around. Laboratory checks showed that each project performed excellently and exceeded most requirements for high-quality sound reproduction. In fact, the 500-mW audio amplifier and mike preamplifier are now part of our test bench for checking those projects that require audio amplification. This enables us to check a project before finishing the audio portion.

If you spend a lot of time outdoors, several of these handy IC projects can be combined to make a portable, yet high-quality, audio system that can be driven from a mike or pair of mikes, from a portable phono system, from the earphone output of a conventional transistor radio, or from the output of an electronic instrument. The half-watt of power available from the KC4003 delivers a surprising amount of sound. The units are small enough to be packed in a single small cabinet; and all you need is the input, batteries, and a speaker.

In addition to the project kits, RCA has available a Kit Enclosure and Hardware Pack (KC4500, $4.75), which includes a sturdy plastic case and cover, input and output jacks, on-off switch, and all required mounting hardware. The kit is designed to hold the KC4000, KC4001, and KC4002 projects and also is suitable for some of the upcoming projects.

Incidentally, the transparent plastic containers that the kits come in make excellent holders for small parts and hardware. The hinged lids have strong snap latches that will not separate during normal handling.

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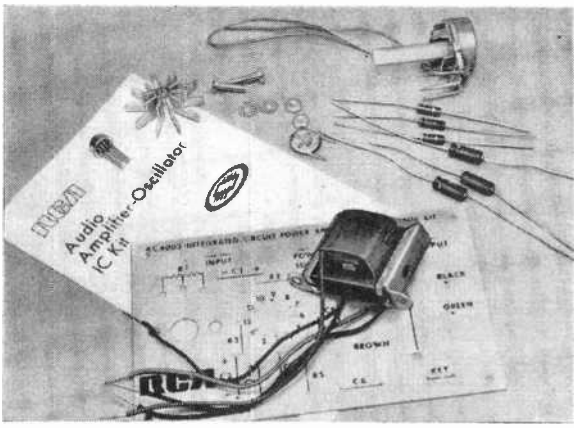


Each kit is complete with drilled PC board and all components, including solder. All you need are soldering iron, battery, and input/output device. Construction details, suggested uses, and IC techniques are provided in enclosed brochure.

## DE-SOLDERING TOOL (Continental Products)

ELECTRONICS technicians in Europe have, for several years, used a somewhat different type of de-soldering tool. In the States, the usual de-soldering tool consists of a separate special soldering iron with a rubber, bulb-activated suction pump. The unwanted solder is first heated by the iron and then sucked up into the barrel of the de-soldering tool and expelled by shaking the iron or pumping it out through additional bulb action.

Europeans use a solder "remover" (sold under the trade name of Oryx) which is a plastic barrel with a spring-loaded suction pump and Teflon tip. Rather than heat the work to be de-soldered with a special tool, you simply use your regular soldering instrument, cock the "remover" and, when the solder is molten, release the trigger so that the solder is sucked up into the barrel.

The so-called Oryx remover is distributed in this country by Continental Products Co. (P.O. Box 129, Bronxville, N.Y.) and sells for about $18. Its obvious advantage is that there is no waiting for a special tool to heat up. Your reviewer used one for several weeks and was very satisfied with its performance. Our only admonition is to be careful of the plunger release—it has tremendous force and the plunger shoots upward like a bolt of lightning.

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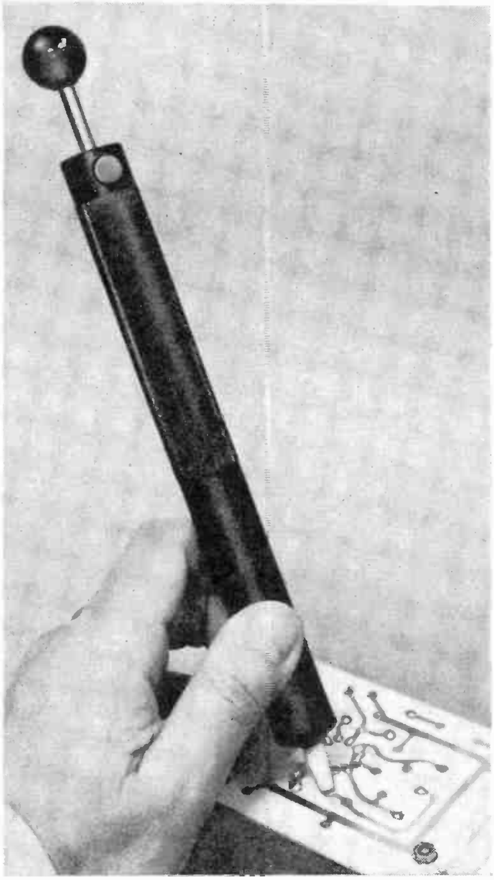
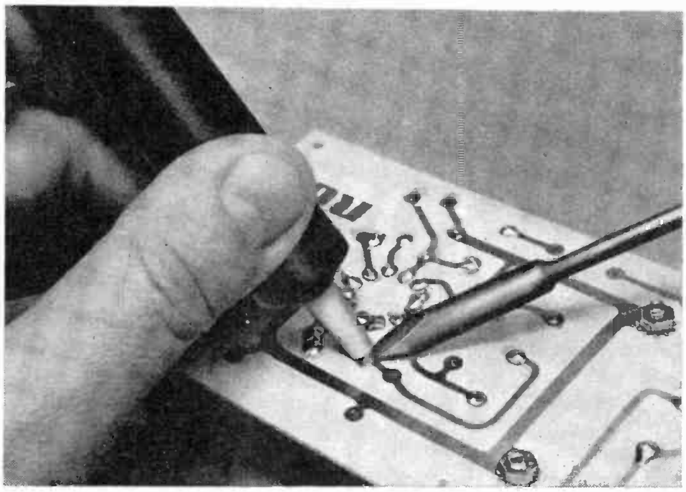


The Continental Products de-soldering tool is operated by depressing the plunger (knob shown at top) to create sucking-pump action. The release for the plunger is the button at top of the barrel and, in this reviewer's opinion, was not in a particularly "handy" location. A redesign to put the release button at bottom of shaft would help.



Imported de-soldering tool has tremendous sucking action. Molten solder is drawn into Teflon tip and expelled by releasing plunger. Note that de-soldering tool does not require a separate soldering iron with attachments—as in some other of the products distributed in U.S.A.


BY DAVID L. HEISERMAN

## Technicians in Scientific Electronics

*Because I have a ham radio license and have expressed an interest in following electronics as a career, my high school counselor suggests "scientific electronics" as the opportunity of the future. I don't have the credits for an engineering college, but could certainly make a top-notch technician. What do you think?*

THIS IS AN important question and, as a result, I am devoting this entire column to answering this high school senior.

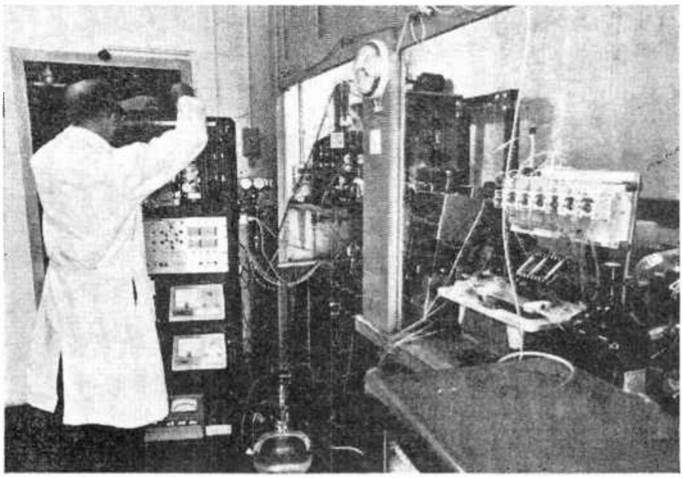
Before the end of the '70's, one out of four electronics technicians will be working in the exciting branch of modern technology called scientific electronics. For the past twenty-five years, electronics technicians have worked in either commercial or industrial electronics. Now, however, the explosive growth of science and technology is creating new career opportunities, and a third major branch of electronics.

The need for specialists in scientific electronics is developing the same way the need for industrial electronics technicians developed after World War II. Before WWII, everyone who worked in electronics dealt with commercial electronics—the electronics of home entertainment and communications. The war brought on major developments in electronic control systems and gave birth to industrial electronics. Today's relentless pressure to develop new scientific ideas and techniques is the catalyst which is creating scientific electronics.

Scientific electronics concerns itself with the endless variety of the latest electronic test instruments and specialized circuitry that fill modern science research laboratories. Scientific electronics technicians deal with problems quite different from their commercial and industrial counterparts. Solving these problems demands an especially rigorous understanding of electronics and science, combined with a well-developed sense of personal initiative and creativity.

### What Do Scientific Electronics Technicians Do?

Today's scientists have a lot of electronic



The skills of electronics technicians made it possible for Battelle Memorial Institute, a major private research lab, to develop a life-sustaining bacteria for long space missions. (Photos are courtesy of BMI.)

equipment that is considered "standard"—high-gain, high-impedance preamplifiers, signal-averaging oscilloscopes, analog recorders, etc. In fact, there is enough off-the-shelf research electronics equipment in physics and biology labs to keep thousands of technicians busy with routine operation, maintenance, and repair.

The really unique feature of scientific electronics, however, is not the "standard" laboratory electronic equipment. Research labs need an almost endless variety of one-of-a-kind electronic circuits, instruments, and systems. The whole point of scientific research is to push knowledge and techniques to new frontiers; and this calls for equally new and unusual electronic circuits and devices. One of the most attractive features of a job in scientific electronics is the lack of routine.

Most scientists have a rough idea of what electronics can do for their research projects. They rely on their engineering technicians, however, to show them exactly how to go about it, and to put the ideas into practice. The design work scientific electronics technicians do today falls into three main categories: (1) designing special kinds of transducers and the circuits to match them to standard scientific instruments; (2) designing special instruments and measuring devices; (3) designing ways to interconnect standard scientific electronic test and measuring equipment to do non-standard tasks.

### What Labs Need Technicians Now?

Physics labs were among the first to recognize the importance of electronic instrumentation. Bio-medical labs got off to a late start but they now spend more money for electronic equipment than for all other kinds of materials and equipment combined. Electronics also finds its way into some of the most unlikely sciences—such as anthropology, psychology, and zoology.

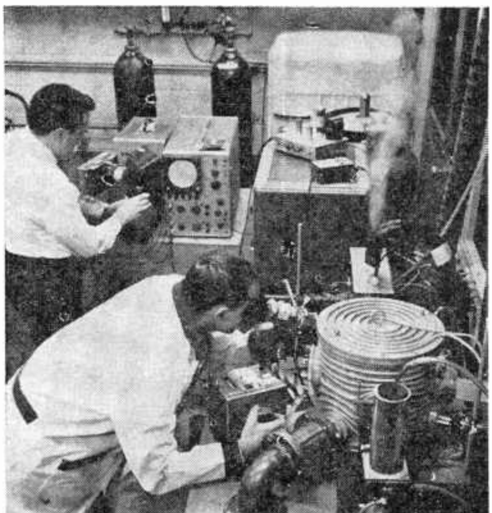
Electroscience laboratories seem to use more scientific electronics technicians than any other kind of research lab. "Electroscience" is a relatively new term that describes scientific and technical research in all phases of electronics. The most active areas of electroscience research are in solid-state electronics, advanced control systems research, and communications.

A scientific electronics technician can find a position in electroscience labs that are either privately owned or sponsored by the U.S. Government. Bell Labs, G.E., RCA, and IBM—to name only a few—are private firms that sponsor extensive electroscience research programs. Many government contracts for electroscience research go to colleges and universities. Ohio State University, for instance, has one of the world's largest electroscience labs. It employs nearly 100 technicians and engineering assistants, and specializes in space communications research.

Physics labs use nearly as many scientific electronics technicians as electroscience labs. Present-day physics research can be divided into atomic and high-energy research, solid-state physics, laser research and development, low-temperature physics, and plasma physics. Most physics research is carried out in university labs, though some government-sponsored research goes on at private laboratories.

Biological research runs second to physics in the number of electronics technicians employed. If we include medical technology as part of biological research, however, the number of scientific electronics technicians employed surpasses that of physics. Most bio-medical research is carried out at large universities.

A technician with more than a passing interest in the biological sciences stands a good chance of getting into some kind of biological research lab, and one interested in the physical sciences should try for a spot in a physics or electroscience lab. The career opportunities in scientific electronics, however, have not yet stabilized to a point where a technician interested in cell research, for example, can be sure he will find a job in a cell research lab; but that point may be reached before too long.



These electronics technicians at BMI are using a pulsed laser and electronic measuring instruments in carrying out a delicate thermal physics study.

## Salaries and Benefits

As in any other situation, the salary a scientific electronics technician makes depends largely on his experience, talent, capabilities, and the amount of responsibility he can handle. The lowest salary is around $5000 per year for a technician who operates equipment or does routine maintenance and minor repair work. Engineering technicians who do a lot of design work, take an active part in the research programs or supervise a staff of technicians can earn an annual salary of $12,000 or more. A typical salary for a technician in scientific electronics is around $7500 per year.

Unlike commercial and industrial electronics, however, salaries for scientific electronics technicians are often sensitive to the amount of laboratory funding. In a small university lab, for instance, one technician may have the responsibilities of a graduate engineer and do the work of two technicians. His salary, however, might be very small if the scientist in charge can't find enough money to support the research.

Once noted for their low-paying technical jobs, university labs now realize the need for sound technical talent. So, with the help of some fringe benefits, they are trying to offer opportunities that will attract good electronics technicians from industry.

Jobs in scientific electronics offer unique fringe benefits. University scientists are usually anxious to help technicians further their education, either in electronics or in some specific area of science. Scientific electronics technicians can attend part-time classes on the campus, and eventually earn a college degree.

Technicians who take an active part in the actual research work and make creative contributions to its success often see their names on scientific papers. Top-notch technicians sometimes publish their own papers in important electronics and scientific journals. This gives a scientific electronics technician recognition not only as a technician but also as an active scientist.

## Preparing for a Job

The Vice President of Education for the DeVry Institute of Technology, J. J. Gershon, says, "The scientific electronics technician is not a special type of person. A qualified electronics engineering technician with a good, strong background in mathematics through at least calculus and differential equations as well as a rigorous course in physics on the engineering level has the prime requisites for a scientific electronics technician." Mr. Gershon also believes that the scientific electronics technician should undertake a few specialized science courses.

The main educational requirements—electronics, mathematics, and physics—are relatively easy to fulfill because most home study and resident technical schools already offer these courses. Schools that offer the specialized science courses, however, are difficult to find. It is nearly impossible to find a technical electronics school that offers any kind of course in the biological sciences, so an eager technician who wants to work in a biology research lab must learn the biology on his own.

The employers in scientific electronics are generally professional scientists. These men recognize the fact that most new technicians will know little, if anything, about the scientific work they have to do. To compensate for this lack, scientists look for men who have the ability to learn quickly and a knack for scientific thinking. According to Dr. E. L. Jossem, Chairman of the Ohio State University physics department, "We look for men with initiative and creativity. When we find these technicians, learning the science takes care of itself."

In time, scientific electronics will be recognized as an important part of modern technology. Now is the time for creative, ambitious technicians to get in on the ground floor and shape the image of a new and exciting kind of career opportunity. —30—

### TECHNICAL COURSES FOR SCIENTIFIC ELECTRONICS TECHNICIANS

Parenthetical numbers indicate:
- (1) Readily available from most technical and home study schools.
- (2) Presently offered by a few schools.
- (3) Presently offered by very few, if any, schools.

Parenthetical letters indicate:
- (S) For all scientific electronics technicians.
- (P) For technicians in physics labs.
- (B) For technicians in biological labs.

**Electronics**
- Introductory electronics (1-S)
- Intermediate electronics (1-S)

**Solid-state electronic circuit analysis and design (1-S)**
- Digital electronics (1-S)

**Mathematics**
- Algebra (1-S)
- Trigonometry (1-S)
- Calculus and analytic geometry (1-S)
- Differential equations (1-S)

**Physics**
- Mechanics (1-S)
- Heat and light (1-S)
- Electricity and magnetism (1-S)
- Atomic energy (2-S)
- Modern physical theories (3-P)

**Technical writing (1-S)**

**Chemistry**
- Inorganic chemistry (2-S)
- Organic chemistry (3-B)

**Biology and physiology (3-B)**

# SOLID STATE

By LOU GARNER, Semiconductor Editor

## NEWEST CONTROL DEVICE IS CERAMIC

RECENTLY developed by RCA is a new solid-state device that may lead to the development of many new remote control systems. According to Dr. William M. Webster, Vice President of RCA's Princeton (N.J.) Laboratories, the device is a tiny ceramic element whose electrical properties can be adjusted electronically so that it turns on, turns off, or smoothly varies current flow in any circuit in which it is installed.

Completely solid state, the device offers long life and high reliability. Made of relatively common materials, its fabrication is inexpensive, and the associated circuitry can be quite simple. In addition, the device will "remember" its last setting indefinitely, even if power to the circuit is shut off completely.

With the unit installed as a part of standard circuits in the home, many electrical appliances could be controlled from a remote location. For example: a light in the hall or bathroom could be controlled from a bedside table. Kitchen appliances, could be turned off or on and even adjusted from elsewhere in the house. The furnace thermostat could be adjusted from anywhere in the home. A more sophisticated version of such a remote-control thermostat could be used to turn on the heater or air-conditioner in an unoccupied vacation cottage by means of a telephone call from the owner. In other applications, the new RCA device could be used to provide an infinite variety of speeds in household equipment such as blenders, grinders, mixers and fans or, similarly, as a smooth speed control for common power tools.

According to Dr. Stuart S. Perlman and Joseph H. McCusker, co-developers of the new component, its unique control action derives from the interplay of two electrical phenomena—piezoelectricity and ferroelectricity—which are inherent in the device. A piezoelectric material, of course, can transform mechanical motion into an electrical signal, and vice versa, while a ferroelectric material can remain in a state of electric polarization indefinitely, much as a permanent magnet retains its magnetic characteristics. When a material contains both properties, a change in its ferroelectric polarization changes the efficiency of its piezoelectric effect.

The interaction of these two effects was utilized by designing a sandwich consisting of two ceramic wafers bonded together on a common electrode with epoxy cement, as illustrated in Fig. 1. Each wafer has *both* ferroelectric and piezoelectric properties. Physically, the complete device is comparable, in overall size to standard transistors.

In operation, an a.c. signal applied to one wafer causes it to vibrate due to its piezoelectric properties. These vibrations are transmitted to the second wafer which converts them back to an electric output signal. The amplitude of the output signal can be raised or lowered by subjecting either wafer to an electronic control pulse, thus changing its ferroelectric polarization and its piezoelectric efficiency. Since the wafers are made of a stable material, the output signal changes only when the polarization is changed.

Two versions have been developed. One, an adaptive resonant filter, responds only

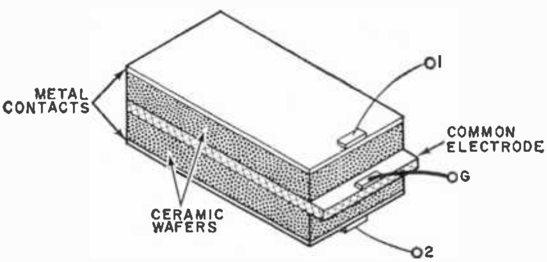


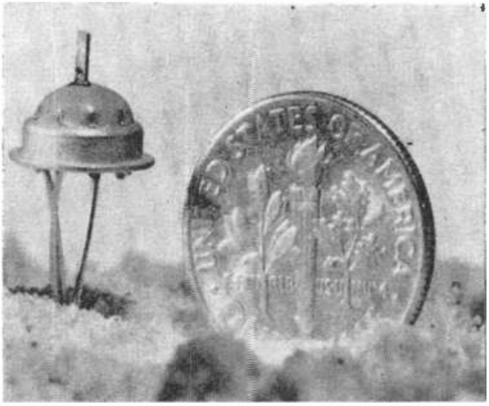

Fig. 1. Drawing shows sandwich construction of new RCA solid-state device that has many new remote control possibilities. The elements are bonded together with epoxy cement.

to input signals in a narrow frequency range. The other, designated an adaptive ferroelectric transformer, responds to input signals covering a broad frequency spectrum.

Both versions of the device use wafers made of ceramic lead zirconate/lead titanate material, commonly used in ordinary phonograph pickups. The wafer's polarization can be altered in any desired magnitude by applying voltage pulses that produce an electric field intensity, typically, of from 10 to 45 volts per mil of wafer thickness. In this way, the output signal of the device can be changed over a dynamic range of approximately 60 dB in as little as ten-thousandths of a second or as slow as 1000 seconds by high and low field pulses, respectively.

In more sophisticated versions, the input wafer can be mechanically coupled to several smaller output wafers. Each output wafer can be pulsed and its output regulated independently, thus making it possible for one device to control several functions of an electronic device as, for example, the tint, color and audio volume of a TV set.

Still experimental, it is unlikely that production versions of this exciting new device will be available until late this year.



The new RCA control element is the tiny rectangular "tab" projecting from the transistor header.

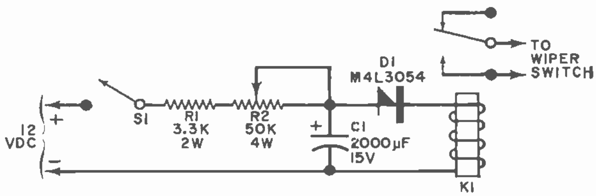
**Reader's Circuit.** Quite often, any of a variety of circuits may be used to achieve a specific goal. A good example of this can be found in the stirring "Saga of the Slow-Kick Windshield Wiper." The slow-kick operation is to provide slow wiper movement for use under such marginal driving conditions as mist or drizzle, where there is inadequate moisture to lubricate the wiper blades in continuous action, yet enough to require occasional cleaning.

Part One of this exciting drama took place in our March 1968 issue with the publication of Donald K. Belcher's original article "Slow Kick your Windshield Wipers." Belcher devised an interesting circuit using a unijunction relaxation oscillator driving a two-stage transistor amplifier which, in turn, controlled an electromagnetic relay to operate the wiper switch.

Belcher's article struck a responsive chord with reader Jonathan J. Albers, who had been using a somewhat different circuit for several years to accomplish the same action. Part Two, then, was the publication of his circuit in our December 1968 column—a unijunction oscillator driving an SCR served as an electronic switch across the regular wiper control.

Now for Part Three of the story. Reader Charles A. Huber found neither of the earlier circuits satisfactory for use in his truck and, remembering another article featuring a four-layer diode, worked up the design

Fig. 2. Very simple "slow-kick" circuit for electric windshield wiper motors is adaptable to any 12-volt electrical system, regardless to the ground polarity.




illustrated in Fig. 2. It is by far the simplest of the three designs and should be suitable for all vehicles with electric wiper motors and 12-volt systems, regardless of ground polarity.

Referring to the schematic diagram, Charles has used 4-layer diode *D1* in a simple relaxation oscillator to drive an electromagnetic relay (*K1*) which, in turn, controls the wiper switch. In operation, closing switch *S1* permits *C1* to be slowly charged from the d.c. power source through current-limiting resistor *R1* and rate control *R2*. When *C1*'s voltage reaches *D1*'s breakdown voltage, the diode switches to a conducting state, discharging *C1* through the relay's coil and actuating this device. As *D1*'s current drops below 1 mA, it switches back to a non-conducting (high-resistance) state, the relay drops out, and the cycle starts to repeat, continuing at a rate determined by *R2*'s setting as long as *S1* is closed.

Conventional components are used in the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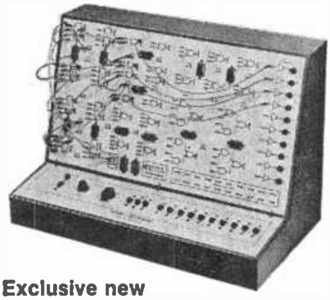

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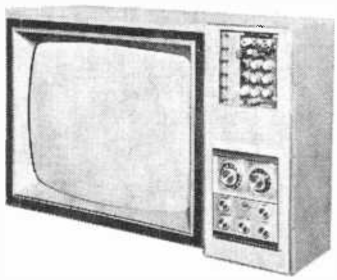

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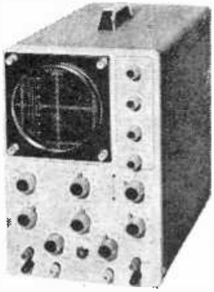

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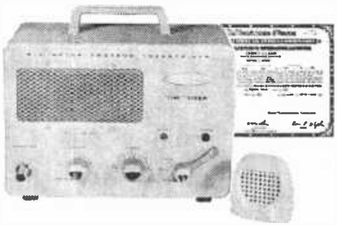

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design. A Motorola type M4L3054 diode is used for *D1*, while relay *K1* is a s.p.d.t. type having a 12-volt d.c. coil (typically, P & B type KA5DY).

Neither parts placement nor wiring arrangement should be critical and, therefore, the circuit can be assembled using any standard construction technique. A small case (probably aluminum) can be used for housing the project. The completed assembly, after test, normally would be installed below the vehicle's dash at a position within easy reach of the driver.

**Manufacturer's Circuit.** The relatively simple electronic photoflash circuit shown in Fig. 3 is one of three schematics featured in *Thyristor Application Report 901*, published by the Transitron Electronic Corp. (168 Albion St., Wakefield, Mass. 01881). The circuits were all chosen to highlight the manufacturer's versatile RTJ series of low-cost plastic-encapsulated SCR's.

Not far different from popular commercial designs, circuit action is straightforward and easily followed. Components *R5*, *D1* and *C1* form a conventional line-operated d.c. power supply, shunted by bleeder resistor *R1*. In operation, *C2* is charged slowly to source voltage through *R4*, with *SCR* remaining in an "open" (non-conducting) state during this period. When normally open shutter switch *S1* is closed, a gate signal, established by voltage divider *R2-R3*, is applied to the SCR, switching this device to a conducting state and discharging *C2* through trigger transformer *T1*'s primary winding. The resulting secondary voltage is applied to the flash-tube's control winding, firing this device and discharging *C1*. With both *D1* and *C2* discharged, the SCR switches back to an open state. Afterwards, *C1* and *C2* recharge slowly, resetting the circuit.

Easily assembled in one or two evenings, the project requires relatively few components. Rectifier *D1* is a 400-volt line rectifier (typically, International Rectifier type 8D4), while *SCR1* is a Transitron type RTJ0520. Except for *R5*, a 2-watt unit, all resistors are half-watt; *C1* and *C2* are 400-volt plastic or paper tubular capacitors, trigger transformer *T1* is Stancor type P6426 and flash-tube I1 is a type FT-30.

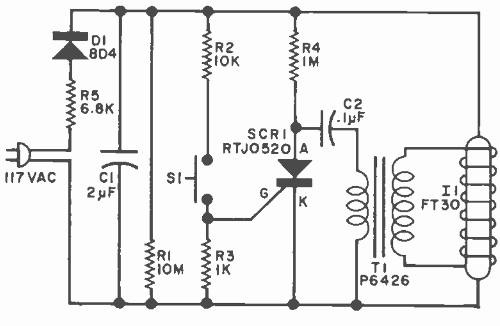



Fig. 3. Relatively simple electronic photoflash circuit uses low-cost plastic-encapsulated SCR.

Although neither layout nor lead dress are overly critical, good wiring practice should be followed when assembling the unit, with special care taken to insure adequate insulation in *T1*'s secondary circuit, due to the high voltages developed by this component. In addition, for safety's sake the entire circuit should be isolated from chassis ground and the unit's housing, with a plastic case preferred to a metal cabinet. Naturally, a suitable reflector assembly should be provided for the flashtube.

**Power!!!** *High power*, as happiness, means different things to different people and, moreover, its meaning is likely to change as time passes. During the transistor's first half-decade, a one- or two-watt device was considered a "high-power" type. A little later, this designation was reserved for 5- to 10-watt units. Today, a device must have at least a 20- to 25-watt rating to warrant a high-power classification, and the day is not far distant when any device *with less than* a 100-watt rating will be considered a medium- to low-power type.

TRW's Semiconductors Division (14520 Aviation Blvd., Lawndale, Calif. 90260), for example, has recently announced a new hybrid *microcircuit* capable of handling a 500-watt power output. The device, designated type DPS-1000, is a dual power Darlington switch mounted in a TO-3 package, with each switch capable of delivering currents of 5 amperes average, 10 amperes peak, from power supplies up to 50 volts.

If high voltages are to be handled, then Delco Radio (Kokomo, Indiana) can offer a real contender with its type DTS-702 triple diffused silicon power transistor. An *npn* unit designed for use in television deflection circuits, the DTS-702 has a 1200-volt collector-to-emitter rating and a maximum collector current rating of 3 amperes. Its power dissipation rating is 50 watts.

Where substantial power is needed at relatively high frequencies, one can turn to the Electronic Components Division of the United Aircraft Corporation (Trevose, Pa. 19047) and their type 2N5643. An *npn* silicon transistor with a 60-watt dissipation rating, the 2N5643 can deliver 40 watts at 175 MHz when powered by a 28-volt d.c. source.

On the other hand, if one requires *sheer power*, the Transitron Electronic Corp.

(*Continued on page* 103)

# TWO WAY REACTIONS

BY G. H. REESE, KCN6990

## CHANNEL 9: USE OR ABUSE?

AS THIS WAS being written in late January, we were still awaiting final FCC action on the proposed rule limiting CB on channel 9 to communications for emergencies.

This pending action is of great significance to the future of the Citizens Radio Service. It will provide a new, more serious, positive communications function that should attract many users. While the final action has not been taken, we have every reason to hope that it will become effective in the spring of this year. In addition to the support of many individual REACT teams and CB clubs, REACT National Headquarters and many individuals; such organizations as the Citizens Radio Section of the Electronic Industries Association, the American Automobile Association (AAA), and the Automobile Manufacturers Association have officially supported the rule change. A number of official governmental agencies including state police and Civil Defense authorities have also endorsed the action.

A few objections to this proposal have been received—the chief one being the problem of simultaneous monitoring for emergency calls and personal communications. Some monitors now use channel 9 to receive personal communications as well as emergency calls. Under the proposed rule, non-emergency communications would not be permitted on channel 9. Thus, the dual-purpose monitoring cannot be accomplished with a single transceiver.

We recognize this as a problem that will perhaps reduce the number of people who monitor channel 9 in some areas. However, the advantages of the emergency channel far outweigh the disadvantages. If use of the emergency channel is strictly observed, many official agencies such as police, fire, Coast Guard, Civil Defense and others will be encouraged to monitor channel 9. In addition, many dedicated REACT team members and individuals are sure to enlarge their monitoring of the channel. Monitors who are interested in maintaining their own personal communications as they monitor channel 9 can utilize a secondary receiver unit for that purpose. It is anticipated that special low-cost equipment for this purpose will be made available.

Many REACT teams now use a secondary "work" channel for communications between team members. This removes traffic from channel 9 to permit emergency messages to get through. Often they maintain a supplementary receiver to handle the two-channel communications. This can be a used piece of equipment purchased at low cost.

Once channel 9 becomes an official emergency channel, all CB radio users will be chal-

*(Continued on page 102)*

Members of Prescott (Ariz.) Emergency Radio Association (REACT) line up on a fire lookout tower operated by the U.S. Forest Service. In cooperation with the Forest Rangers, they have installed a base station in the tower on 7700-ft. Spruce Mt.

# ENGLISH LANGUAGE NEWS BROADCASTS FOR THE MONTH OF APRIL

**Prepared by ROGER LEGGE**

### TO EASTERN AND CENTRAL NORTH AMERICA

| TIME-EST | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|
| 7:00 a.m. | Peking, China | 11.685, 15.095 |
| 7:15 a.m. | Montreal, Canada | 9.625, 11.72 |
| 7:30 a.m. | Melbourne, Australia | 9.58, 11.71 |
| 9:00 a.m. | Stockholm, Sweden | 15.315 |
| 12 Noon | London, England | 21.61 |
| 4:30 p.m. | Hilversum, Holland | 11.73, 15.425 |
| 6:00 p.m. | Montreal, Canada | 9.625, 11.945, 15.19 |
| 6:45 p.m. | Tokyo, Japan | 15.445, 17.825 |
| 7:00 p.m. | London, England | 6.11, 9.58, 11.78 |
| | Moscow, U.S.S.R. | 9.685, 11.87, 11.90 |
| | Sofia, Bulgaria | 9.70 |
| | Tirana, Albania | 7.30, 9.78 |
| 7:30 p.m. | Johannesburg, South Africa | 9.705, 11.875, 15.22 |
| | Stockholm, Sweden | 11.915 |
| 7:50 p.m. | Brussels, Belgium | 6.125 |
| | Vatican City | 9.615, 11.725, 15.285 |
| 8:00 p.m. | Berlin, Germany | 9.56, 9.73 |
| | Budapest, Hungary | 9.833, 11.91 |
| | Havana, Cuba | 9.525 |
| | Madrid, Spain | 6.14, 9.76 |
| | Peking, China | 15.06, 17.715 |
| | Prague, Czechoslovakia | 5.93, 7.345, 9.54, 11.99 |
| | Rome, Italy | 9.575, 11.81 |
| 8:30 p.m. | Berne, Switzerland | 6.12, 9.535, 11.715 |
| | Cologne, Germany | 6.075, 9.735 |
| | Melbourne, Australia | 15.17, 17.775 |
| 9:00 p.m. | Hilversum, Holland (via Bonaire) | 11.73 |
| | Lisbon, Portugal | 6.025, 11.935, 15.125 |
| | London, England | 6.11, 9.58, 11.78 |
| | Moscow, U.S.S.R. | 9.685, 9.70, 11.87 |
| | Oslo, Norway (Sunday) | 11.85 |
| 9:30 p.m. | Beirut, Lebanon | 11.82 |

### TO WESTERN NORTH AMERICA

| TIME-PST | STATION AND LOCATION | FREQUENCIES (MHz) |
|---|---|---|
| 7:00 a.m. | Tokyo, Japan | 9.505 |
| 8:00 a.m. | Stockholm, Sweden | 15.315 |
| 5:30 p.m. | Melbourne, Australia | 15.17, 17.775, 21.74 |
| | Tokyo, Japan | 15.235, 17.825, 21.64 |
| 6:30 p.m. | Johannesburg, South Africa | 9.715, 11.875, 15.22 |
| 7:00 p.m. | Madrid, Spain | 6.14, 9.76 |
| | Moscow, U.S.S.R. | 9.685, 9.70, 11.90 |
| | Peking, China | 15.095, 17.673, 21.735 |
| | Prague, Czechoslovakia | 5.93, 7.345, 9.54, 11.99 |
| | Seoul, Korea | 15.43 |
| | Tokyo, Japan | 15.105 |
| 7.30 p.m. | Berlin, Germany | 9.65, 9.73, 11.84 |
| | Stockholm, Sweden | 9.725 |
| | Tirana, Albania | 6.20, 7.30 |
| 8:00 p.m. | Budapest, Hungary | 9.833, 11.91 |
| | Havana, Cuba | 9.525, 11.76 |
| | Lisbon, Portugal | 6.025, 11.935, 15.125 |
| | London, England | 6.11, 9.58, 11.78 |
| | Moscow, USSR (via Khabarovsk) | 11.87, 15.18, 17.775 |
| | Sofia, Bulgaria | 9.70 |
| | Tokyo, Japan | 15.105 |
| 8:30 p.m. | Kiev, U.S.S.R. (Mon., Thu., Sat.) | 9.685, 11.90 |
| 8:45 p.m. | Berne, Switzerland | 9.72, 11.715 |
| | Cologne, Germany | 6.145, 9.545 |
| 9:00 p.m. | Havana, Cuba | 11.76 |
| | Hilversum, Holland (via Bonaire) | 9.715, 11.73 |
| 10:00 p.m. | Moscow, USSR (via Khabarovsk) | 11.87, 15.18, 17.775 |
| | Tokyo, Japan | 9.505 |
| 10.30 p.m. | Havana, Cuba | 11.93 |

# AMATEUR RADIO

By HERB S. BRIER, W9EGQ
Amateur Radio Editor

## VISITING HAMS

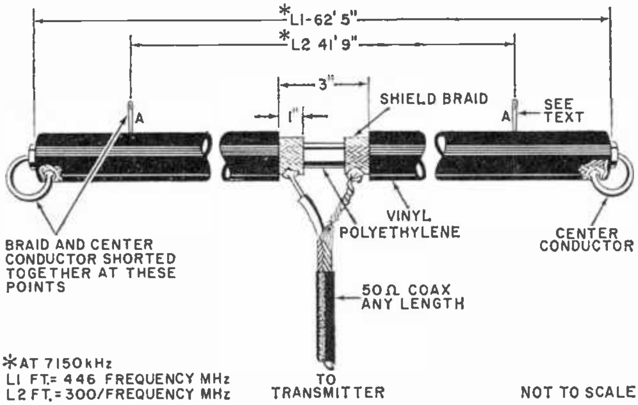
Some years ago, R. L. Gunther, VK7RG, Tasmania, Australia (then a W6) organized the "International Ham Hop Club," in which U. S. and overseas amateurs exchanged visiting and housing in each other's countries. The club was quite successful as long as Mr. Gunther coordinated its activities, but "Ham Hop" faded away when he was no longer available to do so.

In late 1968, Fred Thode, DL8VQ/W2, revived the idea under the name "Ham Exchange." Fred wrote articles for a Sunday edition of a Syracuse, N.Y. newspaper and the German amateur radio magazine *DL-QTC*, and gave talks at radio clubs. The idea of "Ham Exchange" is for participating amateurs in different countries to supply a home base—food and room only—for guests, including the entire family. Beyond these basics, the details are left to the individuals involved.

Through the efforts of Fred in the United States and of Uwe, DL8QP, in Germany, lists of interested amateurs were prepared in the two countries. In 1969, a number of amateurs and their families from each country visited the other country under the auspices of "Ham Exchange." Byron Jay, K8WGJ, who supplied much of the information used here through the Amateur Radio

AMATEUR STATION OF THE MONTH

Joe Zolik, WB2SAF, 153 Lincoln Ave., East Paterson, N.J. 07407, operates a Collins kilowatt "S-line" station into a Mosley TA-33 beam on a 66-ft motorized Tri-Ex tower. He has worked all states and over 100 countries and runs phone patches for men on U.S. ships. He's now building a TV station. We are sending WB2SAF a one-year subscription for winning this month's Amateur Station Photo Contest. You can enter by sending us a clear picture of yourself at the controls of your station with some details about your amateur radio career. Send them to Amateur Radio Photo Contest, Herb S. Brier, POPULAR ELECTRONICS, P.O. Box 678, Gary, IN 46401




Homebrew dipole made of coax has a standing wave ratio very close to 1:1 over the entire 40-meter band. Large effective diameter helps to broaden the antenna's frequency response.

News Service *Bulletin*, was one of the satisfied participants in last year's program and is an enthusiastic booster of the idea of amateurs being ambassadors of good will and hosts in the program. For more information, write to Ham Exchange, c/o Fred Thode, DL8VQ/W2, 225 Candee Ave., Syracuse, N. Y. 13224.

**The Coaxial Dipole Antenna.** Bill Caldwell, W9ALM, Kokomo, Ind., extols the virtues of a new idea in a coaxial dipole antenna. Bill (and others) claim that it has a wider frequency loading capability than a conventional dipole, radiates just as well, and produces a close match to a 50-ohm transmission line. Bill says, for example, that the standing wave ratio (SWR) of the coaxial dipole sketched in Fig. 1 is very close to 1:1 over the entire 40-meter band.

If you would like to try this antenna, cut a piece of RG-8/U coaxial cable to the overall length shown. Remove about three inches of the vinyl covering at the center of the cable. Cut out an inch of the exposed outer braid at the exact center. Connect the inner conductor of the 50-ohm coaxial feedline to one side of the split braid, and connect the shield of the feedline to the other side. Wrap the connections firmly with plastic tape to waterproof the assembly and keep the weight of the feedline off of the connections. (Note that the center conductor of the radiator is not broken or connected to the feedline.) However, connect the inner conductor and the shield braid together at each end of the radiator. Tape these connections for weatherproofing.

For broadest frequency coverage, short the outer braid and the inner conductor of the radiator together at the "A" points in the sketch; however, the antenna will work well over a slightly reduced frequency range without these shorts. Alternatively, the coaxial cable can be cut to the shorter length and extended to the required length with number 12 wire at each end. This coaxial dipole is a variation of the folded dipole. By varying the ratio of the diameters of its conductors, the center impedance of a folded dipole can be varied over a wide range. It happens that the ratio between the inner and outer conductors of conventional, polyethylene insulated, 50-ohm coaxial-cable folded dipole effects a good match to a 50-ohm transmission line. Also, the large effective diameter of the antenna (actually the braid) helps to broaden its frequency response. The large diameter also decreases the physical length of the antenna.

**Developing New Amateurs.** As evidence of our long-held belief that help and encouragement are the main ingredients in producing new amateurs, we offer the record of Richard Hardt, WA9SBR, 242 Marimar Court, Crown Point, IN 46307. In one year, he taught code and theory to seven Novices.

(*Continued on page* 111)

At WA6THG, Goleta, Calif., everybody gets into the act using Collins 75S-3 and 32S-B, even K9 Sam.

# SHORT-WAVE LISTENING

By HANK BENNETT, W2PNA/WPE2FT
Short-Wave Editor

## DX ON THE BROADCAST BAND

THE OTHER DAY at the post office, one of my buddies, who knew vaguely that I have something to do with radio (which thereby qualified me, in his opinion, as an expert), asked me how come he can hear WHAS, 840 kHz, Louisville, Ky. at 2 o'clock a.m. (EST) but not in the daytime. It seems he wakes up every morning at 2 a.m. (he didn't explain why) and likes to tune in to Louisville. But tuning the same frequency during daylight hours proves to be fruitless.

In order to get my friend to understand why he can't hear WHAS in the daytime, it was necessary to give him a dissertation on radio theory, including a discussion on the ionospheric layers, sunspots, skip effect, daytime stations, and the whole bit. This took about 10 minutes. My friend shook his head resignedly, said he understood fully, and probably felt that I was more of a kook than he had first surmised. But he still wasn't satisfied; he wanted to hear WHAS at 2 p.m. as well as at 2 a.m. Realizing that I was a complete failure at explaining the workings of the AM broadcast band, I made it a point to come straight home and prove out some of my pet theories. But much to my amazement the AM band was wide open.

WHAS was coming in like a local—at 5:15 p.m. Other 50-kW stations around the eastern states were heard, too, along with a number with lower power. Conditions were extraordinary and it's just as well that my friend hadn't tuned in that afternoon.

Having read in various club bulletins of the tricks involved in hearing real DX on the AM broadcast band, we tried to put some of these practices to use. For instance, the appearance of heterodyne whistle may signify that a station is coming in on a split frequency. (Europeans and some Latin Americans operate on channels between our normal 10-kHz separations.) The first one that we found was Rome on 845 kHz. When we snapped on the crystal selectivity switch and rotated the phasing knob a bit, Rome came through in the clear and was almost perfectly readable. At 7 p.m. we heard an unmistakable ID from "Radiotelevisione Italiana." Other stations tuned within a couple of hours included Lille, France, on 1376 kHz; Surinam on 725 kHz; *R. Titania*, San Jose, Costa Rica, on 825 kHz; Miramar, Portugal, on 782 kHz; an unidentified station on 1394 kHz (which was probably Albania); and one on 818 kHz which we think was Andorra although Cairo is the station usually reported on this frequency. We have no clue about what we heard on 566 kHz.

Dyed-in-the-wool AM broadcast band DX'ers will quickly realize that what I've listed here are stations that have been heard for months and years. But for the newcomer to the hobby it can be a genuine thrill to be able to tune in a trans-Atlantic AM station.

Ben Messersmith, WPE7CLQ, Ogden, Utah has 35 QSL's from 100 states and countries logged. His receivers include a Hallicrafters S-118, Realistic DX-150, and PRO-2 for VHF work. As you can see, he has a lot of CB, Civil Defense and test equipment.

And careful tuning like this can make you feel like a real expert; at least you've accomplished something that you can talk about.

So, folks, the AM broadcast band does have DX. It's up to you to pull it through. Have fun trying and let us know of your results.

**Arthur Cushen Now M.B.E.** Although we're positive our photo feature on Arthur Cushen (February, page 74) had nothing to do with it, we were delighted to learn that he was on Queen Elizabeth's New Year Honours List. Arthur was given the M.B.E. for his work in many community services involving radio broadcasting, journalism, and work with the blind—Arthur is blind himself.

Our heartiest congratulations for a well-deserved honor to this New Zealand SWL.

**World Time Wheel Available.** The Hallicrafters Co. (600 Hicks Road, Rolling Meadows, IL 60008) is offering a small "World Time Dial and Radio Frequency Chart" for $1. The face of the rotary slide rule is marked to show the time in various major cities. On the reverse side are listings of frequencies used for broadcasting, time signals, hams, aircraft, etc., etc.

## CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports were as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to Short-Wave Listening, P. O. Box 333, Cherry Hill, N. J. 08034, in time to reach us by the fifth of each month. Be sure to include your WPE identification and the make and model number of your receiver.

**Albania**—*R. Tirana* is heard well on 7065 kHz at 2358-0028 in English to N.A. with news, music, talks, and in dual to 9780 kHz. Other outlets heard include 9510 kHz at 0145-0157 s/off and 6200 kHz at 0230-0300, both in English. Albania is also heard on 1394 kHz (*R. Tirana's* medium-wave foreign service outlet) around 2200 in language.

**Angola**—*R. Luanda,* 9535 kHz, has a wood-like drum IS at 0457-0501; s/on in Portuguese follows. News is given to 0506 and into African music until past 0514; this is parallel to 7245 kHz.

**Argentina**—Seemingly new, a Buenos Aires outlet, *R. El Mundo,* is noted on 11,754 kHz around 0130-0300 closing with native music and a two-gong tone at breaks. From announcements given, it belongs to "Emisora Comerciales de Argentina" network.

**Austria**—*Osterreichischer Versuchsende-Verband* is operating over OE3XNB on Saturday at 1300-1330 on 3678 kHz and on Sunday at 1000-1030 on 7040 kHz. Programs include DX news. Reports are welcome and IRC's will be appreciated. Reports go to the station at A-2380 Perchtoldsdorf, Hugo-Wolf-Gasse 31, Austria . . . Vienna is heard well on 9770 kHz at 0015 to N. A. and on 7245 kHz to Europe from 0700 s/on.

**Brazil**—A station on 5035 kHz is believed to be ZYW22, *R. Anhanguera,* Goiania, heard from 0230 to abrupt s/off at 0330 with "Taps"; it featured Portuguese talks and music. Another, rarely heard well, is ZYX2, *R. Brasil Central,* Goiania, 4995 kHz. Check for it during the silent period of WWV at 2345; it features US pop music and Portuguese talks.

**Cape Verde Islands**—*R. Clube Cabo Verde* is fair in Portuguese with semi-classical music from 2230-2300 s/off on 3883 kHz but you may expect QRM from US amateur stations.

**China**—Reports from west and southwest areas include: Peking on 17,700 kHz at 0130 in English, 6155 kHz at 1425 in Japanese, 7490 kHz at 1450 in Chinese, 7420 kHz at 1435 in Chinese, 7025 kHz at 0325-0337 with English talks and Chinese music, 4200 and 3830 kHz at 1517-1525, both in Chinese, 3660 kHz at 1508 in English, and 3290 kHz at 1458 in Chinese; Foochow on 2340 kHz at 1445 in Chinese and on 2200 kHz at 1145 with Chinese music; and Fukien on 3535 kHz at 1505 in Chinese, 2430 kHz at 1454 in Chinese, and at 1107 on the same frequency with Chinese and high-pitched music, but very weak.

**Colombia**—All Spanish heard on *R. Colosal,* 4945 kHz, at 0530-0545; *R. Santa Fe,* 4965 kHz, at 0100-0130 and 0430-0445; *La Voz de Caqueta,* Florencia, 5035 kHz, at 0315; *R. Sutatenza,* 5060 kHz, at 0515-0532 s/off, and *La Voz del Llano,* Villavicencio, 6065 kHz, at 2357. Back on the air is HJLW, *Ecos del Combeima,* Ibaque, on 4790 kHz, as noted at 0200 in Spanish.

**Costa Rica**—*R. Reloj,* San Jose, is wandering as noted recently on frequencies from 4650 kHz to 4750 kHz at 0215-0800 in Spanish with many ID's.

**Ecuador**—After its return of a few months ago, HCCR1, *R. Casa de la Cultura,* Quito, has settled down on 4930 kHz where it is heard from 0100 to past 0300 in usual Spanish programming.

**Egypt**—Cairo is good on 11,630 kHz at 0045 with Arabic news after a clock strike, and on 9475 kHz at 0240 in English requesting letters from listeners.

**Ethiopia**—A new frequency for ETLF, Addis Ababa, is 11,855 kHz, heard at 0250 with light music and multi-lingual announcements.

**Greece**—The current schedule for *R. Athens* reads: 0700-0815, 0900-1000, 1030-1300, 1930-2100, 2200-2230 and 2300-2330 on 9605 and 11,720 kHz; 1330-1515, 1630-1700 and 1830-1900 on 7295 and 9605 kHz; and at 1730-1800 on 11,720 and 15,425 kHz.

**Guatemala**—TGNB, *R. Cultural,* Guatemala City, may be back on the air by the time you read this, probably on 9670 kHz. All equipment is ready and only the slowness of the government in issuing the license is keeping the station off the air. Wayne Berger, Chief Engineer, writes that he will answer all reception reports but please be patient since he is also in charge of YNOL and YSHQ, in Nicaragua and El Salvador respectively.

**Guyana**—*Action Radio,* Georgetown, is on the

With a variety of antennas covering virtually any frequency, Bruce McCoy, LaPorte, Ind., has DX awards for 25 countries and 10 zones. WPE9JMY uses a Realistic DX-150, EV20CL tape deck amplifier.

## DX ALL-ZONE AWARDS PRESENTED

*To be eligible for one of the new DX All-Zone Awards designed for WPE Monitor Certificate holders, you must have verified stations in 10, 20, 30, or 40 of the radio zones of the world. The following recently qualified for and have received awards.*

**10 ZONES VERIFIED**

Rick Abshier (WPE9IQX), Lisle, Ill.
Alain Miville-de Chene (VE2PE1NK), Hauteville, Que.
Ron Budziack (WPE9JHK), Cicero, Ill.
Mike Martin (WPEØBTP), Manassas, Va.
David Reichert (WPE4JWU), Mary Esther, Fla.
Tom Felton (VE7PE1EA), Vancouver, B. C.
Roger Matus (WPE2OBQ), Lido Beach, N. Y.
Terry Moorby (VE3PE2OI), Ottawa, Ont.
Ken Piper (WPE6GVB), Stockton, Calif.
John Stevenson (WPE9GNU), Delavan, Wisc.
Ernest Baird (VE2PE1KI), Pointe Claire, Que.
Marvin Robbins (WPEØMW), Omaha, Nebr.
Harold Hollabaugh (WPE8AHX), Toledo, Ohio
Robert Sygiel (WPE2QBD), Clifton, N. J.
Gordon Collister (WPEØEZK), Lawrence, Kansas
Thomas Blossom (WPE9FHQ), Lancaster, Pa.
Peter Rudolph (WPE6GOR), Sylmar, Calif.
Paul Curran (WPE1HNV), E. Boston, Mass.
Gary Nuthals (WPE9JNA), Green Bay, Wisc.
Bruce McCoy (WPE9JMY), La Porte, Ind.
Charles Mohr, Jr. (WPE2MKI), White Plains, N. Y.
Joseph Havrilla (WPE3HMN), Tresckow, Pa.
David Arndt (WPE8KAT), Ann Arbor, Mich.
John Ehrmann (WPE9JJO), Chicago, Ill.
Kevin Boutwell (WPE2QSA), Latham, N. Y.
David Perry (WPE2QFK), Pleasant Valley, N. Y.
Stanley Starks (WPE8KDR), Midland, Mich.
Dennis Davenport (WPE9JLT), Edwardsville, Ill.
Paul Dougherty (WPE4JSN), Birmingham, Ala.
Gary Hawkins (WPE7CWG), Phoenix, Ariz.
Michael Dopson (WPE4KCF), Enterprise, Ala.
Jeff Guernsey (WPEØFJE), Salina, Kansas
David Weinberger (WPE3HVV), Philadelphia, Pa.
E. Lloyd (VE7PE1ED), N. Vancouver, B. C.
W. Striplong (WPE5FCL), Fort Worth, Texas
T. Wieber (WPE2QVT), Summit, N. J.
Richard Moore (VE3PE2NZ), London, Ont.
Michael Nickel (WPEØFML), St. Louis, Mo.
Barry Levine (WPE2QMM), Elmira, N. Y.
Mark Waldman (WPE5FBD), Kilgore, Texas
Thomas Phillips (WPE1HQE), Rutland, Vt.
Wade Smith (WPE3FGX), Wayne, Pa.
James Bochantin (WPE9JDA), Du Bois, Ill.
R. D. Gee (VE7PE1EG), Victoria, B. C.
Warren Flack (WPE4KEL), Atlanta, Ga.
Alan Macnaughton (VE3PE2PP), Kitchener, Ont.
John Cazahous (WPE6FCR), San Francisco, Calif.
Charles Leftis (WPE4KEF), Landrum, S. C.
Steven d'Adolf (KX6PE1B), APO, San Francisco, Calif.
Gary De Bock (WPE7CUX), FPO, Seattle, Wash.
John Burda, Jr. (WPE8KAO), Willard, Ohio
John Kiernan (WPE2EMN), New York, N. Y.
Fred Parkinson (WPE2QTW), Hewlett, N. Y.
Joseph Cooper (WPE9JRT), Milwaukee, Wisc.
Donald Williams (WPE7CVW), Salem, Ore.
Jim Brenner (WPE2QUL), Nutley, N. J.
Anthony Arndt (WPE6HIH), Los Angeles, Calif.
Milton Nichols (WPE1HGE), Holden, Mass.
Everett Slosman (WPE2QZB), Endicott, N. Y.
Gregory Martin (WPE8KFL), Wyoming, Mich.
Bruce Towle (WPE9JQQ), Thornton, Ill.
Laurie Coghlin (VE4PE7N), Winnipeg, Man.
Walter Miscichowski (WPE2BEH), Buffalo, N. Y.
Steven Solomon (WPE2QTM), Saddle Brook, N. J.
Bob Raymond (WPE1HOE), Bradford, Mass.
Rex Wilson (VE3PE2OV), Kitchener, Ont.
J. L. Smith (WPE5FCX), Beeville, Texas
Nick Chinn (WPE6HKB), San Leandro, Calif.
Willie Martin (WPE5FBJ), Blytheville Air Force Base, Ark.
Mike Hardester (WPE6HIM), Modesto, Calif.
Dan De Carlo (WPEØFJL), Joplin, Mo.
Mike Mc Clelland (KL7PE4C), Anchorage, Alaska
Robert Reynolds (WPE9JAF), Elmwood Park, Ill.
John Mraz, Jr. (WPE3HIT), Phoenixville, Pa.
Bob Barr (WPE3HNC), Willow Grove, Pa.
Charles Smith (VE5PE6R), Saskatoon, Sask.
Andre Lavigne (VE2PE1NO), La Salle, Que.
Glen Wilson (WPE4KDK), Arlington, Va.
Mitchell Bademan (WPE6HAB), Long Beach, Calif.
Ronald Richmond (WPE9JIH), Alexandria, Ind.
James Ziegler (WPE9JOW), Milwaukee, Wisc.
Robert Bass (WPE5FDE), New Orleans, La.
Frank Priore (WPE2MYB), Bayside, N. Y.
Peter Heindel (WPE6GLR), Waukegan, Ill.
Jack Dashper (WPE4KCJ), Camden, Tenn.
Kim Stenson (WPE1HPU), Wilmington, Vt.
Kent Kirkland (WPE3HXL), Wilmington, Del.
George Butela (WPE3HZA), Glenshaw, Pa.
Homer Ingler (WPE4JJY), Durant, Fla.
Terry Luttrell (WPE4KBX), Columbia, Tenn.

air on 560 kHz (20 kW), 705 kHz (2 kW), and on 3290 and 5950 kHz, both with 10 kW.

**Honduras**—HRN, *La Voz de Honduras*, Tegucigalpa, was heard on 5875 kHz relaying HRVF, *R. Exitos*, 5955 kHz, with a special program at 0430.

**Iran**—*R. Iran* is on a new frequency of 7044 kHz as noted at 0315-0400 in Home Service with Balkan music, language news and pop music.

**Japan**—Far East Network, Tokyo, 15,260 kHz, is good at 0200 with pop music and some news.

**Kuwait**—*R. Kuwait* is now using 15,185 kHz in English to India and Pakistan starting at 0400 with mostly pop music to 0500; a weathercast is given at 0500.

**Mexico**—*R. Mexico* is good on 6055 kHz at 0123-0137 with Spanish anmt's and L.A. music. XEUDS, *R. Universidad de Sonora*, is strong on 6115 kHz at 1700-0300 with Spanish programming and mostly Mexican music.

**Nepal**—*R. Nepal*, Kathmandu, was heard on 11,696 kHz at 0120 s/on in Nepali with IS and bells; then into local music and talks. It fades by 0300.

**Pakistan**—*R. Pakistan*, 21,730 kHz, has English news at 1500. Other outlets heard: 11,705 kHz at 0130 s/on in Urdu with chanting but QRM'ed out by 0153, and on 7135 kHz with Urdu chanting at 0136, a newscast from 0141-0159, a time signal on the hour, and into Indian language.

**Papua and New Guinea, Territory of**—A recent program schedule shows a new station, VH9RA, on 3985 kHz with xmsn time of 1430-2130. No xmtr power or station location was given.

**Peru**—OAZ4R, *R. San Juan*, Tarma, was noted on 4891 kHz with lengthy listener request music and Andean music, with Spanish anmt's after 0200.

**Poland**—*R. Warsaw* is scheduled to Europe at 0800-0830 on 7125 and 6035 kHz, 1200-1225 on 7145 and 9675 kHz, 1930-2000 and 2130-2155 on 6135 and 7145 kHz, 2030-2057 on 6035 and 7125 kHz, and 2330-0000 on 5995, 7285, 9540, and 11,955 kHz. Numerous reports list English at 0315-0345 on 9675 kHz but we have no information on this xmsn. Does anyone know the target area?

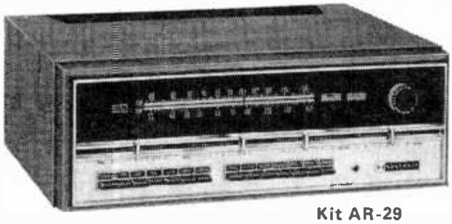
**Puerto Rico**—DX'ers who need this country for DX Awards might try for WPRA, Mayaguez, 990 kHz, at 0900 s/on in Spanish and English.

**Senegal**—Dakar can be heard daily on 4890 kHz at 0530-0800 in French with news, sports and music. Also good is 4950 kHz at 0630 with jazz and anmt's in French, and 7120 kHz at 0725-0758 with a variety of music.

*(Continued on page 110)*

# Exciting New Kit Ideas from Heath

## New Heathkit 100-Watt AM/FM/FM-Stereo Receiver



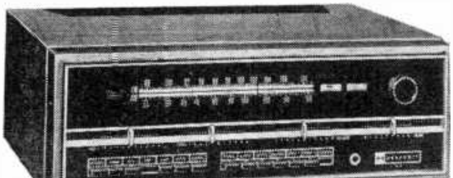
Kit AR-29

$285^{00}$*

World's finest medium power stereo receiver . . . designed in the tradition of the famous Heathkit AR-15. All Solid-State . . . 65 transistors, 42 diodes plus 4 integrated circuits containing another 56 transistors and 24 diodes. 100 watts music power output at 8 ohms — 7 to 60,000 Hz response. Less than 0.25% distortion at full output. Direct coupled outputs protected by dissipation-limiting circuitry. Massive power supply. Four individually heat sinked output transistors. Linear motion bass, treble, balances and volume controls. Push-button selected inputs. Outputs for 2 separate stereo speaker systems. Center speaker capability. Stereo headphone jack. Assembled, aligned FET FM tuner has 1.8 uV sensitivity. Two tuning meters. Computer designed 9-pole L-C filter plus 3 IC's in IF gives ideally shaped bandpass with greater than 70 dB selectivity and eliminates alignment. IC multiplex section. Three FET's in AM tuner. AM rod antenna swivels for best pickup. Kit Exclusive: Modular Plug-In Circuit Boards . . . easy to build & service. Kit Exclusive: Built-In Test Circuitry lets you assemble, test and service your AR-29 without external test equipment. The AR-29 will please even the most discriminating stereo listener.

**Kit AR-29, (less cabinet), 33 lbs................................$285.00***
**AE-19, Assembled oiled pecan cabinet, 10 lbs.....................$19.95***

## New Heathkit 60-Watt AM/FM/FM Stereo Receiver



Kit AR-19

$225^{00}$*

The AR-19 circuitry reflects many of the advanced concepts of the AR-29. It uses 108 transistors and 45 diodes including those in 5 integrated circuits. It delivers 60 watts music power at 8 ohms. At any power level, Harmonic and IM Distortion is less than 0.25%. Frequency response ranges from 6 to 35,000 Hz. Direct coupled outputs are protected by dissipation-limiting circuitry. A massive power supply includes a section of electronically regulated power. The assembled, aligned FET FM tuner has 2.0 uV sensitivity.

A preassembled and factory aligned FM IF circuit board gives 35 dB selectivity. The multiplex IC circuit provides inherent SCA rejection. It features two switched noise muting circuits; linear motion controls for bass, treble, volume and balance; input level controls; outputs for 2 separate stereo speaker systems; center speaker capability; two tuning meters; stereo indicator light; front panel stereo headphone jack. The Modular Plug-in Circuit Board design speeds assembly. Built-in Test Circuitry aids assembly, simplifies servicing. "Black Magic" panel lighting, black lower panel, chrome accents. Compare it with any model in its price range . . . the AR-19 will prove itself the better buy.

**Kit AR-19, (less cabinet), 29 lbs................................$225.00***
**Assembled AE-19, cabinet, 10 lbs................................$19.95***

## New Heathkit Deluxe 18-Watt Solid-State Stereo Phono

Kit GD-109

$74^{95}$*

Looks and sounds like it should cost much more. Here's why: 16-transistor, 8-diode circuit delivers 9 watts music power per channel to each 4½" high-compliance speaker. Speaker cabinets swing out or lift off . . . can be placed up to 10' apart for better stereo. Has Maestro's best automatic, 4-speed changer — 16, 33-1/3, 45 & 78 rpm. It plays 6 records, shuts off automatically. Ceramic stereo cartridge with diamond/sapphire stylus. Has volume, balance & tone controls. Changer, cabinet & speaker enclosures come factory built . . . you build just one circuit board . . . one evening project. Wood cabinet has yellow-gold & brown durable plastic coated covering. This is a portable stereo you can take pride in.

**Kit GD-109, 38 lbs..............................................$74.95***

## New Heathkit 80-10 Meter 2 KW Linear Amplifier

Kit SB-220

$349^{95}$*

Incomparable performance and value. The new SB-220 has 2000 watts PEP input on SSB & 1000 watts on CW and RTTY. Uses a pair of Eimac 3-500Z's. Pretuned broad band pi input coils. Requires only 100 watts PEP drive. Solid-state power supply operates from 120 or 240 VAC. Circuit breaker protected. Safety interlocked cover. Zener diode regulated operating bias. Double shielded for max. TVI protection. Quiet fan — fast, high volume air flow. Also includes ALC to prevent over-driving. Two meters: one monitors plate current; the other is switched for relative power, plate voltage and grid current. Styled to match Heath SB series. Assembles in about 15 hours.

**Kit SB-220, 55 lbs.............................................$349.95***

## New Heathkit Portable Fish-Spotter

Kit MI-29

$84^{95}$*

Costs half as much as comparable performers. Probes to 200 ft. Spots individual fish and schools . . . can also be used as depth sounder. Manual explains typical dial readings. Transducer mounts anywhere on suction cup bracket. Adjustable Sensitivity Control. Exclusive Heath Noise-Reject Control stops motor ignition noise. Runs for 80 hrs. on two 6 VDC lantern batteries (not included). Stop guessing — fish electronically.

**Kit MI-29, 9 lbs...............................................$84.95***

## TWO-WAY REACTIONS

*(Continued from page 93)*

lenged to demonstrate good citizenship and pride in their use of equipment. We know that a few outlaws on the air will make it difficult for all of us to get the maximum benefit from our CB equipment. The FCC action making channel 9 an official emergency channel however gives a new level of recognition to the entire CB community. It elevates the Citizens Radio Service to a point where the FCC recognizes that CB can be used for a serious and worthwhile purpose.

We hope that everyone who is on the air will acknowledge this coming of age for CB radio. With a new maturity, goes a new and higher level of responsibility. Let us all observe the channel 9 ruling as strictly as possible. It may very well be that the future of the Citizens Radio Service depends on how well users observe the ruling on channel 9. If compliance is universal, then we can expect CB radio to develop into a bigger, more significant service. However, if the ruling is extensively violated, then it is very possible that the Citizens Radio Service may be seriously curtailed.

REACT National Director, Henry B. Kreer, presented a paper before the Automotive Engineering Conference of the Society of Automotive Engineers in Detroit in January, entitled, "Safety and Service Applications of Citizens Two-Way Radio." It brought the knowledge of CB radio to this important group of people who are the technical backbone of the automotive industry.

### CURRENT EVENTS

**Fruita, Colo.** . . . Mayor Roe F. Saunders and Chief of Police Richard S. Walker recently commended the All American Citizens Band Radio Club of Grand Junction for their assistance during the power failure in Fruita. Donna Cosby, KGC1383, acted as monitor and dispatcher for the town police department. Other members of this REACT team cooperated to assist in patrolling the town for fire and vandalism.

**Dodge City, Kan.** . . . Citizens Two-Way Radio was used in a Civil Air Patrol search and rescue operation with the cooperation of Civil Defense authorities here recently. Primary communications between air and ground were on the local sheriff's frequency. Ground vehicles communicated with each other on CB channel 11. Air-to-air communications were on the CAP frequency.

**Mexico, N.Y.** . . . Oswego County REACT's snowmobiles saw a lot of action last winter in search and rescue operations. The members assist the sheriff and state police in rescuing people in the rugged Adirondack Mountains.

**Rockford, Ill.** . . . Rock River Valley CB Club Jamboree will be held May 30 and 31 at the Winnebago Co. Fair Exhibit Bldg., Pecatanica, Ill. Contact, H. E. Keirn, Box 4002, Rockford, Ill. 61110.

## SOLID STATE

(*Continued from page 92*)

(Wakefield, Mass. 01880) can supply their ST14030-32 and ST40002-04 series. Both series are silicon planar devices with 60-ampere current and 300-watt power dissipation rating. They are assembled in TO-63 stud-mounted packages. The ST14030-32 are *npn* units with voltage ratings from 125 to 170 volts, while the ST40002-04 are *pnp* complements with ratings from 80 to 120 volts.

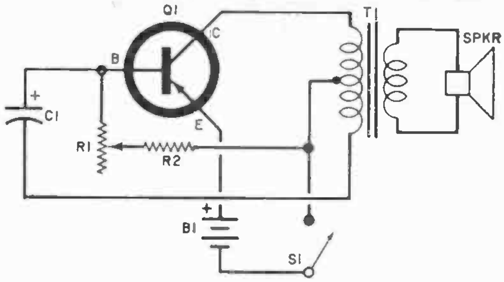



Fig. 4. Component values depend on the transistor type, supply voltage, and transformer windings.

**Transitips.** Our discussion of the basic blocking oscillator and its possible applications in January brought an unusually rapid response from readers. While most of the letters were complimentary, a few complained about our failure to detail component values.

Actually, parts values were omitted deliberately since the design is so basic that, quite literally, any of hundreds of transistors and scores of transformers could be used. The optimum component values in any specific case depend on the type of transistor used, on the supply voltage, and, to some extent, even on the transformer's characteristics.

In view of reader interest, however, we can offer a few guidelines for the serious experimenter. The original circuit is reproduced in Fig. 4 for reference. Capacitor *C1*'s d.c. polarity is indicated in the event an electrolytic capacitor is used, while all d.c. polarities are for a *pnp* transistor. If an *npn* type is used, of course, these polarities would be reversed.

If *Q1* is a small-signal transistor with characteristics smiliar, say, to the 2N107 or 2N109, then a conventional 9-volt power supply (*B1*) can be used, while *T1* should have a primary impedance of from 500 to 1500 ohms (Argonne types AR-137 or AR-138 are good choices). A 500,000- or

1-megohm potentiometer can be used for *R1*, while *R2* should be a half-watt resistor of 10,000 to 16,000 ohms. Feedback capacitor *C1* can have values ranging from 0.02 μF for a CPO to as high as 20 μF for a metronome.

On the other hand, if a medium-power transistor such as the 2N301 is used for *Q1*, *T1* should have a 40- to 50-ohm primary, with the Argonne AR-503 a suitable choice. A 6-volt lantern battery (or four series-connected flashlight cells) should be used for *B1*. Potentiometer *R1*, in this case, should be about 5000 ohms and *R2* a half-watt type with a value of from 500 ohms to, say, 1000 ohms. Here, *C1* can range in value from 0.1 μF for a CPO to as high as 100 μF for a metronome.

These suggested values are not necessarily optimum for all modes of operation, but can serve as "starting values" for experimental tests. A higher gain transistor will require larger bias resistors (*R1* and *R2*) and a smaller feedback capacitor for a given application, while a moderately high-power transistor could require relatively small bias resistors and a fairly large feedback capacitor. —*Lou.*

### ELECTRONICS GEOGRAPHY QUIZ ANSWERS

(Quiz appears on page 42)

| Part I | Part II | Part III |
|---|---|---|
| 1-G | 1-G | 1-D |
| 2-H | 2-M | 2-L |
| 3-J | 3-C | 3-M |
| 4-D | 4-H | 4-B |
| 5-L | 5-N | 5-J |
| 6-I | 6-D | 6-A |
| 7-K | 7-L | 7-I |
| 8-O | 8-I | 8-E |
| 9-C | 9-B | 9-K |
| 10-F | 10-F | 10-H |
| 11-E | 11-O | 11-F |
| 12-M | 12-A | 12-O |
| 13-N | 13-K | 13-C |
| 14-B | 14-J | 14-G |
| 15-A | 15-E | 15-N |

# OPERATION ASSIST

*Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information,* write him *directly—he'll appreciate it. If* you *need help, send a postcard to Operation Assist,* POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name and model number of the unit. If you don't know both the maker's name and the model number, give year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Do not send an individual postcard for each request; list all requests on one postcard. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

**Philco** AM/FM phono TV console chassis No. 30227. Circa 1948. Schematic and operating instructions needed. **RCA** color TV chassis No. 643L1, serial No. B8124970. Circa 1959. Schematic needed. (Joseph Siacca, 855 Alden Rd., Paramus, NJ 07652)

**Autovox** S.P.A. Noma transmobile radio (made in Italy). Volume control, tuning knobs and additional info needed. (Alfred Brown, RR #2, Matheson, Ontario, Canada)

**Challenger** Model CH30 PA amp. Schematic and info needed. (Cornel Buboi, 3329 W. 8 Mile Rd., Detroit, MI 48221)

**Precision** Model 201 signal tracer. Operation manual and schematic needed. (Arvin Richardson, Box 389, Ashley, OH 43003)

**Western Auto Supply Co.** Model 557 receiver. Schematic needed. (Rick Bowersox, 7415 Canton Dr., Lemon Grove, CA 92045)

## 100-kHz STANDARD

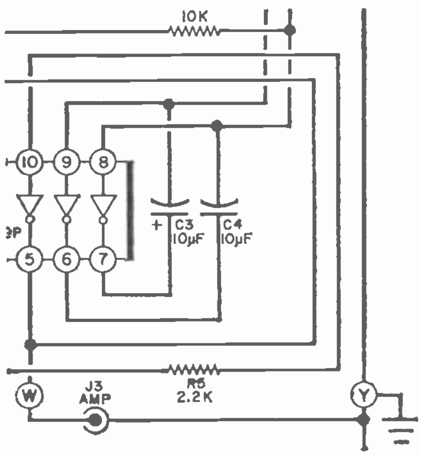
(*Continued from page* 58)

ed alignment tool to obtain either a 100 kHz reading on the counter or a quiet "chuffing" zero-beat note from the receiver speaker.

The circuit should operate properly with all good-quality 100-kHz parallel-resonant crystals. However, older surplus or odd cut crystals might require a shift in the values of capacitor *C4* and, rarely, *C3* for proper starting and clean operation. If you are using non-standard crystals, you might have to experiment to get the best results. Also, crystals with other frequencies can be used for special applications, up to 8 MHz or so.

For powering the standard, you can use batteries or any power supply capable of delivering 1.5-6 volts of relatively clean d.c. Supply voltage has a slight effect on the operating temperature; so, be sure to calibrate your 100-kHz Standard at the voltage you will be using. —30—

# OUT OF TUNE




"Build the Two-Tone 'Waverly' Alarm" (February 1970). The schematic diagram, Fig. 1 on page 30, shows *R6* and *R7* connected to the incorrect pins on *IC1*. In the partial diagram above the correct connections are shown.

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*Note: Firm names available on request.*

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## SHORT-WAVE LISTENING

(*Continued from page* 99)


**Spain**—Madrid is on 6140 kHz (up from its former 6130 kHz spot), dual with 9760 kHz in all Spanish at 2300-0000 beamed to the Canary Islands and mid-Atlantic areas.

**Upper Volta**—Ouagadougou, 4815 kHz, was logged with a French talk after 2045; this seemed to be some sort of interview.

**USA**—AAC55 is an experimental Civil Defense station operating on long-wave at 179 kHz with tone modulation and word recognition tests and, on the hour, a short anmt that gives callsign, frequency, power (5 kW) and location (. . "a few miles south of Hagerstown, Maryland . . ."). One of our long-wave listeners has heard it at times from 1900 to 0600.

**USSR**—Another long-wave station is one on 388 kHz with about 50 kW operating from Moscow for non-stop music for public and working clubs, schools, villages, and probably also for city street networks in smaller towns. There are no anmt's but after each third tune there is the Morse signal for the letter U . . . Novosibirsk, Siberia, a Zone 18 area, is in an Oriental language at 0254 to past 0346 on 11,815 kHz. Baku can be heard on 11,920 kHz at 0319 with classical music and anmt's to 0330, a Moscow ID plus another—probably a local station ID—and more music and anmt's. Baku is also being reported on 4785 kHz at 0315 to past 0400 with talks and music in Russian.

**Vatican City**—Two more new frequencies are in use by *Vatican Radio:* 6175 kHz, heard closing English at 0104 and opening in French until 0125, and on 21,700 kHz with an English religious program to Southeast Asia with s/off at 1138.

**Venezuela**—*Ecos del Torbes,* 4980 kHz, has a special news bulletin for Venezuelans abroad at 0200, 0500 and 0900 on Monday and Friday; this is in Spanish and English. Reports go to P. O. Box 152, San Cristobal . . . YVMS, *R. Universo,* Barquisimeto, 4880 kHz, is heard after 2315 with L.A. pop tunes and Spanish anmt's. . . . YVPE, *R. Central,* Maracay, 3345 kHz, is heard well in the West at 0015-0100 in all Spanish with L.A. music, frequent anmt's and ID's. . . . YVLK, *R. Rumbos,* Caracas,

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Donald Roberts, Windsor, N. Y.
Bob Roeder, El Cerrito, Calif.
William Scheider, Jersey City, N. J.
David Szafranski, Colorado Springs, Colo.
J. K. Wheeler, Midwest City, Okla.
Sweden Calling DX'ers Bulletin, Stockholm, Sweden

is often very good on the West Coast at 0930-1000 with lively L.A. music, many ID's and time checks and network news at 1000. This is on 4970 kHz.

**Windward Islands**—*W. I. Broadcasting Service,* Grenada, has two new channels in service: 15,115 kHz at 2115 to Great Britain in English, and 15,140 kHz at 2325 with pop music and time checks. Two other channels, well heard, include 5015 kHz at 2200-2250 with news at 2200 and 2245, and 11,970 kHz at 0123-0209 with L.A. music on "Juke Box Saturday Night".

**Zambia**—*R. Lusaka,* 6165 kHz, has religious music with singing at 0810 and anmt's, possibly in French, to 0816, then more music and piano tunes.

**Clandestine**—*Radio Peyk-e Iran* is heard on 11,695 kHz at 1530 in Kurdish or Persian with some music, and at 1725 on both 11,395 and 11,695 kHz . . . *R. Euzkadi* is being heard at 2030, 2130, and 2230 with xmsns usually 30 minutes long. Frequencies are 13,250 and 15,080 kHz. Opening ID's are in Basque, English, French, and Spanish. Preceding this (but not always) is an eight-chime IS. The mailing address given is P. O. Box 59, Paris-16, France . . . What is believed to be the *Voice of the Patriotic Militiamen's Front* is being heard on 7216 kHz at 1500-1515 with a male Vietnamese announcer and some type of military music.

## AMATEUR RADIO

(*Continued from page* 96)

In September 1969, he organized a radio club at the school where he teaches. It has 22 members; by Christmas vacation, one member had his Novice license, and two members had passed the code test and were waiting for their written tests. Another 15 members were waiting to take code tests. Rich was confident that these members would all obtain their licenses, and he had hopes for the rest. The club has applied for its own station license and will use a donated transmitter, receiver and vertical antenna.

Of course, there is more to helping prospective Novices than just the desire to do so, as several clubs have discovered when their inadequately prepared amateur courses have turned out to be mediocre successes. Anyone interested in organizing an amateur study course should send a 10" × 12" return envelope with $2.00 in stamps attached and $2.00 to cover printing costs for a sample set of the LERC Amateur Radio Club's license course examinations and handouts. Address your request to: William Welsh, W6DDB, LERC Amateur Radio Club, 2814 Empire Ave., Burbank, CA 91505. Bill has probably taught more people to become amateurs than anyone else in the country.

**Sixth Annual Florida QSO Party,** 1500-2000, GMT, Sunday, April 5. Florida stations exchange the names of their counties for the names of the states, provinces or countries (if not U.S. or Canada) of the stations worked. Vice versa for stations outside of Florida. Phone and CW contests are separate, and the same station can be worked once per band. Suggested frequencies: CW: 1807, 3570, 7070, 14,070, 21.070, and 28,070 kHz. Phone: 1817, 3870, 7270, 14,270, 21,370, and 28,570 kHz. General class licensee's might also try 3970 and 14,330 kHz. Florida stations multiply their QSO points by the number of states, provinces and foreign countries (up to 11) worked. Other QSO's count for points but not as a multiplier. Stations outside of Florida multiply QSO points by the number of Florida counties worked (67 maximum). Mail full log information to: *Florida Skip*, Contest Chairman. P.O. Box 501, Miami Springs, Fla. 33166. Include a 6-cent stamp to receive a tabulation of contest results when compiled.

Having built his own console, Mark Garrett, WN3KXV Baltimore, Md., worked 28 states and six countries using his Elmac AF-67 with a Hallicrafters S-20.

## News and Views

**Steve Barrymore, WA5YBX,** 4760 N.W. 24, Apt. 124, Oklahoma City, OK 73127, enjoys helping prospective Novices as much as anything he does in amateur radio. Steve's landlord objects to antennas on the roof, but Steve has an indoor 10-meter dipole, and he snakes in a coaxial feedline from the mobile whip on his car for the other bands. The whip is a Webster "Bandspanner" and is fed by a Galaxy 550. The combination has worked 45 states, but Steve is another radio amateur who is convinced that certain states do not really exist. His nominee is Delaware. . . **Paul Hitchcock, WN2JBE,** State Street, Port Byron, NY 13140, credits the Port Byron Amateur Radio Club for getting his license. He works the 80-, 40- and 15-meter Novice bands with a Heathkit DX-60 transmitter and a Hallicrafters S-85 receiver. Also on his operating bench are a homebuilt, ten-watt transmitter, homebuilt transmit/receive switch, and a tape recorder (which RCA claims to have made). Paul uses the recorder to record "prime" contacts, like new states and countries. . . To keep the record straight, **Dr. Shailer Peterson, W5PJ,** whose Memphis station was pictured in our January column, is Associate Dean of the University of Texas Dental School. He was recently Dean at the University of Tennessee.

**Joe Hendrzak, WA3NGO,** 3104 Richlieu Road, Cornwells Heights, PA 19020, works 15 meters mostly with an occasional visit to 10 meters for local ragchews. He uses a Swan 270 Cygnet Deluxe on SSB and CW. His record of 20 states and six countries more or less verifies Joe's preference to ragchew than to chase DX. He is waiting for his Rag Chewer's Club certificate to arrive and hopes to have an Advanced ticket by the time this is printed.

. . **Dan Vanderplough, WA9ZRA,** 824 Earl Road, Michigan City, IN 46360, is doing his modest bit to decrease the Citizen Band population. He became an amateur via the CB route and has so far made Novices of two more CB'ers. Dan splits his air time mostly between 80 and 20 meters on phone and CW using an EICO 753 transceiver to drive separate 80- and 20-meter dipoles. Even though he is not pushing hard for a Worked All States certificate, he has 30 states confirmed. We have to guess his DX record; nevertheless, he does chase DX, usually on 20-meter CW. . . **Bill Kresl, WN9BBC,** 1109 Sherman, Janesville, WI 53545, started out with a borrowed homebrew 15 watter then graduated to AMECO AC-1—about the same power. A Heathkit GR-64 did the receiving and a "long wire" the radiating on 40 meters. A converted "surplus" BC-453 receiver and a 40-meter converter then took over the receiving chores, and a much-modified 50-watt transmitter materialized. But, while trying to "soup up" its power to 75 watts, something burned out in the latter; so Bill put

Jaime A. Coloma, OA4EK, Lima, Peru, works DX and U.S. with Johnson Viking on 40, 20, and 15 meters.

the AC-1 back on the line, and he is getting out better than ever! Bill has 24 states confirmed, and his twin brother, Bob, WN9BJX, has 32. If all went well during Christmas vacation, Bill is now sporting a General ticket.

**Eric Strassler,** writing for the **Passaic, N. J. High School Radio Club, WA2YXQ,** reports that code and theory lessons, talks by members of the club, and operating the club station are regular features of their club meetings. A Heathkit DX-100 transmitter; Hallicrafters SX-99 receiver; Clegg 66'er, 6-meter transceiver; a 10-, 15-, 20-meter beam; and a 6-meter Saturn Halo antenna comprise the equipment. Four of the members are licensed and teach the code and theory to other members. . . **Jerome Olson, WBØAAC,** 2927 Hillsboro, New Hope, MN 55427, reports that he is "delighted" that his station takes up half of the bedroom closet in a small apartment. The station consists of a Heathkit DX-60B transmitter and HG-10B VFO; Allied Radio 2515A receiver; SWR bridge, crystal calibrator; and audio amplifier/compressor. Jerry's antenna, a Hy-Gain 18-V vertical, is fastened to a balcony railing. He works 80- and 15-meter CW and 10-meter, AM phone, where he has worked 10 states. Adding his CW totals gives him 22 states and two Canadian provinces in the log. . . **Jaime A. Coloma, OA4EK,** P.O. Box 538, Lima, Peru, transmits on a Johnson Viking transmitter via a Hy-Gain 152-TG-3 on 20 and 15 meters and a vertical on 40 meters. He receives on either a Hammarlund Super Pro or an Italian-made Geloso 209. He has worked 36 countries and 30 U.S. states and is QRV (ready) for your call.

**Ambrose Barry, W4GHV,** reports that WB4ICJ, of the Kennedy Space Center (Florida) Amateur Radio Society, worked 1650 stations in 50 countries during the first 17 hours of operation following the launching of Apollo 11. At least that many more stations were still calling when the "Special Event" ended. WB4ICJ gets on the air during each space shot from Cape Kennedy and sends attractive certificates to each amateur worked who includes a couple of stamps with his QSL card. Watch for WB4IBJ on 80, 40, 20, 15, and 10 meters, phone and CW when the next Apollo space shot is scheduled.

As always, we remind you that the first step toward seeing your "News and Views" and picture in *your* column is for you to write that letter you keep planning to send. We continue to thank all clubs and individuals who see that we receive copies of their club publications. If we are not on your club's mailing list, we would appreciate being added to it. The address is: Herb S. Brier, W9EGQ, Amateur Radio Editor, Popular Electronics, P. O. Box 678, Gary, IN 46401.

73, Herb, W9EGQ.



## LIBRARY

*(Continued from page 14)*

and designing circuits. By means of the "black box" approach, the student applies general techniques to a large class of problems. His insight is developed through graphical methods, and he is encouraged to implement the techniques learned—by digital computer wherever possible. The book is not limited to college use; anyone with a firm grasp of electronics fundamentals and familiarity with calculus will find it interesting and rewarding.

*Published by McGraw-Hill Book Co., 330 West 42 St., New York, NY 10036. Hard cover. 1014 pages. $22.50.*

### ELECTRONIC INSTRUMENTATION AND MEASUREMENT TECHNIQUES

*by William David Cooper*

In the past, test instruments were mainly used to measure values of such physical quantities as current, resistance, and voltage. Transducers now allow the measurement of many other physical parameters. Hence, it behooves the technician and technologist to know how to use intelligently the test equipment available to him. He must also have a good knowledge of the component, circuit, or system under test and understand the capabilities and limitations of his test instruments. This book, therefore, was written to familiarize the reader with the properties of the circuit and component under test and the instruments to be used. It is a storehouse of information, covering both basic and sophisticated test gear.

*Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. Hard cover. 495 pages. $12.95.*

### TRANSMISSION LINES AND ANTENNAS

*by Stephen Roman*

Most books written about transmission lines and antennas are directed at the graduate or advanced undergraduate engineering student. This book, however, attempts to fill a genuine need for this subject matter discussed at a level that most engineering students can comprehend. It also tempers the strictly intuitive approach with some of the mathematical statements necessary for a firm understanding of the subject. The book is decidedly not for the beginner; a working knowledge of both differential and integral calculus and vector algebra is required. Notwithstanding, this is decidedly an excellent tutorial book for anyone seriously interested in antennas and transmission lines.

*Published by Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York, NY 10017. Soft cover. 146 pages. $3.95.*

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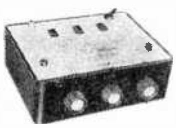
## NEW PRODUCTS

(*Continued from page 24*)

tuned r.f. stages for greater image rejection, temperature-compensated noise-free squelch, plug-in channel crystals, and military-quality glass-epoxy circuit boards.

Circle No. 88 on Reader Service Page 15 or 115

### 1.5-KW COLOR LIGHT ORGAN



The new Model LO-104 light organ made by *Science Workshop* translates electronic signals into patterns of throbbing, flashing lights that are precisely synchronized to the electronic signal. High-power outputs (500 watts/channel) provide power sufficient to transform a large room into a total light/sound environment. The light organ employs three solid-state frequency-selective filters to divide the audio range into the low, medium, and high frequencies. Each amplifier has an intensity control to enable the user to adjust relationships between channels. The amplifiers, in turn, drive high-power solid-state switching devices which control the amount of power available at the three receptacles mounted on the top panel of the instrument.

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### STEREO HEADSET

As a solution to the ever-present problem of musical privacy, *Pioneer Electronics U.S.A. Corp.*, has announced the availability of their new Model SE-20A headset. The headphones reproduce the sound of the original music with a fidelity not possible with any but the most expensive speaker systems. Each earpiece contains a cone-type high-fidelity speaker with a frequency range of 20-18,000 Hz. The response is practically distortion-free, with a deep, rich bass, smooth midrange, and outstanding clarity of the highs. Each earpiece element is rated at 8 ohms and a maximum allowable input of 0.5 watt.

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### OUTDOOR VERTICAL SWL ANTENNA

The shortwave listener who has looked enviously at ham-band vertical antennas now has a vertical receiving antenna of his own. The *Mosley Electronics, Inc.*, Model SWV-7 vertical antenna was designed at the behest of the POPULAR ELECTRONICS staff. It stands a little over 13′ tall and is "loaded" to tune to the 11-, 13-, 16-, 19-, 25-, 31-, and 49-meter international broadcast bands. Inside the heavy-duty center section are six weatherproofed loading coils that "automatically" tune the antenna to these bands. The SWV-7 can be mounted near ground level or atop a roof when used with a group of home-made copper wire radials. Ground-level mounting requires only a 3′ length of pipe—no concrete footing.

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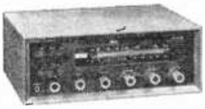
## AM/STEREO FM RECEIVER

The Model RA-193 AM/stereo FM solid-state receiver is the most recent addition to *Olson Electronics'* high-fidelity equipment line. It has 2 IC's, 23 transistors, and 15 diodes. The walnut cabinet has a black-out dial glass; precision tuning meter; stereo station indicator; and flip-tab switches for tape monitor, high and low filters, loudness, mono-stereo mode selection, and a.f.c. Technical specifications: circuit breaker overload protection; stereo headphone and tape output jacks; magnetic and crystal phono, tape, and auxiliary inputs; 2-$\mu$V FM sensitivity; 25-dB multiplex separation; 20-20,000-Hz frequency range.



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## THREE-CHANNEL VHF MONITOR RECEIVERS

Two new VHF monitor receivers, the Model COP-30L for 25-50 MHz and Model COP-20H for 150-175 MHz coverage, are being marketed by *Courier Communications*. The three crystal-controlled channels provided in these receivers pick up broadcasts on the VHF police and fire bands, as well as weather reports. Also included are facilities for receiving the AM broadcast band. Both receiver models feature a variable squelch control, built-in battery indicator, earphone and carrying strap, built-in antenna, and jack for an optional a.c. adapter. (The optional a.c. adapter is available as the Model PEC-1.)

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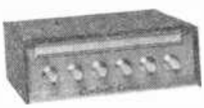
## AUDIO CONTROL CENTERS

Designed for home and professional sound installations, the *ALCO Electronic Products, Inc.*, control centers allow up to four or six stereo speaker systems to be selected for simultaneous operation. Unique push-on/push-release switches allow the user to select only the speaker systems of his choice and he has easy-access rear panel connectors to suit his particular system. No external power is required for operation, nor are there any internal resistors to affect impedance matches. The centers are usable in both low- and high-impedance systems. There are two major models from which to choose, and each is available with phono, miniature phone, or standard phone jacks. The basic models available are the CC4 and CC6.



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# ELECTRONICS MARKET PLACE

**COMMERCIAL RATE:** For firms or individuals offering commercial products or services. $1.15 per word (including name and address). Minimum order $11.50. Payment must accompany copy except when ads are placed by accredited advertising agencies. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance.
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**GENERAL INFORMATION:** First word in all ads set in bold caps at no extra charge. All copy subject to publisher's approval. Closing Date: 1st of the 2nd month preceding cover date (for example, March issue closes January 1st). Send order and remittance to: Hal Cymes, POPULAR ELECTRONICS, One Park Avenue, New York, New York 10016.

## FOR SALE

**FREE!** Giant bargain catalog on transistors, diodes, rectifiers, SCR's. zeners, parts. Poly Paks, P.O. Box 942, Lynnfield, Mass. 09140.

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**WEBBER LAB's.** Police & Fire Converters. Catalog 25¢. 72 Cottage Street, Lynn, Mass. 01905.

**RADIO—T.V.** Tubes—33¢ each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

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**PSYCHEDELIC** catalog. Posters, lighting, etc. Send 25¢ for handling to Hole In The Wall, 6055PE Lankershim, North Hollywood, Calif. 91606.

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**DEGREE** in Electronics Engineering earned mostly by correspondence. Free brochure. Dept. G-9, Grantham School of Engineering, 1505 N. Western Ave., Hollywood, California 90027.

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