COMPUTER NERVE CENTER LINKED TO YOUR HOME - Page 7

ELECTRONICS HOBBYIST

ELECTRONICS HOBBYIST

FALL-WINTER 1977 $1.35 EC 02396

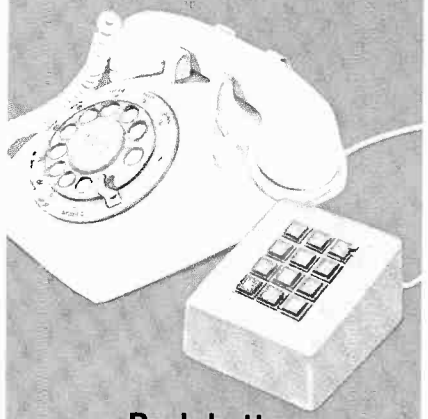
By the Editors of ELEMENTARY ELECTRONICS

Sounds Do Things You Never Thought Possible-

SIMPLE-SYN

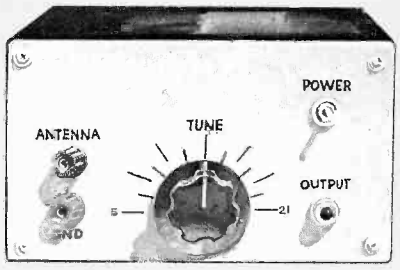
Imitate a beagle or a bugle with Simple-Syn, the Music Machine—Page 41

TONE TO PHONE



Push-button dialing when you Add Tone to Your Phone—Page 21

SW BOOSTER



Cover the globe with the hottest new Shortwave Booster—Page 68

Plus

Lissy, the TV Light Pen **makes the boob tube *really* weird**

Always win on the red with *Las Vegas LED* electronic roulette

Smooth FM without slick sales from *Super Soother SCA*

Alternator Tester **keeps your car all charged up**

Lone Ranger **light meter rides again**

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A DAVIS PUBLICATION

The chances are excellent that...

You have a talent other people are willing to pay for!

You're "handy" around your house, have the ability to fix things, and "make them work right"... that's why there may be a rewarding career for you in Electronics.

A career in Electronics?

Absolutely. Because you're interested in *things*. How they work. Why they work. How to take them apart and put them back together. Plus . . . you've got a head for detail work.

Your chances are excellent

With the right kind of *specialized* technical training, you can have a challenging, financially rewarding future waiting for you in Electronics. Think of the career opportunities . . . computers, aerospace, 2-way radio communications, radio/TV broadcasting, medical electronics, to name just a few.

And, surprisingly, you don't need a college degree!

All you need to do to qualify for one of these exciting career fields is to build upon the technical aptitude you already have . . . just put your hands and your head to work with a CIE Electronics career course.

You learn by doing

The CIE method of instruction is the refinement of over 40 years of Electronics, independent home-study experience. It works. And you don't need *any* prior electronics experience. A CIE *career* course can take you from ground zero right up to training in Lasers, Microminiaturization, Radar, Analog Computers, and various applications in Communications.

In some CIE courses, you'll perform "hands-on" experiments and tests with your own CIE Experimental Electronics Laboratory. And, if TV technology and digital Electronics are your main interest, you can select from several courses that involve working with and troubleshooting a TV. (And the TV is yours to keep, too!) This combination of "head and hands" learning *locks in* your understanding of the crucial principles you'll use on-the-job in your new career. But, don't kid yourself . . .

Electronics is not an "easy" science and CIE courses are not "snaps." Subject matter is technical, thorough, and challenging. It has to be. We're training you for a *career*. So the presentation of ideas is logical, written in easy-to-understand language . . . you progress step-by-step, at your own pace.

CIE Education by mail

There is no need to "go back to the classroom" with CIE. Because you learn at *home* or wherever else is convenient. You keep your present job and income. No cross-town commutes. *You* decide when and where *you* study best.

Your eventual success . . . at CIE and in your electronics career . . . will be determined by your own motivation and self-discipline. You *can* do it. And CIE can show you how.

Patterns shown on TV and oscilloscope screens are simulated.

If you want a career in servicing two-way radio communications equipment

. . . you'll have to get a First or Second Class FCC Radiotelephone License.

One good way to prepare for your license exam is a specialized home-study course from CIE..."the FCC License school."

There's a gigantic potential market out there for communications equipment service skills. (For example, there are about 4 million mobile transmitters that are licensed by the FCC.) And that's just the beginning. Radio systems are also used in air and railroad traffic control; police, fire-fighting, and rescue vehicles; ship-to-shore communications; dispatching of fleet vehicles, such as taxis and trucks; assigning field service specialists; security networks; satellite communications; and many other new and growing applications. But before you can start a career servicing any radio system, you must have at least a Second Class FCC Radiotelephone License.

How CIE Can Help You

We've been helping people prepare for the government-administered FCC License examinations since 1934. Our record speaks for itself: in continuing surveys, nearly 4 out of 5 CIE graduates who take the exams get their FCC Licenses. No wonder the people who know us best think of us as "the FCC License school."

CIE independent study courses combine the necessary FCC License preparation with a thorough education in electronics technology. In fact, one course . . . "FCC License and Communications" . . . includes that in-depth instruction plus intensive training in the specific career skills needed to maintain and repair two-way FM radio equipment. In addition, CIE offers five other career courses which include FCC License preparation. Some even provide valuable "hands-on" training with professional equipment such as a solid-state oscilloscope, a Zenith color TV, and a color bar generator.

Learning New Skills Is No Picnic

But, don't kid yourself. You really have to want success if you're going to build your skills properly. CIE independent training is no snap even with our Auto-Programmed® Lessons. It takes work and it takes time. But when you make it , the rewards can be worth it all.

So, if communications troubleshooting looks like the career field you want . . . and want it enough to roll up your sleeves and work for it . . . let us know.

Send for CIE's FREE School Catalog

Mail the card or coupon or write and mention the name and date of this magazine. We'll send you a copy of CIE's FREE school catalog — plus a complete package of independent home-study information. For your convenience, we'll try to have a representative contact you to answer your questions. Mail the card, coupon, or your letter to: CIE, 1776 East 17th St., Cleveland, OH 44114.

CIE **Cleveland Institute of Electronics, Inc.**
1776 East 17th Street, Cleveland, Ohio 44114
Accredited Member National Home Study Council

EB-25

Yes, I want your FREE school catalog and career information package.

PRINT NAME _____

ADDRESS _____ APT. _____

CITY _____ STATE _____ ZIP _____

AGE _____ PHONE (area code) _____

All CIE career courses are approved for educational benefits under the G.I. Bill.
Check box for G.I. Bill information: ☐ Veteran ☐ Active Duty

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ELECTRONICS HOBBYIST

PROJECTS **FALL—WINTER 1977**

QUICK CONSTRUCTION

DEPARTMENTS

What's Happening...

in Helsinki, Nairobi, Tel Aviv, Capetown, Moscow, Saigon or a thousand other places?

Find out with the Realistic® DX-160

A pro-feature receiver for HAM/SWL CB/SSB/AM listening.

The modern world really *is* a "global village" when you own the versatile DX-160. Five bands covering 130 kHz to 30 MHz let you monitor transmissions from all over the world. Listen in on all 120 CB channels, AM and single-sideband. Hear world news *as it develops* by tuning in local programs in faraway cities. Receive code as well as voice transmissions. You'll be amazed at the DX-power you can get even on the standard AM broadcast band! Eleven controls and switches really let you "pull out" those distant stations. Main tuning control plus precision bandspread tuning calibrated for the Amateur bands. Switchable noise limiter. Multiple controls for CW and SSB reception. A built-in receive/standby switch lets you use the DX-160 with a Ham transmitter. High-performance FET's in all critical stages. With matching speaker, headphone jack, AC and DC power cords. The DX-160 — what a way to travel! Only **169.95**.*

Ham Radio Starter Set

Bought Separately 23.24

Special Price* 21.00

Prepares you to join the action as a Ham operator. Learn theory and code technique with instruction cassette tape, programmed textbook, practice oscillator, and high-speed brass hand key.

FREE! New '78 Catalog

Come in for your copy and see what's *really* new in electronics. 164 pages — 100 in full color. 2000 exclusive items.

SOLD ONLY WHERE YOU SEE THIS SIGN:

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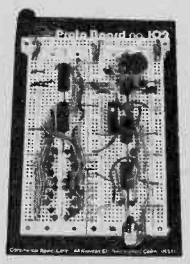
*Price may vary at individual stores and dealers. Prices and products may vary in Canada.

EVERY PROJECT IS ANOTHER REASON

Design and test circuits as fast as you can think— with CSC Proto-Board® Solderless Breadboards.

As quick as pushing in or pulling out components, you can design, test, and modify all kinds of circuits, with CSC Proto-Boards. Sockets are *already mounted*, on sturdy metal ground/baseplates with non-marring feet. They're great for a wide variety of audio and digital projects, and you save money by using components over and over again.

PB-101—940 solderless tie points: ten 14-pin DIP capacity. 140 five-point terminals plus 8 bus lines of 30 tie-points each. 4.5"W x 5.8"L x 1.4"H (114 x 147 x 35mm); 9 oz. (.26 Kg). Price: $29.95



PB-102—1240 solderless tie points: twelve 14-pin DIP capacity. 188 five-point terminals plus 6 bus lines of 40 tie-points each and 2 bus lines of 30 points. 4.5"W x 7"L x 1.4"H (114 x 178 x 35mm); 10 oz. (.31 Kg). Price: $39.95

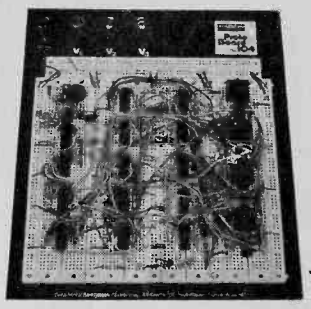
PB-6 Kit—630 solderless tie points: six 14-pin DIP capacity. Economical way to get Proto-Board speed and convenience. 94 five-point terminals plus 4 bus lines of 40 tie-points. Comes with pre-assembled sockets, four 5-way binding posts, base-plate, all hardware. 10 minute assembly with pliers and screwdriver. 6"L x 4"W x 1.4"H (152 x 102 x 34mm); 7 oz. (.20 Kg). Price: $15.95

PB-100 Kit—760 solderless tie points: ten 14-pin DIP capacity. 140 five-point terminals plus 2 bus lines of 30 tie-points each. Comes with pre-assembled sockets, two 5-way binding posts, base-plate, all hardware. 4.5"W x 6"L x 1.4"H (114 x 152 x 35mm); 7.5 oz. (.21 Kg). Price: $19.95

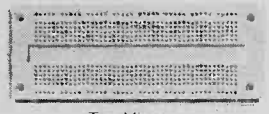
EXTRA LARGE CAPACITY FOR MORE COMPLEX CIRCUITS!

PB-103—2250 solderless tie points: twenty-four 14-pin DIP capacity. 354 five-point terminals plus 14 bus lines of 50 tie-points each, plus 2 bus lines of 40 points. 6"W x 9"L x 1.4"H (152 x 229 x 35mm); 1.25 lb. (.57 Kg). Price: $59.95.

PB-104—3060 solderless tie points: thirty-two 14-pin DIP capacity. 472 five-point terminals plus 14 bus lines of 50 tie-points. 8"W x 9.8"L x 1.4"H (203 x 248 x 35mm); 1.75 lb. (.79 Kg). Price: $79.95.

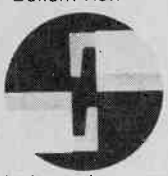


Now, breadboard in any direction! With EXPERIMENTOR™ sockets, the breadboarding system that gives you more flexibility for less dollars!



Top View

Bottom View



Sockets lock together, snap apart, to handle any circuit

Arrange EXPERIMENTOR sockets to suit your circuit instead of rearranging your circuit to fit the breadboard.

Discover the ease and convenience of solderless breadboarding. CSC EXPERIMENTOR* sockets let you design, assemble and modify circuits as fast as you can push in or pull out components.

- **Large Capacity**—Large sockets have 550 solderless tie points (94 five-point terminals) plus two 40-point bus strips.
- **Full Fan-Out**—A CSC exclusive. The only solderless breadboard sockets with full fan-out capabilities for microprocessors and other larger (0.6") DIP's.
- **Snap-together in a domino pattern**—Arrange EXPERIMENTOR sockets to suit your circuit. Expand or contract at will.
- **Simple Mounting**—Vinyl insulated backing lets you mount EXPERIMENTOR sockets anywhere without shorting. Mount to any flat surface with 4-40 flat head screws or 6-32F self-tapping screws for behind-the-panel mounting.
- **Accepts All Standard Components**—Sockets conform to 0.1" grid and are DIP compatible. Accepts IC's, diodes, resistors, capacitors, transistors, etc.

Use #22-30 solid AWG wire interconnections.

*U S Pat No 0235 554

← EXPERIMENTOR™ 300
.3" centers, perfect for smaller DIP's. Ideal mate for peripheral microprocessor IC's. 6.0" x 2.1" overall Just $9.95

EXPERIMENTOR™ 600 →
6" centers, perfect for microprocessors, clock chips, RAM's, ROM's, and PROM's. 6.0" x 2.4" overall Just $10.95

SPECIFICATIONS			TIE POINTS			
Model	Length	Width	Center Channel	5 Tie Points Terminals†	Bus Strips†	Price
300	6.0"	2.1"	.3"	94 (470)	2 (80)	$9.95
600	6.0"	2.4"	.6"	94 (470)	2 (80)	$10.95
350	3.5"	2.1"	.3"	46 (230)	2 (40)	$5.50
650	3.5"	2.4"	.6"	46 (230)	2 (40)	$6.25
Quad	6.0"	0.75"	—	—	4 (160)	$4.00

Both units are .375" deep
†Number in parentheses refers to total number of tie-points

CALL OR WRITE FOR FULL LINE CATALOG AND THE NAME OF YOUR CSC DEALER.

All Prices Shown are Manufacturer's Recommended List. Prices and Specifications Subject to Change Without Notice.

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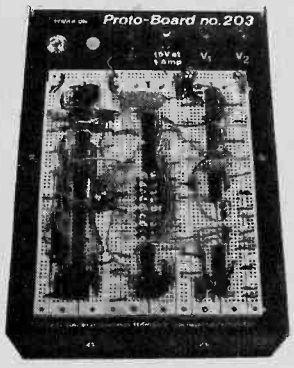


Proto-Boards with Built-In Regulated Power Supplies!

For extra convenience and breadboarding speed!

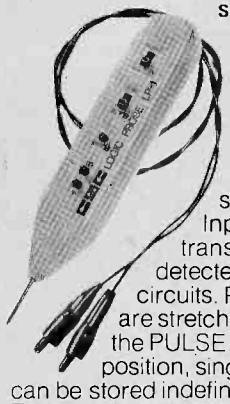
PB-203—Same capacity and layout as PB-103, *plus* short-proof, fused 5VDC, 1A regulated power supply. Ripple and noise are a low 10mV at 0.5A. Has on-off toggle switch and pilot light plus four 5-way binding posts (2 for power). 9.75"L x 6.6"W x 3.25"H (248 x 168 x 83mm); weighs 5 lb. (2.27 Kg). For 117VAC, 50/60Hz (220VAC available at slightly higher cost). Price $80.00.

PB-203A—All PB-203 features plus separate regulated +15VDC and −15VDC, 0.5A supplies, with internally and independently adjustable output voltage. Same size as PB-203; 5.5 lb. (2.5 Kg). For 117 VAC, 50/60 Hz (220 VAC, 50/60 Hz at slightly higher cost). Price: $129.95

All Prices Shown are Manufacturer's Recommended List.
Prices and Specifications Subject to Change Without Notice.

LOGIC PROBE LP-1.

Compact, self-powered, multi-family probe with pulse stretching and latching (memory) capability for DTL, TTL, HTL, and CMOS. By means of unique circuitry that combines the functions of a pulse detector, stretcher and memory, the LP-1 makes one-shot, low-rep-rate, narrow pulses—nearly impossible to see, even with a fast scope—easily detectable and visible. Input events—*positive and negative* level transitions, pulses, etc.—are automatically detected by the LP-1's specially-designed input circuits. Pulses as narrow as 50 nanoseconds are stretched to ⅓ second and by simply setting the PULSE MEMORY switch to the MEMORY position, single-shot as well as low-rep-rate events can be stored indefinitely.



To insure long trouble-free service, the LP-1 incorporates a rugged, high-impact plastic case, built-in strain relief power-cable, reverse polarity and over-voltage protection. Price: $44.95.

HIGHLIGHTS.

- HI and LO LED's blink on and off, "tracking" "1" and "0" states at square wave frequencies up to 100Hz.
- PULSE LED blinks on for ⅓ second during pulse trains.
- With square waves of up to 100KHz both HI and LO LED's will be activated; PULSE LED will blink continuously at 3Hz rate to indicate level transitions.
- With duty cycles of less than 30%, LO LED will light, in addition to PULSE LED blinking at 3Hz.
- With duty cycles of more than 70%, HI LED will light, in addition to PULSE LED blinking at 3Hz.
- Input impedance is 100,000 ohms for minimum circuit loading.
- Maximum input signal frequency is 10MHz.

MEET MAX-100

CSC's 100 MHz 8-digit Audio/CB/RF/Digital counter. At $134.95, nothing else does so much for so little.

- **MAXimum frequency range—20Hz-100MHz**
- **MAXimum CB performance—ideal for CB applications**
- **MAXimum visibility—big, bright, 0.6" 8-digit LED display**
- **MAXimum accuracy—crystal-controlled timebase**
- **MAXimum operating ease—automatic, no controls to set**
- **MAXimum range of applications—use for audio through ultrasonic through RF: AM, FM and digital**
- **MAXimum portability—completely self-contained**
- **MAXimum versatility—use with clip-lead cable, in-line tap, mini-whip antenna, etc.**
- **MAXimum flexibility—choice of four power sources**

MAX-100 is a portable, high-precision frequency counter that sets new standards in performance and value. In a compact, portable case, it gives you *continuous readings* from 20Hz to a *guaranteed 100MHz,* with 8-digit accuracy. Fast readings with 1/6-sec. update and 1-sec. sampling rate. Precise readings, derived from a crystal-controlled time base with 3ppm accuracy. High-sensitivity readings from signals as low as 30 mV, with diode overload protection up to 200V peaks.

Input signals over 100MHz automatically flash the most significant digit. And to indicate low-battery condition and extend remaining battery life, the *entire* display flashes at 1 Hz. Price: $134.95

SPECIFICATIONS

Range: 20 Hz to 100 MHz, guaranteed. **Gatetime:** 1 sec. **Resolution:** 1 Hz. **Accuracy:** ± 1 count + time base error. **Input Impedance:** 1 MΩ/56pF. **Coupling:** AC. **Sine Wave Sensitivity:** 30 mVRMS @ 50 MHz. **Internal Time Base Frequency:** 3.579545 MHz x tal osc. **Setability:** ± 3 ppm @ 25°C. **Temp-Stability:** Better than 0.2 ppm/°C, 0-50°C. **Max. Aging:** 10 ppm/year. **Display:** Eight .6" LED digits. **Lead-zero blanking:** decimal point appears between 6th and 7th digit when input exceeds 1 MHz. **Overflow:** with signals over 99,999,999 Hz, most significant (left hand) digit flashes, allowing readings in excess of 100 MHz. **Display update:** 1/6-second plus 1 sec. gate time. **Low Battery Indicator:** When power supply falls below 6.6 VDC, all digits flash @ 1 Hz. **Power:** 6 AA cells (internal); **External:** 110 or 220 VAC Eliminator/charger; Auto cigarette lighter adapter; 7.2-10VDC ext. supply; **Bat. Charging:** 12-14hr. **Size (HWD):** 1.75" x 5.63" x 7.75" (4.45 x 14.30 x 19.69cm.) **Weight:** Less than 1.5 lb. (0.68 Kg) w/batteries.

CONTINENTAL SPECIALTIES CORPORATION

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CIRCLE 9 ON READER SERVICE COUPON

New Products

3½ Digit Portable DMM Kit

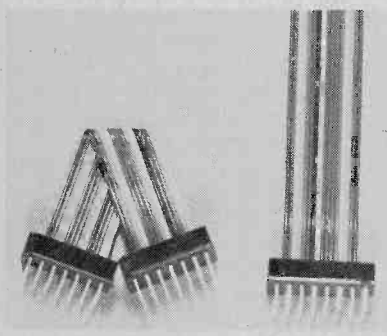
A 5-function battery operated Digital Multimeter by EICO features 3½ digits. The EICO 270 is a compact, battery-operated DMM that utilizes LSI technology. It measures AC and DC volts, AC and DC current, and resistance in 21 ranges. Polarity indicators and overload protection are provided as are 0.5-inch LED displays for easiest-to-read digital readout to 1999. The 270 has a

CIRCLE 52 ON READER SERVICE COUPON

basic 0.5% DC accuracy, 10-megohm input impedance, low voltage drop in all current ranges, automatically-flashing over-range indicator when input exceeds the value of the range selected. Low profile design for ultra-modern appearance. Supplied with test leads and functional tilt stand. (Batteries not included). Sells for $79.95. For further information, write to EICO Electronic Instrument Co., Inc., 283 Malta Street, Brooklyn, NY 11207.

Stock Cable Assemblies

Interconnect cable assemblies by O.K. Machine and Tool Corporation are perfect for testing or connecting circuitry within a board or for jumping from board to board. Assemblies feature rainbow color coded flat cable with 26 AWG stranded conductors soldered and epoxy encapsulated to popular top-entry plugs. Plugs are available in 14 and 16-pin



CIRCLE 49 ON READER SERVICE COUPON

DIP configurations to fit all standard sockets and hole patterns. Pins are gold-plated phosphor bronze for performance and durability. Double ended configuration available in 2, 4, and 8-in. lengths. Single ended assemblies are offered in 12 and 24-in. sizes. Prices from $3.75-4.35. In stock at your local electronics distributor or direct from O.K. Machine and Tool Corporation, 3455 Conner Street, Bronx, New York 10475.

Keep the Rust Out

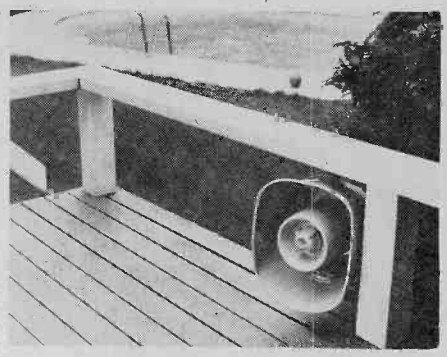
Whether electrical systems is your hobby or your profession, WD-40 is a product you shouldn't be without. WD-40 is a must in maintaining electrical systems because it guards against corrosion and insures clean contacts. A light spraying with non-conductive WD-40 will displace moisture and prevent rust on electrical outlets and outside wiring. WD-40 is

CIRCLE 51 ON READER SERVICE COUPON

harmless to most rubber, plastics, painted surfaces and fine metal finishes. It's non-oily so it won't stain your clothes. Because it contains no silicone, it will never become sticky, gummy or attract dust. WD-40 is available in a variety of spray cans and also larger gallon containers for bulk use. Comes in several sizes and is found in hardware departments in most stores. For further information, contact WD-40 Company, 1061 Cudahy Place, San Diego, CA 92110.

Rugged Indoor/Outdoor Speaker

Hi-fidelity sound for deck, patio, poolside and other outdoor areas is possible with full-frequency all-weather speaker systems pioneered by Atlas Sound of Parsippany, New Jersey. The all-weather speaker systems, capable of providing high power music and voice reproduction comparable to some of the best indoor loudspeakers, are equally well suited for home use as well as such commercial applications as hotels and motels, leisure areas, shopping malls, schools, service and industrial facilities. Power rating is 15 watts, with frequency response of 150-15,000 Hz and sound level of 117 dB. Rectangular in shape, model WT-15 speakers are all-metal coaxial units incorporating a weatherproof woofer, a high-efficiency compression driver, and associated crossover filter



CIRCLE 64 ON READER SERVICE COUPON

and network. Designed for use in areas with medium and high sound levels, the WT-15 provides optimum music reproduction together with unusually clear and intelligible voice projection when used as part of a public address system. The unit is finished in beige baked epoxy enamel, is equipped with 36-in. weatherproof connecting cable, and features a heavy-duty positive-lock steel mounting bracket suitable for wall, ceiling or pole installation with fully adjustable orientation. Priced at $104.15. Complete details on the WT-15 is available from Atlas Sound, 10 Pomeroy Road, Parsippany, NJ 07054.

UHF Prescaler

Sencore's new UHF frequency prescaler extends the range of any 60 MHz frequency counter to 600 MHz. The new model PR47 600 MHz UHF Prescaler quickly connects between the test lead and a frequency counter to fully equip technicians for UHF band testing on land mobile transceivers, scanners, aircraft radio and navigation, amateur equipment, and many other uses. The PR47 divides the input frequency by ten, so the actual readout is multiplied by

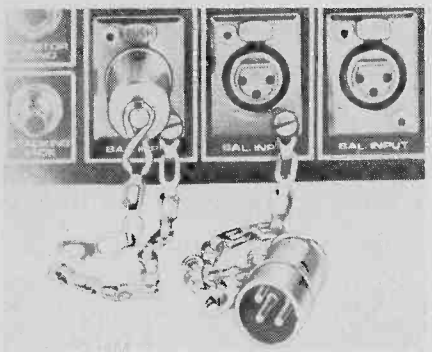
CIRCLE 61 ON READER SERVICE COUPON

ten to obtain the measured frequency. The PR47 is equipped with a BNC connector cable to adapt directly to the 1-megohm input jack on any frequency counter. Transmitters may be tuned up to 2.5 times the FCC standards in the UHF range as the PR47 does not change

the accuracy of the counter. The company notes, however, that a 1 part per million counter must be used to meet these FCC specs. A special pick-up loop supplied with the PR47 connects into the high sensitivity 300-milliVolt input on the PR47 to allow troubleshooting through circuit stages without frequency change due to circuit loading. The PR47 Prescaler is available at a cost of $9.95. For all the facts, write to Sencore, 3200 Sencore Drive, Sioux Falls, SD 57107.

Shorting Plug Reduces Hum

A new shorting plug for eliminating hum and noise pickup by unterminated microphone circuits is being offered by Switchcraft, Inc. New Q-G shorting plugs (Part No. N3MS) connect directly to female receptacles, shorting circuits together. This feature virtually eliminates hum and noise pickup by unterminated



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circuitry. A six-inch chain is provided to anchor the shorting plug, preventing loss or misplacement. The new shorting plug connects directly into Switchcraft Q-G and QGP (Quick Ground Professional) female receptacles (and similar types with compatible contact configurations). A shorting jumper connected between pins 2 and 3 on the plug shorts out unterminated microphone inputs, thereby minimizing hum and noise pickup. The plug locks firmly to mating receptacles. Sells for $5.40. For more information, write for New Product Bulletin No. 323, Sales Dept., Switchcraft, Inc., 5555 No. Elston Ave., Chicago, IL 60630.

Direct Drive Turntable

A new, easy-to-operate direct drive turntable has been added to Marantz' line. The Model 6150 turntable features a brushless low voltage DC servo-controlled motor system to minimize motor vibration. Wow and flutter is specified to be less than 0.045% WRMS, even under extreme line voltage fluctuations. To assure perfect accuracy, the motor design allows speed control to be varied ±3% by two separate controls for 33 RPM and 45 RPM. Precise speed is indicated by the raised dots on the platter edge as they pass in front of a strobe light. The precision, statically balanced tone arm has unrestricted gyroscopic movement and is resonance free throughout the audible range. The Model 6150 features a viscous dampened cue control to assure accurate gentle action, thus protecting the stylus and all records. The Marantz 6150 provides tracking at extremely low stylus pressures, and is low profile. Priced under $200. Get all the data direct from Marantz Co., Inc., 20525 Nordhoff St., Chatsworth, CA 91311.

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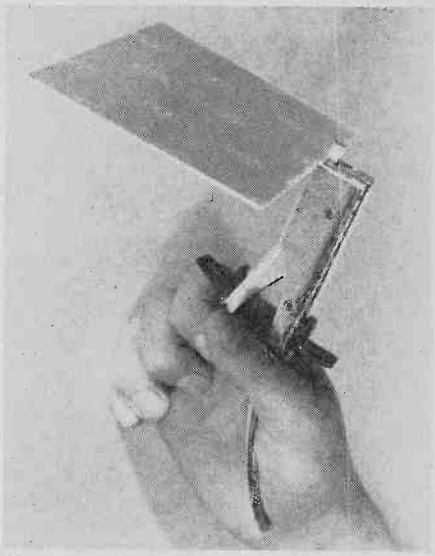
Nibbling Tool

GC Electronics' new nibbling tool (Cat. No. 805) cuts sheet metal like a chassis punch. It cuts clean holes of any shape and size in metal or plastic. Start with a ⅜-in. hole or at an edge, then simply "nibble" to size needed. The tool is capable of cutting 18 gauge steel or 1/16-in. thick copper, aluminum, or plastic. Since it's hand-operated, the need for bothersome cords or expensive batteries is eliminated. The nibbling tool is ideal for templates, shims and model

New Products



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parts. Use it to trim undersized holes to fit, notch clearance on flanges of cabinets or air ducts. Priced to sell at $7.25. GC Electronics markets a wide range of electronic tools and service aids, as well as a complete line of CB equipment and accessories. Get all the facts from GC Electronics, 400 South Wyman, Rockford, IL 61101.

It Has Everything

A stereo portable cassette recorder, the Superscope Model CRS-4000, is an AM/FM radio cassette recorder with matrix stereo. It comes equipped with an AFC switch, FM stereo LED indicator and an FM telescopic antenna. The cassette section is driven by a servo control motor and features one touch record and auto shut off. In addition, there are left and

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right VU meters which indicate record levels and a tape counter. Other features include a tape select switch (normal/CRO_2/FECR), variable sound monitor, magnetic phono input and line input provisions. The CRS-4000 may be powered by one of 4 ways; AC, DC, 12V-DC,

and rechargeable batteries. Sells for $309.95. For more information, write to Superscope, Inc., 20525 Nordhoff Street, Chatsworth, CA 91311.

General Coverage Booster

If that SW receiver can't pull in the tough signal, look to Ameco's Model PT-2 RF preamplifier. Tunable from 1.8 to 54 MHz, it improves the receiver's sensitivity and signal-to-noise ratio. If

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used with a ham station, it will bypass automatically when the transmitter is on. The FET amplifier circuit gives good cross modulation protection. Simple to install, you can expect up to 26 dB signal increase. Sells for $69.95. Write to Ameco Equipment Co., 275 Hillside Avenue, Williston Park, NY 11596.

Big Sound on Board

The Sparkomatic Model LC-100 Wide Spectrum Amplified automotive sound system has been engineered to uniformly amplify the total sound spectrum, using the latest integrated circuits. These IC's allow for high amplifier gain along with an increase in power. The high gain makes possible separate bass

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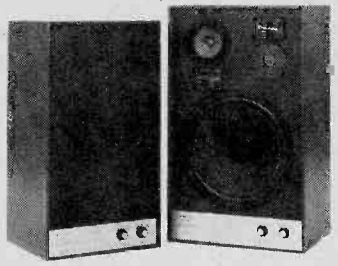
and treble controls which "mix" the sound for individual preference. Special high-performance, high-fidelity coaxial speakers are matched to the systems power potential to insure totally balanced reproduction along the entire frequency range. The LC-100 retails for approximately $79.95. For more information, write to Sparkomatic Corp., Milford, Pennsylvania 18337.

Bookshelf Speaker

H. H. Scott, Inc. has a new Large Bookshelf Series, called the Scott S196 and the Scott S186. Both are air suspension, three-way, full-range speakers which can be used as floor or bookshelf systems. For adjustment to the acoustical environment, the S196 and S186 both offer three-position midrange-woofer and tweeter controls as well as frequency response charts mounted on the cabinet. Both models feature contemporary styling, walnut vinyl finishing and removeable knit grilles. The Scott S196 contains a 12-in. high compliance woofer, a 4½-in. cone midrange and a 1-in. dome tweeter. The speaker is rated at 6 to 8 ohms nominal impedance. It has a frequency response of ±4 dB from 40 to 20,000 Hz and crossover frequencies of 800 and 4,000 Hz. Minimum required amplifier power is 15 watts per channel. The power handling capacity of the S196 is 75 watts and it can be used safely with amplifiers rated up to 100 watts per channel RMS. The S196 measures 24½ x 13⅞ x 11-in. and weighs 40 lbs. The suggested retail price is $179.95. The Scott S186 contains a 10-in. high compliance woofer, a 4½-in. cone midrange and a 1-in. dome tweeter. The speaker is rated at 6 to 8 ohms nominal impedance. It has a frequency



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response of ±4 dB from 40 to 20,000 Hz and crossover frequencies of 800 and 4,000 Hz. Minimum required amplifier power is 10 watts per channel. The power handling capacity of the S186 is 60 watts and it can be used safely with amplifiers rated up to 80 watts per channel RMS. The S186 measures 23 x 12½ x 10½-in. and weighs 26 lbs. The suggested retail price is $139.95. For more information, write to H. H. Scott, Inc., 20 Commerce Way, Woburn, MA 01801.

Home Television Programmer

The RCA entry into the video game field is a home TV programmer, called "Studio II." Heart of the RCA programmer is one of the company's new COSMAC microprocessors. This tiny electronic component is often called a "computer-on-a-chip" since it contains over 6,000 transistors and can perform complex calculations in millionths of a second. Studio II, which can reproduce games and instructional material on the screen of any size black-and-white or color TV set, has five games built into its control console, and provision for add-on cartridges containing other games and educational programs. These cartridges, which are inserted into a slot in the console, will be offered initially in three series: TV School House, TV Arcade and TV Casino. The five programs, built into the console, are bowl-

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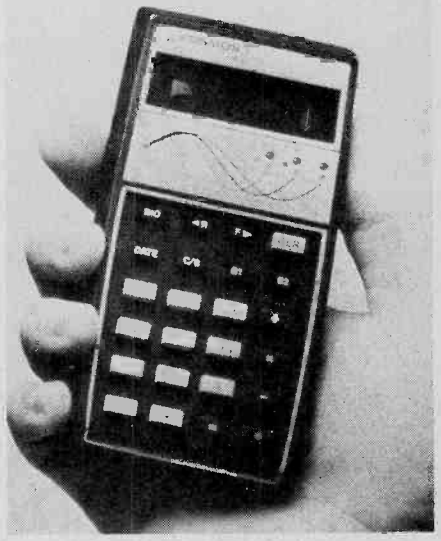
ing, freeway (car racing), patterns, doodles, and a competitive math game. RCA's add-on cartridges for the TV programmer utilize semiconductor memories. The initial cartridges are called: TV School House I, Space War and Fun-With-Numbers. TV School House features tests at various educational levels on subjects including social science, math and other subjects. Space War includes two missile target games. Fun-With-Numbers includes three mathematical exercises and puzzles. RCA's "Studio II" sells for $149.95. The Space War and Fun-With-Number cartridges are priced at $14.95 each, while TV School House will be priced at $19.95. A comprehensive program manual is included with the TV School House cartridge. For further information, write to Dept. TR, RCA Distributor and Special Products Division, Deptford, NJ 08096.

Calculator Charts Biorhythms Cycles

A new, specialized computer/calculator features separate functions to chart the three Biorhythm cycles. The pocket-size Kosmos I Biorhythm Computer and Calculator has in addition to the four standard mathematical functions (addition, subtraction, multiplication and division), separate functions to compute the emotional, intellectual and physical Biorhythm cycles, as well as the Biorhythmic compatibility between two or more persons through its memory function. Kos-



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mos I sells for $49.95. For further information, write to Kosmos International, 3930 First National Bank Tower, Atlanta, GA 30403. ■

Got a question or a problem with a project—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Personal replies cannot be made. Sorry, he isn't offering a circuit design service. Write to:

Hank Scott, Workshop Editor
ELECTRONICS HOBBYIST
229 Park Avenue South
New York, NY 10003

Replacement Guide

I know about RCA's solid-state replacements because whenever I want a particular transistor of a 2N-type, the dealer never has it, but he has the replacement. Where can I find out about the RCA replacements. I'm an active hobbyist.

—L. L., Tempe, AZ

What you want is the "RCA SK Series —Top-of-the-line 1977 Solid State Replacement Guide." You can have it by just sending a check or Postal Money Order of $1.50 to RCA Distributor and Special Products Division, P.O. Box 85, Runnemede, NJ 08078. Tell 'em Hank Scott at ELECTRONICS HOBBYIST sent you.

Meters to Frequency

I hear so much about the SW 60-meter band, the 49, 41, 31, etc. What are the frequencies?

—D. W., Black Oak, AK

You asked for the frequencies, so here they are:

BAND	FREQUENCIES (khz)
120	2300-2495
90	3200-3400
75	3800-4000
60	4750-5060
49	5950-6200
41	7100-7300
31	9500-9775
25	11700-11975
19	15100-15450
16	17700-17900
13	21450-21750

SCA and Squelch

Do SCA adaptor circuits need squelch circuits? Can't see why?

—T. F., Iowa Park, TX

For most musical program material, squelch circuitry is not necessary. However, from time to time, when the program material blanks out, some stations kill the pilot carrier causing the SCA adaptor to receive loud interstation hiss you normally hear on the FM dial. A lot of paging systems still do this. It is a power conservation device that plays heck with SCA adaptors without squelch.

The Heats On

I built your digital clock project. It works fine but the transformer buzzes and heats up. What's wrong?

—P. R., Tacoma, WA

The laminations in the transformer are loose and a new unit may be in order. Try what I once did. I clamped the loose laminations with a C-clamp and epoxied the metal frame around the lamination to the laminations. It worked. The unit was quieter and cooler. Give it a try. If it doesn't help, get a new transformer.

Needs a Buddy

I have a serious problem. I cannot buy component parts for projects because I live in Canada. Can you help me?

Keven Brown
52 Webster St.
New Hamborg, Ont.
Canada N0B 2G0

I believe parts are available to you in Canada so that it would not be necessary to buy in the U.S.A. There are serious problems in mail ordering parts across the border and our respective post offices should get together to eliminate them. Nevertheless, I am asking all our Canadian friends to clip ads and coupons from magazines, newspapers and catalogs and send them to you so that you'll know where to buy parts. Good luck!

Fix it Yourself

Why is it that the tuner in my TV costs the most to service and stays in service only a short time? I have bought my serviceman a new van. What can I do, and don't tell me to buy a new set—my last three sets all had tuner trouble!

—L. M., May Landing, NJ

The trouble is all you! First, you may be a channel flipper like me and that's rough on tuners. Next, your TV serviceman may be shooting cleaner chemicals into the tuner instead of a cleaning overhaul. I suggest you remove the tuner from the TV set and mail (insured) to PTS Electronics, Inc., P.O. Box 272, Bloomington, IN 47401. They'll repair it or replace it for a modest fee, usually under twenty dollars. Get a quote from them and a list of their authorized service centers around the nation. One may be located in your home town. When the tuner is returned, install in reverse order of removal. Do as I do, make diagrams and take notes as your emove the tuner—some people can never reassemble units several days after disassembly.

Nice Guy Report

We received a nice letter from Ronald Lettieri, President of ISCET of Pennsylvania (an electronic technician society) who informs us that there is a company that supplies test data and roll charts for Paco, Precision and other tube testers as well as adaptors for updating these units. This company is Coletronics Service, Inc., 1744 Rockaway Avenue, Hewlett, NY 11557. Save this address, you may need it some day. And if you are an electronic technician who would like to join a soci-

ety, write to Ron at 433 E. Drinker St., Dunmore, PA 18512.

Lend a Hand, Boys

What a group we have out there helping those who request assistance. You guys and gals are wonderful!

Graymark 2-band receiver #506 Model B: wiring diagram and other info requested by N. F. DeMinco, Burlington Flats, R.D. 1, NY 13315.

Hallicrafters SX110, SX108: need bandspread slide rule dial and circular main tuning dial. Will buy SX110 or SX108 for cannibalization. Contact John Chiclgey, 11110 Sagittarius Rd., San Diego, CA 92126.

Orcoa Concert Electronic Organ, Model 552 (Serial No. 1815): unit made by Estey Electronics Co., Inc., of Torrance, CA cannot be serviced without info. Please send schematic diagram, alignment instructions and service info to Richard D. Taft, 76 Alexander Ave., Parsippany, NJ 07054.

Webcor Model 2110-1 Recorder: Instruction book urgently required. Write to Albert Schwankhaus, 632 Cascade Road, Cincinnati, OH 54240.

Hallicrafters SX62-A receiver: urgently need schematic diagram, dial cord guide (who doesn't), and instruction manual. Contact Jerry Meyer, 83 Sperry Court, Brentwood, NY 11717.

CV-157/URR SSB converter (Government issue): Info needed by Bill Ostrander, 111 S. Forest, Mesa, AZ 85204.

Philco 38-116 SW receiver: not operative–transformer suspected. Can someone help Neil M. Califano, 10 Clarence Ave., Long Branch, NJ 07740.

Atwater-Kent Model 60 (Serial No. SS77697) receiver: Literature and transformers needed. Write to John Weeks, R.R. 2, Merrill, WI 54452.

Superior Instrument Co. Transistor Radio Tester Model 88: send copy of schematic to Everett Thompson, P.O. Box 1426, New London, CT 06320.

Philco 38-38 battery-operated general coverage SW receiver; needs information on battery types and hookup. Send to Gerald Overmore, Hillsboro, ND 58045.

Master-Craft Electronics Corp. Model 7FT787 Walkie-Talkie: send schematic diagram, service info or company address to Daryl M. Hagarty, Rt. 1, Williamstown, VT 05679.

Hallicrafters SC-77A SW receiver: will pay for copies of schematic diagram and would like copy of operator's manual. Send to Bill Dickinson, Box 355, Port Alice, B.C., Canada VON-2N0.

Wiper Noise

The noise from my 1974 Subaru windshield wiper comes through my CB set on both receive and transmit. I have hooked both the positive and neagtive power leads directly to the battery and it doesn't help. What now?

–H. W., Jay, NY

Check out the wiper motor. Sparking brushes can cause a lot of problems. I am not familiar with the Subura auto, but try this. Oil the linkage to the wiper motor. Heavy loads cause motors to be noisy. Also, one Ford I worked on was corrected immediately when the spring tension (causing the wiper to press on the glass) was reduced. This may not help. In line capacitor filters may be necessary to those wires connected to the wiper motor. One long shot–the regulator may be defective. You'll be surprised how many things you will try before you hit on it.

Too Many Thumbs

Every time I have to replace a phone cartridge, I am all thumbs. I break leads, lose screws and spacers, etc.; it's a disaster! Why don't they make snap-in units for guys like me?

–M. P., Gillette, WY

They do make snap-in units, but only on cheaper cartridge models. Weight is very important, the lighter the mass on the tonearm, the better is the sound reproduction. Thus, convenient mounting systems which are heavy cannot be used. But that doesn't help you. Do what I do, when installing a phono cartridge. When inserting screws, put a bit of bees wax on the screwdriver blade so that the screw will afix to it. It helps to hold it, and the bees wax is non-corrosive. Also, use tweezers to handle the delicate clips and fine wire that attach to the phono cartridge. And use a magnifying glass attached to your glasses or one that comes on a headband. Be sure not to rush, your fingers can't move as fast as your eyes.

King Sol for Heat

I would like to use Mother Nature to make electricity so I personally can save on fossil fuel. What's the best way to convert solar energy to useful energy, like electricity?

–A. H., Nazareth, PA

There is not much you can do to convert solar energy to electrical energy efficiently at your home to make a difference. In fact, the cost is prohibitive. However, you can use solar energy to heat your house, swimming pool or hot water tank, save on fossil fuel, and save money. A lot of companies are entering this business area, and equipment soon will be available. I know of one home owner who heats his pool water by pumping the pool water through a long garden hose that rests on his black-top driveway. Works fine! He now wants to use a commercial solar switch to turn the pump on and off as the sun goes in and out from clouds. Little battery chargers with solar actuators are good, but the big savings here is dollars and materials by reusing the same batteries over and over. The most successful applications to date have been from experimenters who have assembled wind driven generators to power water pumps, heat houses and charge emergency batteries in remote areas.

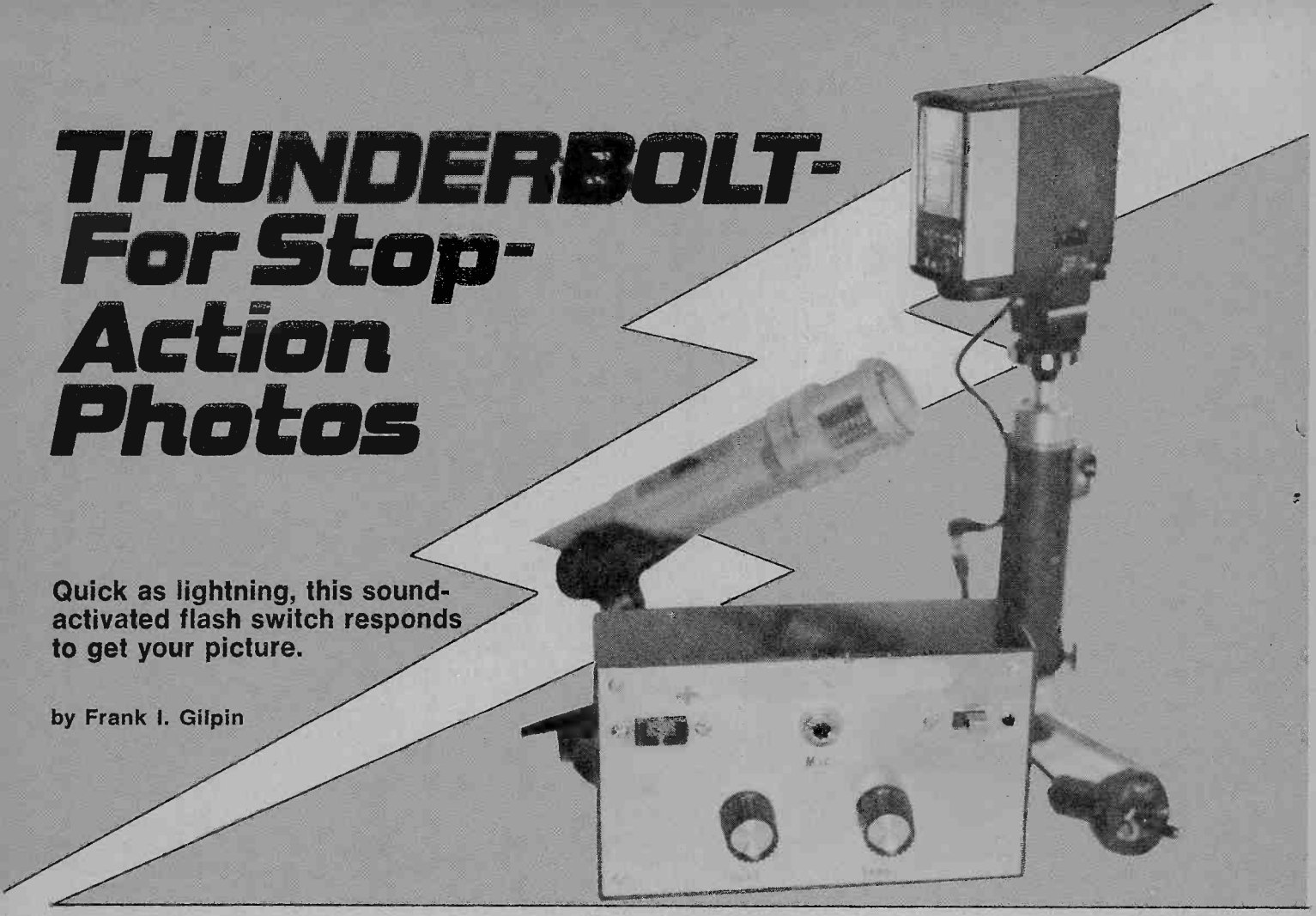
Signal Picking

All these hi-fi buffs talk numbers, and when I ask them what these numbers mean, they don't know. Can you tell me what capture ratio is?

–M. M., Cedar City, UT

Capture ratio refers to a receiver's ability to pull in, or capture an FM station it is turned to while rejecting a weaker station on the same frequency. ■

THUNDERBOLT- For Stop-Action Photos



Quick as lightning, this sound-activated flash switch responds to get your picture.

by Frank I. Gilpin

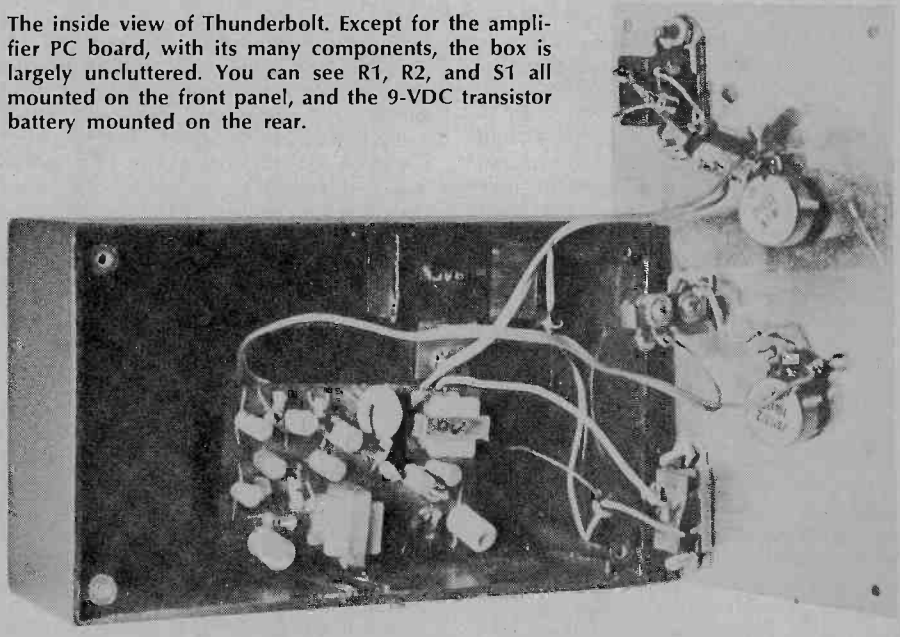
HOW WOULD YOU LIKE TO CAPTURE the sphere-capped minaret of a drop of water at the precise moment it strikes the surface of a pool, or a bursting balloon with the piercing dart still in mid-air? All you need is this easily-constructed, sound-activated, electronic flash—Thunderbolt.

Sound-activated switches have been around a long time. The first one I built 18 years ago weighed 25 pounds and would have cost nearly $100 if I hadn't cannibalized some old radios for the parts and tubes . . . remember tubes? When I built Thunderbolt a few months ago it cost five dollars and weighed in at about eight ounces. What made the difference? Solid-state components, including a silicon-controlled rectifier, make it lighter and cheaper—and it works much better and faster.

How It Works. Sound picked up by a microphone is boosted by an amplifier which feeds the signal in the form of a rectified pulse (via R3 and D1) to the gate and cathode of the SCR. The SCR is internally like three diodes connected (alternately) in series—positive-negative-positive—so it acts like a conventional rectifier in the reverse direction. Thus, the SCR's forward conduction is controlled by operating the "switch," or *gate*. Since the sound we are picking up is a single, sudden sound of short duration, it acts like a pulse, when magnified by the amplifier, and it causes the SCR to conduct. An electronic flash unit connected across its anode and cathode "sees" this conduction as a direct short so it flashes.

In practice, you will find a wide latitude of application techniques possible. You can control the microphone's sensitivity so it will respond only to certain higher level sounds, if the ambient noise level is high. Additionally, you can select the time at which an event is photographed by varying the distance between the event and the mike.

Various Applications. Let's say, for example, the event to be photographed is a coin dropping into water. By placing the mike very close to the container of



The inside view of Thunderbolt. Except for the amplifier PC board, with its many components, the box is largely uncluttered. You can see R1, R2, and S1 all mounted on the front panel, and the 9-VDC transistor battery mounted on the rear.

water, and by turning up Thunderbolt's sensitivity control, you can freeze the coin as it first touches the water. On the next shot, repeat the event, but place the mike farther away from the point of impact. The sound must now travel farther to reach the mike and the flash will go off at a later stage in the splash sequence.

By repeating this process, you can get a series of shots to cover the entire sequence from the coin first touching the water, to the final catapulted droplet falling back into the water. It could be a club flattening a golf ball, a dart bursting a balloon, a hammer shattering a light bulb, or a (patient) athlete diving into a swimming pool. Any event which produces a sound, faint or deafening, can be recorded on film at the decisive moment chosen by you.

The great advantage of Thunderbolt is that it is totally electronic, as opposed to the electromechanical heavyweights of a few years ago. The older devices depended on mechanical relays and electromagnets to close a switch. This mechanical energy transfer added milliseconds to reaction time. Even that is a significant interval when you are planning to break up into sequences such events as bursting firecrackers and shattering lightbulbs. Once the sound gets to Thunderbolt's mike the reaction time approaches the speed of light. That's about as fast as you're going to get—in *this* world.

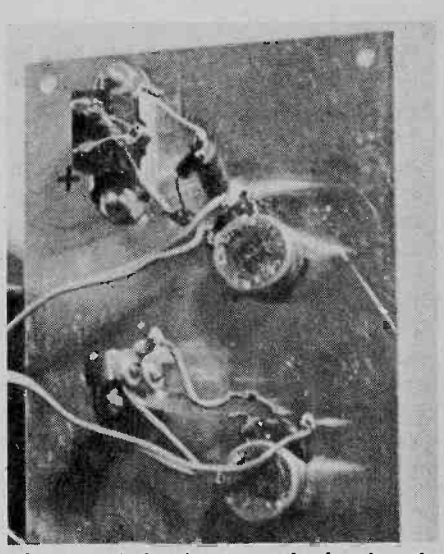
Putting Thunderbolt together is easy, because the most complicated part—the amplifier—is a module, ready to wire into a circuit with just a few simple connections and a handful of other parts.

Building It. Begin by selecting an amplifier. Almost any inexpensive module will do as long as it has an output transformer. Note that most modern transistor amps don't have an output transformer. Radio Shack and Lafayette Electronics sell suitable amp modules for less than six dollars apiece. Any amp capable of delivering a couple hundred milliwatts is sufficient. I scavenged the amp for my Thunderbolt from an old, discarded portable tape player. You can find many of these old reel-to-reel relics in second-hand stores for a dollar or two. Goodwill and Salvation Army Thrift Shops are a good hunting ground. All you need do with these old units is carefully trace and identify the input and output leads and the battery supply leads. If you get a unit that's fairly intact, it may even have volume and tone control pots which are of the correct value for your Thunderbolt.

The cabinet I show in the parts list will accommodate almost any transistor amp you select. You could even get ambitious and build a simple transistor amp. Most any old tube amp will also work fine, though it'll be quite bulky.

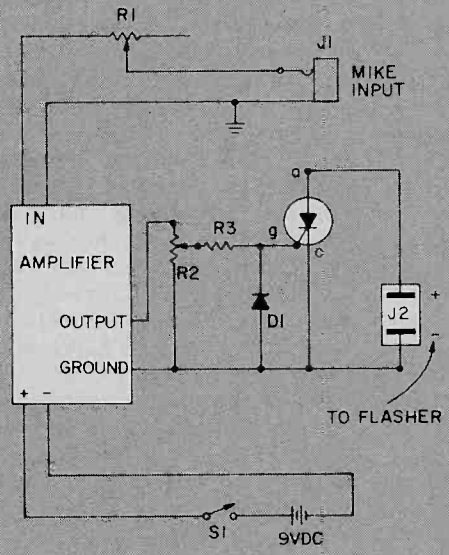
Just which mike jack, you use will depend on the plug on the microphone you use. It may be a standard phone jack, or the miniature type—whatever, as long as it matches your mike plug. When you have all the parts in hand, arrange them on the cabinet's front panel and mark the panel for the mounting holes to be drilled. Parts placement is not critical, but the leads to R1 and R2 should be kept short. If you locate S1 close to the *sensitivity* control, R2, then you can use point-to-point wiring for the SCR, D1 and R3. They are rigid enough to be self-supporting if the leads are kept short; otherwise a tie-point terminal can be used. Follow the schematic and wiring illustrations carefully and you'll have no trouble. You must use shielded (co-ax audio cable) for the input connections from R1 to your amp.

Hookup To Flashgun. After making all the connections, double check your work. Be sure you have connected the SCR's three leads correctly and check the polarity of D1. When you are sure everything is in order, you'll need to

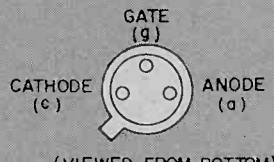


Closeup of the front panel, showing the way SCR1 is mounted directly on S1, and D1 and R3 attached to R2.

make a connector cord for your flash unit. Insert the PC plug of your flash extension cord into the flash unit's sync cord. Both ends of some brands of extension cords look almost alike and you don't want to cut off the wrong end. With one end plugged into your flash unit to make sure, cut off the other end close to the plug. Strip off the insulation and carefully separate the braided



Schematic diagram for Thunderbolt. As you see, most of the components are encapsulated in the amplifier, which is described fully in the text. Virtually any amplifier will do, as long as it produces a couple hundred milliwatts. The diagram below shows the connections to SCR1.



PARTS LIST FOR THUNDERBOLT

R1—10,000 ohm potentiometer
R2—5,000 ohm potentiometer
R3—2,200 ohm half-watt resistor
D1—PIV 50 volts Rectifier Diode
J1—To suit your mike. (see text)
J2—AC chassis-mount receptacle
S1—SPST slide switch
SCR—Silicon Control Rectifier (General Electric C5G or equivalent in TO-5 type case.)
Misc.—Wire, solder, two control knobs, chassis box (see text), a PC type extension cord for electronic-flash sync cord, and an AC plug. Total cost for all parts should not exceed $12, excluding chassis.

You'll find Thunderbolt to be one of the most useful photographic accessories. It's easy to build, both at the worktable and on the pocketbook, and is a truly fun project. Before you know it, you'll be happily strobing away roll after roll.

shielding from the inner conductor of the co-ax cord. There is little or no standardization in the photo industry, so you can't be sure that the inner conductor of any given sync cord is connected to a positive voltage when plugged into a flash unit. Some units have a positive ground and some have a negative ground. In order to make sure your Thunderbolt will work with any flash unit, you need a plug which can be reversed for any polarity match. You may have more than one flash unit and they may not be the same, hence the adaptor cord.

Plug one end of your modified cord into Thunderbolt and the other into the flash unit's sync cord. Set the *sensitivity* control, R2, at the center of its rotation and *input* control, R1, fully counterclockwise. Plug in a microphone and apply power to both the switch unit and the flash unit. The flash may fire once or twice by itself before it settles down. If the flash unit keeps firing as fast as it recycles, reverse the plug in J2 to get the correct polarity match.

With the polarity established, whistle or hum into the mike as you slowly turn R1 clockwise. The flash should go off. From this point, it's a matter of see-sawing controls R1 and R2 back and forth until you get the hang of your mike's sensitivity. The best way to discover what your Thunderbolt can do is to use it in a closely controlled test set-up. This procedure is easier

This is one of the things you can do with Thunderbolt. You can use it to capture any sound-producing motion instantaneously, as long as the object to be photographed is within the range of your electronic flash gun.

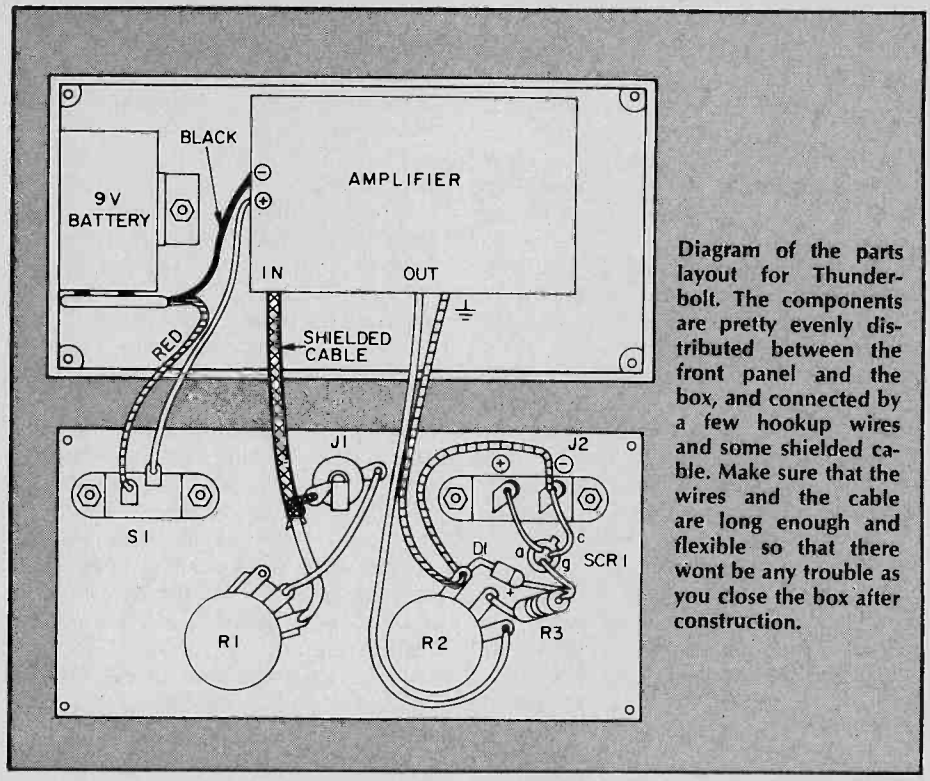


Diagram of the parts layout for Thunderbolt. The components are pretty evenly distributed between the front panel and the box, and connected by a few hookup wires and some shielded cable. Make sure that the wires and the cable are long enough and flexible so that there wont be any trouble as you close the box after construction.

with an assistant, so recruit a friend.

Against a dark background, set up a clear glass, or bowl, of water. Place the mike as near to the bowl as possible without it getting into the picture area. Position the flash on a tripod and aim it at the bowl. The camera, also tripod mounted, should be aimed at the bowl at a 45 degree angle to the flash. Focus on the surface of the water and compute your f-stop as you normally would for a flash shot using the flash's guide number divided by its distance to the subject. (For instance, if the manufacturer's recommended guide number for your flash is 45 when used with ASA 25 film and your flash is placed five feet from the subject, divide 45 by five. Since the answer is nine, choose the f-stop closest which is f-8).

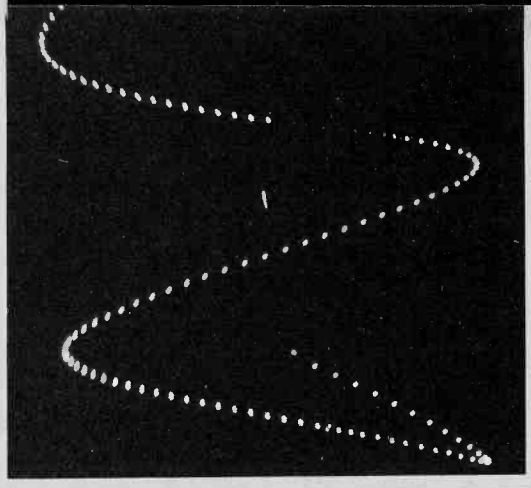
Set the camera's speed control on "B" as you would for a time exposure. Attach a locking type shutter release cable to the camera and position your assistant close to the bowl, but out of the camera's field of view.

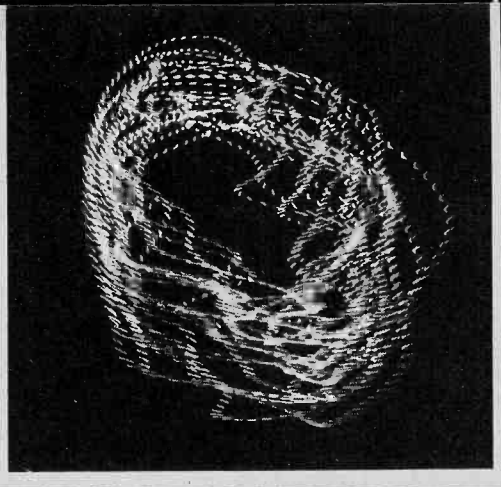
Turn off all the lights in the room and open the lens with the shutter release cable, but *do not* remove the lens cap yet. With your assistant poised over the bowl, ready to drop a coin into the water, turn on the flash unit and the switch unit. The flash may go off, triggered by the sound of its own switch, which is why you've left the lens cap on. Wait for the flash to recycle, then snap your fingers. It should go off again. When it recycles, remove the lens cap and give your assistant a visual signal to drop the coin. As the coin hits the water, the flash will go off and you can close the shutter and replace the lens cap.

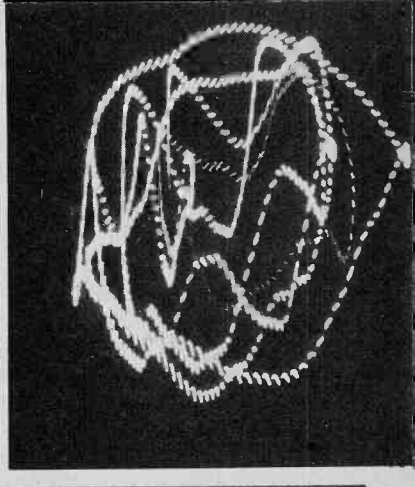
On the next shot, move the mike a foot or two farther away and repeat the process. On successive shots, move the mike exactly the same distance farther away. You should have a complete sequence after about six to eight shots.

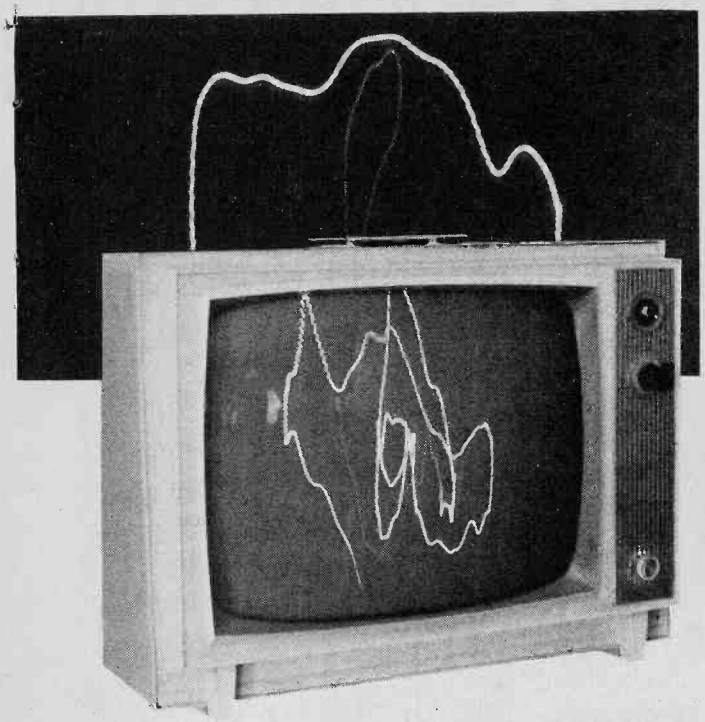
The film should be a very slow film, that is one with a very low ASA number, such as Plus-X by Kodak, which has an ASA of 125. If you have a setup which requires you to have more room illumination in which to work, use an Othro type film which is insensitive to red light. With this film, you can use a fairly bright red light in the room without affecting the film image while the lens is open.

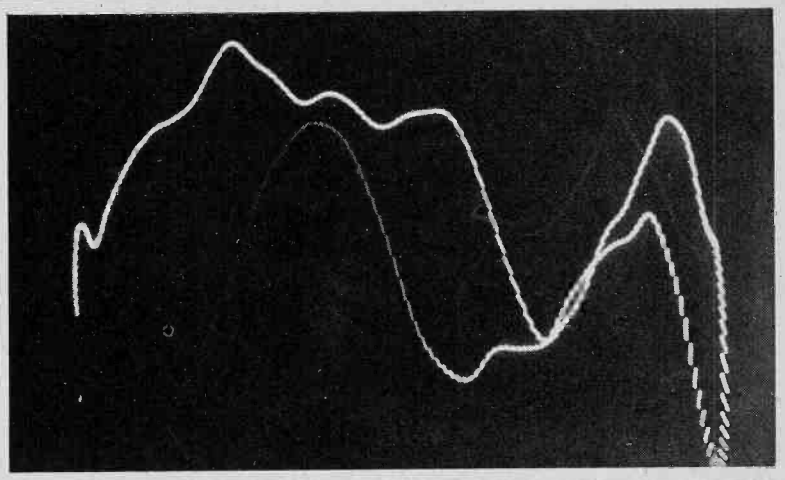
Once you've done a series such as the water bowl and coin, you will know what Thunderbolt can do for you and how to predetermine its sensitivity to a given sound. When you have all its parameters for operation understood and set up, you can start thinking of things to do with Thunderbolt. Its applications are virtually limitless, since the principle of stopping sound-producing motion is an especially fascinating one. You can use it indoors in ordinary ways, such as the coin and bowl technique, or you could even use it for crime detection, by fixing it at night on a window or door you expect an intruder to come through. Any sound he makes will take his picture. Good luck! ■











LISSY, THE TV LIGHT PEN

Lissajous patterns on your old TV add excitement to stereo.

by Dean Hock

☐ Are you an avid stereo enthusiast looking for a new way to experience your favorite music? Have you tried conventional "color organs" and found them fun for a few minutes, but dull as dishwater thereafter? Have you perhaps seen an oscilloscope hooked up with a microphone on its input and watched in fascination as the sound waves dance on the screen in perfect synchronism with your voice?

If you'd like something new to stretch your visual sense and expand the aural connection with your eyes, look no further. *Lissy,* the adapter which turns any beat-up old TV set into an oscilloscope for stereo sound, displays myriad sound patterns on the receiver screen. Its *Lissajous* patterns respond to both right and left-hand stereo signals—although it can also work with just one channel—providing an infinitely-variable light/sound display for your friend's pleasure and amazement.

What's a Lissajous? Let's go back to basics for just a minute, and review what a Lissajous figure is. Those of you who read our Basic Course in the March/April issue (*Using the Oscilloscope,* pages 83-88) will recall that Lissajous figures are 'scope displays of *two* signal inputs to the display screen —not just the usual vertical input signal which we use when we want to measure the amplitude of a voltage or watch how its amplitude changes with respect to time (the most common use of the oscilloscope).

With signals going to both the vertical *and* the horizontal inputs of an oscilloscope we can measure the relationship with respect to time (it's called *phase*) between the two signals.

For example, if a known signal is applied to the horizontal input and an unknown signal is applied to the vertical input, the resulting Lissajous pattern shows the phase relationship of the two signals.

Lissajous patterns can also be used to measure frequency. A known frequency is applied to the horizontal amplifier and an unknown frequency is applied to the vertical. By counting the number of tangency points at the top and at one side, a ratio of unknown-to-known frequency can be obtained. By multiplying the ratio times the known frequency, you can determine the frequency of the unknown.

A Simple Pattern. The drawing shows a Lissajous pattern for two sine waves. Numbers have been assigned to corresponding voltage points on the two signals. Extensions of these points are brought to the screen. The intersection of corresponding numbered lines is the position of the electron beam at that instant of time. In this case the two sine waves are in phase.

In the figure below, voltage/time relationships are different; corresponding voltage points are 45° apart. Therefore the waveforms are 45° out of phase.

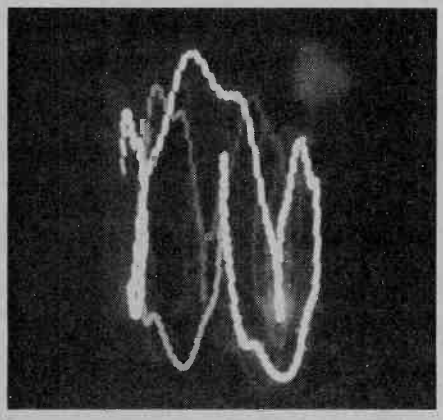
Lissy's Pictures. A continually shifting Lissajous pattern results when the phase relationship between the two input signals is constantly changing. The more complex the pattern (resulting from a frequency ratio having large numbers, such as 17/13) the harder it is to interpret. But since were not trying to *analyze* Lissy's pictures, we can just lean back and enjoy. *(Please turn page)*

LISSY TV LIGHT

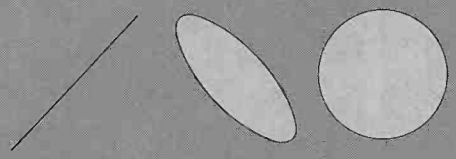
How Lissy Does It. By connecting the parts of an old TV set so that the output from one channel of a stereo set (for example, the left) drives the electron beam of TV tube vertically, and the output of the stereo set's right channel drives the beam horizontally, we can use the TV set to display Lissajous figures created by the signals from the two stereo channels. What we do is make the old TV set/stereo amplifier combination into an uncalibrated oscilloscope. Then we feed it the two signals without worrying what they mean.

Putting It Together. Begin with an old television set. You can use one in which the tuner, IF, and sound sections do not work since they will not be used. You'll also need an extra deflection yoke from another old set. Most of the older tube-type black and white sets have yokes the same size. As long as the extra yoke will fit over the neck of the set's picture tube it can be used. A junked TV is the best place to look. You must also have a stereo set with amplifiers capable of producing 12-15 watts of output power per channel. Even better is a spare (second) stereo set. This will insure better results and will also allow you to adjust the tone, volume and balance controls to the TV set without upsetting your listening pleasure, by changing the volume setting while you listen.

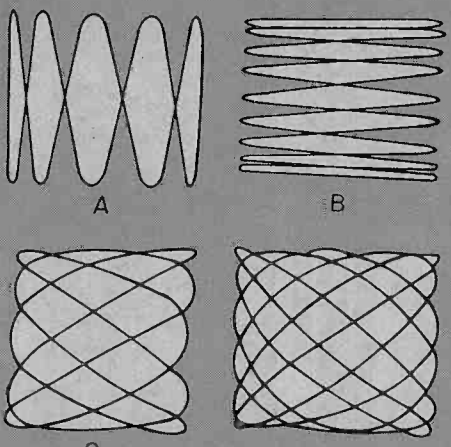
Begin by removing the back from the old TV set. Disconnect the socket from the rear of the picture tube. Loosen the clamps holding the deflection yoke and slide it off the neck of the tube. Do not disconnect any of the wires from the



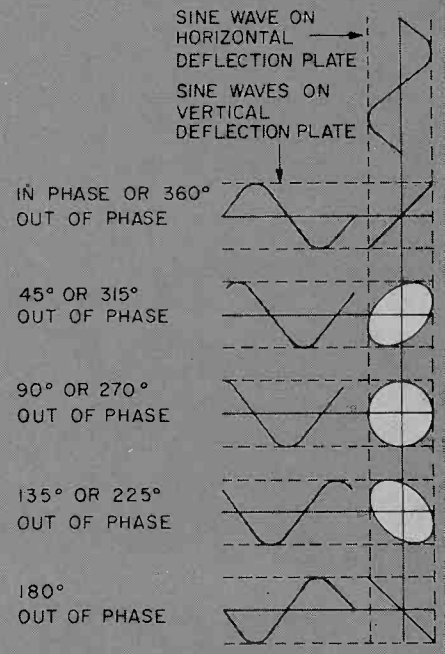
These patterns appear from moment to moment on the TV screen when it's being driven by signals from music. To see what they really look like you'd have to have motion pictures.



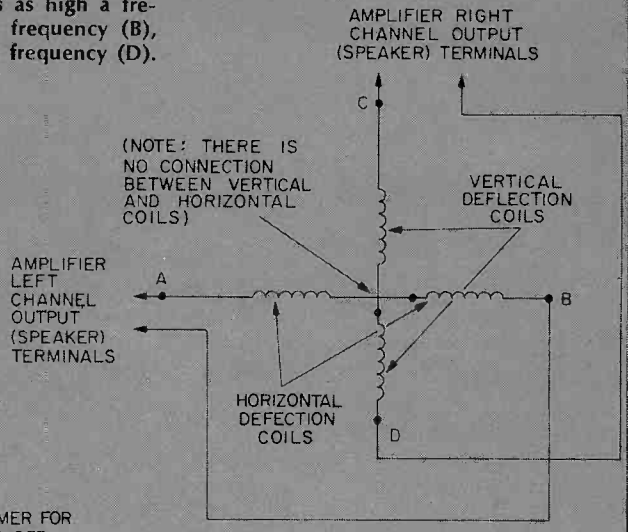
Simple Lissajous figures like these result from putting the same (or almost same) signal voltages on horizontal input and vertical input of oscilloscope (or TV picture tube).



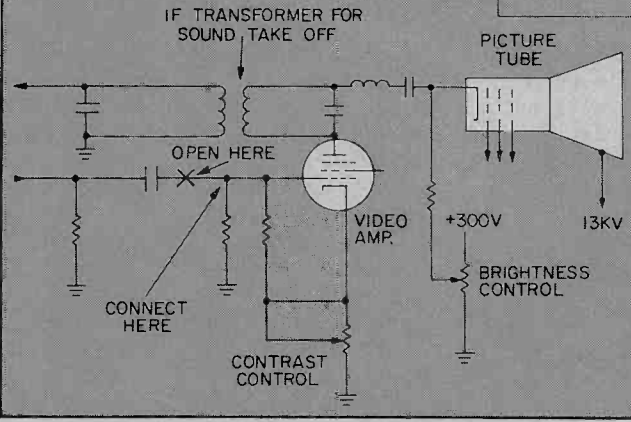
These more-complex Lissajous patterns are created by feeding a simple sine wave to the horizontal input of a scope and sine waves of exactly five times as high a frequency (A), one-ninth the frequency (B), 3/5 frequency (C), and 5/6 frequency (D).



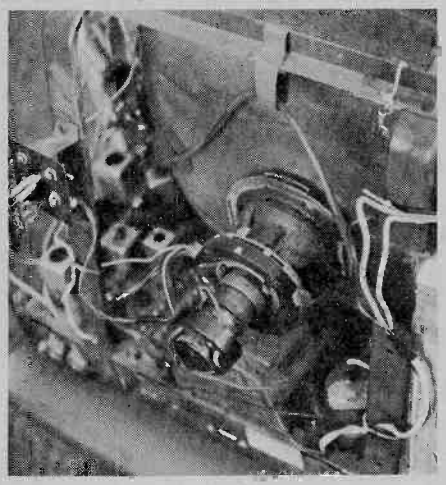
If your two stereo channels put out exactly the same signals (or you put a mono signal into both) you should get a straight (diagonal) line on the screen. If not, adjust gain of one channel. Other Lissajous patterns like these will result from out-of-phase signals. Music waveforms are extremely complex compared to the signals used to derive simple patterns shown here.



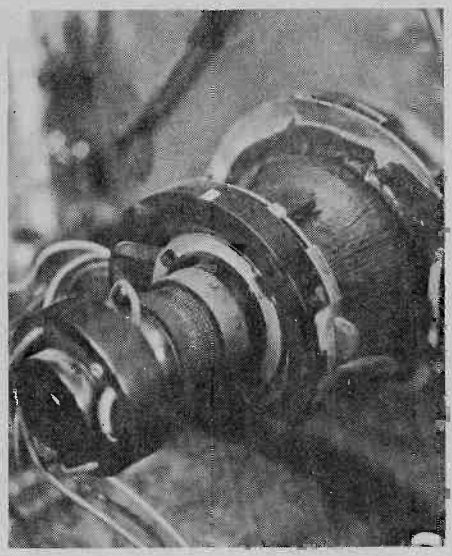
The added deflection yoke from second TV set is connected as shown above to the two stereo channels of an amplifier or receiver. Using a separate amp (from the one you listen to) is recommended, but not essential.



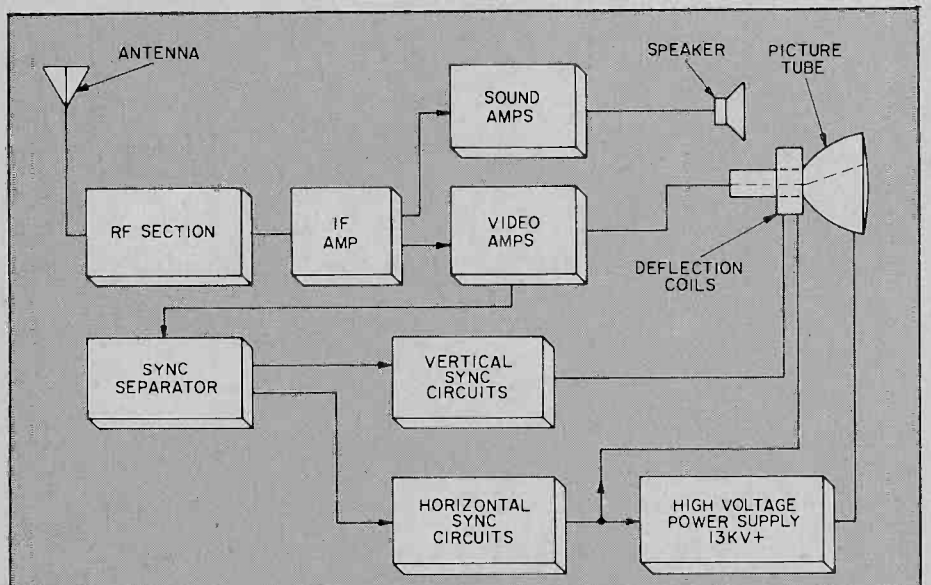
This schematic shows a typical video amplifier tube for TV sets six to 15 years old. Disconnect the video input signal on the grid side of the grid-coupling capacitor and connect your Lissy oscillator at the same point to make Lissy do extra tricks.



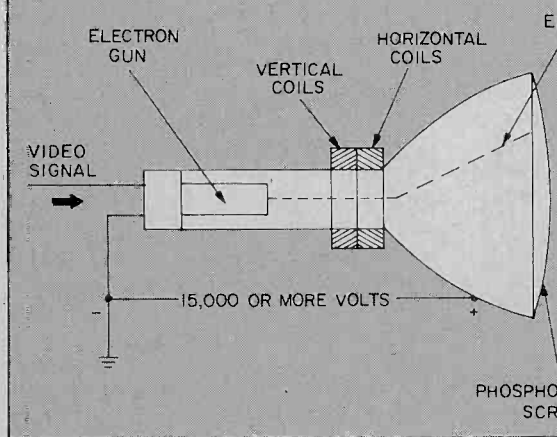
Here's how the back of author's set looks with the new picture tube yoke (deflection coils) on neck of picture tube. Original deflection yoke is removed from tube but kept hooked up because it's also used in the circuit which generates high voltage for picture tube. It's tied out of way at upper right, atop high voltage cage.



Closeup of picture tube neck shows large circular positioning magnet which some sets have behind yoke. Be sure to replace any magnets your set had into their original position after you replace the yoke.



Simplified block diagram of TV set shows how vertical and horizontal sweep currents are derived from the synchronizing signals sent from the transmitter. Vertical and horizontal sweeps feed vertical and horizontal deflection coils.



Typical TV picture tube and its horizontal and vertical-deflecting coils. Old deflection yoke is still used in Lissy because it's part of the circuit which produces thousands of volts required to attract the stream of electrons from the electron gun to the screen.

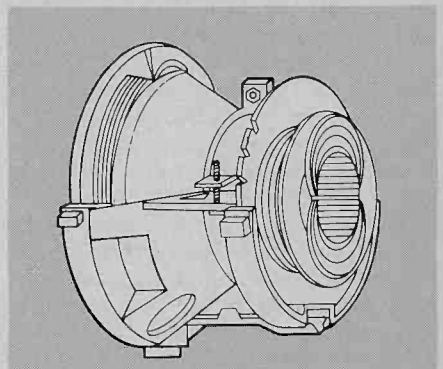
yoke since it is part of the circuit for putting the beam on the screen. Secure the old yoke to the chasis of the TV somewhere out of the way, taking care in seeing that it does not short circuit.

Preparing the Deflection Yoke. There are two coils in the deflection yoke of a TV set. One is called the horizontal and one the vertical.

Each of these two coils is divided into two sections, and we must eliminate any extra parts such as a small resistor or capacitor which are often connected to one or both of the yokes. They are usually connected to the midpoint of the horizontal coil or vertical coil. Simply remove any resistor or capacitor connected to any parts of the yoke, and if this separates the two sectional parts of either the horizontal or vertical coil, put a jumper between the two sections. Check with a voltmeter to be sure which terminals are connected (through the two coils) together. Mark them in some way so that you'll know which two leads of each coil are connected together (through each coil). Solder 2 three-foot lengths of speaker wire to the terminals of the vertical and horizontal coils.

Putting It Together. Take the yoke and slide it on to the neck of the picture tube securing it with a clamp. Return the socket to the back of the tube along with any magnets that may have been removed. Put the magnets back exactly where they were. (Adjust to center beam, later.) Route the speaker wire out the back of the TV set as you put the cover back on. Run wires from the speaker outputs on your stereo to the TV set and connect the two sets of wires together using a terminal strip.

You are now ready to test out Lissy. Leave your stereo off and turn on the TV set. After warmup a small dot should be visible in the middle of the screen. Adjust the magnets, if any, to



Most old TV sets have deflection yokes which look like this. Large end (left here) goes snug up against the flare of the picture tube. May require loosening of screw which secures clamp around coils.

LISSY TV LIGHT

center the beam. If necessary turn the brightness control up or down. Now turn on the stereo set and turn up the volume slowly until you start to notice the dot moving. By adjusting the balance control you should be able to make the dot move about an equal amount horizontally and vertically. It may be necessary to disconnect the speakers in order to move the beam enough. Adjust the brightness for a pleasing light level without burning the screen phosphor. Low bass notes will show up as rotating circles. Each tone has its own pattern which intensifies with the volume.

Now that you are finished sit back and enjoy the added dimension of the music TV in a dark room. It will provide you with many hours of listening and viewing pleasure.

More Fun With Lissy. Once your Lissy is working you may want to add an extra circuit which will strobe the moving pattern on and off, making a more unusual and interesting light display. By connecting the output of an oscillator to the grid of the TV set's video amplifier tube you can turn on and off the electron beam in the picture tube. This will produce dots and dashes as the beam is moved around on the screen. The effect is quite pleasing. A stop-action type of display (called "strobe") is only one interesting improvement you'll see.

The added circuit is a simple two-transistor oscillator. The switches and potentiometers allow you to select different dot line lengths and frequencies. By connecting the output of the oscillator to the grid of the video amplifier you force the tube alternately into conduction and cutoff.

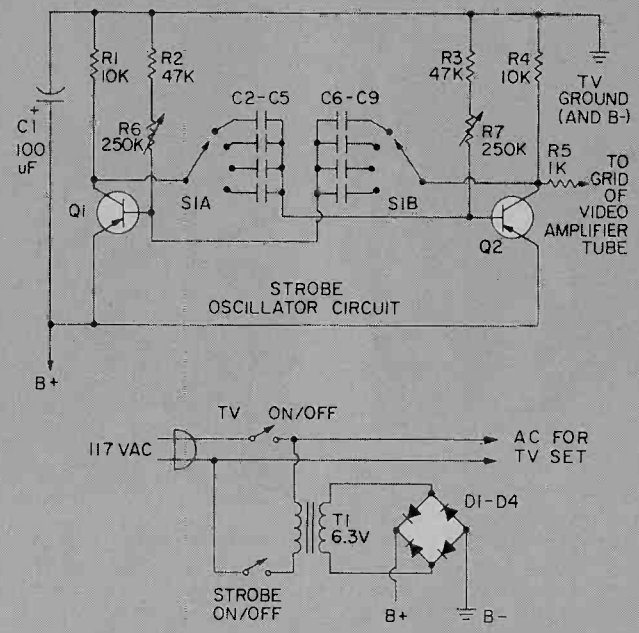
The oscillator and power supply are not critical and can be constructed any way that is convenient, as long as safe construction practices are used. The circuit in the prototype was built on a terminal strip using point-to-point wiring and then mounted inside the TV. Almost any general purpose PNP transistors can be used for Q1 and Q2.

If you can't get a schematic of the TV set you are using the best way to locate the video amplifier tube is to look at the tube placement chart (usually on the side or back of the TV) and find the tube which is labeled *Video Amp*. If the video amp tube also contains other elements in the glass envelope you will have to trace down that part of the tube which has its plate connected to the sound trap transformer (usually a metal can type) and its cathode connected to the contrast control. This may vary slightly in your set.

Once you have found the video amplifier cut one of the leads of the capacitor going to the grid and replace it by connecting the oscillator output to the tube in its place, (see the schematic). Connect the negative lead on the oscillator's power supply to the TV common ground.

Fire Her Up. Now you are ready to test the circuit. Look it over for any wiring errors. Set the potentiometers to maximum resistance and set the rotary switches at the .01 uF capacitors. Turn on the TV set and allow it to warm up. Get a music display on the screen. Turn down the brightness control until you can no longer see the raster (white lines). Turn on the strobe oscillator and adjust the brightness control as needed. The display should be chopped up into little line segments. By adjusting the controls you can get different line lengths and frequencies—anything from star-like dots to a pulsating array of stopped action traces.

Now you can lean back and enjoy your Lissy—the TV light organ which will amuse and amaze your friends for many evenings ahead. ■



PART LIST FOR LISSY—THE TV LIGHT ORGAN

TV receiver—which has light (raster) on the picture tube. It need not have a working tuner or IF section, nor sound.
Picture tube deflection yoke—in working condition. (Most are—this is a part that rarely fails in TV sets.)
Speaker wire—8-10 ft.
Stereo amplifier or receiver—preferably 12-15 watts or more per channel.
Misc.—Solder, wire, switches, etc.

PARTS LIST FOR STROBE CIRCUIT FOR LISSY

C1—100-uF, 16-VDC electrolytic capacitor
C2, 6—.002 or .22-uF capacitor
C3, 7—.01-uF capacitor
C4, 8—.1-uF capacitor
C5, 9—1-uF capacitor
D1, 2, 3, 4—rectifier diodes, 30 PIV or better, any amperage
R1, 4—10,000-ohm, ¼-watt resistor
R2, 3—47,000-uF, ¼-watt resistor
R5—1000-ohm, ¼-watt resistor
R6, 7—250,000-ohm potentiometer (or 500,000 if 250,000 not available)
S1—Single-pole, 4-position (or more) rotary switch
Q1, 2—General-purpose PNP silicon transistors, HEP-242 or similar
T1—Power transformer, 117 VAC primary, 6.3 VAC secondary, any amperage

You can call Lissy's designs Lissajous patterns, but your friends will call them "out-of-sight"! The twisting, convoluted, ever-changing, swirling designs are truly a visually exciting wonder which can't fail to draw the viewer's eye into almost hypnotic attention. You can convert almost any old television from a boob tube to a groove tube with just a little effort, and at almost no cost at all. Just an evening's work, and your place will be jumping like never before.

ADD TONE TO YOUR PHONE

With your own Touch Tone Pad you can key a phone, computer, or transceiver for peanuts.

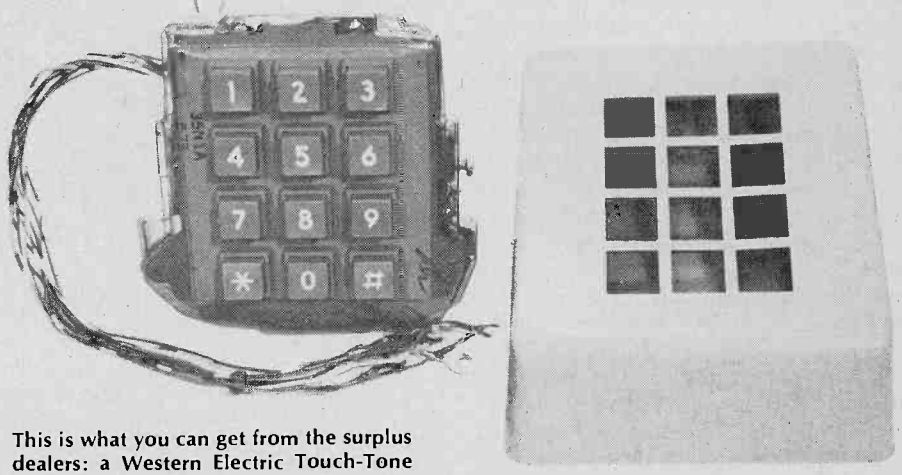
☐ One of the most popular hobbyist items—appealing to hams, experimenters, *phone phreaks* and thousands of other experimenters—is the Touch-Tone Pad or Encoder, that two-tone generating device used on Touch-Tone Telephones. It seems the uses for the Touch-Tone signals are almost endless: hams use them to activate and use autopatches that permit telephone calls from a mobile transceiver to a landline, experimenters use them in conjunction with the Signetics touch-tone decoder ICs for remote control applications, and *phone phreaks* use them to help make "free" (though illegal) long distance calls. Some people use them to access hobby and time shared computers, and others simply connect them to standard dial phones to get additional Touch-Tone service without paying Ma Bell a lifetime's worth of extra charges for a relatively inexpensive extension phone.

In actual fact there is a difference between a Touch-Tone Pad and an Encoder. Though they eventually do the same thing you can be stuck for some rather expensive, unusable hardware if you can't get them straight. The original telephone pad, the one used in Touch-Tone phones, generates a two-tone signal when a key is depressed and is called a Touch-Tone Pad. On the other hand, when a keyboard device resembling the telephone keyboard is used to control an electronic tone generator—usually an integrated circuit purchased as an independent component—the keyboard is also called a Touch-Tone Pad but it is really only a switching matrix; it does not generate any tones. When this keyboard is combined with an electronic circuit that generates the tones—usually at a signal level slightly higher than normal microphone level—the entire device is called a Touch-Tone Encoder.

The encoder is a rather small, somewhat fragile device generally used by radio amateurs for controlling autopatch repeaters. The pad—which is made by Western Electric and other telephone equipment manufacturers—is built like a battleship, produces a relatively high level output that can be used for just about anything, and until recently the only way to get one was to go directly to a telephone equipment dealer and pay list price, or hope one fell off the back of a truck.

But now the telephone-type Touch-Tone Pad has flooded the surplus market and anyone can pick one up for between $8 and somewhat less than $20, depending on condition. For an extra couple of dollars you can also get a beige plastic cabinet pre-punched to fit the pad. About the only problem you'll have is that some of the pads have only numerals, not letters; but this should create no problems since most touch-tone coding, and even telephone numbers, are now predominantly numerals.

Probably the most flexible pad is the Western Electric type shown in the pho-



This is what you can get from the surplus dealers: a Western Electric Touch-Tone pad and plastic housing.

TONE TO PHONE

tographs. This model is available from several surplus dealers.

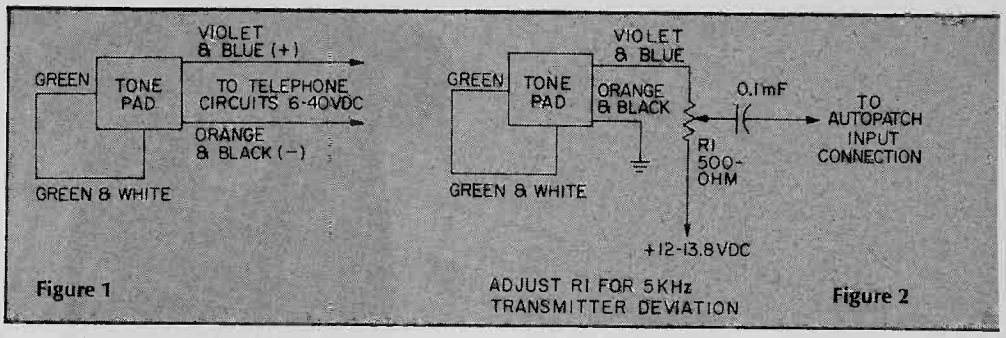
Wiring. The Western Electric pad comes jam packed with attached color coded wires which are generally used for connecting into telephones. For many hobbyist uses most of these wires are simply ignored. There is some variation in color coding between different models of Western Electric pads, but most models are very similar and some general color coding can be used. Also, most reliable suppliers will send connecting instructions and so specify in their ads.

In fact, before undertaking this project, you might want to check your ability to discern colors. It often happens that people who ordinarily would have no trouble seeing colors find it difficult to distinguish between color-coded wires in electronic equipment. A problem in this area could make it impossible to wire the Touch Tone Pad properly. So why not compare your reading of the wires with one or two friends', just to make sure.

The schematics show the hobbyist connections for the Western Electric type 35N1A and 35N3A pads—or dials as they are called by Western Electric—the most common type of pads available. The circuit shown in Fig. 1 can be connected directly across the telephone terminals of a telephone where touch-tone is already provided by the local telephone company. You will hear the tones in the receiver (handset). If you don't hear a tone simply reverse the connections to the line.

A normally open switch which is built into the pad is closed each time a key is pressed. This switch closes the circuit between the pad and the line, simultaneously applying power from the line to the pad (an external power supply isn't needed). If you want the pad connected only when the handset is off the hook connect the pad after the line switch terminals; usually terminals F and C on the phone network (repeat coil or transformer).

Figure 2 shows the connections for using the pad with an FM transceiver for autopatch. Potentiometer R1 sets the level into the modulator and is normally adjusted for 5 kHz deviation. Some phase modulated transceivers require a frequency correcting network when using a touch-tone pad and instructions for a simple resistor-capacitor (R/C) equalizer are generally given in the transceiver's instruction manual.

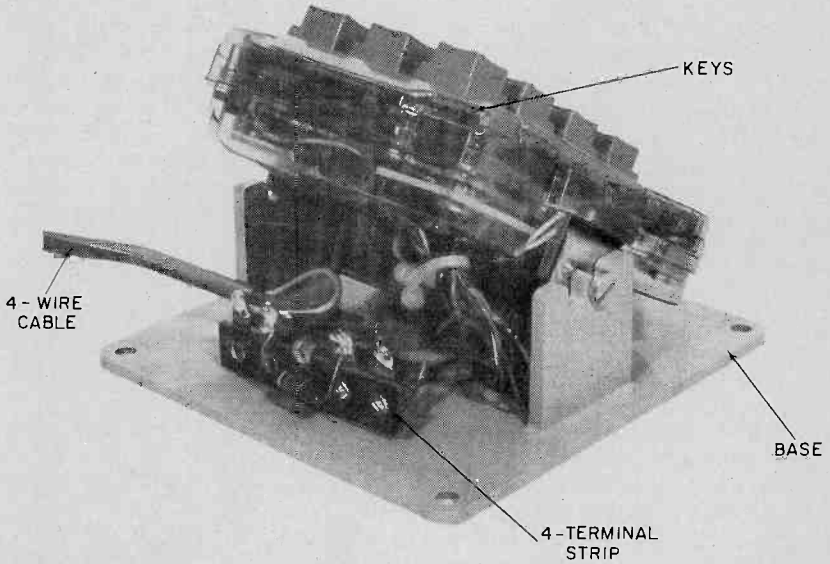


The circuit in Fig. 2 requires the transceiver's PTT (push to talk) be held down when the tones are keyed in. We will show later how to modify a pad so it also provides automatic transmitter keying each time a tone is keyed.

Mounting the pad. The best way to mount and wire a pad is in one of the plastic cases usually available from the same dealer who supplies the pad. As shown in the photographs there's plenty of room inside the cabinet for a terminal strip and associated components. To avoid short circuits clip the unused pad leads short, or tape the lugs on the end of each wire. The pad wires are standard stranded type—not *litz* silk wound—so you can clip off the lugs, strip the insulation and solder just as you would any other stranded hook-up wire.

If you need or want automatic PTT, or control circuit switching each time a pad key is depressed, you can easily modify the pad to provide the circuit control shown in Fig. 4. Note that switch S1 is the normally open switch that is part of the pad and applies the power to the pad as well as connecting the pad's output signal. Switch S2 is the modification and can be wired directly across a PTT switch, or used as control wires for a keying or switching circuit.

First step is to remove the plastic covers of the pad. They snap right off. Remove the front one first, the one over the keys. Then remove the rear cover taking care to snake the wires carefully through the opening in the plastic cover. You wil find the rear of the pad looks like the photograph, with a set of multi-switch terminals at the upper left. If you look carefully at the switch you'll find almost all the sections are normally closed, opening when a pad key is depressed. But two sets of contacts are normally open and close only when a key is depresesd. The bottom set of contacts is S1 and should not be disturbed. Counting down from the top, the second set of contacts is also normally open and usually is the only set of contacts to which no wires are connected. (Note that some pads might



With the pad installed in the cabinet mount there's plenty of room in the back for a terminal strip and some components. This 4-terminal strip installation provides the connections shown in Figs. 1 and 2 through a 4-wire cable. The user simply selects the right set of color-coded wires.

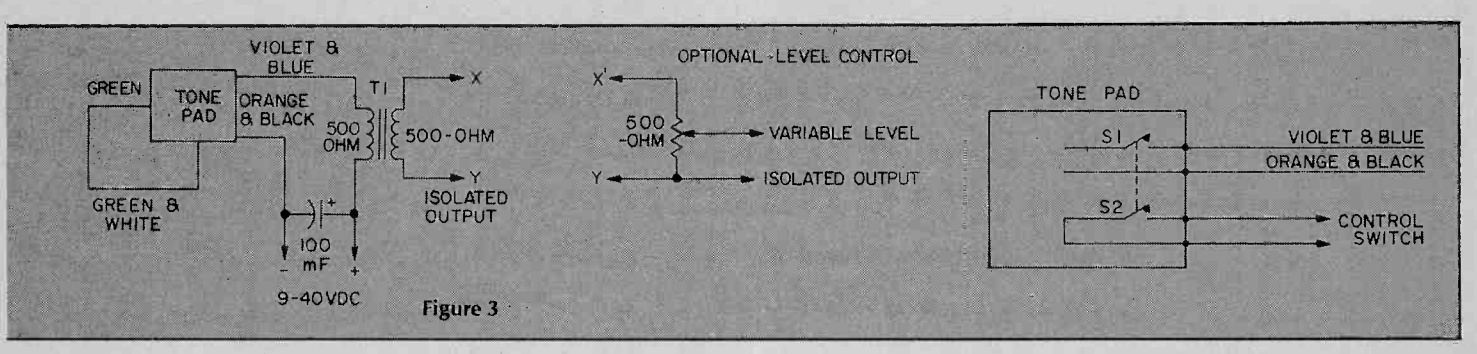


Figure 3

have one wire connected to one of the normally open terminals, and the wire is generally brown. Simply cut the wire off at the terminal and leave it alone.)

Carefully cut off the unused wires from the top set of normally closed contacts and move them to the normally open contacts using a very small soldering iron (about 20 watts) and as little heat as is possible. Use a tiny drop of solder to prevent a solder bridge. If you don't want to cut the wires from the top contacts use #22 stranded wire for the normally open connections.

Carefully slip the plastic cover over the wires, seat it on the pad and then install the front plastic cover. You now have a touch-tone pad with an extra set of normally open switch contacts.

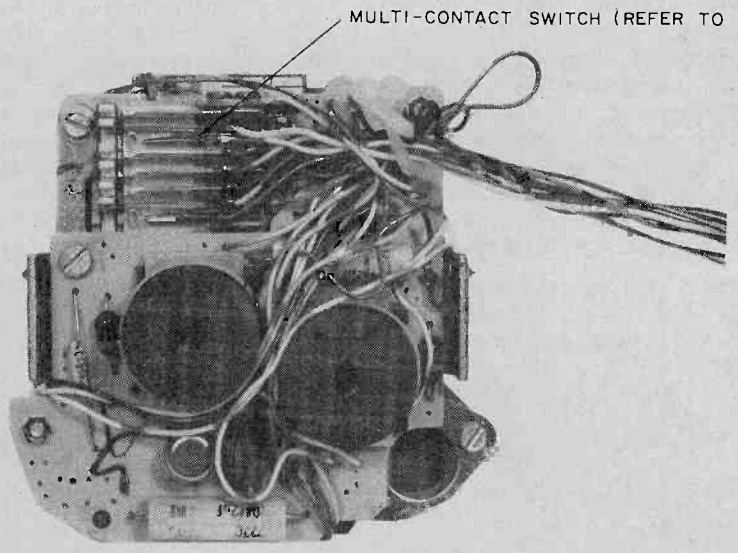
Get Out the Grinder. For some unaccountable reason a few of the plastic touch-tone pad cabinets do not make allowance for pointed projections on the mounting ear located on each side of the pad. Each ear has two projections with a mounting screw in between. The plastic cabinet has been pre-formed to accommodate the screw and one projection; the remaining projection gets in the way and can result in damage to the cabinet when the mounting screw is tightened. For best results use a hand grinder or file and remove the projection towards the bottom when the pad is held upright. When the pad is installed in the cabinets don't tighten the two mounting screws; let the pad *float* on its mount. When the top of the cabinet is secured with the four mounting screws provided, the pad will be rigidly locked in position without damage to the cabinet.

Correct Voltages. The Western Electric touch-tone pad will work with an applied voltage between 6 and 40 VDC at the orange/black and violet/blue terminals. If the voltage is less than 6 volts the oscillator won't "start," or the output signal will be highly distorted. Keep in mind that if you use the circuits shown in Figs. 2 and 3, there is a voltage drop across R1 and T1, and less than the applied voltage arrives at the pad. In Fig. 2 about 3 volts is dropped across R1; you can normally get good operation if the voltage applied to the power supply end of R1 is no less than 9 VDC. Of course, if Fig. 2 is used for an autopatch the normal transceiver power supply of 12 to 13.8 VDC is available and you'll have no problems.

The transformer shown in Fig. 3 has less of a voltage drop than the resistor load of Fig. 2, so the applied voltage can be closer to 6 volts and still insure proper operation of the pad.

The pad has build-in Zener diode voltage regulation so the output voltage is more or less constant over the power supply. The maximum output voltage measured across R1 in Fig. 2 is nominally 0.77 volts RMS when indicated by a standard VOM; 3.5 volts peak-to-peak when measured by an oscilloscope. If you plug these values into a calculator nothing comes out the way you expect because two tones are involved.

(Continued on page 99)



PAD CHASSIS WITH PLASTIC GUARD REMOVED

Switch arrangement to secure the control function shown in Fig. 4. Switch S1 is part of the pad wiring and controls both the power and pad connection. The set of contacts labeled S2 is the second down from the top and can be connected as in Fig. 4 to provide an isolated control circuit.

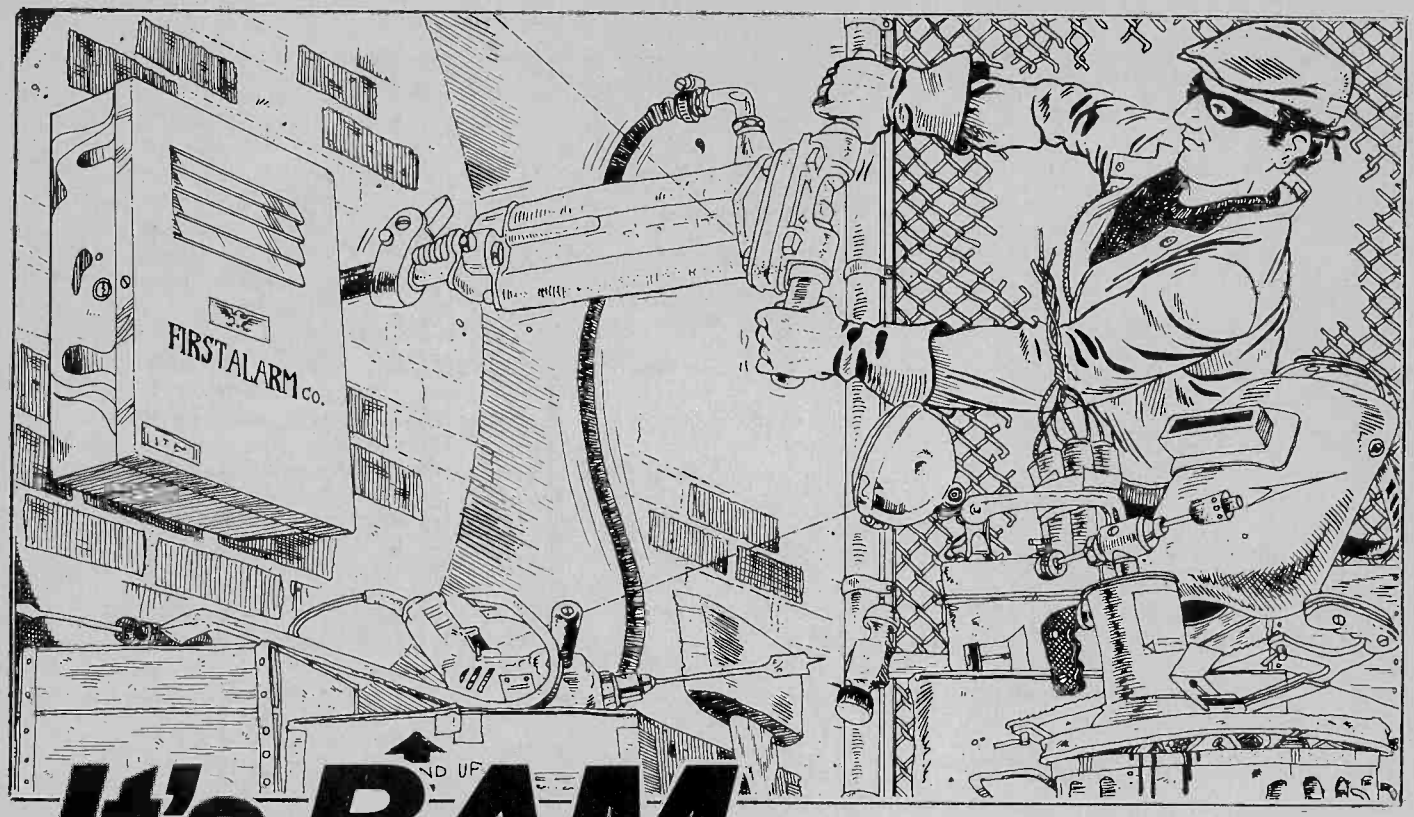
Figure 4. Power switch S1 is part of the pad and is connected in series with the violet-blue (positive power) lead. It automatically closes each time a key is pressed. Switch S2 is connected to S1's operating lever but is not normally used in the pad. You can connect a pair of wires, as shown, to provide a set of isolated control terminals. S2's terminals can be used to operate the PTT switch of a transceiver whenever a key is depressed, or to lift the 500-ohm potentiometer off a microphone circuit with connection shown in Fig. 2 or the optional circuit that is included in Fig. 3.

PARTS LIST

1—0.1-uF capacitor
1—100-uF, 50-VDC electrolytic capacitor
1—500-ohm adjust potentiometer
1—Isolating transformer, primary 500-600-ohms, secondary 500-1000-ohms (Calectro D1-728 or similar) Calectro-GC Electronics, Rockford, IL 61101.

Touch tone pads can be purchased from: Telephone Equipment Co., P.O. Box 596, Leesburg, FL 32748; King Products, P.O. Box A, Lomita, CA 90717.

You can add touch-tone dialing to your phone by building now—and saving for years and years over Ma Bell's costs.



It's BAM...

Burglar Alarm Modification

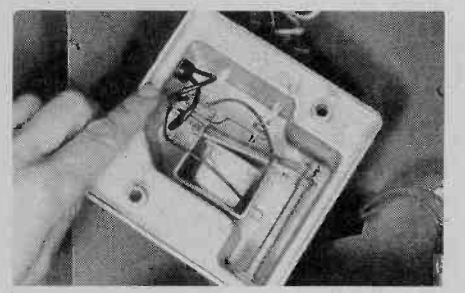
Simple changes to make your alarm burglar-proof.

by Jorma Hyypia

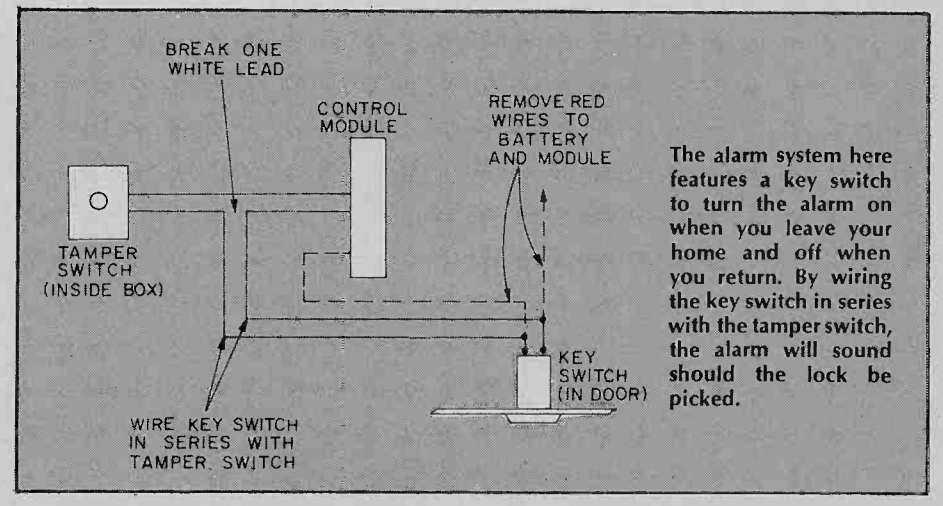
☐ One of the slickest ways to fool a burglar, even a professional who thinks he knows all about alarm systems and how to silence them is to alter a seemingly-standard system into something quite different. An economy-minded homeowner can start with a basic system such as the Radio Shack alarm shown here and upgrade it at a cost of less than five dollars into an even more convenient and effective system that will provide as much security as custom installations costing hundreds of dollars.

This intruder alarm system is popular with do-it-yourself home owners for several reasons. It is easy to install; it provides complete perimeter protection for all doors and windows; the conspicuous heavy-gauge steel box mounted outside the house or garage door serves clear notice that the premises are protected. In addition, there's no need for you to race against a built-in time delay when going in or out of the house because this system is activated and de-activated with an outside key switch. Finally, the loud eight-inch gong will alert the entire neighborhood if it is triggered by an intruder.

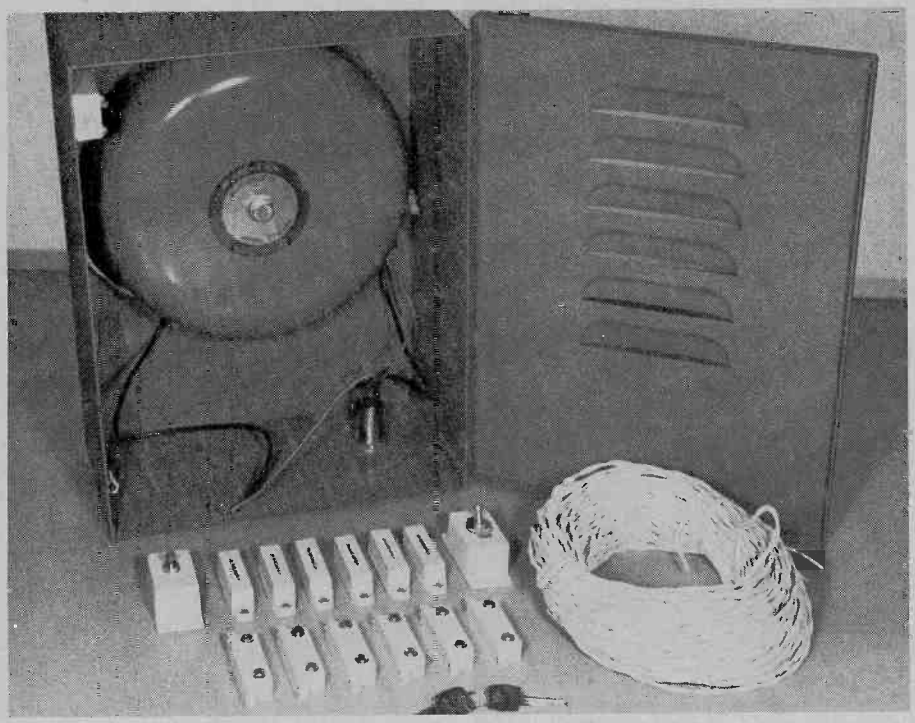
You Can Make It Better. Installed in the normal way, this system will provide good protection against most



The two black wires under the bell mount, which lead to the clapper mechanism, may be cut to permit wiring-in the circuit test box. Even more professionally, the leads may be unsoldered from where they connect with the vibrator terminals and a new two-conductor wire may be run from the terminals to the test box



The alarm system here features a key switch to turn the alarm on when you leave your home and off when you return. By wiring the key switch in series with the tamper switch, the alarm will sound should the lock be picked.



This low-cost perimeter alarm system includes a heavy gauge steel box, a loud 8-inch gong, more than 100 feet of wire, key lock switch, a separate indoor switch and a panic button. Enough magnetic switches are provided to protect six doors and/or windows. You can add more switches, window foil or other sensors.

would-be burglars. However, it can be defeated by a truly determined, knowledgeable burglar who knows how it is constructed. You can frustrate even such experienced crooks with easy-to-make alterations that require no extra parts. And for less than five dollars you can add a silent testing device so you can check the readiness of your system as often as you like without annoying your neighbors with the loud noise made by the eight inch gong. Silent testing provides another important advantage; if the gong should be triggered by an intruder, your neighbors will not mistakenly think that you are just testing your system, for the hundreth time!

This simple and effective test unit consists of a small box containing a DPDT toggle switch, part of the original equipment, is for the alarm bell. The white switch part of the original equipment, is used to arm and disarm the detection system from inside the house. Use lamp cord or 12-volt bell wire to connect these units.

The Testing System. You'll need three readily-available parts that cost a total of under five dollars. You'll need a small box to house the double-pole, double-throw (DPDT) toggle switch, and a 12-volt panel lamp. If your alarm system works on some voltage other than 12, substitute a pilot lamp with the proper voltage rating.

Drill a couple of holes in the box lid and mount the switch and lamp, then solder the two lamp wires to either pair of *end* terminals on the switch. Locate the box in a convenient place inside the house, as close to the outside alarm box as is possible (try to keep the connecting wires less than six feet long).

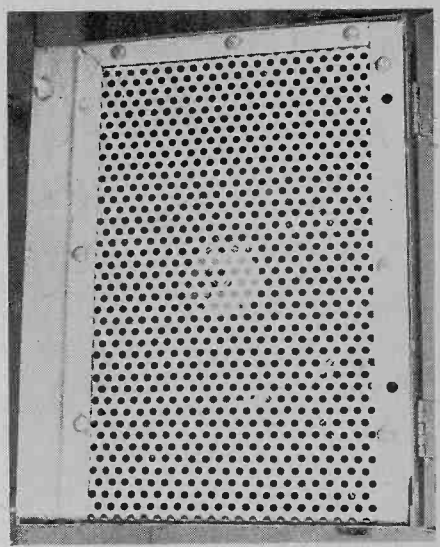
How To Rewire System. Remove the gong from the outside alarm box to reveal the metal mounting block that houses the activating mechanism for the bell clapper. Cut the two black wires that go from this housing to the plastic electronics module that is also hidden under the gong. Extend both cut pairs of wires so that they reach to the switch box inside the house (mark the wires for indentification) and solder the pair connecting with the module to the *center* terminals of the switch, and the pair going to the gong mechanism to the remaining pair of end terminals on the switch. By flicking the toggle switch you can now cut off the gong and substitute the panel lamp; whenever the lamp lights during routine testing you know that the bell would have sounded had it been switched into the circuit.

To use the test circuit, close all doors and windows that are fitted with sensor switches. Turn off the main switch which should be located next to the test unit. Put the toggle switch into the *Test* position (the lamp position), then turn on the main power switch. The lamp should *not* light. If it does, you know that there is a break in the perimeter circuit or you have forgotten to close a door or window. If the lamp does not light, open any nearby window or door that is fitted with a sensor. The lamp should now go *On* to indicate that the bell would have sounded had it been in the circuit. When all units test properly, turn off the power switch, put the test switch back into the *Bell* position, and switch *On* the main power, when you want to arm the perimeter sensors.

Outwitting a Smart Burglar. This begins by moving the 12-volt lantern battery from its normal location inside the alarm box to a new place inside the house, again keeping the connecting wires as short as possible. If you keep the wires inside the box under the gong, a burglar can no longer deactivate the system by ripping the battery wires loose with a wire poked into the box through the cover vent holes.

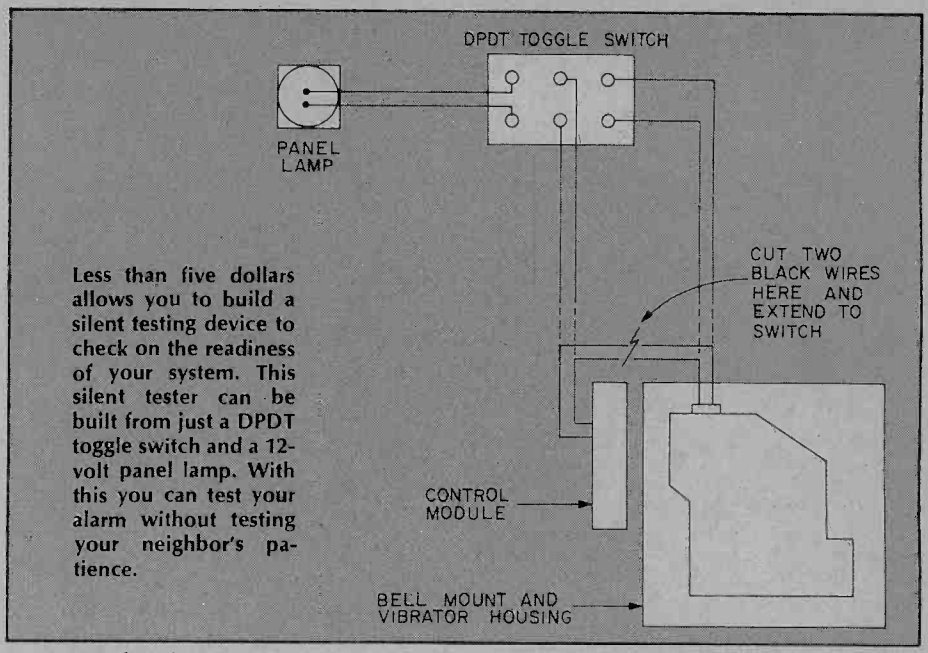
There are several other advantages to moving the battery indoors; it's easier to check periodically and replace when necessary; it is subjected to less deterioration because of weathering; it will provide power much more reliably during winter months if it is inside a warm house.

(Please turn page)



Mount some scrapped metal grill underneath the regular cover to serve as an additional foil to any burglar who attempts to defeat the alarm system by either opening the cover or working a wire through the cover vents.

Burglar Alarm Mod



Less than five dollars allows you to build a silent testing device to check on the readiness of your system. This silent tester can be built from just a DPDT toggle switch and a 12-volt panel lamp. With this you can test your alarm without testing your neighbor's patience.

A really knowledgeable burglar knows where the gong clapper is located and could possibly jam it to silence the gong. But not if you drill a couple of new mounting holes in the rear of the box and turn the entire gong assembly so that the clapper is no longer where the burglar thinks it should be.

Some More Tricks. The alarm box has a tamper switch which turns the alarm *On* if any attempt is made to open the cover. Although difficult to do, it is possible to defeat this tamper switch. You can frustrate a determined burglar just by moving the switch to a different location along the same side of the box. Better yet, add another tamper switch and wire it in parallel with the first. Thus if the burglar defeats the first switch, he will be caught by the second switch which he doesn't know is there.

The alarm system shown here, and many others like it, features a key switch that is used to turn the alarm on when you leave your home and to turn the system off when you wish to re-enter. This lock, like most door locks, is vulnerable to an experienced lockpicker. The easiest way to overcome this weakness is to cut the wires leading to the key switch and lead them to another hidden switch that only you know about. Even if a lockpicker manages to turn the box switch, he does not succeed in disarming the alarm system, as he will discover when he attempts to break through a window or door. But there's an even better way to outwit the crook. Wire the box key switch *in series* with the regular tamper switch and turn the lock into the *On* position. If a burglar picks the lock, the alarm will sound immediately, just as if a door or window had been opened.

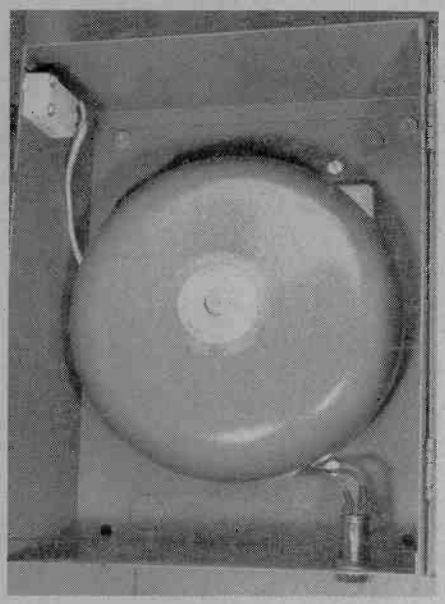
There's one more thing you can do whether or not you elect to follow the suggestions made so far. Add a perforated mesh or screen, of rugged steel (rather than soft aluminum), inside the box just behind the door. Bolt it in place using angle irons to hold it in position. Even if you leave the battery inside the box, a burglar will not be able to get at the wires. And if the intruder manages to get the lid open, figuring that he can silence the alarm before it attracts much attention, he will be frustrated by the *second* barrier that he unexpectedly finds inside the box. He isn't likely to stick around to figure out how to get past it. You can probably find a suitable screen or grill in a local junk yard. Don't worry about how it looks, so long as it is of tough metal and difficult to break through.

If you already have an alarm system that is different from the one discussed here, think about how you might attempt to defeat it if you were a knowledgeable burglar. Then figure out ways to mislead the burglar by making the system different from what he thinks it is. If you are really clever about it, you can make the burglar turn the alarm *On*, when he confidently thinks he is deactivating it. These design modifications provide you with a basis for understanding both the workings of a standard burglar alarm system, and the workings of a burglar's mind. When you put the two together you can easily outwit intruders. ■

PARTS LIST FOR IMPROVED BURGLAR ALARM

Basic burglar alarm
DPDT switch, toggle
12-volt indicator lamp
Case for above

A good electronic-sneak can foil a good burglar everytime—and BAM (Burglar Alarm Modification) is one tricky way to greater protection and security.



Interior of the box with the battery and the most vulnerable wiring removed. Read the text to learn how to improve the tamper switch and alter the key lock.

A warning label advertises the fact that BAM is ready to help foil any burglary. The arrow indicates the key lock which can now be used normally to turn the system on or off, or that can trick a burglar into setting off the alarm himself.

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FLASHMATE— THE PHOTOGRAPHER'S DREAM

Photoflash problems vanish with this easy-readout solid-state meter.

Frank I. Gilpin

☐ Any photographer, amateur or pro, will tell you the biggest bane of his life is figuring exposures for electronic flash photography. *If* you know the manufacturer's guide number for your flash unit, and *if* that number is close enough to being accurate for your production line unit, and *if* you can remember it from one shooting session to another, and *if* you remember how to use it, and *if* your flash is fully charged, and *if* you use straight, harsh flash instead of bouncing it, and *if*. . . . Well, flash photography is very often *iffy*.

Theoretically, you divide the guide number by the number of feet between the flash and subject, and the answer you get is the f-stop. This has to be figured for every shot, if you move between shots and this guide number is only good for one film type. Again, it gets pretty iffy. There are, to be sure, flash meters on the market, but the least expensive one I know of costs nearly $100, and they are all rather bulky.

The answer to these problems is Flash-Mate. It's smaller than an Instamatic camera, inexpensive to build, reliable and accurate, and easy to build, with readily-available parts. It takes all the IF variables in stride, and gives you the right f-stop for *any* flash at *any* distance and for *any* film type from ASA 10 to ASA 400. Flash-mate can be either of two basic types of meters. One, called an *ambient* light meter, measures the light output of your flash, aimed right at it. The other type, for measuring *reflected* light, is aimed at the subject and reads the light reflected by the subject. Your Flash-Mate can be calibrated for either type, as you choose.

How Circuit Works. The silicon phototransistor used as the light-sensing element in Flash-Mate has a very high resistance to ambient light, therefore the unit will work effectively under a wide range of lighting conditions, even including sunlight. The *sudden* light provided by the electronic flash causes a sudden drop in the phototransistor's resistance. This sudden drop in resistance pulses the trigger circuit of Q2-Q3. This pulse allows Q3 to charge capacitor C2 to a value proportionate to the intensity of the energy-producing light striking Q1. The value of this charge on C2 is then measured by FET Q4, and indicated on the meter. Because of the high input resistance of the FET, C2 does not discharge for several minutes and you have plenty of time to take a reading.

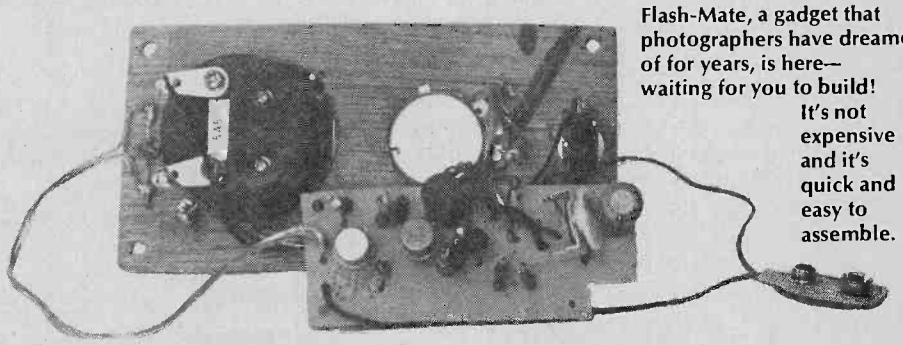
A discharge path for the meter and C2 is provided by R4 and S1. The switch turns the unit off and simultaneously discharges C2, leaving it ready for another reading, in about two seconds.

Sensitivity adjustments for various film types are effected by adjusting R8. A rotary switch could be used to connect a different trimmer resistor to the meter for each ASA number, but that would boost the cost, increase the size of the unit and limit the number of ASA numbers for which Flash-Mate can be calibrated.

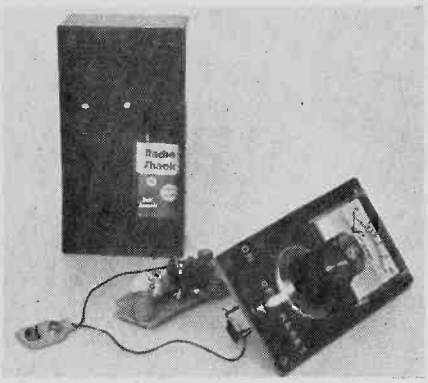
Potentiometer R8 can be calibrated for any ASA value, and as many as you want. You can even add more calibrations later. The only drawback to this compromise is that you must take care to set the pot directly on the reference marks before taking readings for a given ASA. If you exercise care and patience when calibrating the unit, this will present no problems in later use.

The two PNP transistors Q2 and Q3 are audio signal types and almost any high gain experimenter grade units will do. There are, however, few substitutes for Q1. It has a very high resistance to ambient light, has a reaction time on the order of 2.8 microseconds and has a wide range of illumination sensitivity. You can use a HEP-312, or a Clairex CL902, which also have the necessary reaction times and ambient light resistances required to keep the trigger circuit biased off until a bright, sudden light is sensed. The FET, Q4, is a P-channel, small signal unit and there are a number of substitutions possible, such as 2N5461 through 2N5465.

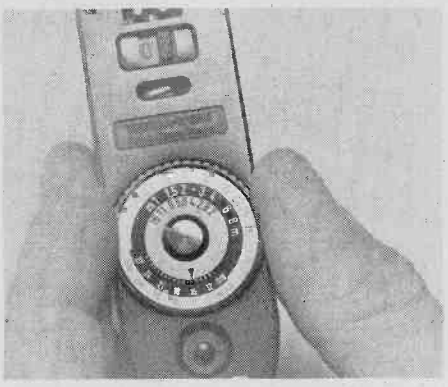
Assembly Options. You have a choice of assembly methods. Your Flash-Mate can be assembled on a perforated board using point-to-point wiring, or on a printed circuit board, for which the foil pattern is shown. Layout is not overly critical and you can vary the arrangement. Q1 is made with a clear epoxy lens which is quite durable, but an extra measure of protection can be provided by covering it



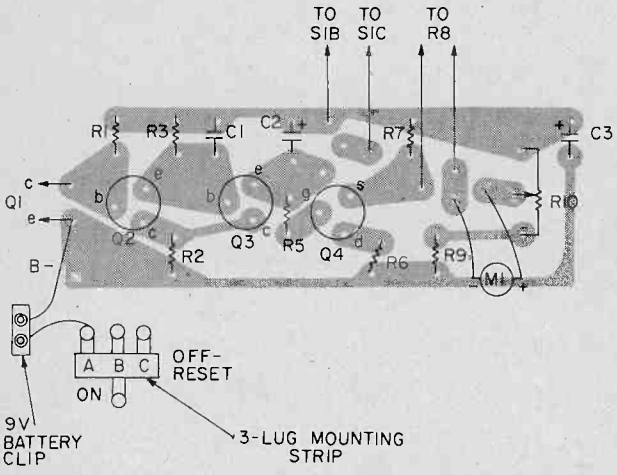
Flash-Mate, a gadget that photographers have dreamed of for years, is here—waiting for you to build! It's not expensive and it's quick and easy to assemble.



The layout of Flash-Mate's perf (or PC) board is uncritical and the arrangements of the components may vary. The roominess of the box allows for a clean layout

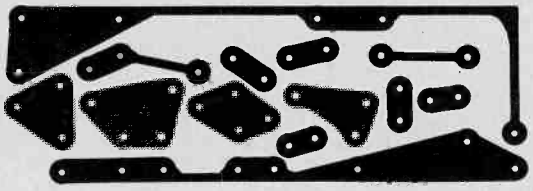


To calibrate Flash-Mate you will need an accurate electronic flash with an f-stop computer disc. Calibration can be done either for ambient light or bounce flash.



Here's the component side of Flash-Mate's PC board. The layout is simple and straightforward, which helps keep assembly time to a minimum. Flash-Mate is a great weekend project; accurate, unique, and goes together easily.

The foil side of Flash-Mate's board is quickly etched, especially if you use this full-size pattern. You could reduce or enlarge this as size and layout are not critical in this circuit.



with a clear pilot light lens or other clear plastic dome. The phototransistor can be mounted in several ways. You can press-fit it through a rubber grommet in the front panel of the cabinet, epoxy it through a hole, or it can be mounted on the chassis board so that it is rigidly suspended behind a hole in the front panel.

After all components are mounted and wired to the chassis board and connected to M1, R8, Q1 and S1 on the front panel, check to make sure all polarities are correct. Remember that when the chassis board is mounted in the cabinet, you have to be able to reach R10 to make adjustments. If the shaft is slotted you can drill a small hole in the cabinet facing the adjustment slot in the trimmer.

Some potentiometers have a knurled plastic wheel for adjustment which can be manually roated regardless of its mounting position.

When you are sure all is in order and you have double checked your wiring, apply power to the unit with S1. Turn R8 fully clockwise for least resistance and adjust R10 until the meter needle rests on zero. After this one internal adjustment, you can close the cabinet, screw down the front panel and prepare for the calibration procedure. You'll need a tape measure, a tripod and a flash unit.

To calibrate Flash-Mate either for ambient readings, or the reflected light reading mode, you will need a reliable electronic flash with an f-stop computer disc. You should also be sure the unit is charged fully, or has fresh batteries.

Ambient Light Reading Calibration. Set the flash computer to ASA 400. Determine the distance-from-subject necessary for an f-stop of f22. For instance, if your computer says a distance of three feet for f11, two and a half feet for f16 and 18 inches for f22, place the meter on a table and the flash mounted on a tripod exactly 18 inches in front of it. Carefully remove the clear plastic meter cover. Turn on the meter and set R8 fully clockwise and after a few seconds to stabilize, fire the flash. The meter needle should travel all the way upscale. Adjust R8 until the needle rests exactly on the uppermost reference mark of the meter scale. Label this spot "f22." Reset the meter with S1 and consult your flash computer once more to determine the distance for f16. Measure off this distance, set the flash at that spot and fire it at the flash meter. The needle should rest at a spot lower than the first. Mark this spot on the meter scale "f16." Take care not to disturb the setting of R8 during this calibration step.

Follow this procedure all the way through the scale to f2, remembering to reset the meter after each reading. When you've finished this step, replace the cover on the meter face and label the panel adjacent to R8's indicator knob "400."

This completes the calibration of the meter scale for all ASA values and the calibration of R8 for ASA 400. Select the next highest ASA on the computer and find the distance for an aperture of f16. Set the flash that distance from the meter and fire it. Adjust R8 until the needle rests exactly on the previously established mark for f16. Now mark the panel adjacent to R8's indicator knob and label it for the ASA number used to determine the distance. The meter is now calibrated for that ASA. Repeat this step for each ASA value desired. I have my meter calibrated for 25, 64, 80, 125 and 400, the five films I use most, but I can easily add more at some later date by using a reliable flash and the above procedure.

Reflected Light Calibration. The best situation is to find any wall which is an 18 percent gray, but any neutral color wall, or off-white bedsheet will do. In this procedure, the wall (or a sheet tacked up on a wall) becomes your "subject." Using the reference flash

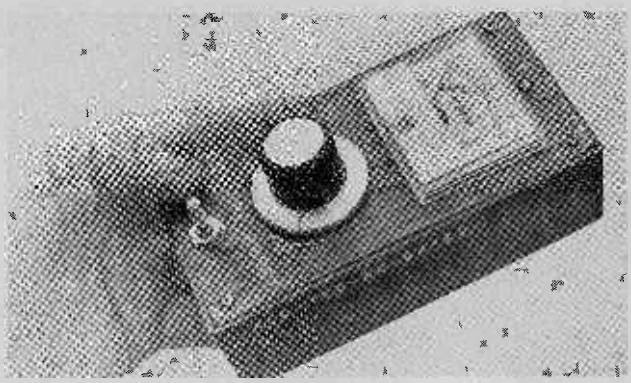
FLASHMATE

unit's computer to determine the first distance for f22 at ASA 400, place the meter and flash this distance from the wall. Both the flash and meter are aimed at the same spot on the wall. Fire the flash from just above and a few inches behind the meter to avoid "blinding" it with a strong sidelight from the flash. Mark the meter face for f22 and continue moving the meter and flash farther from the wall until f2 is calibrated. Repeat for other ASAs as in the previous step.

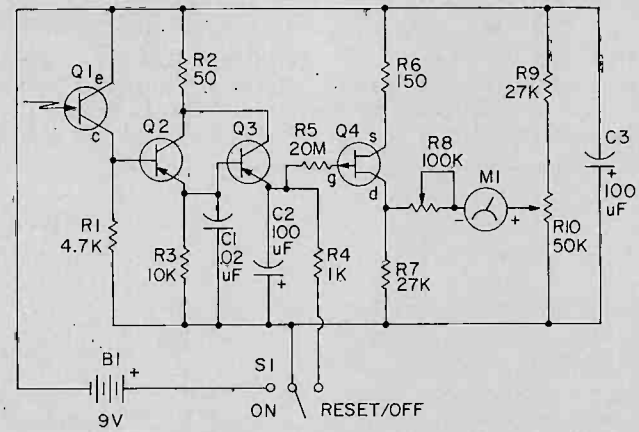
Using Flash-Mate. For the ambient light reading model, the procedure for taking a reading is as follows: Place Flash-Mate at the same location as the subject, facing the flash, and set R8 for the ASA of the film you're using and turn it on. Place the flash where you want it and fire it using the open flash button. Read the f-stop from Flash-Mate and set your camera to that f-stop.

To use Flash-Mate calibrated for reflected light readings, place it facing the subject in the same position as the flash. Fire the flash, take the reading from Flash-Mate and set your lens to that f-stop.

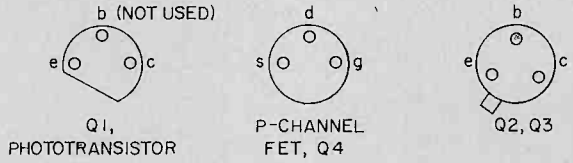
Personally, I prefer the direct, or ambient reading mode of calibration. For me, it offers more versatility. For example, your model need not be present to take a reading in advance. If you were going to shoot portraits using direct flash, bounce flash, or the popular umbrella reflector technique, you need only set up the flash and select where the model will sit or stand for the picture. Place Flash-Mate at that position, take a reading and set your camera lens. When the model arrives, all you need do is focus and shoot with no wasted time and wow, will you appear professional with no fumbling over f-stop computations or camera fiddling. If you plan to shoot from several positions during the session, these spots and their readings can be determined beforehand and noted. A piece of masking tape on the floor with the appropriate f-stop marked on it will remind you of the correct setting for that position. This technique is also handy for those special awards luncheons, handshakes, weddings, graduations, or any other planned events. You can go a little early before the event and take your readings and pick your spots from which to shoot and when that once-in-a-lifetime event occurs, you'll have a perfect exposure of it. ■



Flash-Mate is one useful gadget-bag stuffer. Forget about computing f-stops and concentrate on composing those pictures. The photo-sensitive transistor (above the meter) measures the light, and the meter reads directly in f-stops. The unit can be calibrated to read either ambient light or for bounce flash photography, depending on your own artistic preferences.



Schematic for Flashmate circuitry. Be sure when wiring in the transistors that you carefully observe lead keying, and always avoid allowing them to heat too much.



PARTS LIST FOR FLASH MATE

C1—.02-uF capacitor
C2, 3—100-uF, 16-VDC electrolytic capacitor
M1—0-50 microampere DC panel meter
Q1—Photo-sensitive transistor HEP-312 or Clairex CL902
Q2, 3—General-purpose PNP silicon transistor, 2N5139 or HEP-51
Q4—Field-effect transistor, P-channel, 2N-5460 or 2N5461
R1—4700-ohm, ¼-watt resistor
R2—47 or 50-ohm, ¼-watt resistor
R3—10,000-ohm, ¼-watt resistor
R4—1000-ohm, ¼-watt resistor
R5—20-megohm, ¼-watt resistor
R6—150-ohm, ¼-watt resistor
R7, 9—27,000-ohm, ¼-watt resistor
R8—100,000-ohm printed circuit board-mounting potentiometer
R10—50,000-ohm printed circuit board-mounting potentiometer
S1—Single-pole, double-throw switch

Misc.—Printed-circuit board kit cabinet 6¼-in. x 3¾-in. x 2-in. or larger; knob; hookup wire, hardware, solder, etc.

Note: If you use construction such as perf board, axial-lead capacitors will be more convenient to mount.

Flashmate can be built either with the printed circuit board layout presented with the article, or you could just use a perfboard and point-to-point wiring as the layout is not critical. A few final reminders: Once all components are mounted to the chassis, and wired, check to make certain you have not reversed any polarities; reall that you have to reach R10 to make adjustments so don't forget the small hole in the cabinet facing that trimmer's adjustment slot. The phototransistor, Q1, is made with a clear epoxy lens which is fairly durable and should hold up under most circumstances. If, however, you seek a measure of extra ruggedness, cover the phototransistor lens with a clear pilot light lens or any other clear plastic dome. Properly built and cared for your Flashmate will be calculating F-stops for you for years of parties, weddings, or just plain shutterbugging.

SUPER SCA SOOTHER

Get fancy restaurant music for down-home kitchen prices with your own FM tuner.

by Herb Friedman

YOU CAN LISTEN TO SCA BROADCASTS at far greater distances with this SCA (Subsidiary Communications Authorization) adapter for your FM receiver or tuner than with previous designs, even those costing many times more. The secret lies in a new integrated circuit now available at very low prices which decodes the ultrasonic frequency the SCA signal is on. This IC is a PLL (Phase-Locked Loop) which acts as the detector of the 67 kHz SCA carrier wave which the subsidiary signals are transmitted on.

Although most people are unaware of it, many FM stations transmit not just the two signals of a stereo program, but one, two, or even three other programs, usually music, which cannot be heard by the owners of normal FM tuners or receivers. These programs can be heard only if you have a special SCA receiver, or if you have an SCA adapter, similar to the one described in this article.

Our SCA Super-Soother is so-called because the most common use for SCA is to transmit Muzak-like background music into stores and factories. It uses two ICs which cost $6.00 (total, including postage) plus a handful of resistors and capacitors. Because of the advanced design made possible by the PLL IC, Super-Soother can grab SCA signals which ordinary SCA adapters would lose completely, or at best receive with lots of hash and/or distortion—and who needs that with soothing background music, music to lull you by . . . or whatever?

Using a two IC circuit in an amplifier / (PLL)-detector configuration Super-Soother will actually permit you to DX your FM-SCA programs. No longer will your SCA listening be restricted to local FM stations. You can now monitor *fringe reception* FM stations with SCA programming.

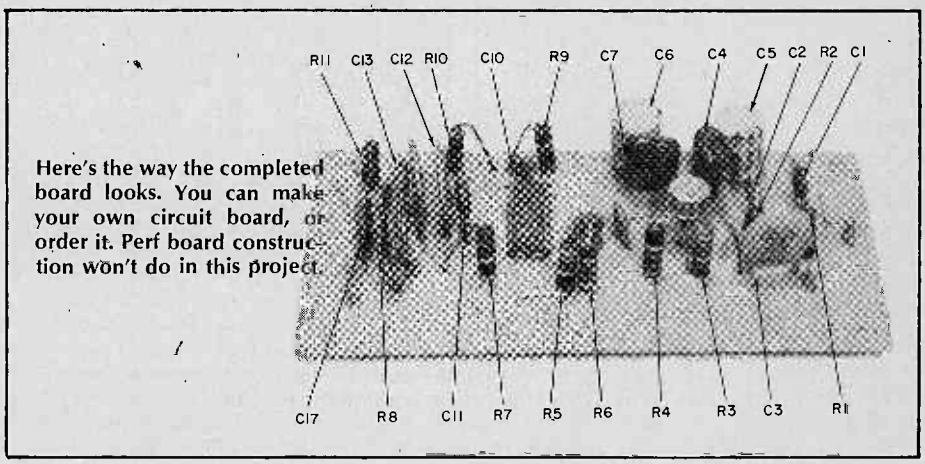
But before going further let's take a look at what SCA is all about. When a *Subsidiary Communications Authorization* is granted to an FM station by the FCC the station is permitted to transmit up to *three more programs* in addition to its regular program (called the main channel program) by a special method of modulation. A standard FM radio—either mono or stereo—cannot detect the SCA programs. The regular listening audience hears only the main channel programming. In fact, there is no way a listener with a standard FM radio can tell the station is transmitting an SCA program(s). Only listeners with FM radios equipped with an SCA adaptor can hear the SCA program.

If you would like to tune in to these "phantom broadcasts" you can do so with Super-Soother SCA Adapter. It's super because its extra-high sensitivity permits reception of SCA programs that other low cost SCA adaptors can't detect.

What You Can Hear. For many years SCA has been used to transmit educational programs and weather reports to specialized audiences; it has been used for reading to the blind, and even for broadcasting some school tests. The most common use of SCA, however, is the transmission of background music —the type heard in restaurants and shopping centers—and ethnic music. For example, in the New York City area there are FM stations with SCA programs of the music of China, Greece, Ireland, and many others.

Best of all, this pleasant, interesting music is rarely, if ever, interrupted by an endless barrage of commercials or the patter of an announcer in love with his or her own voice.

How It Works. SCA programming is transmitted by a 67 kHz FM subcarrier (or sometimes 65 kHz impressed on the main FM carrier). When a station broadcasting SCA is received



Here's the way the completed board looks. You can make your own circuit board, or order it. Perf board construction won't do in this project.

SOOTHER

by a standard FM radio or tuner the SCA subcarrier is simply wiped out in the radio's detector and the listener has no idea it exists.

To receive SCA the regular FM detector output must be fed into a 67 kHz detector before the 67 kHz subcarrier is eliminated by the standard FM detector's de-emphasis network.

Until recently it took a lot of expensive hardware to receive SCA programs: a very sensitive receiver and a rock-steady detector. (A good receiver is needed because the SCA subcarrier is usually only 10% of the total FM signal.) Though many low-cost SCA adaptors have been available in projects, or in wired form, most had a tendency to burp, gargle or distort on weak SCA levels.

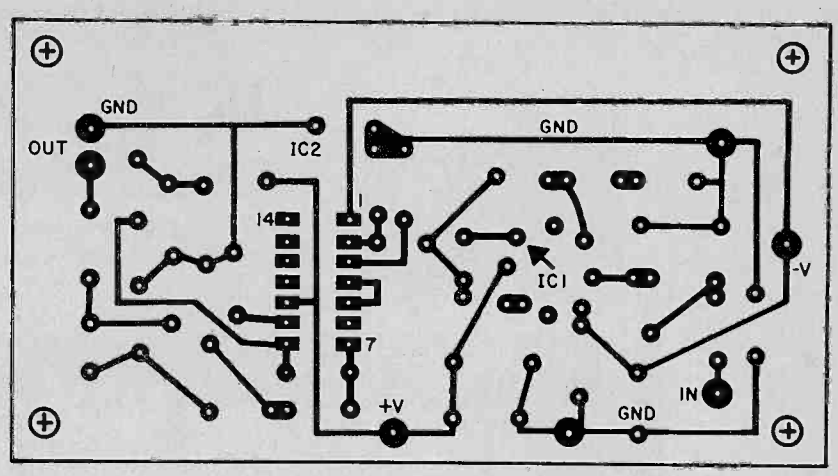
While the radio astronomy crowd had a great weak-signal detector known as the *phase-locked loop* or PLL, it was also true that the astronomical-use PLL was astronomical in price. Thanks to modern solid-state techniques, however, the Signetics Corp. has come up with a PLL specifically intended for SCA detection that's priced well under $5.

Available in both the standard 8-pin round and the 14-pin DIP IC packages the Signetics SE/NE565 requires virtually no external hardware for SCA detection. Most important, since the PLL automatically locks onto the incoming SCA subcarrier frequency the SE/NE565 will demodulate subcarriers of either 67 or 65 kHz without need for individual adjustment.

Combination Gets Results. Unfortunately, the phase-locked SCA detector requires at least 80 mV input from the FM detector for good reception, and this usually means that only one or two very strong, or local SCA stations can be received. To make our Super-Soother the best there is we have combined the PLL with a high gain operational amplifier. The result is the Super-Soother which can receive SCA programs even using a cheapie FM radio and an indoor (rabbit-ears) antenna.

Another plus feature of Super-Soother is that no large filter coils are needed to suppress the main channel program. Even SCA programs on stereo stations are received cleanly, with no trace of *stereo hash*. And because large coils aren't need the entire adaptor can be assembled on a 2¼-in. x 4¼-in. printed circuit board which you can purchase, or make, as you wish.

Because the gain of the adaptor is unusually high it must be assembled on the circuit board exactly as described to insure stability. You can't build this project on perfboard.



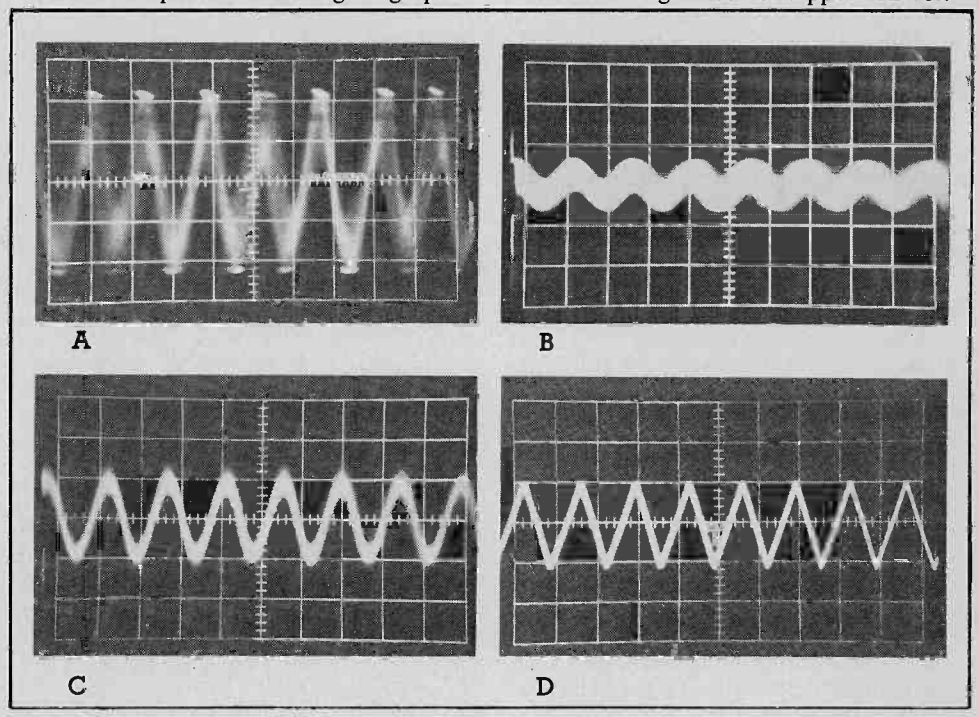
Exact-size printed circuit board layout is shown here. Transfer the image to copper clad board using carbon paper. This is the bottom (copper) side.

How The Circuit Works. The signal from your FM tuner's detector, before de-emphasis, is applied to operational amplifier IC1 through a high-pass filter consisting of C2, R1 and R2. The filter's effective frequency is 60 kHz, which removes just about all of the main-channel information. The frequency response of the amplifier is tailored by the feedback loop through R3 and C3 to further suppress main-channel information.

IC1's output is fed through high-pass filter C9 and R5 to IC2, the PLL detector. IC2's output is passed through a low-pass filter consisting of C12, C13, C14, R9, R10 and R11 which provides SCA de-emphasis and noise suppression. The output level at C15 is about 50 to 100 mV depending on the particular signal, and can then be fed to your hi-fi amplifier.

Since SCA audio response is limited to a maximum of 7 kHz just about any amplifier can be used.

Note that Super-Soother requires a bipolar power supply in the range of ±6 to ±9 VDC. The supply can be either batteries or a power-line bridge rectifier using a center-tapped 12-volt



Oscilloscope patterns will pinpoint any possible difficulty. You can use a general purpose scope since the signals are under 100 kHz. With "triggered" scopes, set the time base to u sec/cm. Photos B and C are input and output of IC1, the 67 kHz amplifier. If signal is clipped as in A, main channel program may break through—see text for curves. Normal IC2 pin 9 waveform is shown in the waveform of D. Vertical sensitivity B, 20mmV/cm; C, IV/cm.

filament transformer as shown on the schematic. Since the SCA adaptor requires only about 10 mA of current any small power transformer can be used.

Assembly. If you cannot make your own circuit board, you can purchase a drilled and plated board. See the parts list for information.

If you make your own board use a #56 bit to drill the holes for the push-in connecting terminals and trimmer potentiometer R8. Drill the corner mounting holes to clear a #4 screw. Drill the component holes with a #58, #59, or #60 bit.

Install IC1 and IC2 before any other components. Note that the IC1 lead opposite the case tab is #8. Insert the leads—beginning with #8 and push IC1 within ¼ to ⅜-inch of the board. Solder the leads and cut off the excess.

If this is your first IC project it would be wise to use IC sockets.

Hold the board so you are looking at the top, with IC1 to your left. Hold IC2 so the notch is away from you and insert IC2's leads into the matching holes. *Doublecheck the notch before soldering.*

Install trimmer potentiometer R8 and solder. Then install the three wire jumpers, and finally, the remaining components, taking extreme care the polarity of capacitors C5 and C6 is correct. Note that C5 has the positive lead connected to ground.

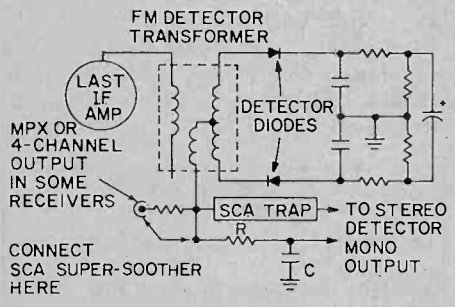
While capacitors C12 and C14 are indicated as 0.02 uF they aren't the easiest to obtain in miniature size. You can substitute two parallel-wired 0.01 uF capacitors.

The three oscillosope traces show what you can expect to get if you are tuned to an SCA station. Photo B is the input, IC1 pin 2; note the presence of a 67 kHz carrier. Photo C is IC1 pin 6; note the very strong 67 kHz carrier. Photo D is IC2 pin 9, the phase lock detector's voltage controlled oscillator triangular wave output.

If you don't get photo B, the trouble is the connection between the tuner and the adaptor. If you get photo B but not photo C, the trouble is in the IC1 circuit. If you get photo C but not photo D, the trouble is in IC2.

If you don't get photos C and D, there is most likely a major fault in the assembly; we have specifically designed the adaptor so one defective IC cannot disable another IC.

Setup And Checkout. Either a bipolar battery power source or an AC supply can be used. Since there is no difference (in this case) in performance between a ±6 and ±9 VDC supply use whatever you have available. For long-term battery life Burgess Z4 6-volt batteries are suggested. However regular (or long-life) 9-V transistor batteries will work fine.



The Super-Soother (or any other SCA adaptor) is connected after the FM detector, but before the deemphasis network, as here.

PARTS LIST FOR SUPER-SOOTHER

C1, 9—470-pF capacitor
C2—47 or 50-pF capacitor
C3—.005-uF capacitor
C4, 7—.1-uF capacitor
C5, 6—100-uF, 16-VDC or better electrolytic capacitor
C8—7 or 10-pF capacitor
C10, 11—.001-uF capacitor
C12, 14—.02-uF capacitor
C13, 17—.05-uF capacitor
IC1—op amp integrated circuit Signetics NE 531T (available from supplier listed below)
IC2—phase-locked-loop SCA detector integrated circuit Signetics NE 565A (available from supplier listed below)
R1, 5, 6—4700-ohm, ½-watt resistor
R2, 4—47,000-ohm, ½-watt resistor
R3—470-ohm, ½-watt resistor
R7—1800-ohm, ½-watt resistor
R8—5000-ohm potentiometer, circuit-board mounting
R9, 10, 11—1000-ohm, ½-watt resistor
S1—SPST switch
Misc.—Cabinet 6-in. x 4-in. x 2⅜-in. or larger, two batteries 9-VDC or 6-VDC unless power supply is used, battery connecting clips, phone jacks, wire, solder, etc.

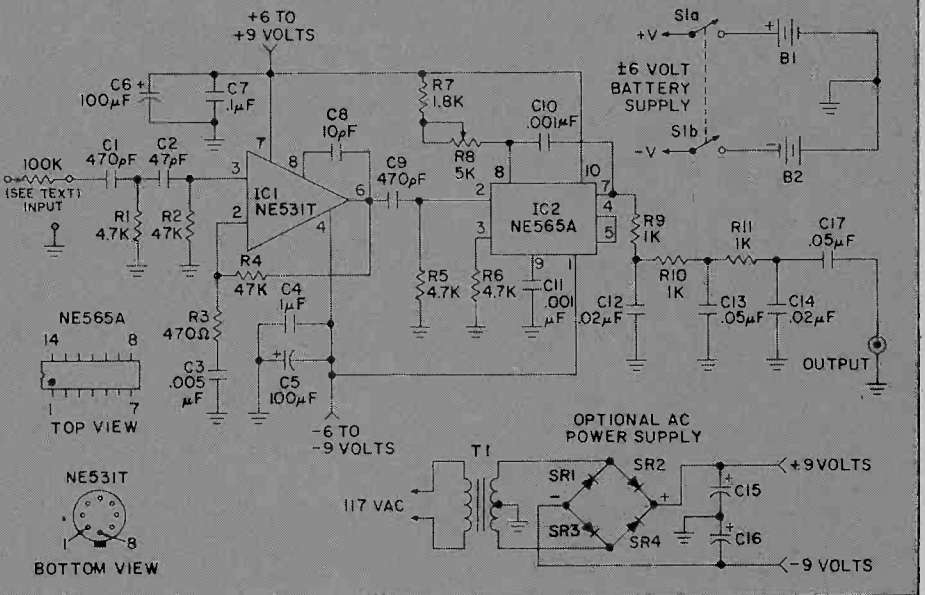
An etched drilled, printed circuit board for the Super-Soother SCA Adapter is available from Electronic Hobby Shop, Box 192, Brooklyn, NY 11235 for $6.95. US orders add $1.50 for postage and handling: Canadian orders add $3.00. No foreign orders, please. Postal money orders will speed delivery; otherwise allow 6-8 weeks for delivery. NY state residents must add sales tax.

The two ICs for this project are available from Circuit Specialists Co., Box 3047, Scottsdale, Ariz. 85257 for $6.00 which includes shipping and postage.

PARTS LIST FOR POWER SUPPLY FOR SUPER-SOOTHER

C15, 16—2000 or 2200-uF, 20 VDC or better electrolytic capacitors
SR1-4—Bridge rectifier, or separate diode rectifiers—anything over about 15 mA will do
T1—Small 12.6-VAC filament transformer

Blasting, raucous commercials can ruin an otherwise blissful evening of enjoying the FM broadcast band. Let Super-Soother calm the savage commercial. With this new adapter you'll be able to pick up even the weaker SCA (Subsidiary Communications Authorization) stations. These SCA stations transmit background music to such clients as stores and restaurants and, with a little ingenuity, right into your own living room as well. This particular adapter features extra-high sensitivity to receive, soothingly clear, SCA broadcast that many other adapters can't detect. Forget about commercials—get fast, fast, fast relief with Super Soother.



SOOTHER

Super-Soother connects to your radio or tuner between its FM detector and de-emphasis filter. If you connect after the de-emphasis filter you will find the 67 kHz subcarrier has been filtered from the detector's output signal and you will get nothing but noise from the Super-Soother. The drawing shows a typical FM detector output, the de-emphasis network, and the correct connecting point for the adaptor. Since it is possible the Super-Soother will load down the detector for normal FM reception I suggest a switch be installed so it can be removed from the circuit when not being used for SCA listening.

Super-Soother is most conveniently connected through a phono jack installed on the rear apron of the tuner or radio, though you can use a direct wire connection.

If you have one of the older FM tuners with an *MPX* output you already have the correct connection because the MPX output *is* the *non*-deemphasized detector output. Similarly, if you have a modern FM tuner with an *FM detector, 4-channel, or FM Quadrasound* output jack you also have the correct connection as they are all FM detector outputs from *before* the de-emphasis network.

Connect the tuner's detector output to the Super-Soother with the shortest possible length of shielded cable, or install it directly inside the tuner or receiver if there is sufficient room. Connect Super-Soother's output to any high-gain amplifier such as the microphone input of a hi-fi or general-purpose amplifier.

Locking The Loop. Tune in a station you know (or believe) is transmitting an SCA program (a call to the station should get you the info) and adjust trimmer potentiometer R8 for best SCA sound quality. Normally, the reception will be almost completely garbled and then fade into a clean signal as R8 is adjusted. As R8 is adjusted further the sound will again garble. Set R8 so it is approximately midway between the two settings that produced garbled sound. Usually, the adjustment is quite broad so don't be too fussy.

If you don't know which stations are transmitting SCA set R8 to its mid-position and tune the station very carefully and very, very slowly. When you hear anything that sounds like distorted music try adjusting R8—if it's real SCA it will turn into clean sound as R8 is adjusted. Note that some stereo stations can cause sound bursts that appear to be SCA. If adjusting R8 doesn't clean up the bursts it's not SCA. Note that once R8 is properly adjusted there is no stereo hash interference with SCA signals; hash will only be heard from non-SCA signals.

Problems? The high sensitivity of this system may require that the overall gain be reduced. In the event you cannot receive *any* SCA stations you either have none in your area or you have made a construction error. Here are some hints to help.

1) If your problem is a weak signal resulting in high frequency noise try changing C12 and C14 to 0.05 uF.

2) If your problem is background breaking through from the main channel the problem is probably caused by adaptor overload (clipping). Simply change C1 and C9 to approximately 300 pF. This will attenuate the subcarrier and clean up the breakthrough on very strong signals, though very weak signal might get lost (you can't grab, or hear, them all). A second, simple corrective procedure is to install a 100k ohm resistor in series with the input from the radio or tuner's detector. This effectively cuts down the input signal and eliminates overload. ■

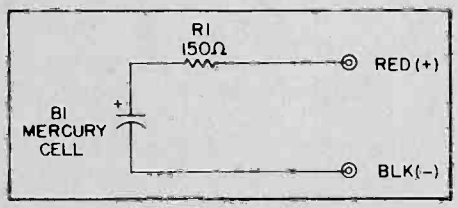
BUILD AN ACU-VOLT CALIBRATOR

THIS EASY PROJECT GIVES YOU A SUPER-ACCURATE VOLTAGE SOURCE FOR CALIBRATING YOUR VOM OR VTVM.

by F. Chapman

☐ You have just finished building that new kit VOM or VTVM and are ready to adjust the calibration. And what do you use—the standard 1.5-volt off-the-shelf dry cell from the local drugstore. Maybe you want to check the accuracy of your meter after a hard bounce in the trunk of the family gas hog. Out comes the slightly used cell from the under-dash flashlight.

Sure, I know, the book says that a fresh dry cell has a terminal voltage of 1.56 volts. But the key word is *fresh*. Just how fresh *is* that cell you are using? How long has it been sitting on the dealer's shelf, or in the flashlight? It *could* be three years old!



Your VOM probably has an accuracy of 2% of full-scale. Why not use a cell whose *known* accuracy is much better than the meter's?

Use a Mercury Cell. Such an animal is the mercury cell, of which there are two types. One has a cell voltage of 1.4 volts, the other 1.35. The latter has an accuracy of about ½% when loaded with one mA or less. Since most VOM's worth calibrating are at least 20,000 ohms per volt, this means they have a full scale deflection current of 50 microamperes. On a 2.5 volt DC scale 1.35 volts will take only 27 microamperes of current from the cell. This allows us to put a resistor in series with the cell and jacks to limit short circuit current to about 10 mA. This insures that the cell will not be damaged by an accidental short. Any of the cells whose voltage is 1.35 volts will do. You will note that they all have an "R" at the end of the type number (Example: An RM12 is a 1.4-volt cell. An RM12R is 1.35 volts.)

Mount the cell, its holder, resistor and red and black pin jacks in a small plastic case and you have a very accurate means of checking your DC meters calibration.

You might feel that it would be good to have several different voltages for calibration. Not so. Most good meters use 1% resistors in the voltage-measuring circuit. Further, they normally only have a single DC adjustment. Set the calibration control on one scale and it should hold within 1% for all other scales. ■

PARTS LIST FOR ACU-VOLT CALIBRATOR

B1—Mercury cell 1.4 volts (Radio Shack 23-1520 or equiv.)

R1—150-ohm, ½-watt resistor, 10% (Radio Shack 271-000 or equiv.)

Misc—Binding posts, one red, one black (Radio Shack 274-662 or equiv.), small box, aluminum (Radio Shack 270-235 or equiv.), or bakelite, (Radio Shack 270-230 or equiv.)

Las Vegas LED

Always win on the red with electronic roulette

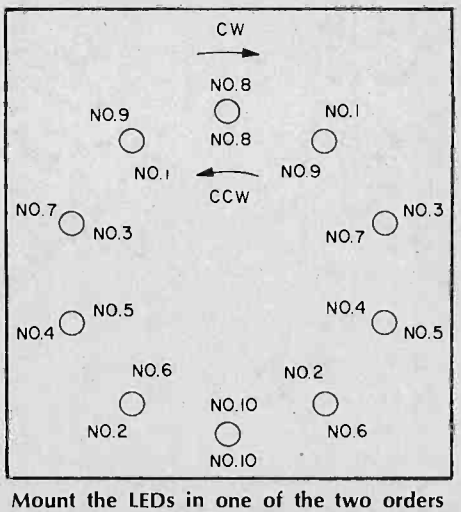
by Walter Sikonwiz

PEOPLE HAVE ALWAYS BEEN fascinated by games of chance, as diversions and obsessions. Inveterate gambler or not, chances are you'll really like *Las Vegas LED*, our version of that old favorite, Roulette. Here's more good news—you won't have to drop a bundle to cash in on the fun.

Las Vegas LED's spinning wheel of fate is a revolving dot of light, provided by a ring of ten LEDs. A glance at the photographs will show you that play is governed by three controls: *Accelerate, brake,* and *decay*. You start by pressing the *accelerate* button, which causes a red dot of light to revolve at an ever-increasing rate until a terminal velocity is reached. If you release *accelerate,* the spinning light will gradually coast to a standstill. The rate of deceleration is determined by the *decay* control. Pressing *brake* while the light is coasting causes a more rapid, but not instantaneous, halt to the spinning.

At least two games are possible, with this control format. Using a little imagination, you can probably devise more. The first possibility is similar to standard Roulette. A player presses *accelerate,* then releases it, and hopes that the number he has predicted beforehand will be the one at which the light ultimately comes to rest. Alternatively, the player starts the light into motion; then, upon the release of *accelerate,* he tries to stop the light on a number designated by his opponent, using only one pulse of the *brake* switch for this purpose. This second variation is quite a frustrating game; particularly so if various decay times are used. Decay times from about 1.5 to 15 seconds can be selected via the *decay* potentiometer.

How It Works. Before discussing construction, let's delve into the theory behind our Roulette game. We start with a very simple voltage-controlled oscillator. We then devise some means for converting the oscillation of our VCO into the apparent revolution of a spot of light (this might seem hard, but we'll see how simple it is later); the velocity of the light will be directly proportional to the VCO's frequency. The VCO's frequency, however, is proportional to the control voltage applied to it. We can produce acceleration of the revolving light if we cause the VCO's control voltage to gradually rise while the *accelerate* button is depressed. Conversely, deceleration of the light is synonymous with a gradual reduction in control voltage. How do we produce a control voltage that behaves in such a manner? We can charge and discharge a capacitor through resistors, and use the voltage across the capacitor as our control voltage.



Mount the LEDs in one of the two orders shown here, which one depending on whether you wish your wheel to "rotate" clock-wise (cw) or counter-clockwise (ccw).

Take a look at the schematic diagram. The voltage across capacitor C3 is our control voltage, and you can see how pressing S2, the *accelerate* button, charges the capacitor through R13. Once S2 is released, charge accumulated on C3 drains away through R13, R11, and *decay* control R12. Setting R12 to its maximum resistance produces the slowest rate of capacitor discharge; hence, as we'll see later, the revolving light will take a maximum amount of time to come to rest.

Brake switch S3 also discharges C3, this time through R14. Since the resistance of R14 is set to a relatively small value, the rate of discharge is quite rapid, and produces a quick cut in the speed of the light. It is the voltage on C3 that is to be our control voltage. Transistor Q11, functioning here as an emitter follower, reads C3's voltage; and because the emitter follower configuration is used, Q11 will not significantly contribute to the discharge of capacitor C3. At Q11's emitter we now have a voltage proportional to that on C3, which is used to drive our VCO.

Unijunction transistor Q13, along with R16, R17, R18, R19, and C4, comprise a relaxation oscillator, the frequency of which is proportional to the input voltage present on the left-hand end of R16. We don't have the nice, linear, voltage-to-frequency conversion of fancier VCOs, but what we have serves our purpose well enough. The output signal of our VCO appears across R19, and is a series of short-duration spikes with an amplitude of a volt or two. Such a signal won't be acceptable to the circuitry that follows, so we first feed it to transistor Q12, set up so that only a small input signal saturates it fully. The resultant output signal, available at Q12's collector, is a well-defined series of negative-going pulses, approximately 9 volts in amplitude.

Now we convert the variable-frequency pulses from Q12 into the ap-

Las Vegas LED

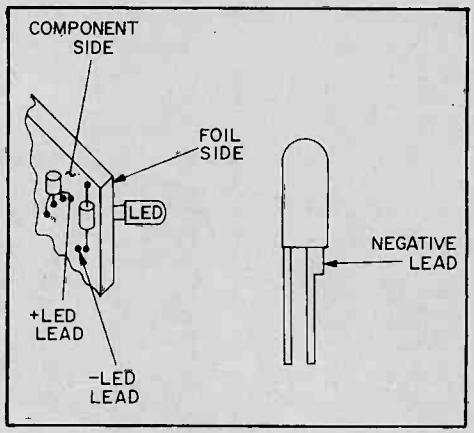
parent revolution of a dot of light by using an integrated circuit known as a decade counter. One essential characteristic of such an IC is that it has ten outputs, and at any given instant of time, nine of these outputs will be at a low potential, while the tenth will be high. The second important feature of the decade counter is that whenever its input, (pin #14 in this case), senses a specific change in potential (high-to-low in this case), the lone high signal advances serially along the outputs. Specifically, successive input pulses to IC1 will cause the high signal to advance from output #1 all the way to output #10, and then back to output #1 again. You might logically assume output #1 to be available at pin #1, and so on; however, this is not the case. We won't discuss the actual location of the individual outputs, because this information is available on the data sheet that accompanies this Radio Shack IC.

From the schematic, we see how Q12's output feeds IC1's input, pin 14. The outputs of IC1 (pins 1 through 7, plus pins 9, 10, and 11) connect to ten LEDs through buffer transistors Q1 through Q10. These buffers are emitter followers; they're necessary because the IC alone cannot supply sufficient current to illuminate an LED. Whenever a particular output is high, its associated driver transistor will supply current to a LED, and light it.

We arrange these LED's in a circle so that as we progress in a clockwise direction, starting at the LED associated with output #1, we encounter, *in proper consecutive order*, those LEDs associated with output #2 through output #10. When we feed an input signal to our IC, we see the LEDs fire sequentially so that a spot of light appears to be revolving in a counter-clockwise direction. One full revolution of the light requires ten input pulses, and the rate of revolution is in direct proportion to the input frequency.

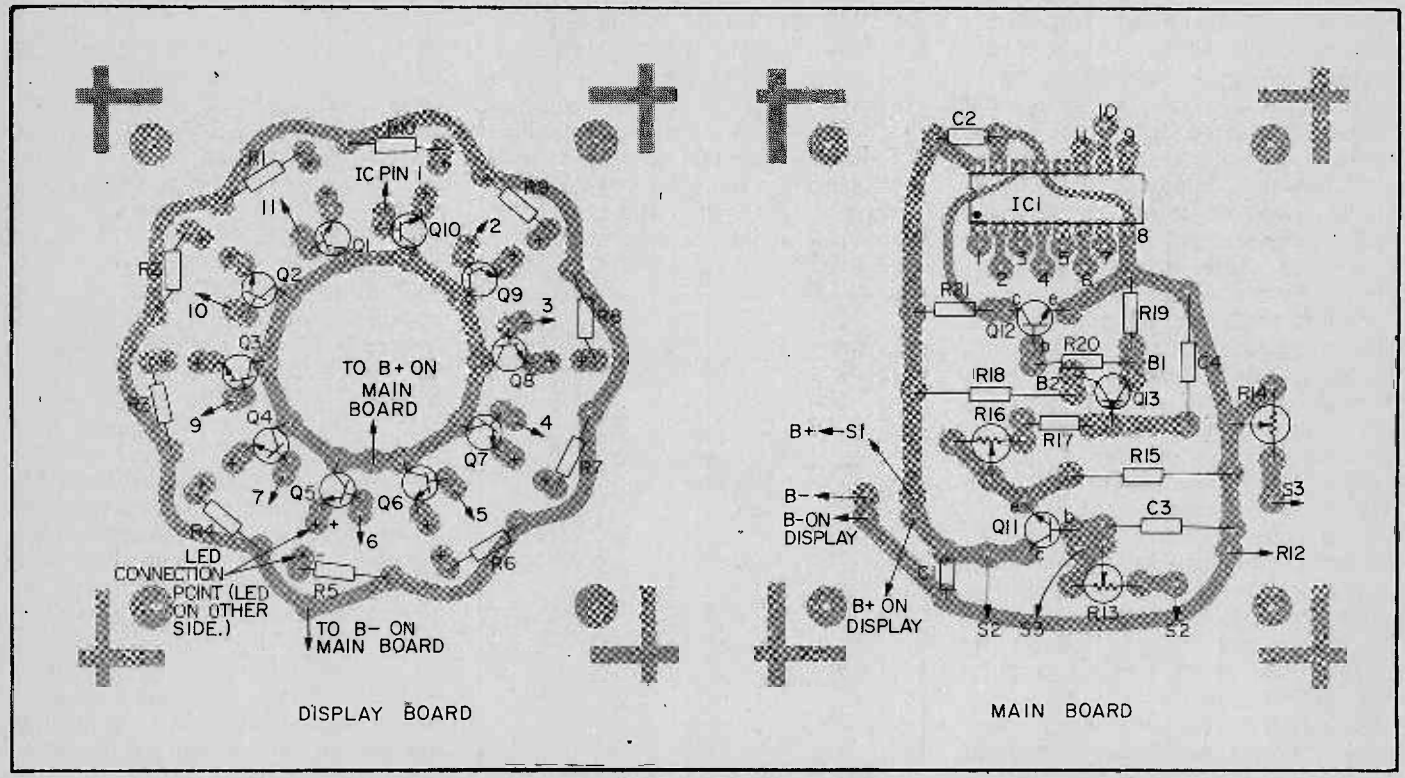
Let's review what we have: 1) the frequency of our VCO is controlled by the gradual charge and discharge of a capacitor; 2) the variable-frequency signal from the VCO feeds a decade counter, which drives ten LEDs; and 3) proper LED arrangement results in the apparent revolution of a single dot of light, with a velocity proportional to the frequency of the VCO. That's all there is to it.

Wiring. Since nothing about the circuit is critical, you may build it any way you wish. Perfboard construction is good. Alternatively, you might want to copy the PC layouts provided; the choice is up to you. A good place to begin construction is by drilling your-



LEDs are to be wired to the foil side, with their leads left long enough that their heads poke through the front cabinet (see text). Observe polarity; the negative leads of the LEDs are notched, as shown, and should be connected as both the pictorials and the schematic indicate.

cabinet to accept the ten LEDs. With a compass, lay out a small circle on a sheet of paper. If you intend copying the PC layout provided, the circle's radius should be exactly .9 inch. With a protractor centered at the circle's center, divide the circle into arcs at 36-degree intervals. Trim away any excess paper, leaving just the circle and a small border around it. Position the circle conveniently on your cabinet, and tape it down. With a fine, sharp awl make



The component sides of the main and display boards are shown in this pictorial view. Make certain that the main board's IC pins are all interconnected properly to the solder-points on the display board, as labeled. Connect, for example, IC pin 1 to Q10. Don't forget about R11 which is not shown and is wired point-to-point between R12 and S2.

slight indentations in the cabinet at the points where the circle is subdivided into arcs. Remove the circle, and at each indentation drill holes through which the LEDs can protrude.

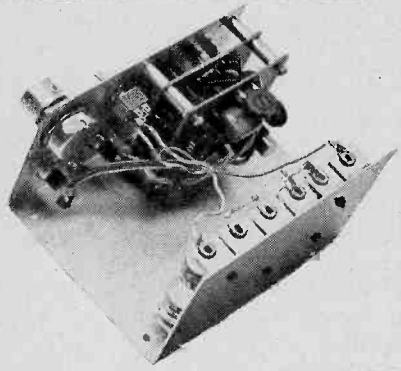
The drawing given shows the order of mounting of LEDs for both clockwise and counterclockwise revolution. The PC layout supplied for the display board provides counterclockwise revolution of the light.

The majority of the components mount on two circuit boards—either the main board or the display board. Even if you decide not to use a PC board, the PC layout provided for the display board may be helpful to you. Note that the arrangement is particularly simple, even though a good many parts are involved, because a radially symmetric pattern is employed instead of the usual rectilinear layout.

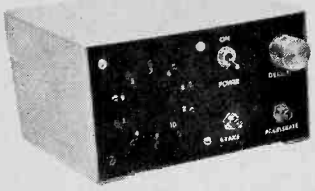
When installing components on the display board, follow the dimensional details in the accompanying drawings. Note that Q1 through Q10, and R1 through R10 mount on the component side of the board. LED1 through LED10 mount on the opposite foil side, with leads of such a length that the tops of the LEDs extend beyond the spacers and through the cabinet's panel. The semiconductors that mount on the display board are not especially fragile, but as is the case with all solid-state devices, excess heat can be damaging. Solder all connections quickly, using a 25-watt iron and fine, rosin-core solder. Twelve wires will run between the display board and the main board; ground, +, and the ten counter output leads.

The main board contains the rest of the components. Note that if the PC patterns supplied are copied, the main board may be stacked right behind the display board. This makes for a very dense packing arrangement, but if you have ample space, the boards may be mounted in any manner you like. R11 does not appear on either circuit board; instead, it is wired point-to-point between R12 and S2. Be sure to use a 16-pin socket for IC1. This IC is a CMOS unit, and should be inserted into its socket only after all soldering is finished. If, in checking out your unit, you should find an error that requires re-wiring, remove IC1 before applying a soldering iron to the board.

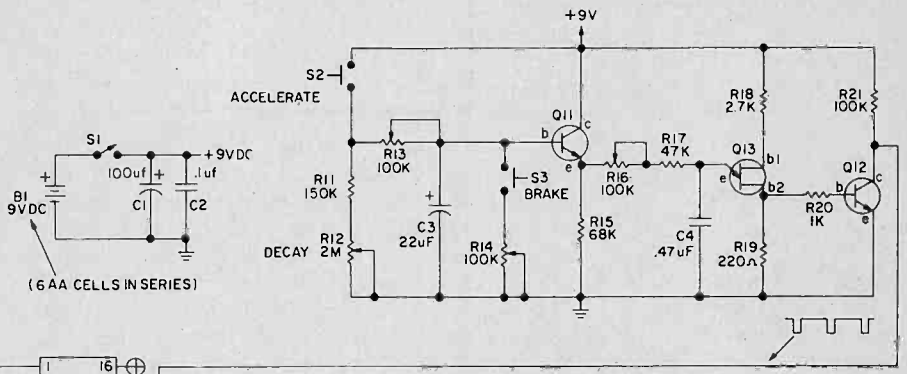
In assembling the circuit, pay atten-

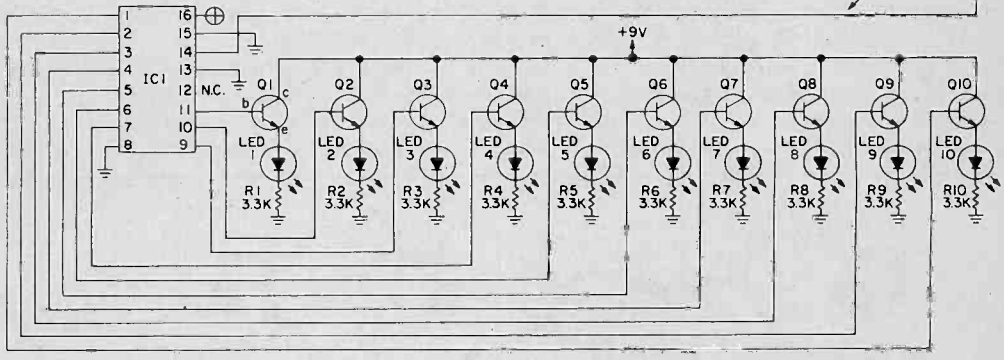


Inside view of Vegas LED showing stacking of PC boards.



Completed Vegas shown fully assembled, and installed in case.





PARTS LIST FOR LAS VEGAS LED

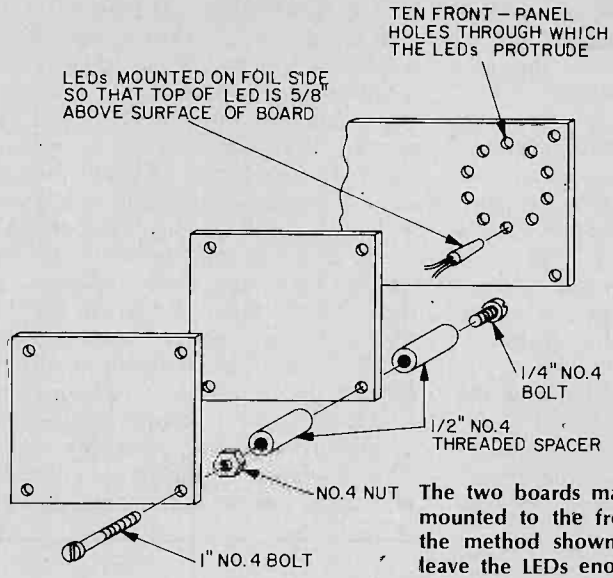
B1—Six AA (penlight cells) 1.5 VDC
C1—100-uF, 16-VDC capacitor
C2—.1-uF capacitor
C3—22-uF, 16-VDC tantalum capacitor
C4—.47-uF, capacitor
IC1—Decade Counter/Divider CD4017
LED1-LED10—Light Emitting Diodes
Q1-Q12—2N3904 transistors
Q13—Unijunction transistor
R1-R10—3300-ohm resistor
R11—150,000-ohm resistor
R12—2-Megohm potentiometer
R13, R14, R16—100,000-ohm trimmer
R15—68,000-ohm resistor
R17—47,000-ohm resistor
R18—2700-ohm resistor
R19—220-ohm resistor
R20—1000-ohm resistor
R21—100,000-ohm resistor
S1—SPST toggle switch
S2, S3—SPST pushbutton switches, normally open
Misc.—Battery clips, IC socket, aluminum spacers, wire, solder, hardware, etc.

You might not be able to afford a trip to Vegas; but Las Vegas LED will bring the glittering, gambling glamor of that city right into your own home town. When you assemble the circuit, just pay strict attention to the orientation of C3 and C1. It also pays to doublecheck the positions of all ICs and transistors; you'd be surprised how often a simple positioning error can lead to hours of fruitless trouble-shooting. The boards may be mounted in any way you like within the cabinet, but remember to leave room for the batteries to fit into later on. Finally, make absolutely sure you have positioned the LEDs properly depending on whether you want clockwise or counter-clockwise rotation of your "wheel." Follow the diagram on the first page very exactly. Once it's all together just get your bet down and start Las Vegas LED spinning around.

Las Vegas LED

tion to the orientation of C3 and C1. Likewise, make sure the transistors and IC are correctly positioned. The LEDs must also be properly oriented. The leads of all these devices are identified on the packages in which they are sold. Because of the circuit's low power consumption, six 1.5-volt penlite cells in series will power it for a long, long time. A single 9-volt transistor battery could also be used.

Because this is not a finicky circuit, the operating controls and circuit boards can be mounted in any convenient way inside your cabinet, but be certain to allow sufficient room to accommodate the batteries. When you've completed cutting and drilling the cabinet, finish off the front panel with press-on decals. As shown in the photographs, LED1 through LED10 should be identified with numerals applied in a random order.



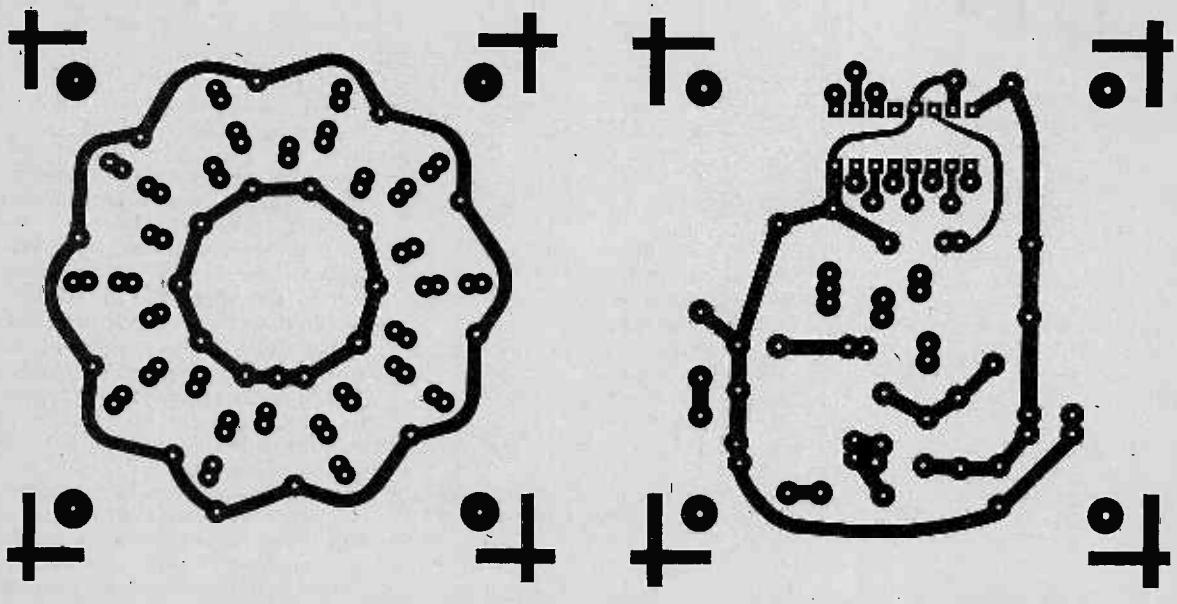
The two boards may be easily and neatly mounted to the front panel by following the method shown here. Make sure you leave the LEDs enough lead, and that you mount them to the foil side of the display board.

Final Calibration. After assembly is complete, only a few simple adjustments are necessary to put the circuit into operation. Turn R12 so that its resistance is at a minimum. Set R13, R14, and R16 to the midpoints of their ranges of rotation. Apply power, and depress the *accelerate* button. Within several seconds you should see a spinning dot of light. Adjust R16 for the desired maximum velocity. Too high a maximum speed blurs the image and spoils the effect, whereas a slow-poke display is equally undesirable.

Release the *accelerate* button, and the velocity of the light will diminish rapidly. Press *accelerate* again, and then release it, repeating the cycle several times, and at the same time adjust R13 to get an acceleration response that you like. In general, the best position for R13 will be somewhere in the middle of its range of rotation.

Turn R12 so that its resistance (and the decay time) is a maximum. Press the *accelerate* button until the display reaches maximum velocity, then release it, and press *brake*. Note the rate at which the display is slowed down. Adjust R14 while alternately pressing *accelerate* and *brake* until you obtain a rate of deceleration that you like. A very rapid braking action is undesirable; the brake should diminish the velocity, not halt motion instantaneously.

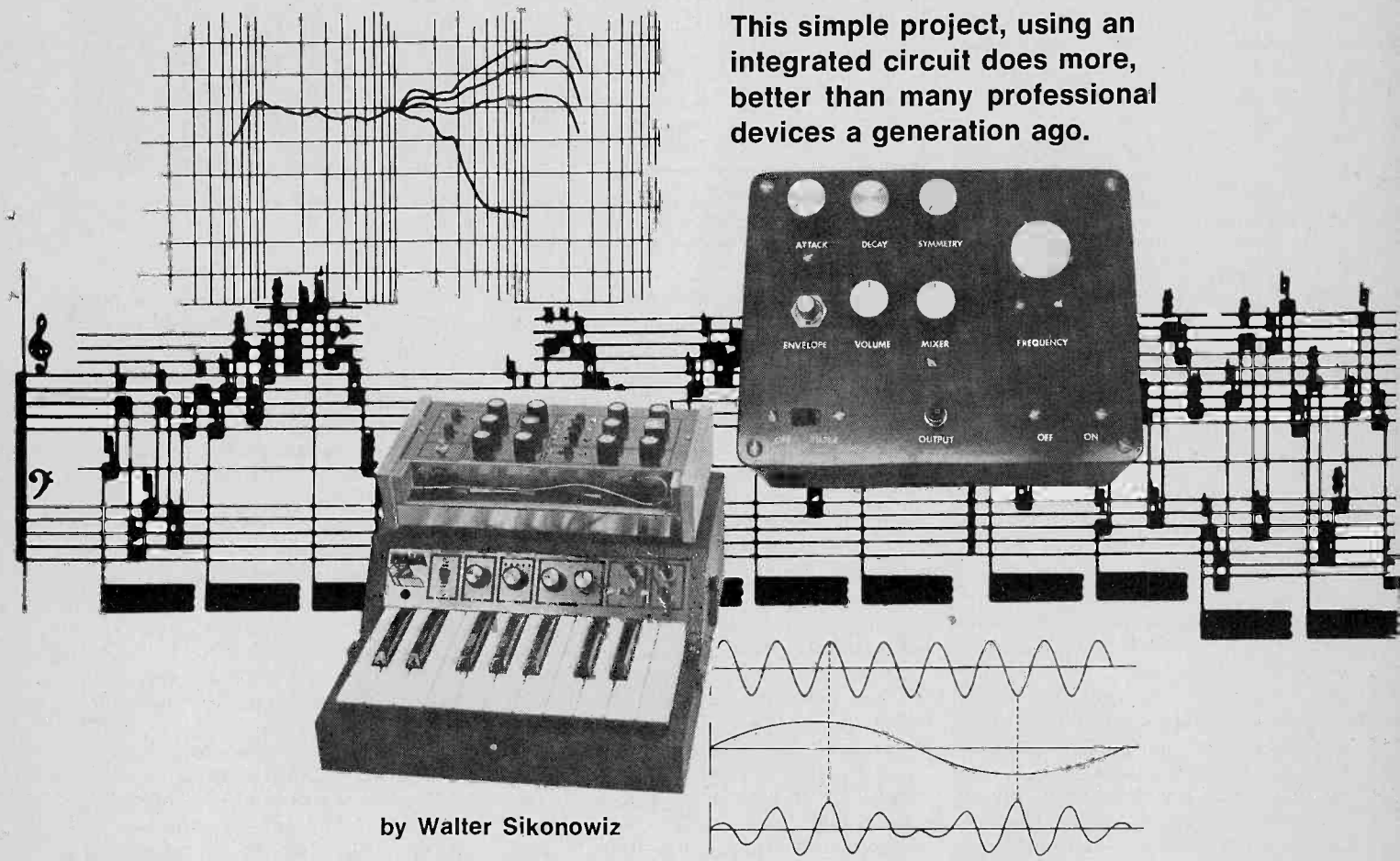
The game may be used as already described in the opening paragraphs. However, just as dice can be found as constituent parts of many other games, so too can Las Vegas LED be adapted to games of your design. ■



Las Vegas LED uses two compact PC boards to keep its "wheel" spinning. The display board, on the left, takes advantage of a repetitious circuit to achieve a neat, clean symmetry of design. The main board, on the right, is also simple to etch and wire. Use these two full-size patterns as templates for your own Las Vegas LED.

SIMPLE-SYN, THE MUSIC MACHINE

This simple project, using an integrated circuit does more, better than many professional devices a generation ago.



by Walter Sikonowiz

IT WAS INEVITABLE that modern man would use electronics to imitate the sounds of earlier musical instruments. Just as the pipe organ has been used for centuries to produce sounds similar to trumpets, flutes, and strings, for the past thirty years electric pianos and organs have been used to mimic the pianoforte and the pipe organ. Only today, with the advent of microelectronics—integrated circuits and other improvements on the vacuum tube and discrete transistors—we are seeing an explosion in the design and manufacture of electronic musical instruments.

In the Beginning. We've had electronic instruments as far back as the 1930's, though they were far simpler than even today's toys. In France the Martinot and the Oniolone used piano-like keyboards to control electronic oscillators which produced sustained tones. They were the forerunners of the keyboards which most rock-pop groups use today to produce those massive 120-dB sound crushers at festivals and concerts—to say nothing of thundering dance halls and discotheques.

Early Instruments. The best-known electronic instrument before today's was the Theremin. It consisted of two radio-frequency oscillators. One had a fixed frequency, and the frequency of the other was controlled by the player moving one hand nearer to, or farther from a sensing plate. The difference between the frequencies of the fixed and the variable oscillator produced a tone capable of being shifted throughout the audio range. The volume was controlled by slight movements of the player's other hand. Because nothing was actually touched to produce the frequency and volume changes, the Theremin made a weird, gliding tone which could, in the hands of a skilled performer, be extremely effective. However, it could produce only one tone at a time, and the world of music had to await the development of much more sophisticated circuitry before true electronic musical instruments were developed.

Electronic Music Today. The modern electronic synthesizer came into being with the construction of a vacuum-tube monster with thousands of tubes and other components. Called the Mark I RCA Synthesizer, and built at Princeton, New Jersey, it was dismantled after several years of experimentation to supply parts for the Mark II. This machine is still in use, and though smaller than the Mark I, it measures about 17 feet square and 7 feet high. It is still in use in the Columbia-Princeton Music Center, in New York City.

In the early 1960s Robert Moog (pronounced like "vogue") began developing and producing a line of electronic music synthesizers which revolutionized music. Within the next few years several other firms began producing synthesizer equipment, and in the last several years the microminiaturization made possible by the development of integrated circuits has made possible synthesizers controlled by keyboards—so now real performance instruments exist.

The Nature of Music. Before describing the construction of our simple syn-

SIMPLE-SYN

thesizer, Simple-Syn, we should first examine the composition of its end product —the music itself. Musical instruments all produce sounds, which can be defined in terms of their *frequency* (also called pitch), *dynamics* (often described, inaccurately, as loudness), and *timbre.*

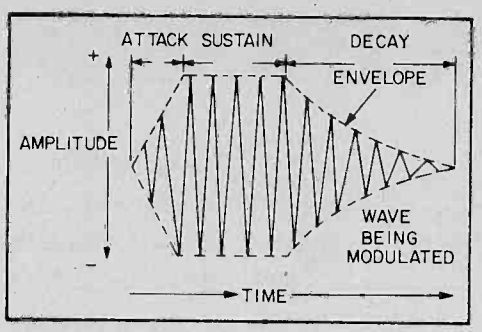
Timbre. This is the quality of sound that differentiates a trumpet from a violin when both are playing the same frequency. The timbre is the result of "secondary" frequencies (harmonics—also called "overtones") being present in the sound of the respective instruments. If there are many harmonics present, the sound is called bright. If there are only a few present, the sound is called dull or mellow.

These harmonics are *above* the basic pitch being played. The timbre of each instrument is different because each instrument has its own particular pattern of harmonics.

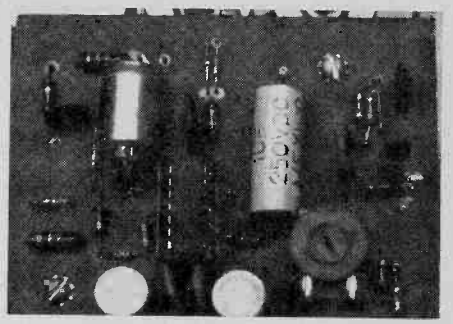
Assume both the violin and clarinet are playing the same pitch, A440. Then A440 would be called the fundamental. The first overtone has a pitch of 880 cycles per second (2x440); the second overtone has a frequency of 1320 cycles a second (3x440); the third overtone has 1760 cps (4x440) and so on.

The clarinet and violin have different overtones. The violin produces the fundamental and all the *odd* and *even* numbered overtones. The clarinet on the other hand produces the fundamental and the odd numbered overtones. The overtones are not as loud as the basic frequency and are therefore not recognized as the fundamental. The loudness of the higher numbered overtones decreases rapidly.

In other words, every instrument has its own set of overtones that make up its timbre. The two factors that account for the difference in timbre are: which overtones are present; and the relative strength of those overtones.



Typical musical note shows approximate areas of attack, sustain, and decay, Any or all of these may be much shorter or longer.



Closeup view of printed circuit board shows placement of the components. Be sure to use an IC socket for the IC.

There are four basic combinations of fundamental and overtones that are important in electronic music. These specific combinations are named: sine, triangle, square, and sawtooth. A sine wave is like a flute in quality.

A triangular wave consists of a fundamental and the odd numbered overtones. The overtones that produce the triangle wave are very weak in strength. The quality of the sound produced by a triangle waveform at an audible pitch is like a wooden recorder.

A square wave, like the triangular waveform, consists of the fundamental and the odd numbered overtones. The overtones that make up a square wave are more numerous and louder than the same overtones in the triangle. The square wave has a "hollow" sound to it, like a clarinet.

Lastly, the sawtooth waveform consists of the fundamental frequency and the even and odd numbered overtones. The sawtooth sound quality is very "bright" like a string or brass instrument.

Dynamics (loudness). Dynamics is the third property of sound. It has two important aspects. It includes *overall loudness,* which can vary from the rustle of leaves to the blast of a rocket. It also includes the changing ratios of sound as time passes.

For most musical sounds the loudness versus time characteristic may be broken into three parts:

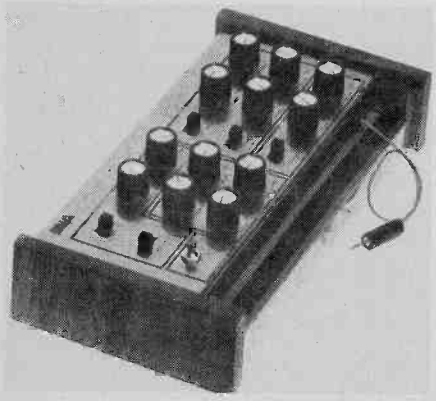
1. Attack time—the time period from silence to when the sound reaches its maximum loudness.
2. Sustain time—the period during which the sound is maintained at some loudness level.
3. Decay time—the period during which the sound fades away to silence.

The voice is an example of a sound that has flexible loudness. A sound from a voice can begin very quietly and increase in volume, then hold some volume level for a time, and finally decrease the loudness of sound until it is silent.

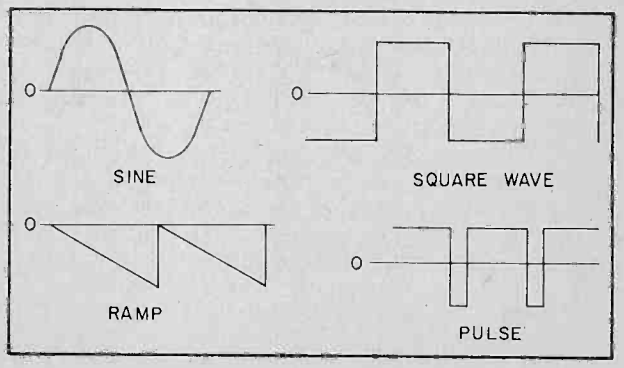
A graph of the variations in loudness in a typical sound is shown.

Two sine waves drawn in dotted lines are labeled "A" and "B." As you can see from the drawing, waveform "B" goes through two cycles in the time that it takes waveform "A" to complete a single cycle. Waveform "B" is therefore twice the frequency of "A" and is said to be the *first* harmonic of the *fundamental* frequency "A." If we draw another wave three times the frequency of "A" it will be the *second* harmonic, four times will be the *third* harmonic, and so on.

If at every point in time we sum together the amplitudes of waveform A and B the result is the waveform shown by the solid line. Note that while the new wave is shaped differently than



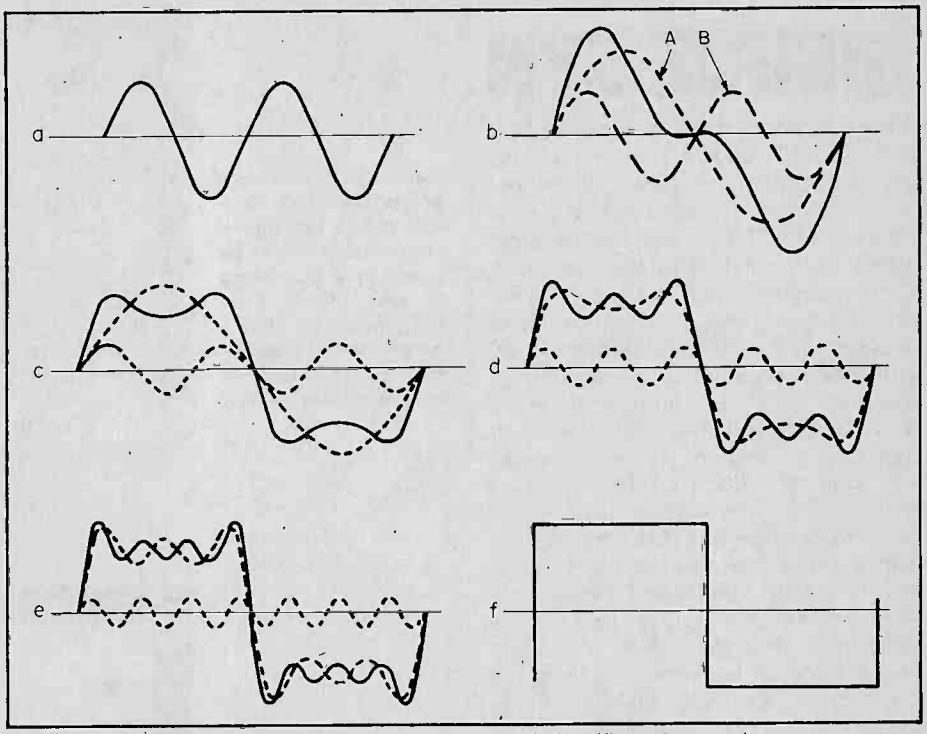
Small electronic musical instruments may be built from kits like this one from PAIA Electronics (address at end of article)



Musical tones may be generated by oscillators, making simple sine waves, or any of several other shapes. The most common of these are shown. Note that the frequency of each note is the same, but the timbre (sound quality) will be different, depending on the wave-shape.

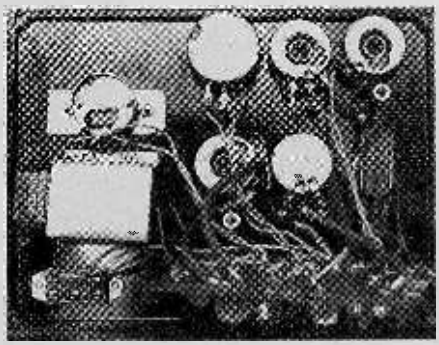
either A or B it has the same frequency (and consequently pitch) as the fundamental frequency A. If third, fourth, fifth and higher order harmonics were added into this wave the result would continue to change shape but the frequency would remain the same.

It is not necessary that every harmonic of a fundamental frequency be included in a wave and indeed the most musically interesting sounds have certain harmonics deleted. The square wave is a good example. It is difficult to imagine that the sharp-edged wave illustrated could be built up from smoothly changing sine waves, but it can, as shown in the progression of diagrams (a) through (e). In (b) the fundamental frequency is added to its third harmonic, producing the waveform shown by the solid line. In (d) the fifth harmonic has been added to the result of (b) to produce the new solid waveform and in (e) the seventh harmonic has been added to all the rest. You can see that the trend as higher order harmonics are added is to steepen the sides of the square and flatten and reduce the ripple in the top. When enough harmonics have been added the result will be a square wave. Notice in particular that not all harmonics are added together for a square wave, only the *odd* harmonics (3rd, 5th, 7th, etc.) are included.



Waveforms show how harmonics of sine wave, added sufficiently, can form square wave. At (b) the fundamental (A) and its first harmonic (B) add to produce shape (b). At (d) and (e) additional harmonics begin to approximate square wave. An infinite number of harmonics would make a perfect square wave, as in (f).

Making Waves. It is much easier to generate a complex ramp or square wave than a sine wave. Since synthesizers operate with harmonic-rich waveforms as their primary signal source there is no need to start out with a sine wave at all. The VCO's supplied with most synthesizers provide a variety of waveforms each of which provides different harmonic structures. Common practice is to use a relaxation oscillator to generate a voltage ramp which is then converted to triangle and pulse waves using simple shaping circuits. In some cases the triangle will also be shaped into a sine wave. These waveforms and their harmonic contents are listed in the Table.



Underside view of front panel shows printed circuit board in place, ready to be dropped into its case.

Building Blocks. Modern synthesizers are made up of one or more each of several different kinds of building blocks, just the way all component hi-fi systems include similar blocks (preamplifier, controls, power amplifier). These building blocks are mostly *oscillators, filters, envelope generators, mixers,* and *amplifiers.* Each circuit is itself fairly simple. When a number of them are connected together they can comprise a performer's synthesizer. To demonstrate the basic principles of the most important of these building blocks we are presenting Simple-Syn—a one-tone synthesizer which incorporates most of the principles needed for practical music synthesizers.

The simple synthesizer in this project shows how basic oscillators (tone generators) work, and how the frequencies they produce are modified to produce a wide variety of sounds.

Simple-Syn is capable of simulating many naturally-occurring sounds, as well as some unnatural ones. It will be useful as a demonstrator of the characteristics of sound, as well as a sound-effects machine for tape recordists. The output of Simple-Syn is sufficient to drive the *Aux* input of an amplifier or the *Line* input of a tape recorder. It may also be adapted to other uses, as will be discussed later.

Shown here is a diagram of a burst of sound. The time interval during which the sound's volume builds from zero to some reference level is called the *Attack* time, while the interval during which the sound remains at the reference level is called the *Sustain* time. Finally, the period during which the sound level decays exponentially back to zero is the *Decay* time.

As you can see, what we have here is an amplitude-modulated sine wave. Now suppose that this sine wave is replaced by some other periodic waveform of the same frequency but with a different waveshape. For instance, consider the ramp, square, and pulse waveforms shown. If you think that they will sound different from the sine wave, you're right. Although these waveforms all have the same frequency as the sine wave, they are aurally perceived as having different timbre.

An important characteristic of natural sound generators is that they filter the waveshapes of the sounds they generate. For example, the body of a violin and the horn of a trumpet are natural resonators which reinforce some frequencies, and attenuate others. The overall shape of a waveform is correlated with the relative amplitudes of its harmonics. So, if a harmonic-rich waveform is filtered, we will alter its shape, since some of its harmonics will be attenuated more than others. Thus, *filtering* produces changes in *timbre.*

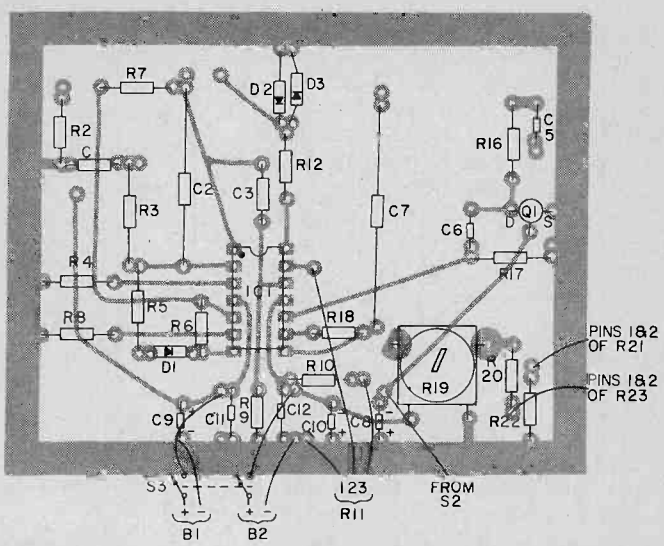
How the Circuit Works. Now let's turn

SIMPLE-SYN

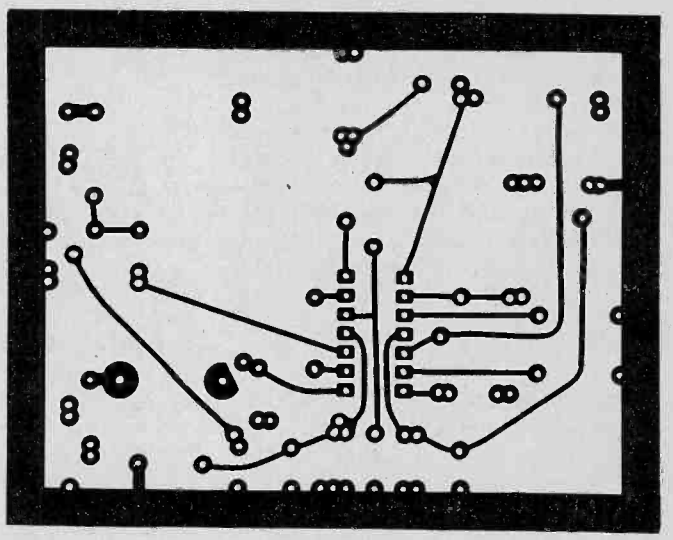
to the schematic of the synthesizer. Sections A and B of IC1 comprise a voltage-controlled ramp generator, whose control voltage is supplied by potentiometer R1. C1 bypasses contact noise generated by rotation of R1. Section A is an integrator, which when fed a constant positive input voltage, produces an output voltage that decreases linearly with time. Section B is a Schmitt trigger which senses the output of A. When A's output drops below some lower reference level, Section B's output drops low, causing current to flow through D1 and R5. This current flow is opposite to (and greater than) the current from R1 that passes through R3. Therefore, A's output is forced rapidly upward. When A's output rises above some upper reference level, B's output swings high, D1 ceases to conduct, and A's output can once again begin to linearly drop. Thus, the whole process repeats itself.

The ramp waveform is fed through C3 to section C, which acts as a comparator. By adusting the *Symmetry* control, R11, we can shift the reference level at which the comparator switches, and thus the ratio of "high" time to "low" time of the rectangular wave at C's output. This rectangular wave is clipped by D2 and D3. The ramp and rectangular waves are mixed in R13 and fed to volume control R15. Closing S1 connects C4 across R15, thus forming a low-pass filter. C5 couples the signal from R15 to the voltage divider formed by R16 and Q1, an N-channel JFET whose resistance decreases as its gate bias decreases.

Large synthesizer, the ARP 2600, has four-octave keyboard, three voltage-controlled oscillators which can produce tones from three Hertz up to 20 kHz. In addition to voltage-controlled oscillators, filters, etc., it includes a ring-modulator, two envelope generators and an envelope follower, a random noise generator, three voltage processors, and a reverberation unit.



Placement of the components on printed circuit board. Perf board construction may be used since placement is non-critical. Controls, however, should be positioned approximately as indicated, for manual convenience.



Printed circuit board layout for Simple-Syn is easy to make even if you haven't made one before. Radio Shack has inexpensive kits for boards.

Gate voltage for Q1 is developed across C8, which we can consider initially discharged with S2 in the position shown. Therefore, Q1's resistance is minimal and the audio signal at its drain is also minimal. Flipping S2 upwards causes C8 to gradually charge through R19, R20, and R21; consequently, Q1's resistance increases and so does the volume. Flipping S2 down again causes C8 to slowly discharge through R22 and R23, and the volume drops once again. Finally, the audio signal from Q1's drain is coupled by C6 to the buffer amplifier formed by section D of IC1.

Building Simple-Syn. Construction of the synthesizer is not critical. The best method would be to copy the printed circuit layout shown. The board is simple enough to be copied using one of the kits available at Radio Shack and elsewhere. My Simple-Syn was built in a plastic box but a metal case is recommended in order to eliminate hum-pick-up problems. The control layout shown in the photograph should be used. The completed printed circuit board will mount behind the control pots, with its foil side facing them, using 1¼-inch spacers.

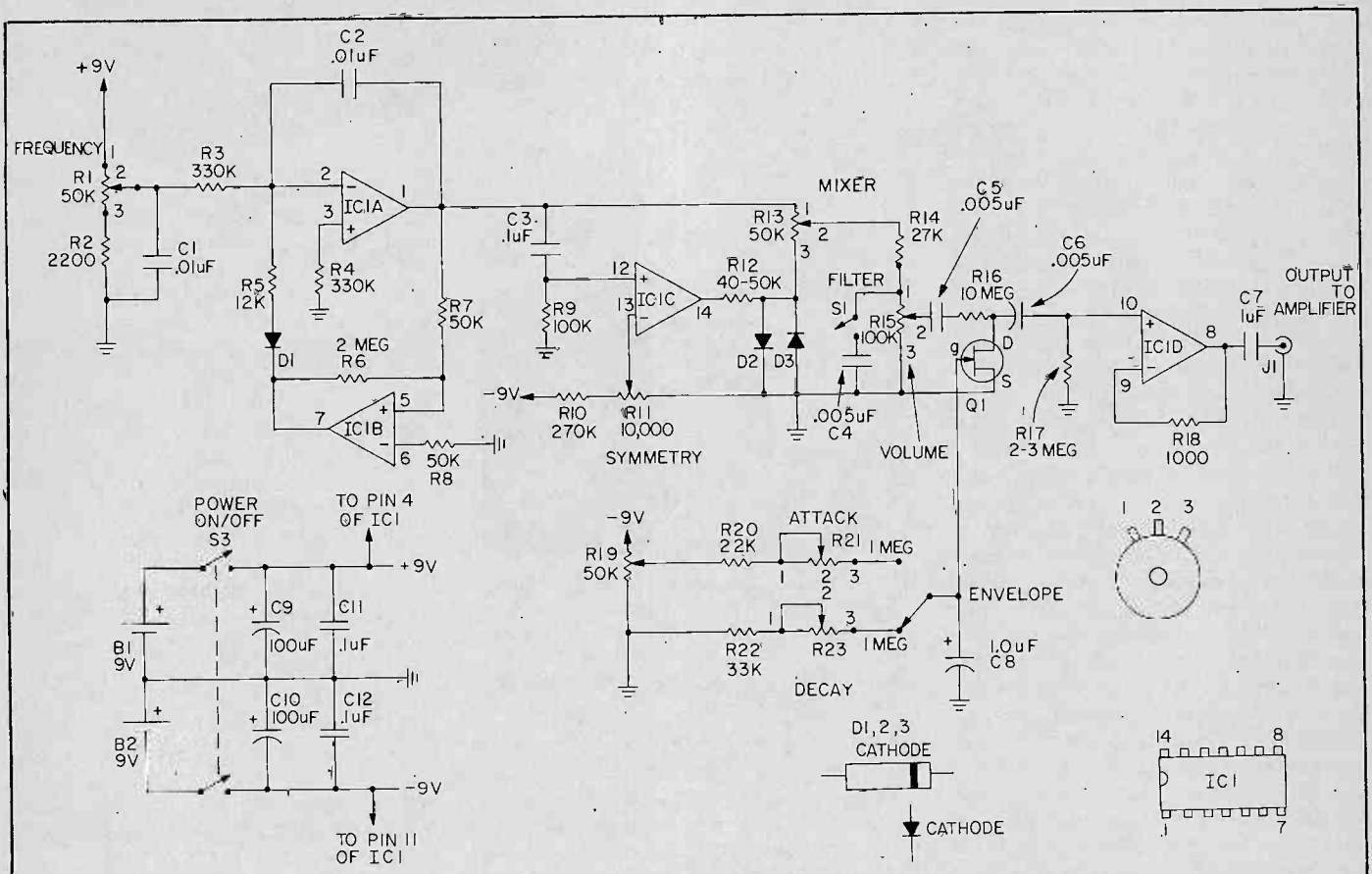
After you have fabricated the board, install the IC socket. The other components may be installed in any order, but solder Q1 last. Be sure to observe proper orientation of Q1, D1, D2, D3, C8, C9, and C10. Trimmer R19 used in my prototype was mounted horizontally. The two large upper pads connect to its wiper. If you use a vertical-mounting trimmer instead you will have to change the position of the pads to accommodate it. Finally, install IC1 in its socket and set the board aside temporarily.

Try to copy the construction of Simple-Syn's prototype cabinet as closely as possible. *Frequency control* R1 mounts in the upper-right-hand quad-

rant and is actuated by the largest knob. Directly below that pot is an aluminum bracket holding B1 and B2. Right below the bracket is *Power* switch S3.

The first row of controls on the left-hand side of the front cover contains R21, R23, and R11 (from left to right). The second row contains S2, R15, and R13. Below the second row are *Filter* switch S1 and *Output* jack J1. With this arrangement, the interconnecting wiring is shortest, and all components mount on the cover, which is convenient when batteries have to be changed. Incidentally, the battery drain is less than 2 ma., so the batteries will last a long time.

After you've located and drilled all holes in the front panel, including those for the spacers that mount the printed circuit, solder short lengths of #22 stranded wire to the appropriate lugs of the controls, then mount them. Six-inch lengths of wire will suffice. This is easier than mounting the controls and then trying to solder to the leads in close quarters. Note that R14 is not on the



PARTS LIST FOR SIMPLE-SYN TONE SYNTHESIZER

C1—.01-uF capacitor
C2—.01-uF mylar capacitor
C3, 11, 12—.1-uF capacitor
C4, 5, 6—.005-uF capacitor
C7—1.0-uF, 250-VDC capacitor
C8—1.0-uF tantalum capacitor
C9, 10—100-uF, 16 VDC electrolytic capacitor
D1, 2, 3—1N914 silicon diode
IC1—LM324 quad operational amplifier IC
Q1—2N3819 JFET (N-Junction field-effect transistor)
R1—50,000-ohm, audio taper potentiometer (Allied Electronics 854-7333 or equiv. See end of Parts List for Allied's address)
R2—2200-ohm, ½-watt resistor
R3, 4—330,000-ohm, ½-watt resistor
R5—12,000-ohm, ½-watt resistor
R6—1.8 to 2.2-megohm, ½-watt resistor
R7, 8—47,000 to 51,000-ohm, ½-watt resistor
R9—100,000-ohm, ½-watt resistor
R10—270,000-ohm, ½-watt resistor
R11—10,000-ohm, linear taper potentiometer
R12—39,000 to 47,000-ohm, ½-watt resistor
R13—50,000-ohm, linear taper potentiometer
R14—27,000-ohm, ½-watt resistor
R15—100,000-ohm, audio taper potentiometer
R16—10-megohm, ½-watt resistor
R17—2.2 to 3.3-megohm, ½-watt resistor
R18—1000-ohm, ½-watt resistor
R19—50,000-ohm, linear taper potentiometer
R20—22,000-ohm, ½-watt resistor
R21, 23—1-megohm, linear taper potentiometer
R22—33,000-ohm, ½-watt resistor
S1—SPST slide switch
S2—SPDT pushbutton switch
S3—DPDT slide switch
Misc.—knobs, cabinet (preferably metal); 9-VDC transistor radio batteries (2); battery clips; socket for IC1, wire, solder, etc.

Allied Electronics' address is 401 East 6th St., Ft. Worth, TX 76102.

Workbenches are alive with the sound of music—wherever Simple Syn is being built! When the first caveman whistled the first tune, who would have thought that just five million short years later such sweet music would be floating from an electronics filled box? Well, Cro-mag-non Man didn't have the editors of e/e backing him up. Today, you'll find that building a state-of-the-art music machine can be as simple as Do-Re-Mi following our PC board foil and component side layouts. You'll find dozens of uses for the Simple-Syn, especialy if you make tape recordings and are in need of special effects. Besides music, Simple-Syn can be used to imitate foghorns, sirens, whistles and can make eerie, creepy, wailing noises like from the soundtrack of a Grade B science-fiction movie of the Fifties. But, more to the point, Simple-Syn can be calibrated to produce some really outrageous music. Just calibrate the frequency control and the Simple-Syn can span more than three full octaves, a wider range than many popular singers of today command.

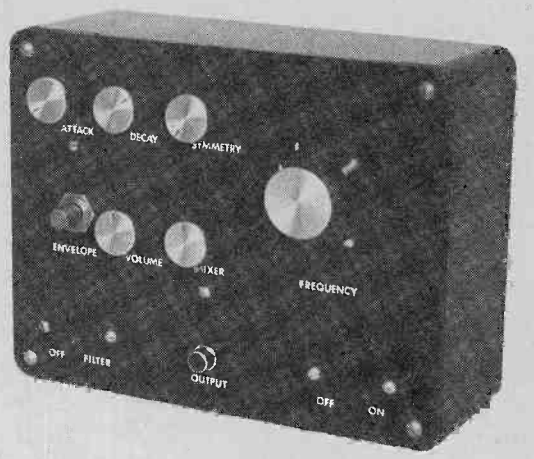
SIMPLE-SYN

circuit board—it mounts point-to-point between lug #2 of R14 and lug #1 of R15. Likewise, C4 is off the board, wired between S1 and R15 as the schematic indicates.

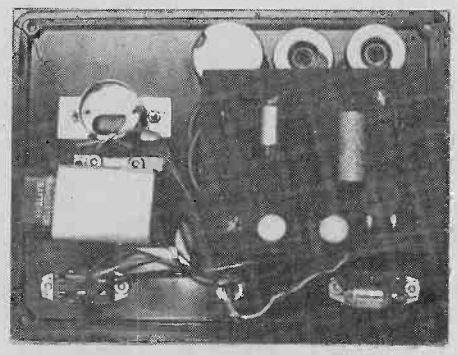
Position the front panel face down on a table, and next to it place the printed circuit board, foil side up. Connect the control leads to the pads indicated on the board by inserting each lead into the appropriate hole from the foil side and then soldering. Trim off the excess wire that protrudes from the component side of the board. When the connections have all been completed, mount the board foil side down behind the controls. All the wiring will now be underneath the board, and your project will not be cluttered by dangling wires.

Final Adjustment. When Simple-Syn is completed, only one adjustment must be made. Turn on the power and adjust R21 for minimum attack time, and then R15 for maximum volume. Press S2. Now turn R19 fully to the right, and then fully to the left. Leave it at whichever end provides a loud tone in your speaker (the opposite extreme should produce silence). Now turn R19 back until there is a just barely-noticeable diminishing of sound intensity. The correct position for R19 is anywhere between R19's present position and the position it was in previously. You will notice that the position of R19 affects the attack and decay times somewhat if you play with those controls. Choose a position for R19 (within the two bounds previously indicated) that produces the most pleasing attack and decay behavior.

Using Simple-Syn. If you make tape recordings, Simple-Syn can be used to imitate foghorns, train whistles, sirens, musical instruments, insect buzzes and hums, as well as surreal science-fiction-movie sounds. In conjunction with a small amp and loudspeaker it can provide realistic horn and whistle effects for a model railroad. You might use it to replace your humdrum doorbell with some really wild sounds. Finally, Simple-Syn can be used as a musical instrument. All that is necessary is that you calibrate the frequency control, perhaps using a pointer affixed to the frequency knob and a scale with the positions of the various notes marked on it. Simple-Syn spans more than three octaves, so the larger scale you use, the easier it will be to calibrate. Calibration is easiest with a frequency counter, but you can also tune it by ear, using a piano as reference. In addition, you can



Completed prototype shows layout of controls. If your cabinet is larger you should still stick to this physical layout, to keep internal leads as short as author did.



Here's what the author's prototype looks like inside. Everything mounts on the top panel, so the cabinet body is used just for support. If you use a metal cabinet (recommended) it will also serve to minimize possible hum pickup.

replace the 9V. batteries with 8.6V. mercury cells, since the frequency of the ramp generator is voltage-sensitive. Your calibration with mercury cells will stay accurate because, unlike zinc-carbon cells whose voltage decreases with age, a mercury cell's voltage remains quite constant throughout its useful life.

Final Remarks. A few final remarks about operation of the synthesizer might be helpful. First, the *Symmetry* control will have its maximum effect when the *Mixer* is rotated to yield a pure rectangular wave; its effect will be inaudible when *Mixer* is rotated to pure ramp. The effect of *Symmetry* and *Mixer* controls, which vary the harmonic structure of the output, will be most evident at low frequencies. This is because the important harmonics (all those up to about the thirtieth) of the higher frequency tones fall above 15 kHz. Beyond 15 kHz the human ear has a rapidly diminishing sensitivity. Thus, a high frequency ramp won't sound tremendously different from a high frequency rectangle because the human ear does not respond to all the important harmonics.

The effect of the *Filter* control will be to attenuate the higher harmonics of a waveform, and produce a more mellow sound. In most natural sounds decay time is longer than attack time. Try using a long attack time together with a very short decay time for a really strange effect. Finally, if you are feeding the synthesizer's output into your hi-fi system, be careful not to sustain a loud tone for too long a time. Home speaker systems can handle large amounts of power only on a transient basis; sustained operation at high power can burn out voice coils.

Learning More About Synthesizers. If you'd like to learn lots more about how today's practical electronic musical instruments work you can get an excellent booklet called the *Synthesizer Primer* by writing to Electronic Music Laboratories, Box H, Vernon, CT 06066. If you're interested in knowing more about their extensive line of Synthesizers, say so, and they'll send you literature and prices, as well as a fascinating 7-inch phonograph disc of five short selections performed on EML synthesizers.

Another good source of information on the subject is PAIA Electronics, Inc., Box 14359, Oklahoma City, OK 73114, the makers of a wide variety of kits for synthesizers and allied instruments. They have several very interesting low-cost modules for producing all sorts of sounds, including wind, surf, chimes, in addition to musical and other sounds. The PAIA "Gnome" micro-synthesizer produces many sounds, such as winds and flutes. Gnome kit costs $48.95. For more information circle number 71 on the Reader Service coupon.

If you're into really heavy performing instruments you can look over the state-of-the-art models being sold by ARP Instruments, 45 Hartwell Ave., Lexington, MA 02173. ARP will send you a record demonstrating the sounds of the ARP Omni, which they call the world's first symphonic electronic keyboard, for $1.00. Moog and Buchla synthesizers are also still being produced, and are available in many music stores. ■

LONE RANGER LIGHT METER

LED readout saves meter cost, and is more rugged too.

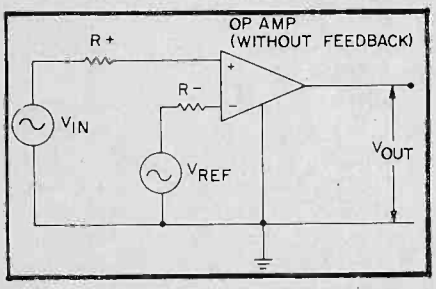
by Walter Sikonowiz

☐ Lone Ranger is a photographic light measuring instrument without the usual (needle-and-scale) mechanical meter. Instead, it uses light-emitting diodes (LEDs for short) to tell you what lens opening to use. In addition to cutting the cost by more than 50 percent, eliminating the meter has other advantages. The chance of damage from dropping is much less. People with no knowledge of photography can easily use this exposure indicator once taught the significance of the displays.

Finally, because the readout is on LEDs, it's always easy to see, even in low light where an ordinary meter's needle might be hard to read accurately.

This comparator-LED light meter is ideal for the serious beginning or intermediate photographer because most people shoot with the same speed film most of the time. And if you do use two or three different speed films, it's easy to apply a conversion factor to the Lone-Ranger's lens-opening scale.

It's a one-speed-range photographic light meter which tells you at what f-stop diaphragm opening to set your 35 mm or other precision camera lens. It provides readings for setting your camera lens opening between f-stops as large as 2.8 and as small as 32. These are based on the most popular black-and-white film for 35 mm use, Plus-X, a widely available fine-grain film.



Operational amplifier without feedback has extremely high gain. It can be used to compare an input signal voltage (unknown) with a known (reference) voltage, and indicate clearly (by its output's going to saturation, or by staying at its initial (very low) voltage that the unknown voltage is either below or above the reference voltage. This makes it a "comparator."

Photo Basics. First before showing how the meter works, let's review some basic photography. The photographer is concerned with three numbers when making an exposure: 1) the ASA rating (the speed) of his film, 2) the f-stop of the lens aperture, and 3) the speed of the shutter. Let's see how these factors interrelate. Suppose you take a correctly-exposed picture under light of intensity **I**, with f-stop **n** and exposure time equal to **T**. If the intensity suddenly jumps to **2I**, you must compensate by either reducing the aperture (multiplying the f-stop by 1.4) or by reducing the exposure time by half—**T/2.** And if the light intensity is reduced by half you would compensate either by making the f-stop 1.4 times larger, or by increasing the exposure time to **2T.** This assumes, naturally, that the film's speed (ASA) remains constant.

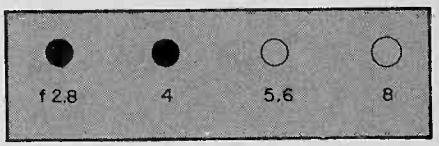
Now suppose that a correctly-exposed photograph is made under light of intensity **I,** with f-stop = **n,** and exposure time = **T.** To take the same picture with a film whose ASA rating is twice that of the original, you'd compensate by making the f-stop = **1.4 n** or by making the exposure time = **T/2.** To take the same picture with a film whose ASA rating is half that of the original film, make the f-stop = **n/1.4,** or make exposure time = **2T.** Now let's look at an electronic circuit to measure the ambient light.

Use a High-Gain Amplifier. Suppose we take a high-gain differential amp and place a known voltage on one input, an unknown on the other. Since we're using the amp open-loop (without the usual feedback), only a small voltage difference at the two inputs is required to send the output either to saturation, or to cut-off. Specifically, if the voltage at the non-inverting (+) input is a few millivolts greater than that on the inverting (—) input, the output will go high. Likewise, if the voltage on the inverting input is the greater, the output will go low.

There are limitations to the size of the voltages which may be compared. For the LM339, input voltages should be less than supply voltage (V)— 1.5V. Furthermore, these input voltages should be much greater in magnitude than a few millivolts, to swamp out measurement errors due to the inherently imperfect nature of the comparator itself. Between these extremes a comparator can give a very accurate answer to the question, "Is the unknown voltage above or below the reference voltage?"

The LM339 incorporates four comparators on a single chip. If one input of each comparator reads some common, unknown, voltage, while the other four inputs connect to different reference levels, then the size of the unknown voltage can be estimated by observing the output states of the comparators.

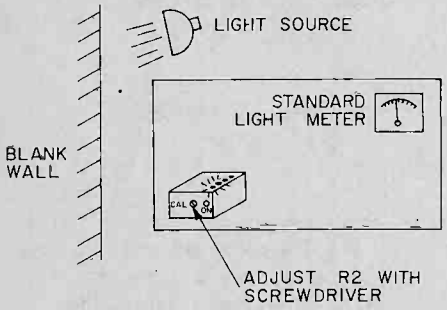
Figure 1 shows the LM339 as the



This is the way the LED readout of the Lone Ranger would look if the amount of light being measured was enough for a camera opening of F-stop 5.6. The two LEDs at the left are dark, the two on the right are lit up.

LONE RANGER LIGHT

heart of a light meter. All the inverting inputs go to the junction of PC1 and R1, and thus sense a voltage whose magnitude increases as the intensity of the light being measured increases. C2 bypasses any interference caused by fluorescent lighting in the vicinity. The non-inverting input of each comparator goes to a reference voltage,



This is the setup you use to calibrate the Lone Ranger light meter. You'll need to borrow an old-fashioned (analog) light meter for this procedure.

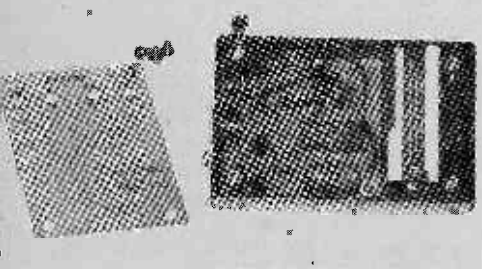
with section A connected to the lowest reference voltage and section D to the highest. Consequently, in very dim light all four comparator outputs will be at cutoff, hence all four LEDs will be extinguished.

As the light intensity increases, section A will be the first to change state (rise toward saturation) and thus cause LED1 to light. At higher intensities LED1 and LED2 will both be turned *On*. The reference voltages I used were chosen to correspond to differences in lens aperture of one f/stop. Thus, a display like the one shown here would indicate that the correct photographic exposure is between f/4 and f/5.6.

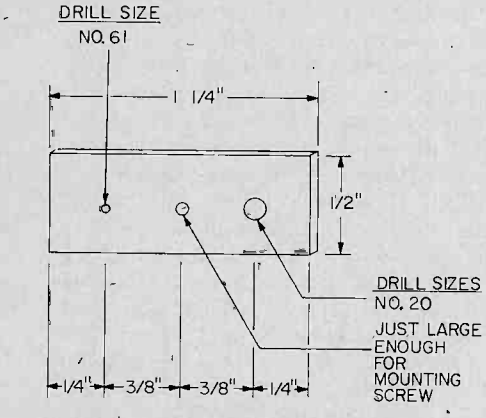
Extending the Meter's Range. Notice that in contrast to the continuous readout of an analog meter, this comparator system of voltage measurement indicates proper exposure as being between two levels. In order to get better resolution (more detailed information as to lens opening) we would need more comparators. We would also need more comparators if a larger measurement range is desired. To accomplish such a range expansion we could add another LM339—inputs 4, 6, 8, and 10 would go to the junction of PC1 and R1, while pins 5, 7, 9, and 11 would go to new (added) reference voltages. However, there is a cheaper method of range expansion. We simply install a variable aperture in front of the photocell. In this way the measurement range of the photometer is doubled to 8 stops, by using two apertures whose areas are in the ratio of 16:1. This is the scheme I adopted for Lone Ranger.

The total measuring range of this instrument thus spans from f/2.8 to f/32 with ASA 125 film (such as Plus-X) at a shutter speed of 1/30th second. Later on we'll discuss the simple mathematical conversion necessary to allow use of the light meter with different film speeds and different exposure times.

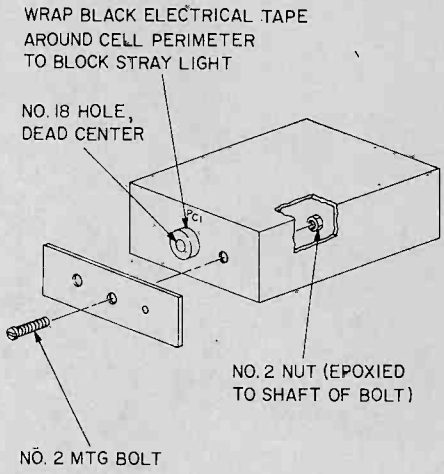
Building Lone Ranger. Actual construction of the Lone Ranger meter is non-critical, but will require some care because of its small size. A printed circuit board was used in my Lone Ranger prototype, and although it is not necessary that you use the printed circuit, it would be wise to copy the same general layout as the prototype. My Lone Ranger is housed in a 3¼ x 2⅛ x 1⅛-inch plastic minibox. If you use the same box, note that the mounting post in the upper-right-hand corner must be removed to make room for S1. A soldering gun with a cutting tip was used to slice out the mounting post, leaving three posts to hold down the metal cover of the box. If you are inexperienced in small-scale construction, by all means use a larger box. Regardless of the box size used, however, the following construction details given will still apply.



Here's how author's Lone Ranger looks inside. To keep it small, make a printed circuit board like his. Perf board is OK too, but requires bigger box.



Dimensions of the range-extender for Lone Ranger are shown above. It's a simple piece of aluminum with two different-size holes in it. The middle hole is for mounting the strip to the front of Lone Ranger.

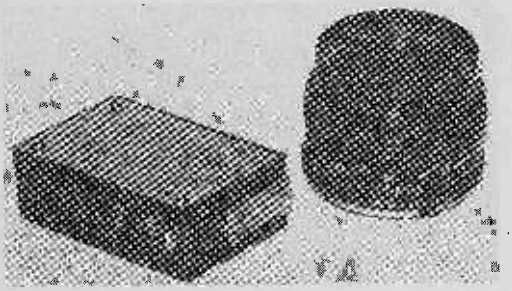


Here are the details for mounting the range extender to the front of the case, and for taping around the photocell to keep it from receiving stray light which can cause misreading of the ambient light.

When the board has been completed, mount the IC socket, trimmer R2, and all resistors and capacitors. Next, solder the negative lead from the battery clip to its hole near pin 12 of the IC socket. Solder a 2-in. length of flexible wire to the hole indicated in the upper-right-hand corner of the board. This wire will later be connected to S1. Now mount the photocell so that its light-sensitive face is perpendicular to the board and facing toward its upper border. Finally, mount the four LEDs into the circuit board, but be sure to observe proper orientation. The tops of the LEDs should all extend the same distance above the board—about ⅞-in. if you have a cabinet of the same depth. Now plug IC1 into its socket and set the board aside temporarily.

The range selector is just a simple aluminum plate (about 18 gauge) with the dimensions shown in the diagram. Note that two holes, one #20 and one #61, must be *carefully* drilled. Further note that the plate must be absolutely flat. Don't cut it out with tin snips. Use a nibbling tool or hacksaw, which will cut the aluminum without distorting it. Now use a file to round off all the edges, and then buff it with steel wool. This will make the range selector rotate readily when you're out shooting.

More On Construction. The drawing of the cabinet shows how to mount the photocell relative to the range selector. When the proper holes have been drilled, mount the range selector with #2 hardware and tighten until the fit is just snug. Use a drop of epoxy to



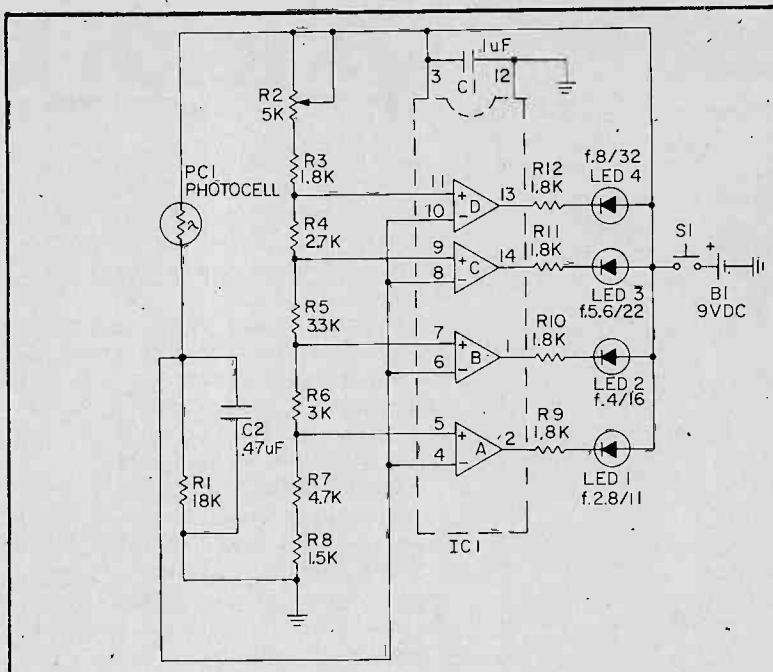
Lone Ranger light meter is about the size of a good lens, as shown here (Pentax Rokkor f=1.7, 50 mm).

lock the nut to the shaft of the bolt, and let the cement dry.

S1 may be placed wherever it is convenient. Be sure to drill a hole to allow calibration-adjustment of trimmer R2 from the outside. Now locate and drill four holes in the cover to allow the LEDs to be visible. The exact location of these holes will depend upon the dimensions of your case and the dimensions of your board. Simply insert the board into the bottom of the box and measure how far from the sides each LED's center is located. Transfer these dimensions to the cover and drill four #22 holes.

Mount the board in the cabinet so that the photocell lies directly behind and flush against its mounting hole. If you used the same size box as I did the ¼-in. spacers will be needed between the board and the bottom of the case to allow the LEDs to protrude slightly through the thin metal cover. After the board has been securely mounted, take a ¼-in. wide, 1½-in.-long strip of black electrical tape and wrap it around the perimeter of the

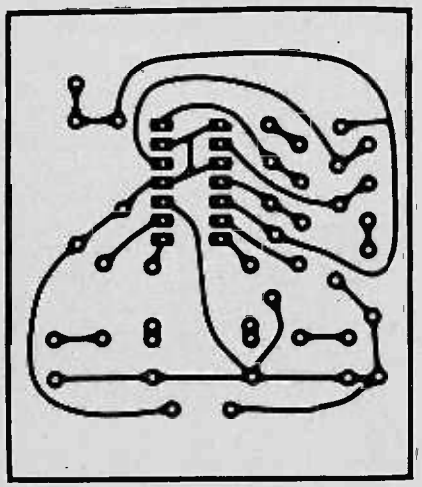
(Continued on page 101)



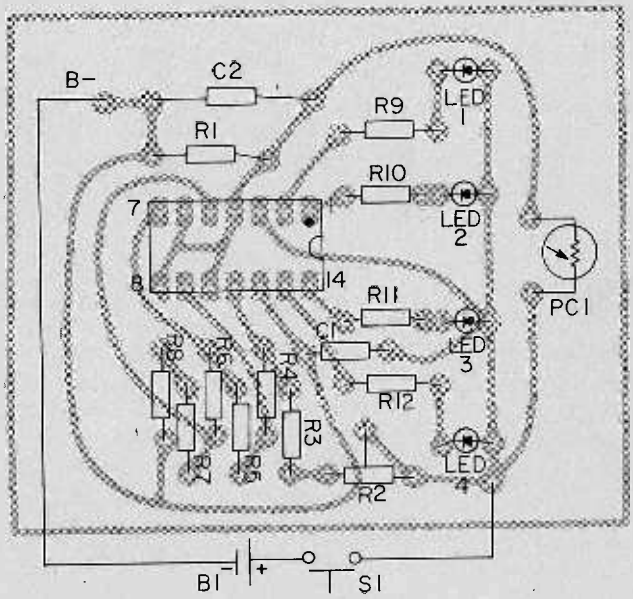
LONE RANGER PARTS LIST

C1—.1-uF capacitor
C2—.47-uF capacitor
IC1—Quad comparator integrated circuit LM 339
LED1, 2, 3, 4—Light-emitting diodes
PC1—Cadmium sulfide photocell
R1—18,000-ohm, ½-watt resistor
R2—5,000-ohm potentiometer, printed circuit board-mounting
R3, 9, 10, 11, 12—1800-ohm, ½-watt resistor
R4—2700-ohm, ½-watt resistor
R5—3300-ohm, ½-watt resistor
R6—3000-ohm, ½-watt resistor
R7—4700-ohm, ½-watt resistor
R8—1500-ohm, ½-watt resistor
S1—SPST momentary on switch
Misc.—Minibox 3¼-in. x 2⅛-in. x 1⅝-in. (or larger), socket for IC1, 9-VDC transistor radio battery, clip for battery, wire solder, printed circuit board kit, etc.

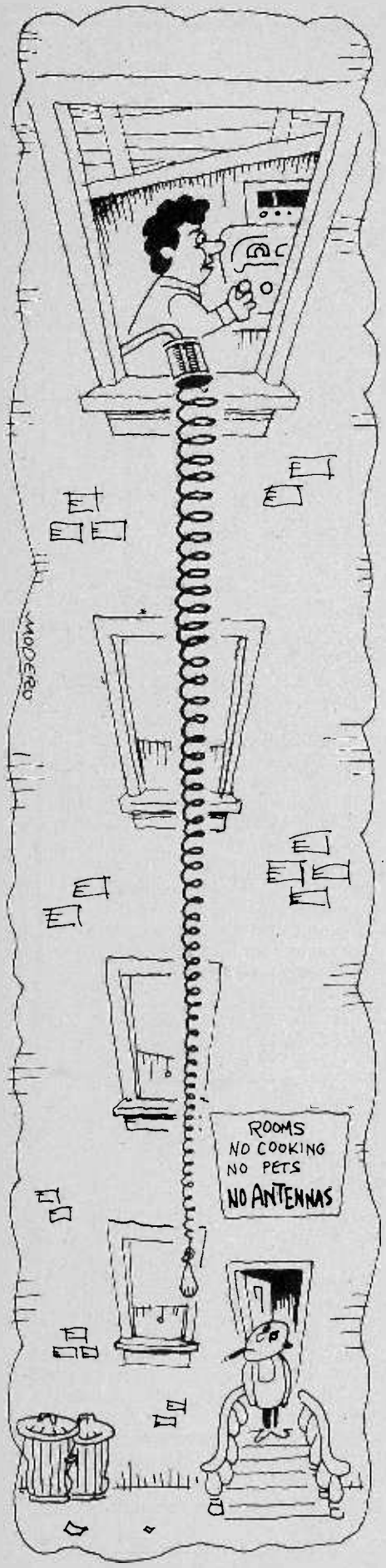
A light meter without the meter. Sure enough, Pardner, if it's the Lone Ranger you're talking about. The circuit enables you to build a meterless light meter to solve your F-stop woes. The Lone Ranger uses Light Emitting Diodes to tell its story, rather than an all too breakable meter. It's absolutely great for the beginning and intermediate shutterbug to use for great picture results. Next time someone asks you, "Who was that masked meter?" you'll know it was the Lone Ranger!



This is a full-size template for the printed circuit board, if you want to make yours just like the author's. See the text for suggestions on making printed circuit boards if this is your first.



Placement of parts on Lone Ranger's printed circuit board. If you use perf board instead you can put the parts wherever you want, but you'll find this general arrangement most convenient.



DX with BOINGER

IF YOU'RE an apartment-dwelling DXer, you've no doubt had your share of the age-old antenna hassle. Sad to say, few landlords sympathize with a shortwave listener's need for a good skyhook.

For those of you whose nerves are just about shot from the continual carping about your antenna (". . . that confounded wire of yours was crudding-up Kung Fu last night!"), the "Boinger" will bring fast relief.

What's The Boinger. Simply put, it's an inconspicuous *canned* antenna that'll sit on your windowsill, drawing about as much attention as yesterday's newspaper. Fact is, people just don't notice this little marvel. That's the beauty of it! But at the push of a button, this DX-dangler literally springs into action for you, as it accordions out to a fully-expanded shortwave longwire antenna. "Boinger" will be music to your ears. That's the sound made by the key to this antenna, a super-long spring. And as it unravels, it'll also unravel your aerial problems. And when you're ready to call it quits for an evening, just a few turns of the crank retracts the Boinger back into the hardly-noticeable case, ready for another day. It's been suggested we call this unit the "Candestine" (clandestine can antenna), since it does incorporate a bit of the old cloak-and-dagger. Call it what you may, it works in even the most impossible antenna conditions.

How It Works. Our Boinger is essentially an end-fed helically-wound longwire. The only big difference between it and the longwire most SWLs use is that it is vertically-oriented.

How do you find helically-wound wire? Believe it or not, the first place to check is in Junior's toy-box! Or, head for the local five-and-ten and ask for "the spring that walks down stairs by itself." Right—a "Slinky!"

Since the coil is vertical, gravity will help pull it down for you. Rigging it to a fishing reel will take care of pulling it back up again. You don't have to be 20 stories up to take advantage of this antenna since the helical winding allows you to pack tremendous wire length into a short distance.

How To Build It. You'll need the following items, all of which shouldn't run more than $6 to $10:

Slinky. Actually it's a highly stretchable coil which folds down to only a few inches, but can stretch clear across the street.

Tin can to house the spring, about four-inches in diameter by five-inches deep. A salted peanut tin is perfect.

Some odds and ends from your fishing gear—a handful of lead weights, and a fishing reel with heavy-duty line. Now don't panic, the cheapest reel available will do. We've seen, and *used* in our own Boinger, a plastic reel that goes

Canning Slinky after it is fixed to a wood insulating block. Here author is checking clearance of block and Slinky from can's inside.

If you decide to solder the leadin wire to Slinky, use an X-rated iron—something that really gets hot. Slinky can draw away lots of heat before the solder flows.

Here's how you can lick the no-antenna-on-the-roof edict landlords use to torture SWLers—by Ralph W. Perry

for about $3.

½-in. conduit pipe cut to the length you need. Aluminum electrical conduit is easy to bend, and you'll need a screw-end adaptor to secure it to the can. If you use iron pipe, it can be threaded at the can end, but it's hard to bend. However, elbow pieces are available. Look at ½-in. copper tubing. It's easy to work with and can be soldered to the tin can.

Miscellaneous hardware: clamps, screws, and a piece of ½-inch-thick wood to fit in the can.

Construction. Solder an insulated leadin wire to the top end of the Slinky coil—or secure it with a machine screw. Any way you do it is okay so long as it's mechanically secure. Be sure not to let the antenna leadin wire contact the can or the conduit.

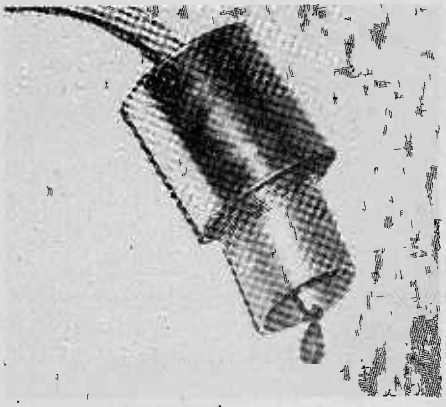
The conduit pipe serves double-duty in the Boinger. It is both the support for the unit and the feeder channel for the fishing line that controls the antenna's ups-and-downs. Bend the pipe into a flattened-out Z, with the center strut at right angles to the ends. Then, lay the pipe down flat and bend one end so it points straight up.

Put the wood-coil assembly into the can, and drill a hole through both, big enough for the pipe to fit through. Slip the end of the pipe (the end you made the last bend in) through the hole in the top of the can and through the wood, clamping both below and above with epoxy glue or threaded pipe and nut so it is solidly joined. Slip the wire through a hole in the can top, and tape it along the length of the pipe. It's a good idea to liberally apply putty or silicone sealer to the can top to seal the cracks—the Boinger will withstand some pretty rough weather.

Now, thread the fishing line into the far end of the pipe and pull it through the coil. Make a cross-hatch with two wires across the *bottom* loop of the Slinky (opposite end from the solder), and tie the fishing line, along with a few weights, here.

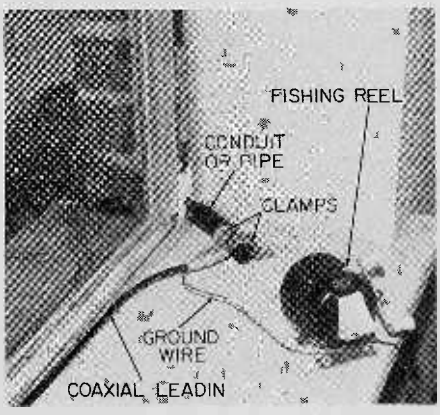
Mount the fishing reel on your inside window sill, and bolt the pipe to the outside wall. Depending upon the type of window, you may have to cut a small piece of glass out of the corner to feed the pipe through. We found that closing the window on the pipe and then trimming a wooden "stopper" to size for the crack is one good way.

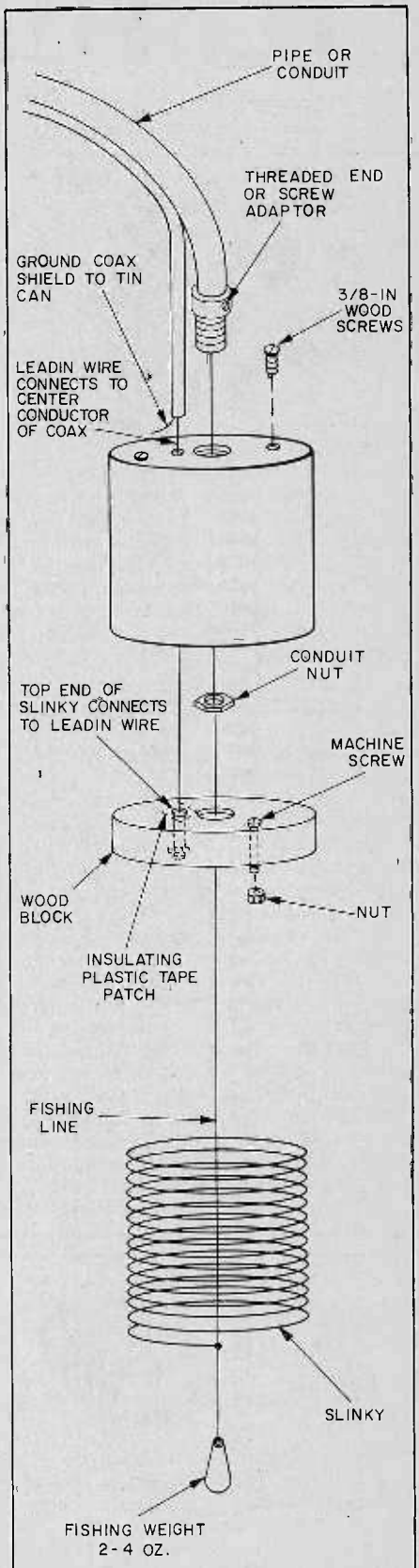
Attach the leadin wire to your receiver and let out some line on the reel. *Boing!* Gravity and the weights will stretch out your mini-antenna as far as you need. When you're finished, the coil will reel up and fit neatly in the can. Paint it a dull black, draw as little attention as possible when you install it and, believe it or not, you'll be surprised when nobody notices all the trouble you've gone to! ■



Boinger is finished and ready for installation. Outside world look out! A coat of black paint will keep down reflections and neighbor's questions. Keep in mind the SWLer's code, "Out of sight, out of mind!"

The finished setup may look a bit weird to the SWL's XYL, but that is the price she must pay to keep the OM at home evenings. Heavy wire running left and down is a shielded coax cable used as the leadin, and thinner wire running left is ground lead.

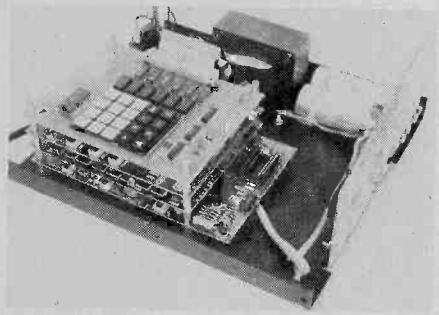




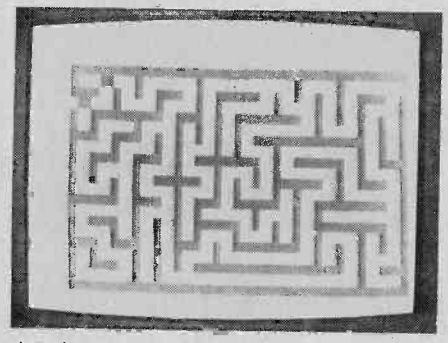
We blew up Boinger so you could put it together. Electrical connection of Slinky to antenna leadin wire should be insulated from tin can and pipe or conduit.

COMPUTER NEW PRODUCTS

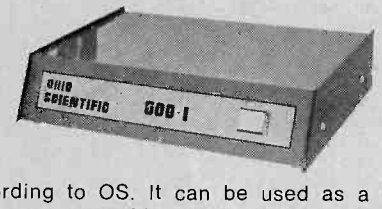
Here in one place ELECTRONICS HOBBIEST presents the latest in home and hobby computers and computer accessories.



Z80-Based Microcomputer System—Martin Research offers the Mike 8, a Z80-based system that is the newest entry in the firm's Modular Micro series of compact (5½-inch x 7-inch) microcomputer boards. The Model 882 system comes with 4K of RAM, a 1K Monitor program in a PROM, the CPU board, and a console board which has a calculator-type keyboard and six LED digits. The Monitor allows the user to enter and execute programs via the console, and offers advanced debug features, including RAM test, single-stepping, and setting traps. The system includes a PROM programmer, so the user can permanently store his programs in a blank 2708 PROM (included). An ultraviolet lamp is supplied for erasing PROMs. Model 882 is mounted on a base with its own switching-regulated power supply. The $895 price, says Martin, brings features comparable with those of small development systems costing as much as $1,495. An extra bonus is said to be the Z80's extended instruction set which includes the 78 Intel 8080 opcodes, plus 80 more. Smaller Z80 systems are offered by Martin Research at prices starting at $495. Circle 58 on Reader Service Coupon for information.



Four New Game Cartridges—Fairchild Camera and Instrument is offering four new plug-in cartridges for its programmable, computer-based video game system. Videocart 8/Magic Numbers pits the player's brains against the computer in two games of logic and deduction. In Mind Reader the player tries to guess an unknown, randomly selected number through a process of elimination. Nim involves the removal of numbers from number groups, the object being to win by removing the last number from the screen. Videocart 9/Drag Strip reproduces the drama of a professional car race, according to Fairchild. Videocart 10/Maze incorporates 52 game variations based on the idea of getting two mice out of a maze. Videocart 12/Baseball is a video game version of the classic sport. Videocart cartridges incorporate programmed semiconductor memory that functions with the system console's microcomputer to increase versatility. They have a suggested retail price of $19.95. Circle 55 on Reader Service Coupon for more information about this product and others by Fairchild Camera



Computer That Thinks in BASIC—Ohio Scientific's new model 500 computer has full mini-computer BASIC in ROM and a minimum of 4K RAM for user programs. The Model 500 can be used for short or medium-sized programs in BASIC while its immediate mode is an "ultra-powerful" scientific calculator according to OS. It can be used as a stand-alone computer or as the CPU in a larger system. The board accepts 8K of ROM, 4K of RAM, 750 bytes of PROM, an ACIA based serial port, a 6502 processor, and full buffering for expansion. Model 500 is available completely assembled with 8K BASIC in ROM for $298. By simply adding a terminal and power supply, the user has a complete system which will accept up to 200 lines of BASIC program without expansion. The board requires +5 volts at 2 amps, −9 volts at 500 ma, an external reset switch, and an ASCII serial terminal for operation. Model 500-1 ($429) is a fully enclosed 500 board with power supply, reset switch, and two 25-pin EIA standard terminal connectors for loop through operation. Model 500-8 ($629) is a 500 board in an 8-slot Challenger case allowing seven slots for expansion; the unit has a heavy-duty power supply. Circle 60 on Reader Service Coupon for more information about this product and others from Ohio Scientific.

8-Bit Digital Computer Kit—Heath Company's new line of personal computing products is designed around this H8 computer and an H11 unit. The H8 is an 8-bit computer based on the 8080A microprocessor, and features a built-in 1K x 8 Read Only Memory (ROM) containing a monitor program for controlling the front panel and load-dump operations. The H8 cabinet is configured for 32K of memory with a total capacity of 65K of addressable memory. An intelligent front panel with 9-digit, 7-segment octal display and keyboard allows considerable control. Register and memory contents can be dynamically displayed while programs are running. A 16-digit keyboard allows quick, accurate entry of data. A built-in programmable speaker makes possible a wide variety of special effects and LED status lights permit operator-monitoring of important machine states. The bus design is a 10-slot mother board type that utilizes 50-pin connectors for low cost expansion capability. The PC board construction eases assembly and provides well-buffered, clean digital signals, according to Heath. The built-in convection-cooled power supply can handle up to 32K of memory and two I/O interfaces. Mail order price, including a fully wired and tested CPU and complete assembly and operations documentation as well as all systems software in audio cassette form, is $375. Accessories: 8K board with 4K static RAM, $140; 4K expansion chip set, $95; serial I/O interface board with 1200 baud audio casette interface, $110; 3-port parallel interface, $150. Circle 31 on Reader Service Coupon.

16-Bit Digital Computer Kit—Heath's top-of-the-line computer, in kit form, is this H11 Digital Computer which utilizes the Digital Equipment Corp. (DEC) LSI-11 microcomputer module (KD11-F) that fea-

(Continued on page 101)

CB NEW PRODUCTS

Electronics Hobbyist looks over some of the newest transceivers, antennas and accessories for you to use in CB contacts this year!

40-Channel Rig

Just introduced by Radio Shack is their new top-of-the-line 40 channel mobile Citizens Band two-way radio, the Realistic TRC-424. The TRC-424 features phase lock loop (PLL) circuitry for full 40-channel operation with superior frequency stability, and an automatic modulation gain control circuit for full, 100% modulation without the need for a power mike. Rated 4 watts maximum RF power output. Other features include an RF gain control for adjusting receiver sensi-

CIRCLE 32 ON READER SERVICE COUPON

tivity, delta-fine tuning to help pull in off-frequency stations, switchable noise blanker, large LED digital readout for easy channel selection, RF/S meter and provisions for use as a public address system with an external speaker. Operates on 12 VDC, positive or negative ground. The Realistic TRC-424 40-channel CB transceiver, complete with mounting bracket and detachable mike, is priced at $169.95. Realistic CB equipment is available exclusively from more than 5000 Radio Shack stores and dealers in all 50 states and Canada.

Modular 40-Channel CB

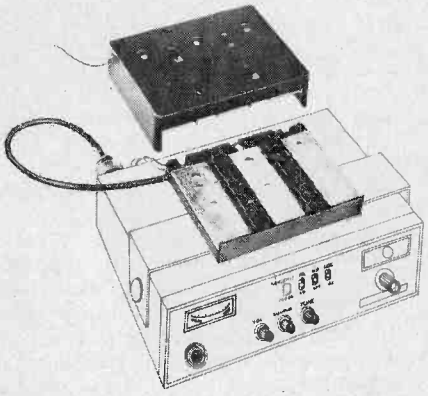
The Midland Model 77-955 is a 3 component, compact system which includes the control head, microphone with remote controls and CB circuit black box. The control head conveniently mounts on an adjustable bracket and is small enough to fit in a glove compartment. Controls include signal/power meter, TX light, P.A./external CB switch, 40-channel dial and power switch. The multi-function microphone has push-to-talk bar,

CIRCLE 65 ON READER SERVICE COUPON

volume and squelch controls. The CB circuit black box installs in the trunk, under the seat or on the firewall with a 20-foot aircraft-quality multiconductor cable included. Midland's Model 77-955 is rated for maximum 4.0 watt output power. The dual conversion superheterodyne receiver has tuned RF stage, automatic gain control and built-in automatic noise limiter. The new unit operates on 12-volt DC, positive or negative ground. Suggested retail price is $274.95. For all the facts on the Model 77-955 and other CB products, write to Midland, Communication Division, P.O. Box 1903, Kansas City, MO 64141.

Magnetic CB Mount

A unique concept utilizes magnetic power to automatically hold a CB transceiver in place and provides a quick connect/disconnect system for both antenna and power, allowing instant, easy removal of the radio to prevent theft. Designed by Cornell-Dubilier Electronics, the Easy Mount uses three powerful permanent magnets to make positive contact, assuring maximum signal transfer with perfect VSWR match. Ordinary slide brackets use flexible metal strips which



CIRCLE 59 ON READER SERVICE COUPON

can easily bend and wear to produce mismatch, causing loss of signal or may even blow the RF output stage of a transceiver. Installation is extremely simple and gives a neat, flush mount appearance. The user has a choice of installing Easy Mount under the dash or on the transmission hump. All necessary hardware and detailed instructions are included. Additional optional top sections are available to allow the user to instantly transfer the transceiver from vehicle to vehicle or to a boat, trailer, office, or home. Sells for $24.95. For additional information, write to Cornell-Dubilier Electronics, 150 Avenue L, Newark, NJ 07101.

Magnetic Mount Sky Hook

A magnetic mount CB antenna by GC Electronics, nicknamed the Li'l Beaver, is a 23-in. high antenna and fully assembled

CIRCLE 54 ON READER SERVICE COUPON

with 17-ft. coax cable and connector. It features a high-Q center loading coil and is suitable for 23 or 40 channel use. The Li'l Beaver attaches easily to roof or trunk, even vinyl roofs. While it is easily removeable for storage or security, it stays put—even at speeds well over 55 mph. Because of its spring-loaded construction, the Li'l Beaver bounces right back from a 90° bend, even after hitting a low-hanging branch or garage. It is also weatherproof, and tunable with the supplied allen wrench. Sells for $19.09. For more information, write to GC Electronics, 400 South Wyman, Rockford, IL 61101.

Stops Ignition Interference

The new Cornell-Dubilier Electronics noise filter CBFT315D corrects the problem of transceiver noise interference by reducing both radiated and conducted noise originating from the ignition coil/point assembly. Designated as an ignition coil/point filter, the unit mounts directly onto the ignition coil with no additional parts, nuts, or bolts. In fact, the installation is accomplished in

CIRCLE 59 ON READER SERVICE COUPON

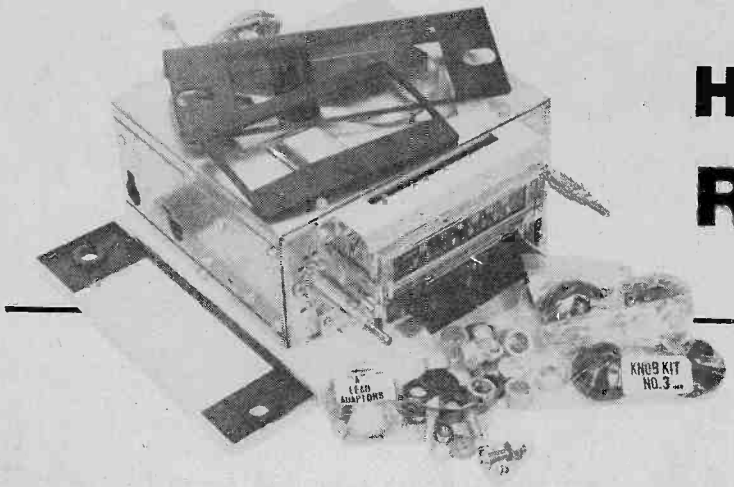
three steps: filter is threaded onto the coil, battery coil wire is then attached to the filter, and the ground strip is attached. A unique feature is the thread arrangement on the filter. It's metric on one end and standard on the other. Thus it can be used on either domestic or imported vehicles. The CBFT315D filter is rated at .1 uF, 20 amps

(Continued on page 99)

HOBBIEST installs a...

RADIO/CASSETTE

In-dash installation can save



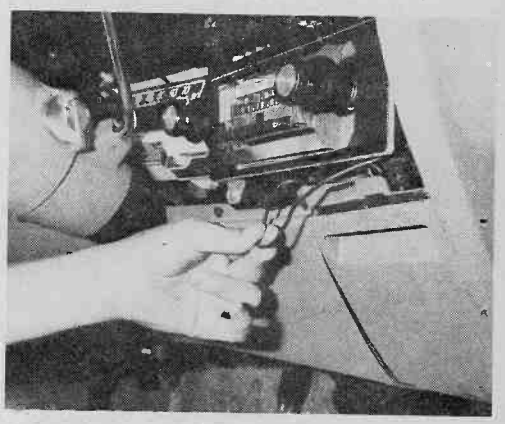
THERE ARE TWO MAJOR WAYS you can save from $100 to $200 by simply installing your auto radio or tape player in the dash so it becomes an integral part of the car, van, or RV. The first way you save money on an in-dash mount is through your insurance. If you've read the latest rider your auto insurance company has buried deep within the incomprehensible legalese that explains the wherebys and wherefores, it is more than likely that equipment for the recording and reproduction of sound aren't covered against theft unless they are a permanent part of the vehicle. As many stereophiles discover after the theft, some insurance companies don't consider four sheet metal screws that secure a mobile bracket to the dash as a "permanent part of the vehicle." But there's no question that a tape player, radio, FM stero, or radio/tape player is *permanent* if it is mounted in-dash.

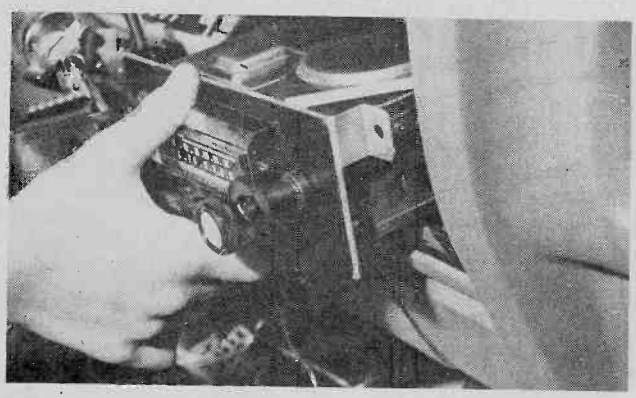
To Save More Money. The way to save even more money—often even up to $200 or more—is to do your own installation at the time you purchase a new car or van. Just look at some typical figures for a new car. An ordinary AM radio costs from $60 to $90 depending on the particular car and dealer. An AM/FM radio runs from about $109 to $190. An AM/FM stereo installation runs upwards from $200, and if you want AM/FM stereo with 8-track or cassette tape you first have to find a car for which the manufacturer will provide the equipment (many won't sell tape players for their smaller, lower priced cars), and then figure $300 or more. Then you must hope he provides the right radio/tape combination. One of the major manufacturers supplies only radio/8-track; if you want cassette you're out of luck.

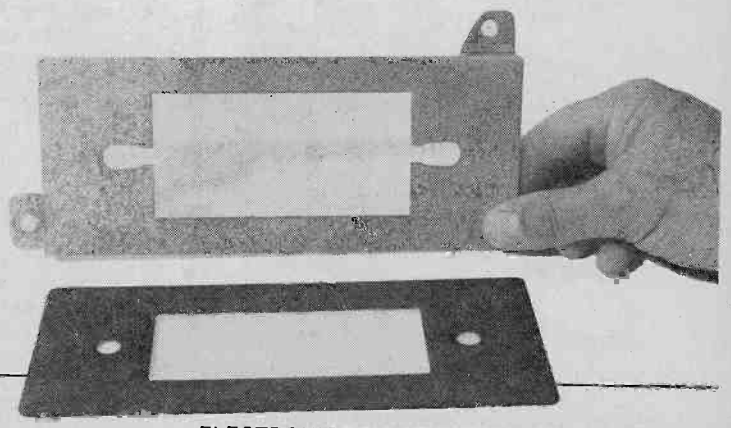
But if you're willing to spend three or four hours doing your own in-dash installation you can save quite a bundle over the new car prices, as well as having exactly the equipment you want.

For example, figuring in good quality speakers worth about $12 each, and talking about the highest quality auto equipment, an AM radio will cost you about $40, an AM/FM radio installation will run around $60, AM/FM stereo will be about $90 (don't forget you need two speakers), an AM/FM Stereo/8-Track will cost about $120,

The "hot (+12 VDC) lead from the car's electrical system is usually red. At left you can see it and the ground lead which hook onto back of player. Lower left shows the unit sliding into place after removal of dashboard plate. Faceplate (lower right) fits over metal supporting plate (bracket). At right is shown separate ground wire which goes to chassis of car. Plastic dash hardware prevents many sets from being automatically grounded as they used to be in the good old days (when cars were all 6 volts DC).







PLAYER IN-DASH
you money two ways.

and an AM/FM Stereo/Cassette will run a little higher, about $140, again including two excellent quality loudspeakers.

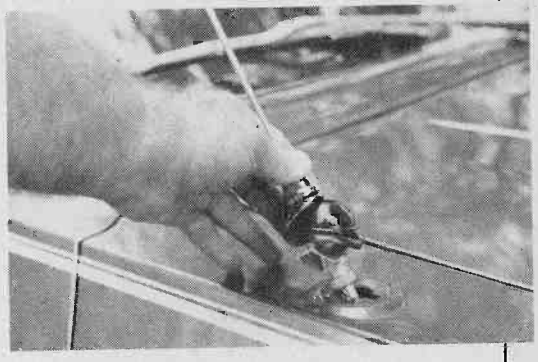
Now any way you look at it, those are big savings, often more than enough so you can get a deluxe combination unit instead of an ordinary AM radio. But, you must do the installation yourself to get so much sound and so many features for so little money.

Easier Than It Looks. At first glance, substituting a tape or combination player for the existing car radio, or starting from scratch with all-new in-dash equipment, might appear formidable, and in the old days it was one hell of a job. Often, at the very least the glove box had to be removed, also part of the ductwork if your car had an air conditioner. But most manufacturers can no longer tie up their assembly line for a radio installation, nor can they make it extremely difficult for their dealer to do an after-sale installation, so you'll find many dashboards literally come apart for easy installation. You just have to locate the few, usually concealed, screws that hold everything together.

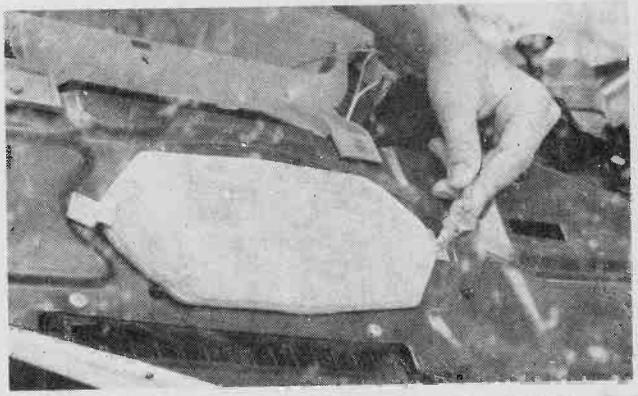
All American cars are pre-cut for radio. Either the dash is pre-punched for a *rear mount* radio, that is, the radio slides in from behind the dash, or there is a concealed cut-out that permits the radio to slide in from the front. A trim plate usually conceals either opening. If the car is designed for a behind-the-dash installation there is generally enough room so you can reach up and install a speaker behind the top of the dash. The radio simply slips into its cutout from the rear. Almost all radios and many tape players have a common size bezel so you have your choice of almost anything you want from at least two handfuls of brands—many you never heard of. Most of the better quality brands such as Audiovox and Automatic Electric have controls with adjustable shafts so you can match almost all radio cutout openings. And all of the better equipment comes with an extra trim plate, so your installation looks like a factory job when you're finished. The popular Radio Shack AM/FM Stereo/Cassette unit with *Fast Forward* and *Reverse* (almost unheard-of-features in combination units) has a universal mount and trimplate.

How To Front Mount. Front mounting takes a bit more trouble if you're starting from scratch because an adaptor plate is required. Also, no two front-installation cars or vans are alike, and your in-dash radio kit requires a lot of special bits and pieces so you can customize your particular installation.

The photographs show how easy it is to install an in-dash radio/tape player. Though a front mount installation is shown, many of the installation



Antenna installation is a snap if you have a Greenlee punch to make the single hole required for most aerials. At right is a standard antenna mounted on typical ball swivel. Lower right shows pre-cut speaker hole (6 x 9-inches) which is generally found (two of 'em) in rear deck. There's often one of these under decorative trim in the front also. Put a ladies stocking over speaker to keep dirt out. At right the set has been installed and the final trim is being replaced and secured. At left is typical oval car speaker.



PLAYER IN-DASH

procedures apply to rear mount equipment also.

Perhaps your most formidable problem will be the speaker. Many smaller cars make no provision for front stereo; the dash has a factory opening for only one (mono) speaker. There is often room for stereo speakers on the rear deck. But just because the dash has room for only one speaker is no reason you can't have a stereo radio or tape player. Just use one of the Radio Shack dual voice coil speakers. As shown in the photographs, these speakers have two independent voice coil connections. If you connect one set of terminals to the radio's right output, and the remaining terminals to the left output, you will hear the full mono equivalent of the stereo output. And you can still feed stereo to two rear speakers.

As you can see from the illustration, the speaker in this car mounts from the top of the dash after the dash cover is removed. To prevent small objects from settling into the speaker and rattling, slip a lady's *Ped* (about 55-cents) over the speaker(s) before installation. A section cut from an old pantyhose or stocking can also be used. Solder the connecting wires to the speaker terminals before mounting the speaker.

Antenna Installation. Next, install the antenna and route the wire all the way to the radio's location. Many cars have a pre-drilled fender hole for the antenna. Others you can cut with 1⅛-inch chassis punch (some antennas require other holes sizes). All standard AM and AM/FM antennas install from the top, and have some form of universal or 8-ball mount that allows the antenna to be vertical regardless of the slope of the fender. Most vehicles have a rubber grommet for the antenna cable somewhere behind the fender; just pierce the grommet with a knife and feed the cable through.

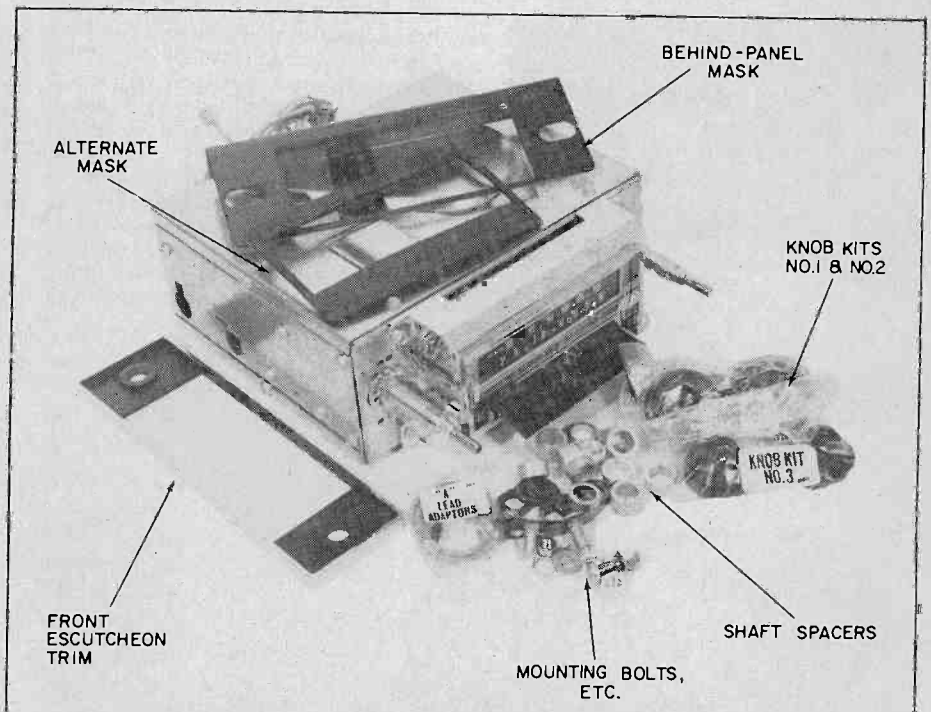
Okay, you have the speaker(s) and antenna in place, now you're ready for the radio/tape player. If your vehicle already has a radio simply remove it and install the new model. If it doesn't have a radio and it's a front mount you've found a gaping hole behind the trimplate. You need an adaptor kit.

In the adaptor kit you'll find a mounting plate, screws and if needed, a new trimplate. Secure the radio/player to the mounting plate, or the mounting and trim plates if that's the way they go into your car. If you have a better quality in-dash unit it comes with male and female connectors on all the connecting leads, and matching connectors are supplied for splicing into the speaker wires. Apply all the splice connectors first, then connect the wires all together. You'll find most cars are already pre-wired for a radio power connection, and the connector is floating behind the dash somewhere near the radio cutout. If your vehicle isn't pre-wired simply pick up the (12-volts positive) radio power terminal at the fuse block. (Audiovox in-dash units come with an assortment of connectors to match virtually any make or model.)

Because many cars now have plastic dashboards make certain you connect a well-grounded wire to one of the screws on the radio/player.

Plug in the antenna connector and then slide the unit into the cutout, taking care that no wires are crimped behind the radio. Secure the adaptor mounting plate with the supplied screws (never substitute adaptor screws) and then secure the ground wire under a dashboard screw you are certain connects to the metal vehicle body. (Use a meter to test for continuity to be sure.) Finally, apply the dash trim, or the radio's trimplate, and your installation is completed. If you have rear speakers install a front/rear fader in any convenient location so you can control the sound levels in the front and rear of the car independently.

Final Steps. If you've installed a radio your final step is to trim the antenna tuning for maximum AM sensitivity. On an AM-only radio the trimmer screw might be on the side, in which case you'll have to make the adjustment before the radio is installed in the cutout. On almost all AM/FM sets, and all radio/tape players, the trimmer is accessible from the front, usually behind one of the knobs, or inside the tape slot. To adjust the trimmer, tune in an AM station on the high end of the dial, preferably a very weak signal. If you cannot get any very weak signals try in the late evening hours. Adjust the trimmer screw for maximum signal strength—the loudest possible volume. That's the one and only adjustment as there is no adjustment for FM reception or tape. Many tape units have an accessible *azimuth* adjustment. Take care not to adjust this screw. Normally, there is a label warning the azimuth is a factory or service adjustment, but labels do fall off. If your home recorded cassettes and 8-tracks don't track properly check the auto player with a commercial pre-recorded tape. If the pre-recorded tape tracks properly the auto player is okay, it's your recording equipment that's out of alignment with the auto unit. If the pre-recorded tape doesn't track the player needs an azimuth adjustment—let a serviceman do the job under the unit's waranty. ■



If your radio/cassette player is mounted in-dash you can benefit in many ways for just a little effort. First of all, your insurance costs are lower for a permanent installation. Then, an in-dash player is just nicer appearing than under the dash.

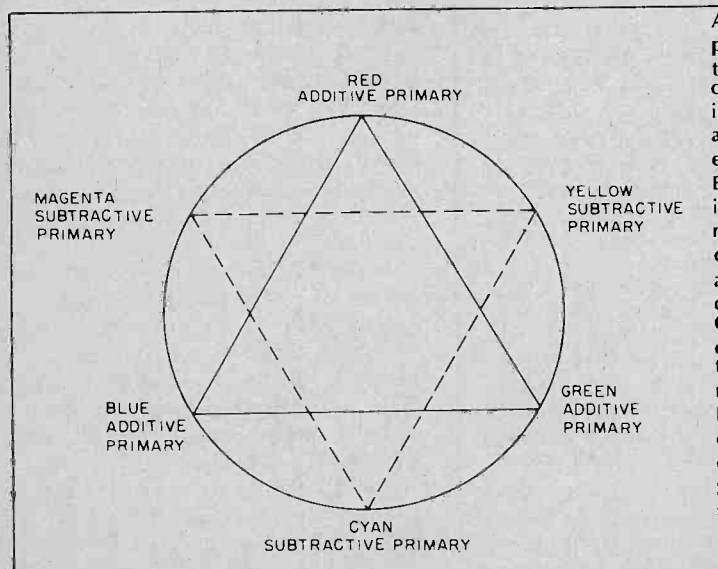
Darkroom Color Analyzer

by Herb Friedman

It's easy to make quality, bright color prints at home with modern color chemistry and this electronic color analyzer!

ONE OF THE SHUTTERBUG'S most satisfying accomplishments is producing his own color prints. For years the time spent on and the cost of making color prints were discouraging, but with modern color chemistry, such as the Beseler system, you can turn out quality color prints *in less time than for black and white* (about 3 minutes), and the prints will be far superior to anything you're likely to get from a color lab.

One thing that takes the drudgery out of color work—besides the chemistry—is a color analyzer, a device that gives you the correct filter pack and exposure time at the very first crack. Most often, the very first print made with the analyzer will be *good*. At most, it will take perhaps 0.10 or 0.20 change of filtration for a *superb* print. This is a lot less expensive and time-consuming than making test print after test print. In fact, it's really the color analyzer that puts the fun into making your own color prints!



Any one of the primary colors on this circle is composed of its immediately adjacent colors in equal amounts. Each primary-color is also complementary to the color directly across the center of the circle. Complementary colors added together form neutral densities. It is the balancing of additive primary colors of photographic light sources and subtractive-type color filters that provides control in color print photography.

Color Analyzers Are Not Cheap. A decent one costs well over $100, and a good one runs well over $200. But if you've got even a half-filled junk box you can make your own color analyzer for just the junk parts and perhaps $10 to $15 worth of new components.

A color analyzer is basically a miniature computer. You make a "perfect" print the hard way—by trial and error—and then calibrate the analyzer to your filter pack and exposure time. As long as you use the same box of paper and similar negatives, all you need to do to make a good color print is focus the negative, adjust the filter pack and exposure so the analyzer reads "zero," and hit the enlarger's timer switch. Even if you switch to a completely different type of negative, the analyzer will put you well inside the ballpark, so your second print is a winner. (And even if

COLOR ANALYZER

the filtration is off, the exposure will probably be right on the nose.)

Construction. The color analyzer shown was specifically designed for the readers of this magazine—essentially an electronics hobbyist with an interest in photography. All components are readily available in local parts stores or as junk box parts. Several protection devices have been designed into the circuit so accidental shorts won't produce a catastrophe. The printed circuit board template has foils for both incandescent and neon meter lamps, as well as extra terminals so you can use either a socket and plug or hard wiring for the color comparator and exposure sensor. In short, you can make a lot of changes to suit your individual needs.

The template for IC1 uses a half-minidip, Signetics V-type package lead arrangement. However, you can also use an IC with a round (TO-5) configuration. If anything is wrong with the IC you can get the TO-5 out easily. The half-minidip removal might result in destruction of the PC board. We'll explain how to install the TO-5 IC on the PC board later.

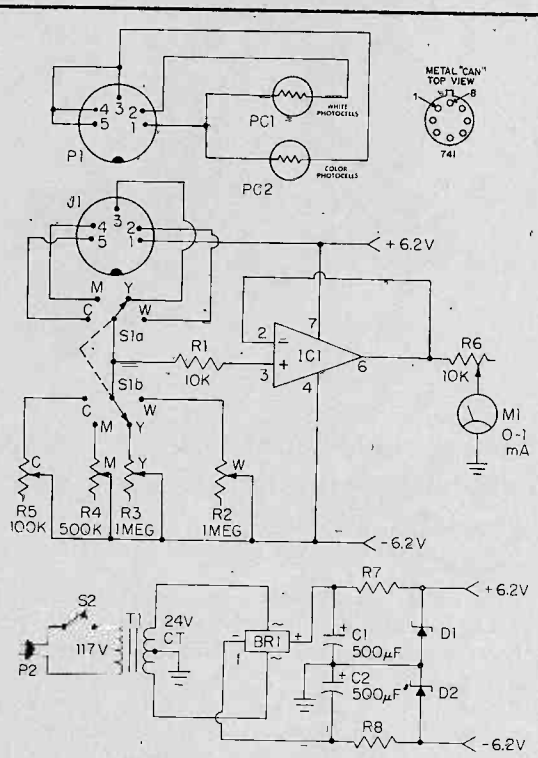
You can either buy or make the printed circuit board (see parts list). Either way, the first step is to prepare the printed circuit board. If you do it yourself, make it any way you like, using free-hand or template resist. Nothing is critical, but be certain there are no copper shorts between the terminals for IC1. Use a #56 bit for all holes. Then use a larger bit for transformer T1's mounting screws (#4 or #6 screws), a ¼-in. bit for resistor R6, and a #30 to 40 bit for the linecord connections (any bit that will allow the linecord wires to pass through the board).

Assemble the power supply and check it out before any other components are installed. Install transformer T1 first. Any 24-volt or 25.2-volt center-tapped transformer that will fit on the board will be fine. Get something small, like 100 milliamperes. A Wescom 81PK-100 is a perfect fit.

Bridge rectifier BR1 is the low cost "surplus" found in many distributors. This type has the positive and negative outputs at opposite ends of a diamond. The AC connections are the remaining opposite ends. Note that BR1 is installed in such a manner that its negative output is farthest from transformer T1 while the positive output is nearest to T1. Make certain your bridge rectifier has the same lead configuration; if it is different, modify the printed circuit template to conform to the rectifier you're using. Get it right the first time.

Finally, install C1 and C2, R7 and R8, and zener diodes D1 and D2. Take care that the capacitors and zener diodes are installed with the polarity correct. If the capacitors have their negative leads marked with an arrow or line, these markings face the *opposite edges* of the PC board (negative to the outside). The zener diodes are installed so that their cathodes (the banded ends) face each other towards the center of the board.

Initial PC Checkout. When the power supply is completed, temporarily connect a linecord. Connect the negative lead of a meter rated 10 volts DC or higher to the foil between T1's mounting screws (that's ground). Connect the meter's positive lead to the junction of R7 and D1, which is in the center of the board; the meter should indicate approximately +6.2 volts DC. Then connect the positive meter lead to the R8 and D2 junction, which is near the edge of the board. You should get approximately −6.2 volts DC. If the voltages



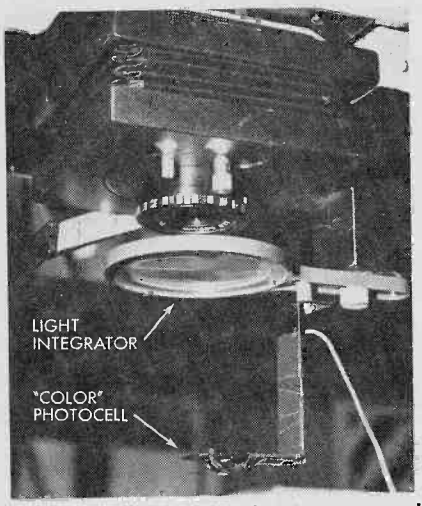
PARTS LIST FOR COLOR ANALYZER

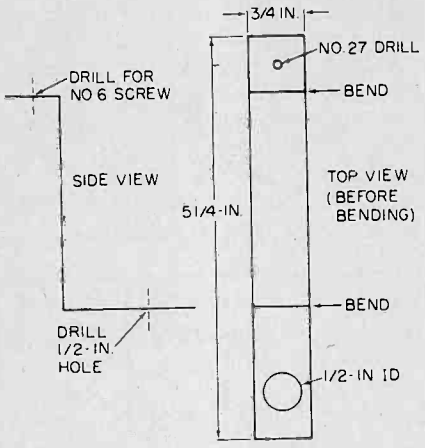
BR1—50-PIV, 0.5-amp or higher silicon bridge rectifier
C1, C2—500-uF, 10-VDC or better electrolytic capacitor
D1, D2—6.2-volt, 1-watt zener diode
IC1—type 741C operational amplifier, see text
J1—5-pin socket, DIN-type (optional, see text)
M1—0 to 1-mA DC meter, see text
P1—5-pin plug, DIN-type (optional, see text)
PC1, PC2—Clairex CL5M5L photocell, **do not substitute**
R1—10,000-ohm, ½-watt resistor
R2, R3—1-megohm potentiometer, see text
R4—500,000-ohm potentiometer, see text
R5—100,000-ohm potentiometer, see text
R6—10,000-ohm trimmer potentiometer (Mallory MTC-14L4 for exact fit on PC board)
R7, R8—820-ohm, ½-watt resistor
R9—100,000-ohm, ½-watt resistor
S1—2-pole, 4-position rotary switch (Allied Electronics 747-2003; adjust stops for 4 positions)
S2—spst switch
T1—117-volt primary, 24 to 26.6-volt secondary transformer, see text for point-to-point wiring (Note: you can also use two less expensive 12-volt transformers with secondary windings connected in series-aiding, if you have the space.)

The printed circuit board for the Color Analyzer is available direct from Electronics Hobby Shop, Box 192, Brooklyn, NY 11235 for only $5.50. US orders add $1.50 for postage and handling; Canadian orders add $3.00. No foreign orders, please. Postal money orders will speed delivery; otherwise allow 6-8 weeks for delivery.

If you cannot obtain the Clairex Type CL5M5L photocell locally, write to Electronics Hobby Shop at the above address, enclosing $3.50 for each photocell. U.S. orders add $1.50 for postage and handling. Canadian order add $3.00. No foreign orders, please. New York State residents add sales tax. Postal money orders speed delivery; otherwise allow 6-8 weeks for delivery.

Misc.—cabinet, pilot lamp for meter, 2-in. or 3-in. size Kodak Wratten filters #70, #98, and #99 (available from photo supply dealers), calibrated knobs, wire, solder, hardware, etc.





The color comparator photocell Z-bracket is installed under a light integrator. If your enlarger has a filter holder under the lens, attach the Z-bracket to the holder.

are far apart in value, or if the polarity is wrong, make certain you find the mistake *before* installing IC1.

Disconnect the linecord and complete the PC assembly. If you use a 24 or 28-volt pilot lamp to illuminate the meter you connect to the holes adjacent to T1's secondary (24-V) leads. If you plan to use a neon illuminator, install a 100,000-ohm resistor (R9) on the PC board and connect the lamp to the holes marked "neon." The lamp must have as little illumination as possible. Incandescent 24 or 28-volt lamps must be the miniature or "grain of wheat" type rated approximately 30 to 60 mA; the lamps come with attached leads. Do not use pilot lamps of the 100 to 500 mA variety. The excessive light will confuse the analyzer.

To install IC1 when it is the metal can TO5 type, fan out the #1 to 4 leads and #5 to 8 leads so they form two straight lines. Note that the lead opposite the tab on a TO5 package is #8. Insert the leads into the board leaving about ¼ inch between the IC and the board. The IC is correctly installed if the tab faces *away* from the transformer towards the nearest edge of the PC board. Solder IC1 and cut off the excess lead length.

The edge of the PC board nearest IC1 has four sets of paired foil terminals. These are provided as mounting terminals if you connect the photocell comparator and sensor without the use of a plug and jack. However, we strongly suggest the use of the specified DIN-type connectors as they allow for easy repairs if the connecting wires break. (The connectors aren't *that* costly).

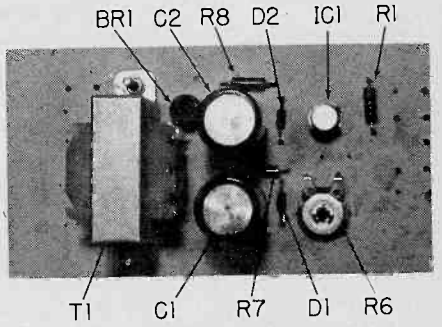
Potentiometers R2 through R5 can be linear or audio taper, though audio taper gives a slightly smoother adjustment; use whatever you have in stock.

The analyzer shown is built in a Bud 7-inch AC-1613 Universal Sloping Cabinet. This is the least critical item and you can substitute whatever cabinet you prefer. Just be certain the cabinet will accommodate the type of meter you use.

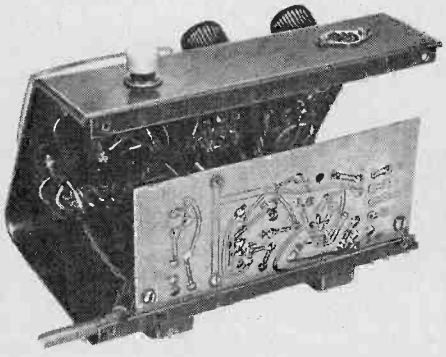
Meter M1 should be O-1 mA with a zero-center scale. But these are expensive, so you can substitute any standard 1-mA meter you want. You will simply calibrate the instrument for zero-center.

If you use a neon pilot lamp mount it directly above the meter and shield the forward brilliance with a piece of black tape; the lamp should radiate straight down onto the meter scale. If you use the meter in the parts list, remove the front cover by pulling it forward. Then remove the meter scale. As shown in the photographs, place a black dot approximately 3/16-inch wide at the center of the scale. If you want, you can also modify the meter for the incandescent lamp. Drill a ¼-inch hole in the lower right of the meter *from the rear*. Position the meter in the cabinet and mark the location of the meter hole on the panel. Remove the meter and drill a ⅜-inch hole in the panel. When the meter is installed you can pass a "grain of wheat" lamp through the panel into the meter. Reassemble the meter and complete assembly.

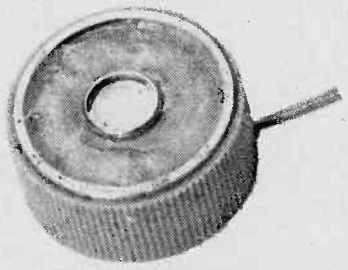
The Comparator. The photocells used for the comparator and exposure sensor, P1 and P2, must be Clairex type CL5M5L. Make no substitutions. From a piece of scrap aluminum ¾ to 1 inch wide, fashion a Z-bracket to the dimensions shown. Drill a ½-inch hole close to the end of the longer Z-leg. Fasten the other end of the Z-leg to your enlarger's under-lens filter holder. If your enlarger does not have a filter

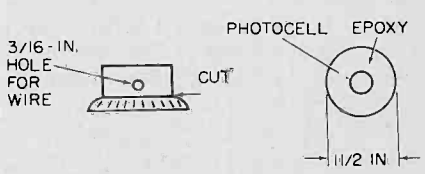


This is the parts location when our PC board is used. To get a free template of the PC board, send a Self-Addressed Stamped Envelope to: Davis Publications, Dept. T, 229 Park Ave. South, New York, NY 10003.



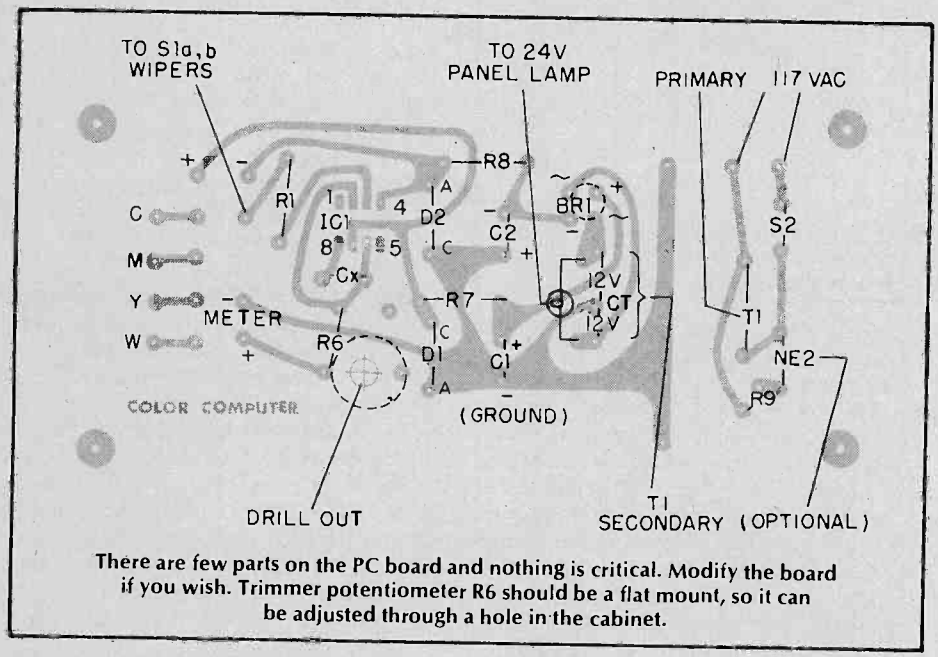
Rear view of author's color analyzer shows vertical mounting of the circuit board.





The exposure sensor photocell is mounted in anything that will keep it in place on the easel. This example was epoxy-cemented into a large control knob after the outside dial section was ground off. In typical operation, the sensor is placed under the lens with the light integrator or filters.

holder, or if it has a permanent swing-away red filter under the lens, mount a Paterson swing-away light integrator (available from local photo shops) under the lens. Fasten the short leg of the Z-bracket to the integrator—which has pre-drilled holes—so that the ½-inch hole is on the optical center of the lens. Then cement photocell P2 in the hole and attach the connecting wires; these can be extra-thin zip cord such as used for short-length speaker connections. (This whole bit reads a lot more complicated than it is. Use the photographs as a guide.)



There are few parts on the PC board and nothing is critical. Modify the board if you wish. Trimmer potentiometer R6 should be a flat mount, so it can be adjusted through a hole in the cabinet.

Photocell P1, which measures the exposure light, can be mounted in anything heavy enough to hold it in place on the easel. The photographs show the photocell epoxy-cemented in an oversize control knob.

When the complete analyzer is assembled, attach oversize calibrated knobs such as the Calectro E2-715 to R2 through R5. The knob calibrations are important so they should run out to the very edge of the knob skirt. If the calibrations don't run to the edge you won't be able to preset the controls with any reasonable degree of accuracy. Place a fine line or other indicator directly above each knob.

Checkout. Connect the photocells to the control unit and apply power. Don't worry if the meter pins at either end of the scale. Set switch S1 to the extreme clockwise position and adjust R2 through R5 until you find the control that changes the meter reading. Mark the switch and the control "C" for cyan. (We suggest you paint the cyan knob insert a blue-green. Also paint the other knobs the appropriate color.) Advance S1 one position clockwise, find the correct knob and label both "M" for magenta. Advance the switch another position clockwise, find the knob and label both "Y" for yellow. The last switch position and knob is labeled "W" for white (white light exposure). Make certain the C, M, and Y controls are reading P2, the color comparator mounted under the enlarger lens.

Set S1 to any position, set all other controls to their mid-position, and turn on bright room lights. If the meter pins out or approaches full scale deflection, adjust trimmer control R6 so the meter pointer just pins (don't be afraid to pin the meter). Depending on the amount of light the meter pointer will pin right (for bright light) and left (for dark or very low light). This is normal and there will be no damage to the circuit or the meter. (Note: If you use a zero-center meter the pointer will barely pin on both sides.)

Close-up of meter face showing a small scale-illumination lamp in lower right corner. This lamp should not be operated at full voltage to avoid fogging the film.

Install the Z-bracket under the lens. If your enlarger uses a filter holder under the lens insert a diffusion screen or glass, or a Beseler Light Integrator or similar ground glass in the filter holder. You are now ready to make color prints.

The first thing you need to make fine quality color prints is a high speed chemistry, such as the two-step Beseler system which can produce a finished print in two minutes. The second item you need is the electronic color analyzer for which we've already given you the plans.

Color Variables. Color materials such as the negative, printing paper, enlarger lamp, and even color correction filters vary in their sensitivity to light colors from batch to batch, roll to roll, and time to time. Even the enlarger's optical system can have a color cast. For this reason it is generally impossible to place a negative in your enlarger, expose the paper, and develop a good—let alone decent—color print.

To avoid upsetting a control setting while groping for the on-off switch in the darkroom, mount switch S2 as far as possible from the controls.

Provides a wealth of worthwhile info for photographers interested in the color print techniques available from Kodak or your photo dealer. Their publication No. E-66.

One way we can correct for these variables is through an *additive* exposure, exposing the paper through blue, green, and red filters for differing lengths of time. Since blue, green, and red create all the colors in additive printing, any correction can be obtained by controlling the precise timing of each exposure. The additive system is a pain in the neck for the hobbyist, for the slightest desired change in the color rendition or saturation (exposure) can involve changes in the exposure through all three filters.

A printing system that's easier to use and more favored by hobbyists is the *subtractive* exposure. A single filter pack made up of two of the filters known as YELLOW, MAGENTA, and CYAN makes all the color corrections at the same time. This filter pack is placed between the enlarger lamp and the negative; virtually all modern enlargers have a drawer in the lamphouse to accommodate a filter pack. A single exposure through the filter pack is all that's required to make a color print. Some of the more expensive enlargers have what is termed a "dichroic head" with variable filters as part of the light system; the exact value of filtration is simply dialed by the user. Again, all the color correction is provided at one time by the dichroic head so only a single exposure is needed.

More Info. A full and complete treatment of both types of color printing is contained in the Kodak publication *Printing Color Negatives;* this book is a required reference for anyone who wants to make quality color prints. The book also gives the most convenient operating procedures for electronic color analyzers.

The subtractive printing procedure is particularly well adapted for use with a color analyzer, is the easiest method for the amateur, and is exceptionally fast-handling, so the illustrations to follow will refer to the subtractive system.

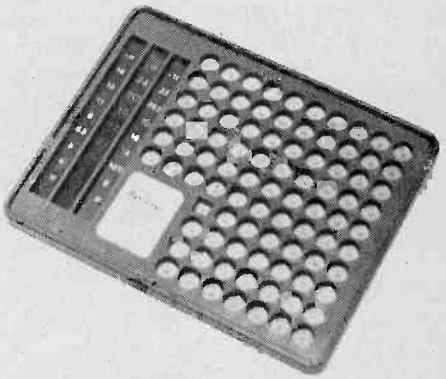
An electronic color analyzer basically consists of a photocell (vacuum tube photomultiplier or photoresistor) positioned under the lens, blue, green, and red filters mechanically positioned over the photocell (or positioned over the cell by hand) and a meter that indicates the amount of light falling on the cell. The meter is connected to the photocell through independent potentiometers as shown in the figure. Color analyzer readings will be accurate for most negatives and lighting situations as long as the same box of printing paper is used. The system needs to be recalibrated only when the printing paper is changed (so purchase boxes of at least 100 sheets to avoid extra work).

The first step is to make a really fine print from a decent negative. You can do it the hard way, one print at a time, or use a Beseler Subtractive Calculator which puts you inside the ball park on the first try. When you have made a print with satisfactory flesh tones and color saturation don't disturb the enlarger or timer controls.

To Continue. . . . Place the color analyzer's probe on the easel or swing it under the lens (if it is mounted on the enlarger). Install a light integrator—which is nothing more than a piece of ground glass or its equal—under the lens, between the lens and the analyzer's probe. The light integrator scrambles the picture into a diffused "white light" which contains all the color elements of your negatives and the filter pack. Place a blue filter (Kodak Wratten No. 98) on top of the light integrator. (Note that most hobbyist analyzers have a selector switch that also mechanically positions the correct filter over the photocell.) Turn on the enlarger and adjust the analyzer's *yellow* control for a convenient reference meter reading. (Usually, center-scale or "null" is used as the reference reading, but any meter reading can be used as a null.)

Remove the blue filter, install a green filter (Kodak Wratten No. 99), switch the analyzer to MAGENTA and adjust the *magenta* control for a null meter reading. Remove the green filter, install a red filter (Kodak Wratten No. 70), switch the analyzer to CYAN and adjust the *cyan* control for a null meter reading (the color controls yellow, magenta, and cyan refer to the color of the subtractive filters in the filter pack). Finally, remove all filters from under the lens, switch the analyzer to WHITE and adjust the *white* control (exposure control) for a null meter reading.

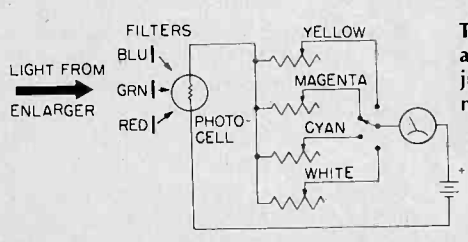
(The color analyzer in this project uses a separate photocell for the exposure. If you look at the easel you'll see a shadow cast by the Z-bracket holding the color comparator cell. Position the exposure cell on the easel so it is just off the edge of the shadow. If you prefer, you can place several thicknesses of opaque paper over the color comparator cell and use it for the white measurement, though we suggest you use the separate cell.)



Modern color print chemistry techniques from Beseler include this subtractive color calculator to aid filter selection.

When all the controls are adjusted you have programmed the color characteristics and exposure of your "reference" print into the analyzer, and you should note the control settings and exposure time for future use.

Down to Business. Now assume you want to make a print from another negative. Put the new negative in the enlarger. Then set the degree of enlargement and focus, leaving the lens wide open. Place the analyzer's probe under the lens, install the light integrator and set the analyzer's switch to CYAN. Install the red filter on top of the light integrator and adjust the lens aperture until the meter indicates null. Switch the analyzer to MAGENTA, install the green-reading filter and note the meter reading. If it is not at null, add or remove magenta filters (from the filter pack) until the meter shows a null. Then switch the analyzer to YELLOW, install the blue-reading filter and

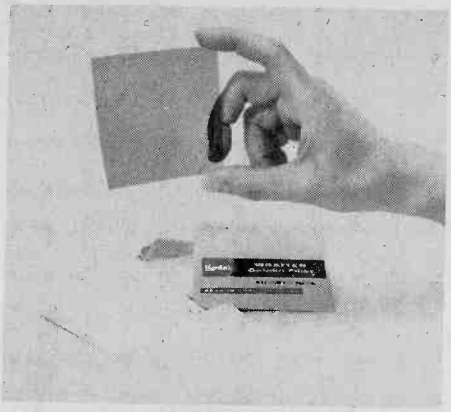


The basic color analyzer. Once controls are matched to a "standard" negative, just select filters for a null on the meter for each individual color and white.

modify the yellow filtration in the filter pack until the meter shows a null. Finally, set the analyzer to WHITE, remove all reading filters and adjust the lens aperture for a null indication.

Through the color analyzer you have now established a new filter pack and exposure for the new negative. If the new negative uses similar lighting to the reference negative the print should be perfect. If the lighting was considerably different the print will be good—acceptable to most people, but requiring just a slight filter pack modification for a great print.

Swinging Filters. In the previous example the filter pack would wind up with magenta and yellow filters—which is what is generally needed. Some Kodacolor negatives, however, might require cyan lters plus magenta *or* yellow (but never all three). This information will have been programmed into the color analyzer, so you will have no difficulty if you make a slight modification in procedure. The first meter reading, the one where you adjust the lens's aperture, should be made for the filter you are *not* using in the filter pack. For example, if your basic filter pack has cyan and magenta, switch the analyzer to YELLOW, place the blue-reading filter in position on the light integrator, and close down the lens for a null indication. Then proceed with the other readings. If your reference negative did not require cyan in the filter pack, if it had yellow, magenta, or both, and you find a new negative just can't be pulled in for null meter readings with yellow and magenta filters, it indicates the new negative requires cyan filtration, so start with the assumption that yellow is not required. If you still can't null the meter, it means magenta should *not* be in the filter pack.



Kodak color printing filters. Typical filter designation CP20Y means color filter with a .20 density; the color is yellow.

As we mentioned, a more thorough discussion and procedure for using a color analyzer is found in Kodak's *Printing Color Negatives.*

Most, but not all, commercial color analyzers use photomultiplier tubes which have no light memory, nor are they confused by infrared from the enlarger lamp. These units are, as you would expect, relatively expensive. Low cost models use photoresistors.

More Data. Photoresistors are infrared-sensitive and they have a light memory, both of which can confuse the meter. The infrared is easily handled by installing a heat or infrared filter glass in your enlarger (it should be there to protect the negative anyway). The light memory is handled by using a consistent measurement procedure. The best way is to turn the enlarger off, install the reading filter and the light integrator, turn off the bright room lights, count to five, and then turn the enlarger *on*. Take the meter reading, or adjust the appropriate color control, slide the new reading filter in place before withdrawing the old one, switch the analyzer, and make the new meter reading. Repeat this for the third reading filter. You'll note that this procedure keeps bright white light from falling on the photocell between meter readings. If you want to change filters under room lights, make certain there are about five seconds of darkness between turning the room lights out and turning the enlarger on.

The whole bit might sound somewhat complicated, but after you've run through the procedure once or twice to get the hang of things it shouldn't take you more than a minute or so for a full color analysis of a new negative.

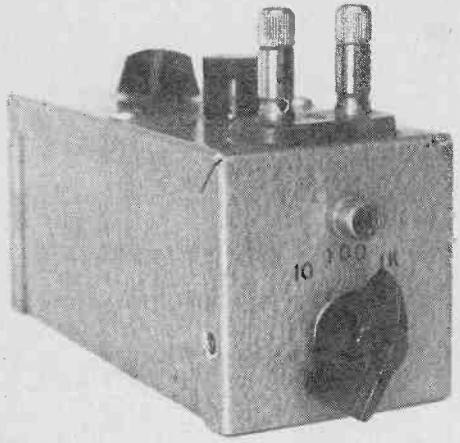
The Kodak Wratten filters needed are available from professional camera shops. For the construction project, color analyzer 2-in. or 3-in. Kodak Wratten filters Nos. 98 (blue), 99 (green), and 70 (red) are recommended. If you have difficulty obtaining these specific filters you can make the following substitutions, through the analyzer's precision will be slightly reduced: 47B (blue), 61 (green), and 92 (red).

The Pro Shop. We could not close without some words on commercially processed color prints such as you might order from a drugstore or camera shop. Commercial color labs have as high (if not higher) a remake rate than the amateur if *quality* color prints are desired. As a general rule, it takes two tries to get a decent color print, so the hobbyist with a color analyzer is way ahead of the game because he can turn out, at worst, two *good* prints for each three first tries. The average is even higher than this as the hobbyist gets skilled in the use of a color analyzer.

Commercial labs come close to a hobbyist's results only when they are equipped with a video analyzer such as the Kodak Video Color Negative Analyzer Model 1-K; and Kodak only claims a 75%+ first try acceptance rate for their analyzer. The video analyzer is a 5-in. x 5-in. TV display. The operator views the color negative as a positive color TV image, and adjusts the TV's controls for proper color balance and brightness (saturation). The control settings are translated to the printing equipment's filter adjustments so that the final print is similar to the image displayed on the TV.

The video analyzer is a fast and easy way to get good color prints on the first try, but since video analyzers cost in the thousands, the color analyzer is the best thing going for the hobbyist. ■

Professional equipment used by color labs includes this Kodak Video Color Negative Analyzer. It uses a 5-in. color TV screen to assist an operator in selecting the correct filter.



FRAG your friendly audio generator

By Frederick W. Chesson

IF YOU NEED AN INEXPENSIVE and highly portable audio test set, this Full Range Audio Generator (FRAG) is for you! Our friendly FRAG delivers variable and fixed outputs of sinusoidal waveform from 10 Hz to over 15 kHz and up to five volts peak-to-peak.

The Circuit. There are several circuit networks which can produce a sinusoidal waveform, including the Phase-Shift and the Twin-T. It is the latter which will be examined here, as it proved in application to be the most suitable for the FRAG.

As shown in the Twin-T Oscillator diagram, we have a Low-Pass network of R1, R2, and C1 in parallel with a High-Pass network formed by C2, C3, and R3. The combined network is connected between the inverting input and output of a gain device, such as the familiar 741 integrated circuit op-amp. Typically, R1 = R2, while R3 is one-half to one-tenth of R1, and C1 = C2, and C3 = 2C1.

Since the phase shifts for the two networks are opposite, there exists, in theory, only one frequency where the total phase-shift from input to output will reach 180°, at which point sinusoidal oscillations will occur, provided sufficient gain is available. The approximate frequency will be

$$F = \frac{1}{2 \pi R1 C1}$$

Varying any or all of the network elements will cause the nominal frequency to change, accompanied by a drop in output, until oscillation can no longer be sustained. Over a certain range, varying the resistive elements simultaneously, as by a ganged potentiometer, will yield a useful frequency span, provided the gain can be raised appropriately, but without causing overdriven distortion.

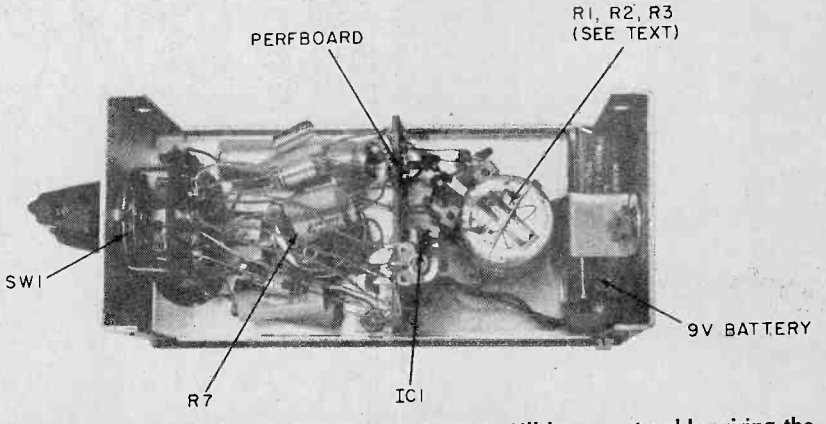
Shunting the Twin-T network with a fixed resistance RF yielded fair results, in experiments conducted to obtain a wide operating range consistent with simplicity. It was then found that addition of a diode back-to-back pair, forming an active feedback element, gave a considerably greater range, as shown. Further experimentation finally showed that even greater improvement could be obtained by connecting the feedback elements between output and the *offset-null* terminal associated with the inverting-input. Three switch positions give ranges of 10-100 Hz, 100-1000 Hz, and 1kHz – 10kHz. A fixed output of about 5 VPP and a variable output of 0-1.0 VPP were added to provide a choice of useful signal levels.

Put It All Together. For convenience in portability, a utility box having a five inch length by two and one-quarter inch height and width was selected (Either Bud CU-2104A or Premier 12P3886 types are suitable).

A photo shows the parts placement of the prototype, with the range-capacitors being strung between the range switch and a perf-board mounting the integrated circuit and other components. Check the drawing to see how these components may be placed on a two inch square section of perf-board having 0.1 inch spaced holes. A pair of No. Six ground lugs are bent at right angles to serve as miniature mounting brackets. There is sufficient room for a 14-pin DIP IC socket for the 741 op-amp, should replaceability be desired. Although a mini-dip 8-pin 741 was used in this circuit, the standard 14-pin unit will do as well, paying attention to the pin connections. The nine-volt transistor battery (Eveready type 222, or equivalent) is secured in place by an S-shaped half-inch wide aluminum bracket.

The only component difficult to find is a three-gang 250K, 250K, 25K potentiometer, used for variable frequency settings. If a ready-made assembly (preferably log-taper) cannot be obtained, use a built-up unit, like Centralab *Fastach* components.

Optional resistors R4, R5, and R6 are included so that the variable frequency dial may be rotated to maxi-



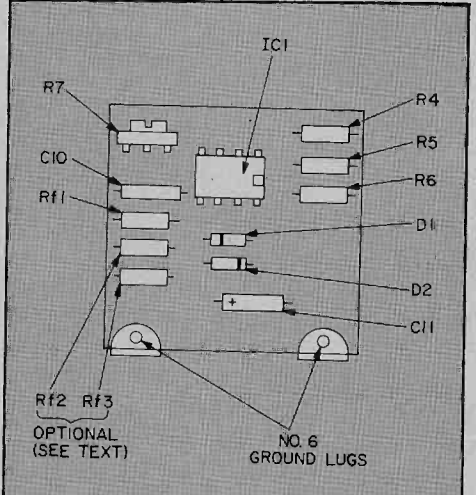
Use the parts layout given for the perfboard and you will have no trouble wiring the capacitors point-to-point as shown here. Be certain that the long leads do not short out against each other by keeping them as straight as possible.

mum frequency without having the circuit drop out of oscillation, as it would should R1, R2, and R3 fall too low. Temporarily omit the feedback resistor(s) RF for later adjustment. If a four pole-three position switch (such as Calectro E2-168) is available, then each range may have its own individually selected feedback resistor for maximum efficiency.

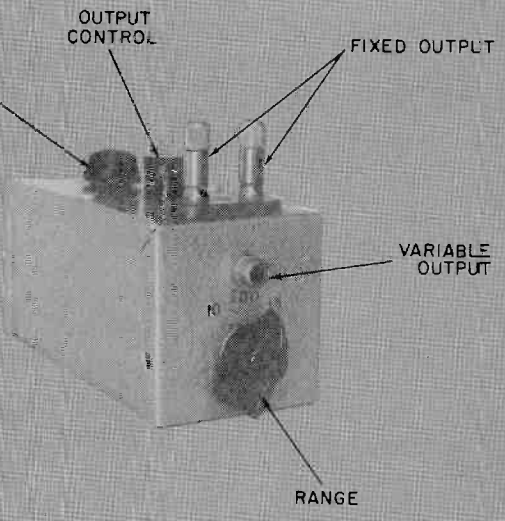
Adjustment and Operation. An oscilloscope is essential for adjustment of the friendly FRAG to determine optimum waveform and amplitude and for rough frequency determinations. A freqeuncy-counter is also useful, although the FRAG is not intended to be a precision audio generator.

Before applying power, set the input bias potentiometer R7 for approximate midrange position and connect a decade resistance box, set at about 33K ohms, in place of RF. Set the Range Switch to its middle (X100) position and the variable frequency control to its mid position. Connect the scope (and frequency counter, if available) to the fixed output terminals.

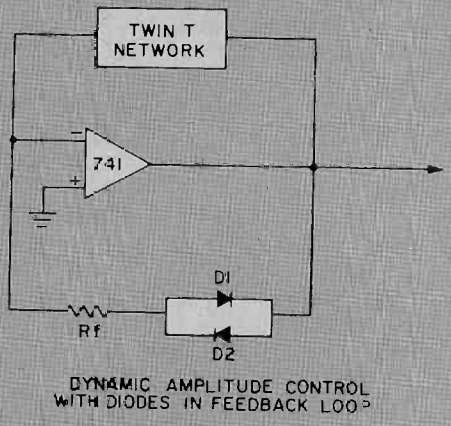
Switch on the power by turning the Output control to mid-position. The scope should display a more or less square wave of about 200 Hz. Adjust the decade box, or individual fixed resistor, for a sinusoidal waveform of maximum amplitude, consistent with low distortion. If the wave is flattened at top or bottom, try adjusting R7 while rechecking RF. Rotate the variable frequency control from one end to the other, rechecking RF and R7



Use this parts layout for your perfboard. Rf2 and Rf3 are optional, as mentioned in the text. Also, use a socket for IC1.

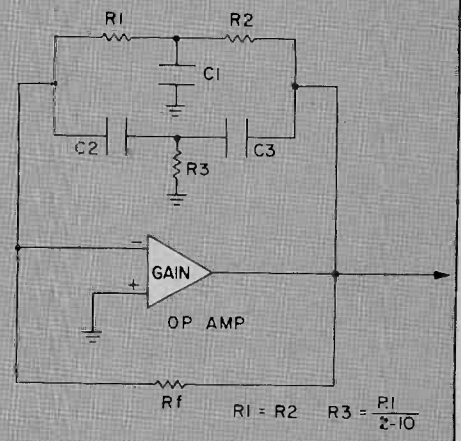


Once built, you will find our friendly FRAG to be one of the most useful accessories. The fixed and variable outputs, the variable frequency control, all combine to make FRAG one versatile instrument.



DYNAMIC AMPLITUDE CONTROL WITH DIODES IN FEEDBACK LOOP

Shunting a Twin-T network with feedback resistance (Rf) yielded fair results. The addition of a back-to-back diode pair as an active feedback element greatly tended to increase the FRAG's operating range.

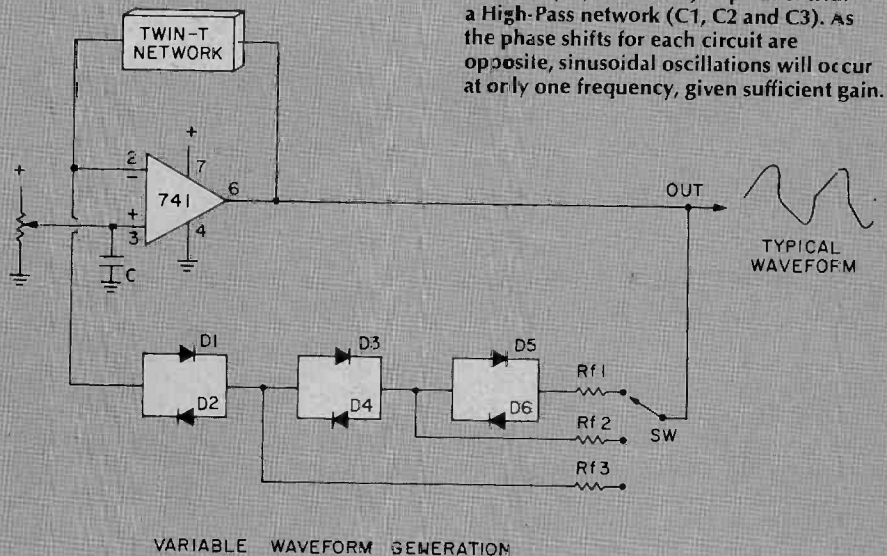


$R1 = R2 \quad R3 = \frac{R1}{2-10}$

$C1 = C2 \quad C3 = 2C1$

BASIC TWIN-T OSCILLATOR

This basic Twin-T circuit uses a Low-Pass network (R1, R2 and R3) in parallel with a High-Pass network (C1, C2 and C3). As the phase shifts for each circuit are opposite, sinusoidal oscillations will occur at only one frequency, given sufficient gain.



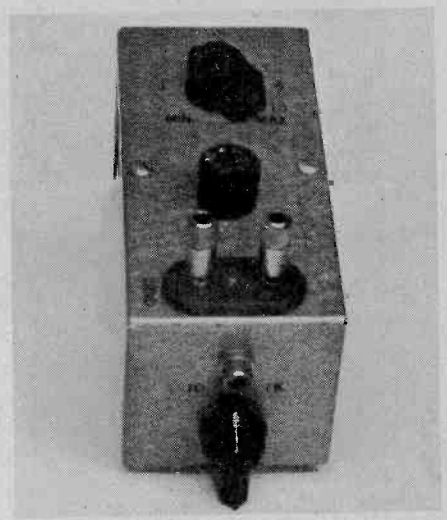
VARIABLE WAVEFORM GENERATION

During development of the FRAG, additional diode pairs were added to see if they would further increase the variable frequency range. They did—but at the cost of adding some distortion. This, however, results in some interesting tones—music!

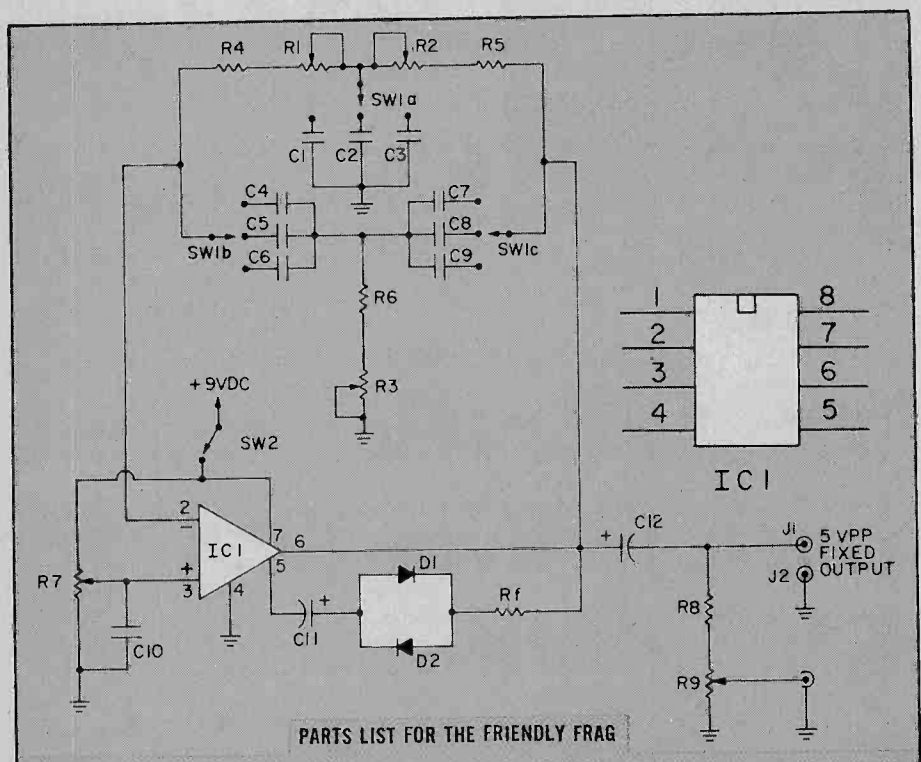
should distortion occur. Amplitude will be less at each end of the dial, and will drop out entirely at the upper end, unless the optional resistors R4, R5 and R6 have been included. A maximum output of 5 VPP should be obtainable at the fixed output terminals and up to 1 VPP at the variable output jack. If separate feedback resistors are used (with a four-pole Range Switch) recheck the other two range positions and select the correct individual resistors and mount them on the perf-board. Otherwise, a single feedback resistor will have to be a compromise for best operation over the entire span of all three ranges.

The variable frequency dial may be calibrated simply on a 1 to 10 basis, which should hold good for the three ranges. If a linear potentiometer is used (all that was available in the Fastach components at time of construction) the dial will necessarily be non-linear, which is why a log-taper pot is more desirable. Also, due to mechanical backlash in the stacked sections, it is best to move well past an over-shot frequency point before reversing to zero back in. The 0-1 VPP shielded jack is best for low-level output applications involving audio amplifiers and other high-input impedance gear. The 5 VPP fixed-output terminals are useful for general purposes, or where it may be desired to construct fixed voltage-divider networks.

Although the battery drain is quite modest, make sure to turn off the test set when not in use.



Looking at FRAG from the front shows the frequency range selector, as well as the output terminals and level controls on top.



PARTS LIST FOR THE FRIENDLY FRAG

IC1—Type 741C
C1—.22uF capacitor
C2—.02uF capacitor (Allied 710R1136 or equiv.)
C3—.002uF capacitor (Allied 710R1093 or equiv.)
C4, C7—.1uF capacitors
C5, C8—.01uF capacitors
C6, C9—.001uF capacitors
C10—.1uF capacitor
C11—10uF electrolytic capacitor
C12—220uF electrolytic capacitor
D1, D2—1N914 silicon diodes
R1, R2, R3—250,000-ohm, 250,000-ohm, 25,000-ohm, ganged potentiometer (Centralab "Fastach")
R4, R5—10,000-ohm, ¼-watt resistor
R6—1,000-ohm, ¼-watt resistor
R7—5,000-ohm trimmer potentiometer
R8—4,700-ohm, ¼-watt resistor
R9—1,000-ohm potentiometer (Allied 854-5800 or equiv.)
SW1—3-position, 3 or 4-pole miniature rotary switch (Calectro E2-168 or equiv.)
SW2—potentiometer switch (mount on back of R9)
Rf—feedback resistors (see text)
J1—Pair of five-way binding posts
J2—RCA type phono jack
Misc.—9-V battery, battery clip, perf board with .1-in. spacing, perf. board terminals, DIP socket, a 5 x 2.25 x 2.25-inch chassis (such as the Bud CU 2104A), wire, solder, etc.

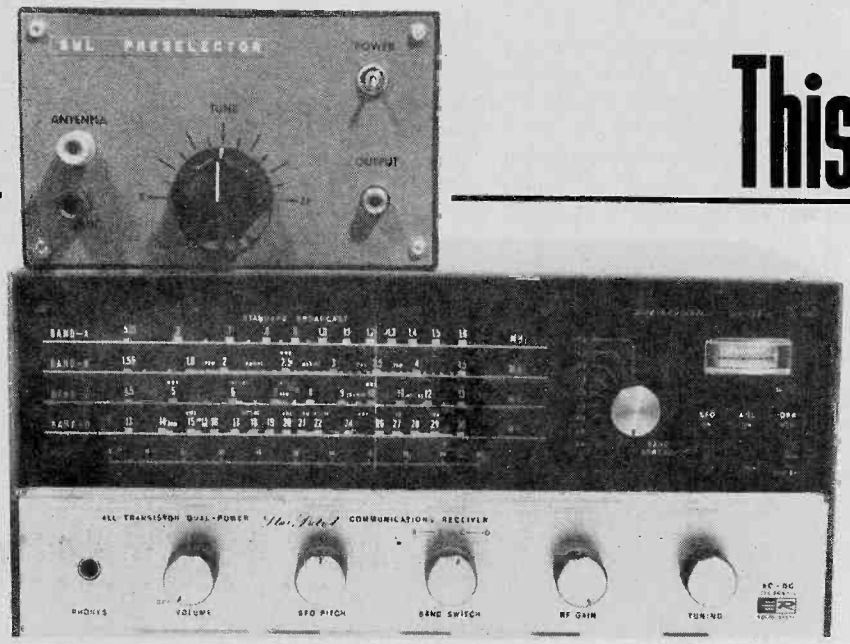
Allied Electronics' address is:
401 East 8th St., Ft. Worth, Texas 76102
Calectro Electronics' address is:
400 S. Wyman St., Rockford, Ill. 61101
Centralab Electronics' address is:
P.O. Box 858, Fort Dodge, Iowa 50501

If you ever need a Full-Range Audio Generator, then call it by its initials, FRAG, and start building a fun and interesting project. Our FRAG uses a neat and unique means of building which can be easily duplicated following instructions in the article. A main perfboard is positioned in the middle of a rectangualr metal box and the many capacitors the circuit calls for are wired point-to-point to the components on the perfboard. It's quick and easy, and results in a very small and compact, professional-looking instrument. If you ever get tired of having FRAG work for a living, a simple and reversible modification, also explained in the text, will turn FRAG into something of a songstress. She is a very friendly FRAG!

Range Switch Positions

X	FREQ.	SW1a	SW1b/c
10	10-100	C1	C4/C7
100	100-1000	C2	C5/C8
1K	1K-10K	C3	C6/C9

Other Applications. During development of the circuitry, additional diode pairs were tried to see how far their "dynamic feedback" operation could extend the variable frequency range. Although two pairs gave some increase, this was at the expense of waveform purity. This distortion, however, can be put to use in the area of electronic music. The last diagram shows how a chain of diodes, with individually selected feedback resistors may be switched in to provide for the generation of interesting synthetic tones . . . another benefit of this original FRAG! ■



This Piggyback SWL

Add 20 dB of valuable signal-grabbing power

by Herb Friedman W2ZLF

BACK BEFORE EVERYTHING came in transistorized subminiature packages, virtually all serious SWLs and radio amateurs used a preselector ahead of the main receiver. No, not a *preamplifier*, we said a *preselector*. A preamplifier simply provides amplification, usually over a broad range of frequencies. With early single-conversion receivers, and the new solid-state high performance, budget-priced, single-conversion receivers, a preamplifier amplifies the image signal interference along with the desired signal. But a preselector, that's a whole 'nother thing. A preselector is a tuneable, high-Q preamplifier that passes only the desired signal frequency, and usually provides considerable attenuation at the image frequency.

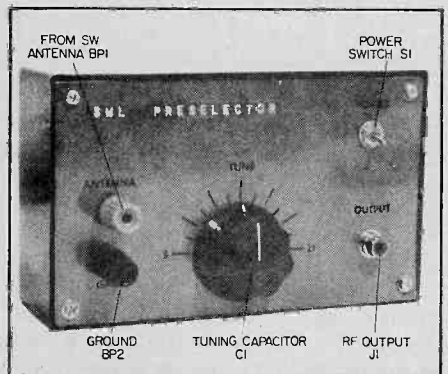
Unfortunately, preselectors have so much gain and sensitivity they had to be built like the Rock of Gibraltar in a cabinet almost as large as the rock itself in order to avoid self-oscillation. Many preselectors were as large as the boat anchors we used to call receivers, so like those old tube-type boat anchors, the preselector went the way of the Dodo.

But a preselector can still give a receiver a good solid kick in the antenna terminals, often digging out signals where you thought none existed. And the preselector can still reduce image interference in those inexpensive solid-state receivers that have terrific sensitivity and great stability, but poor image rejection because they're only single-conversion. What's that? You've got no room for a big boat anchor? Who mentioned anything about size? Using up-to-date technology and components, the same as you've got in that new receiver, you can build a rock-stable preselector that's got more selectivity than those old monsters, will work off an ordinary transistor radio 9-volt battery (or a lightweight line-powered supply) and will provide enough extra front-end selectivity to practically *squash* image interference in single-conversion receivers. Best of all, you can make the whole thing so small it can be glued right to the back of a sub-miniature tuning capacitor—hence the name—"Piggyback Preselector." The unit shown in the schematic and photographs provides from two to three S-units extra sensitivity (about 12 to 20 dB extra gain), depending on the particular receiver it's used with.

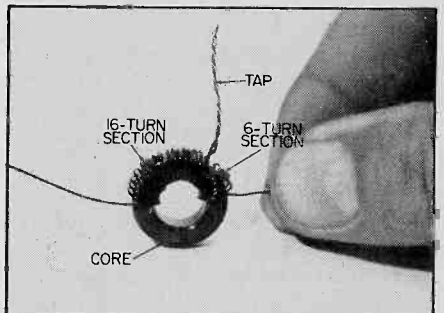
The Design. Input coil L1 is home-brewed on a toroid form. Since toroids have exceptionally high Q the input tuning is razor sharp—sharp enough to attenuate the image frequencies. In fact, if this unit is tuned to 10 MHz while the receiver is tuned to 20 MHz virtually no signal will pass through the preselector into the receiver. On the other hand, when the preselector is tuned to the desired frequency it can really snatch signals up out of the noise level.

Don't worry about static signals blowing Field Effect Transistor Q1 because it's a special type with built-in protection diodes from the gates to the source and drain. In normal operation the diodes are inactive, and Q1's input impedance is extremely high and does not load down L1. Transistor Q2 acts as a matching device and power amplifier, providing a low impedance output for the input of the associated receiver.

Both L1's input impedance and the preselector's output impedance have been adjusted so the unit delivers good performance with every combination of antenna and receiver. While it might be



Plastic cabinet may be used but the front panel should be aluminum or other metal. Input (BP1) and output (J1) connections must be kept apart.



A toroid coil is the easiest home-brew because neatness doesn't count. If the turns aren't spaced just so, or the turns unwind a bit as you make the coil, it won't make any difference. Just spread the turns so they take up about one-half of the form. Don't spread turns to take up entire form.

Preselector Will Make You a Pro in One Evening

possible to get slightly improved overall performance by specific tailoring of the input and output for a given antenna type and receiver, we make no recommendations and suggest you build the model as described with no changes or substitutions. Only if you cannot obtain the specified Q1 should you try a substitute, and a 40673 is suggested. The 40673, however, might require some experimentation with the values of R1 and R2. The correct values provide approximately 5 mA to Q1 and 1 mA to Q2. Bear in mind, however, that we suggest the unit be assembled exactly as described.

The unit shown covers the SWL frequencies from approximately 5 to 21 MHz, actually reaching the top of the 15-meter amateur band. To get optimum coverage of the 15-meter band one turn can be removed from L1 (we'll explain this later). This modification will provide a greater 15 meter adjustment range for tuning capacitor C1.

C1 is a sub-miniature tuning capacitor with a *long shaft* and a plastic dust cover over the stator and rotor plates. (It is available from Radio Shack as No. 272-1341. Do not substitute a similar capacitor that has a calibrated tuning knob and lacks the dust cover. The shaft on the specified capacitor also provides the panel mounting while the dust cover is the support for the rest of the project.)

Construction. We built the entire preselector, except the transistor radio battery which supplies the power, on a special type of perf board which has circles on the back of each hole to facilitate soldering and securing the components in place. We recommend, however, that you make a printed circuit board from the layout shown, unless you are somewhat experienced in point-to-point wiring. The location of the components on the circuit board is shown in another drawing.

You'll have no special assembly problems as long as you follow the parts layout shown in the photographs. The unit will be completely stable and free of birdies and dead spots as long as the input is at one end of the board and the output is at the other end. But if you re-arrange the layout and get the input and output within an inch or so of each other it will almost certainly oscillate, and fail to work.

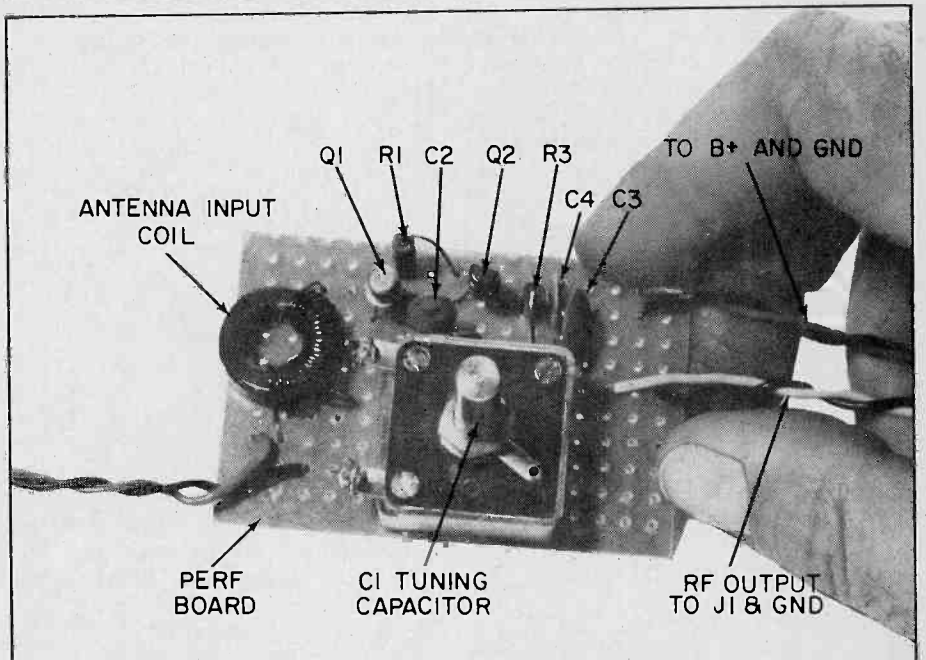
Mark off the approximate location of the tuning capacitor on the circuit board and then complete the board assembly, including the power, input and output wires. These can be about six inches long.

Toroid Assembly. L1 presents no winding problems as even sloppy assembly will work—that's the nice part about toroid coils. Use solid, enameled #24 copper wire to wind the coil. Clamp about three feet of wire in a vise and pull gently on the free end until the wire goes dead slack. By thus taking the spring out of the wire you make it so it won't unwind as you make the coil. Wind six turns, tightly, around the toroid core and bring the end out about two inches. Fold the wire back to the core, forming the ground tap, twist the wires a few times to secure them, and then wind sixteen additional turns *in the same direction as the first six.* Using a knife or razor, scrape the insulation from the wire ends and the tap. Then tin the wires and the tap with solder. Spread the turns so they are roughly equal-spaced, using about one-half the total core. Do not spread the turns to take up the entire core, as is usually suggested. This time, half way is best.

This coil will give frequency coverage with this tuning capacitor about 5 MHz to 21 MHz—just about to the top of the amateur 15 meter band. If you want to be able to tune through 15 meters with tuning capicitor C1, eliminate one turn of the coil's longer winding—make it 15 turns. Do not make any changes to the initial six turn winding. This is the antenna winding and remains the same.

Board Construction. Assemble the perf board circuit as shown—everything except C1. Using silicone rubber adhesive such as G.E.'s RTV, cement the circuit board to the back of C1. After the adhesive has set (overnight), connect C1 across L1's secondary. Make certain C1's rotor, which connects to the tuning shaft, is wired to L1's grounded tap. Use an ohmmeter to determine C1's ground (shaft) terminal if you can't tell by looking. But don't guess; if you guess wrong the tuning will change when you remove your hand from the tuning knob.

Okay, it's all wired. What will you do with the piggyback preamplifier? Since the total current drain is about



The completed preselector ready for installation in a cabinet. The circuit board cements to the back of the tuning capacitor. Note that L1 is flat against the board and all wiring to other parts is also installed on the board. Board may be perf-type shown, or, recommended for beginners, the printed circuit type described in text.

PIGGYBACK SWL PRESELECTOR

5 mA you can use an ordinary transistor radio battery for a power supply and shove the whole thing into a plastic utility cabinet as shown. Just as long as the front panel is aluminum (or other metal) a plastic cabinet can be used.

If you don't like using battery power you can use a slightly larger cabinet and assemble the power supply shown in the schematic. But remember, you only need a 5-mA capacity, so keep T1 small. If you end up using a standard filament transformer for T1 the cost might exceed several years' supply of batteries.

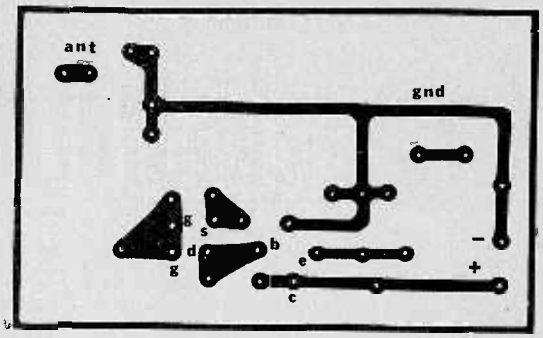
Final Connections. Use some kind of coaxial output connector for J1. Even a standard phono jack can be used. Use coaxial cable such as RG-58 or RG-59 between the preselector and receiver and keep it as short as possible.

If you have a *longwire* or *random* antenna use 5-way binding posts for the input (remember, the antenna post must be insulated from the panel). If you have a coaxial antenna system eliminate the ground binding post and substitute a coaxial connector for BP1. This connector can also be the phono type.

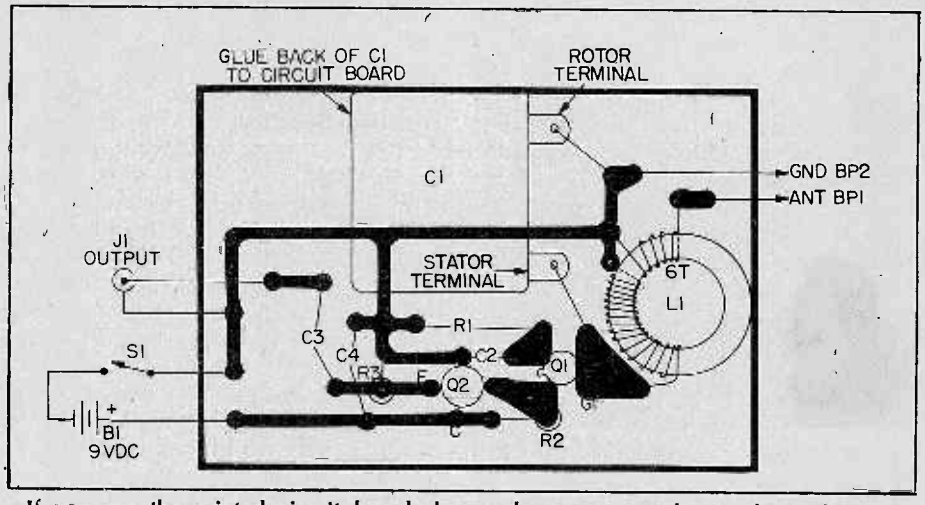
Calibrate! The tuning is so sharp the preselector must be tuned near the desired frequency or you might not hear anything at all in the receiver. Use whatever calibrations on the panel you find necessary to put the preselector tuning inside the ballpark.

After a signal is tuned in on the receiver, peak it with the preselector. If the receiver has an antenna trimmer or tuning control make certain you also peak the signal with the trimmer.

If some local signals come in strong enough to overload the unit, just detune it slightly to reduce its sensitivity and get rid of the overload. ■



Full-size layout for printed circuit board (foil side up) is shown here.



If you use the printed circuit board shown above you can locate the various components on the board by means of this drawing. Parts side is shown.

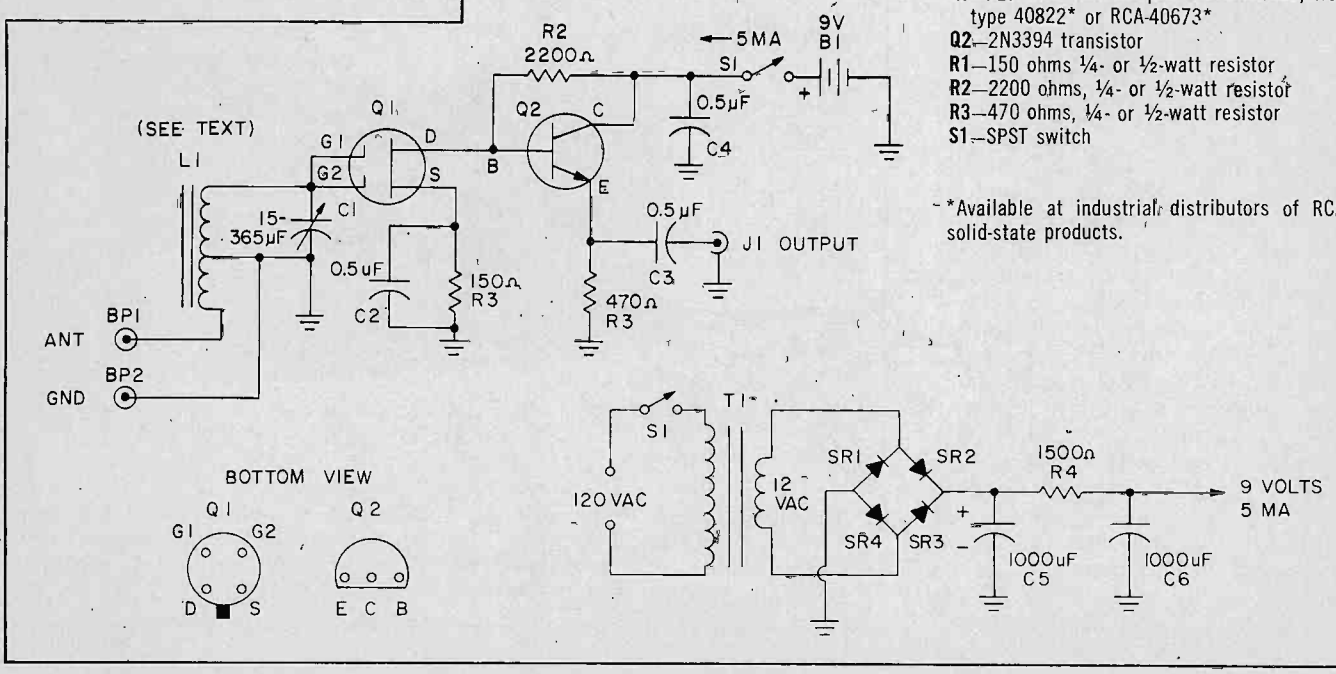
PARTS LIST FOR PRESELECTOR POWER SUPPLY

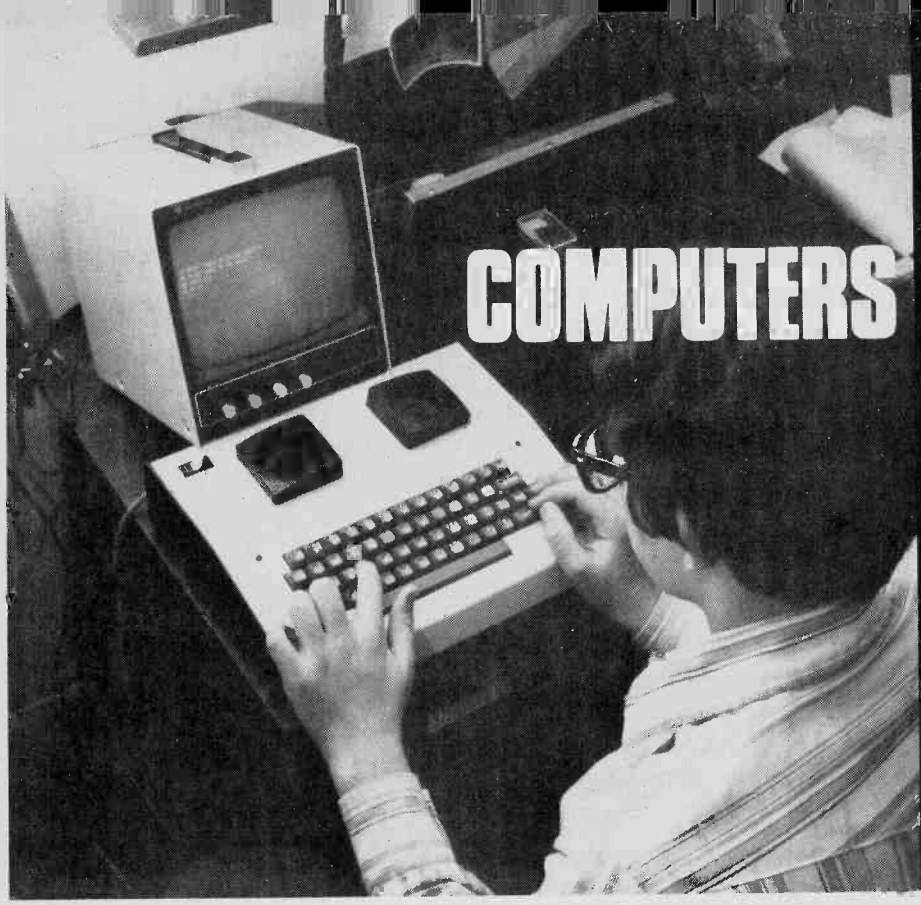
C5, C6—1000 uF 15 VDC capacitor
R4—1500 ohms, ½-watt resistor
SR1 through SR4—Silicon rectifier bridge, 50 PIV
T1—Power transformer 12-VAC secondary

PARTS LIST FOR SWL PRESELECTOR

B1—9VDC transistor radio battery
BP1, BP2—5-way binding posts
C1—365 pF subminiature variable tuning capacitor
C2, 3, 4—0.01 or 0.5 μF ceramic disc capacitors, 100 VDC
J1—Phono input jack
L1—Amidon T68-2 toroid coil form, $1.75 postpaid from Amidon Associates, 12033 Otsego St., No. Hollywood, CA 91607.
Q1—FET with internal protective diodes, RCA type 40822* or RCA-40673*
Q2—2N3394 transistor
R1—150 ohms ¼- or ½-watt resistor
R2—2200 ohms, ¼- or ½-watt resistor
R3—470 ohms, ¼- or ½-watt resistor
S1—SPST switch

*Available at industrial distributors of RCA solid-state products.





COMPUTERS PHONE THE FUTURE

How to link your home to today's new, computerized nerve-centers.

by Herb and Lawrence Friedman

EVEN IF YOU NOW haven't the vaguest interest in personal computers, within a year or two you will likely be up to your neck in personal computing whether you like it or not; and by *personal computers* we don't mean a Hewlett-Packard or TI programmable calculator—though they are, in fact, personal computers.

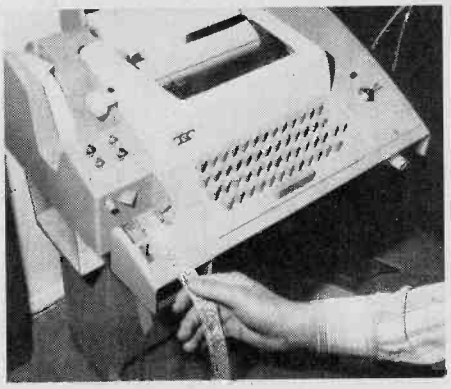
Personal computer means a full blown computer you can use to keep and process business and family records; one your children can, and probably will, use for their math, science and social studies—at all levels from grade school up; a computer your preschool children might use to play games such as *Star Trek* and *Klingon Capture;* a computer you could use for adult education courses taken in the comfort of your own home.

For less than the cost of a decent hi-fi system, or a console color TV with remote control, you can have a computer in your own home as powerful as some of the big IBM jobbies, and the whole computer won't take up much more space than a couple of shoeboxes. If you don't have room for two shoeboxes worth of electronic hardware you can rent computer time from regional and national companies. For example, did you ever wish you had an hour or so of computer time to finish a school problem? *Call Data* will charge you as low as $6 per hour (educational rate) for using their computer. If all you need is a couple of hours on their computer per month the bill could be less than your phone company charges you for the privilege of having a telephone.

Whether you opt for a personal computer in your own home, or a connection through your telephone to a time-share computer service you are going to need a *terminal,* the device that lets you communicate with the computer.

Trouble is, the surplus market is loaded with *computer terminals* that are really worthless for general use, so this article is going to serve as both an introduction to computer terminals and a guide as to what's available and really worthwhile.

Because of space limitations we cannot cover every type of terminal used to communicate with computers. Since the average reader will have access to a time-share dial-up computer, (via the telephone) or a personal computer in the home, we are going to cover only the terminals that work with both systems. There is no reason to spend several hundred dollars for a terminal that works with a personal computer only to find that if someone offers you free time on a giant time-share system your terminal can't be used



By simply feeding punched tape through the reader, as shown, a computer will accept a program at the maximum TTY speed of 110 words per minute. This particular program will require a full thirty minutes of computer time and will check every single bit of memory in an 8K word memory board.

Two Piece Terminals. At the very minimum a computer terminal consists of two separate devices: a typewriter style keyboard that transmits information to the computer, and a display device that "prints" the information coming from the computer. The display can either be some form of printer that "types" a written record—called "hard copy"—on paper; or a CRT, which can be a TV monitor, a modified TV receiver, or anything else using a CRT.

As a general rule the two sections—keyboard and printer—are totally independent even though you might have used, or observed, a working computer and seen that whatever was typed on the keyboard was printed out on the display. The keyboard transmits information to the computer, which then *echoes* back to the display so the user can check the entry. If the user types the word *ready* the computer echoes back the word and the display shows the word *ready*. Without the echo the user would have no idea whether he was transmitting correct data into the computer. The condition of separate

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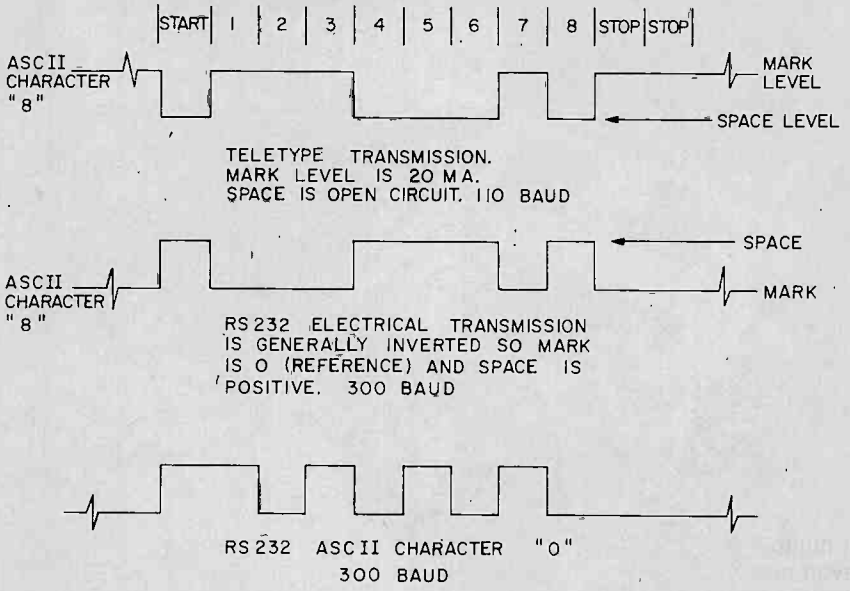
keyboard and display is termed *full-duplex,* meaning two things can occur at the same time—you can transmit and receive simultaneously.

Another condition is termed *half-duplex,* and there appears to be several versions of what is meant by half-duplex. The most common use feeds the keyboard character to the display and the computer. When the computer echoes back, the display shows both the original keyboard entry and the echo. In full-duplex, a keyboard entry of ABCD is displayed via the echo as ABCD. In half-duplex the display shows AABB CCDD. In full-duplex the word *ready* is displayed as READY; in half-duplex it appears as RREEAADDYY Half-duplex transmission is commonly used when time cannot be allowed for the computer to echo back. There are certain conditions when this is necessary, and the half-duplex mode, at the least, allows the user to check *spelling* and codes as they are entered into the computer.

Local is a term meaning the keyboard is connected directly to the printer so that keyboard entries are fed only to the display and any recording device attached to the display. In this manner a tape can be prepared for transmission to the computer at a later time.

If the terminal is in the vicinity of a computer it can be connected directly to the computer via multiple wires—this is termed *hard wired.* On the other hand, it is possible to use the telephone to "converse" with a computer on the other end of town, or even the country. The terminal is connected to a device called a *modem,* an acronym for *Mod*ulator-*Dem*odulator. Some modems can be hard wired directly to the telephone line; others can be acoustically coupled by simply placing the telephone's handset into a built-in receptacle. The modem takes the signal from the keyboard and converts it into audio tones which are fed to the computer through the telephone line. At the receiving end, a different type of modem converts the audio tones back to an electrical signal for the computer. Each modem is a two-way device. The modem at the computer takes the computer's output electrical signal and converts it into audio tones for transmission to the terminal. At the terminal the modem converts the audio tones back into electrical signals needed to drive (produce) the display. To avoid a mix-up on the telephone line the audio tones from the

TECHNIQUES OF ASCII INTERFACING



All time-share and most of the larger personal computers use an electrical character code termed ASCII, short for *A*merican *S*tandard for *C*ommunications *I*nterchange of *I*nformation, and pronounced "as-key."

The 8-level ASCII code presently in use was designed for teletype so the associated terminology refers to TTY operation even if the entire communications system is electronic with a CRT for the display.

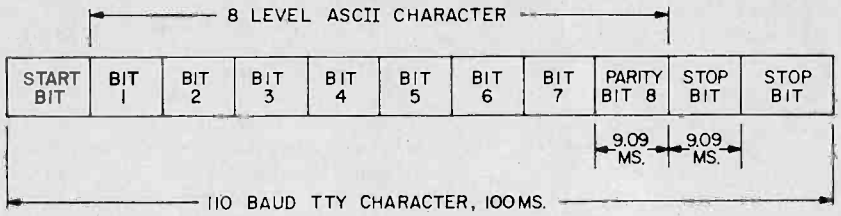
The TTY terminology in turn goes back to the days of the telegraph when one or a series of magnetic sounders was connected in a battery powered loop through the telegraph keys. Since everything was in series, the normal *off* condition was for current to flow in the loop and this condition was called *mark.* When the key was open to send a character the current loop was broken, the sounders made a "click" and the open current loop condition was called *space.* We still use the terms *mark* and *space* today. When a computer's TTY is connected to its associated equipment and it is not receiving a character signal it is fed 20 mA of current for the printer—the *mark* condition. To send characters the current is interrupted—the *space* condition. (You might have to read this over a few times to get the sense because it appears to be the opposite of what's needed. As we'll show, in electronic systems we invert the signal so *mark* is generally zero current or voltage and *space* is some amount of current or voltage.)

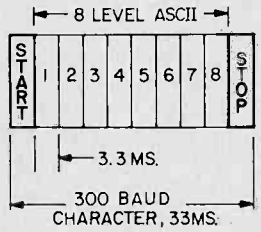
On to the next confusion. The 8-level ASCII character code really uses only seven *bits* to transmit the character; the eighth bit is for something termed *parity,* and even here we don't stop because there must be signals to synchronize the sending and receiving equipment. After all, something has to tell the printer that the electrical pulses to follow are a character and not line noises. So we add a *start* bit in front of the character. Now we must turn off the printer so it doesn't generate "garbage" sensing line noises as character bits. For this we follow the parity, or eighth bit, with two stop bits. Now we have a total of 11-bits making up the 8-level ASCII TTY character, as shown in our earlier diagram.

Note that each bit is 9.09 msec wide, making a total character length of 100 msec. The start bit turns on the printer, the first seven bits represent the character—either letter, numeral, control function, etc.—and the stop bits insure the printer stops and resets for the next character.

The parity, or eighth bit, is used to "test" the transmission when there is the possibility noise can obliterate, or add, a bit. The keyboard can be programmed so the parity bit is added to provide odd or even parity; that is, the *total number of character bits* from one to eight is even or odd.

Assume the keyboard is programmed for even parity and the letter Q is transmitted. The letter Q uses three bits—Numbers 1, 5 and 7. Three is an odd number so the eighth bit is automatically added, making the





total number of bits transmittted four, an even number. At the receiving end only the first seven bits are processed, giving the character Q. A *parity* detector, however, counts all the bits; if it's not an even result the printer might indicate an incorrect character has been received, or the parity detector might light a lamp or sound a bell to indicate something is wrong with the transmission. If the character originally had an even number of bits, such as the letter V which uses bits Numbers 2, 3, 5 and 7, the eighth parity bit is not added since the transmission has an even number of bits for the character, and the parity detector "sees" an even count. Both the keyboard and parity detector can be programmed for even or odd parity. Where there is a direct connection to the computer, or a circuit with little likelihood of noise, the parity detector is usually disabled or simply not used.

Though a TTY requires a bit length of 9.09 msec. the resultant 110 words per minute printer speed is too slow for most users. 300 WPM is the standard for electronic terminals used by time-share (with echo) and personal computers. We get the higher speed by simply reducing the time of each bit to 3.3 msec., and by eliminating the second stop bit.

The actual TTY transmission of the No. 8 is shown in the topmost figure. Note that the reference is *mark,* and the transmitted bits are *start,* 4-5-6, stop-stop. The middle figure shows the electrical equivalent as would be transmitted by an electronic keyboard using the EIA's RS-232 standard. Note that *mark* is now "O" (zero) and the waveform appears as a conventional waveform with the bits positive-going. (Yes, RS-232 provides for a negative-going waveform resembling the TTY waveform shown in the topmost figure). Note that the RS-232 character shown is 300 *baud* so the second stop bit is eliminated.

In both the top and middle figures bit number 1 is not used so the start bit stands alone. The bottom figure shows what occurs when bit 1 is part of the character. The letter "U" has alternating bits starting at bit 1, so bit 1 combines with the start bit to form a "pulse" double the reference bit length of 3.3 msec. The receiving device senses the leading edge of the start bit, times out for 3.3 msec. and since it "sees" a signal at the start of the next 3.3 msec. interval it "counts" bit 1. It is through the timing that the receiver counts bits. For example, in the top figure bits 4, 5 and 6 run together and "appear" as part of a square waveform. In actual fact the TTY doesn't recognize a square wave; its timing mechanism simply counts three contiguous bits followed by a space.

In both TTY, modem, and most personal computer use each ASCII character is transmitted *serially,* meaning one bit follows the other. There are special circuits, however, that require a *parallel* transmission, that is, all bits are transmitted through at least seven wires at the same time (eight wires if parity is used). This is generally done electronically with each bit represented by a *high* (logic 1).

The subject of the ASCII code and its transmission is rather extensive. We have featured the general highlights you'll need to know as you get started in using computers. A more complete explanation geared for hobbyist use can be found in the Sam's publication **TV Typewriter Cookbook** by Don Lancaster. If possibe, avoid the TTY service manuals and handbooks; you need a whole set to find out what's going on and the Cookbook is faster and more easily understood.

terminal are at a different frequency than those from the computer.

The basic input/output device for both time-share and most personal computer systems is the model 33 teletype, and the terminology for the model 33 has become, more or less, the accepted terminology for all I/Os. A model 33 printer (no keyboard) is called an RO for *R*ead *O*nly. CRT displays, or any other type of printer without an associated keyboard are usually termed ROs.

A model 33 teletype which consists of a printer and keyboard is termed a KSR for *K*eyboard *S*end and *R*eceive. Any other type of TTY or CRT terminals with a keyboard and display is termed a KSR.

Then there is ASR for *A*utomatic *S*end and *R*eceive. This is a model 33 TTY with an attached paper tape punch and a reader to read back the paper tape. The tape can be punched either from the keyboard in the *local* operating mode, or by the computer via the echo. The punch is mechanically attached to the printer so whatever the printer receives (with some exceptions programmed through a "stunt box") gets punched out on the tape. The reader feeds out as does the keyboard. If the tape is played (or *read*) by the reader, the output from the TTY is just as if it was sent from the keyboard. Both the punch and reader can be controlled from the computer by special signals, hence, this type of TTY is termed Automatic Send and Receive, or ASR Any similar terminal device is known as an ASR.

Though the model 33 TTY, and its designations such as RO and KRS, is the common standard of reference for most hobby and time-share computer systems there are other keyboard-printer devices that provide similar functions. Other straight TTY equipments are available as ASR and KSR equivalents of the model 33; and there are special *line printers* that print an entire line of copy at high speed, in contrast to the TTY's one-letter-at-a-time printout.

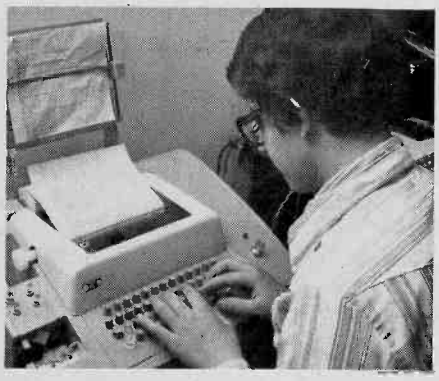
Smart and Dumb. Another variation is the "dumb" CRT terminal. This is a keyboard and CRT display made to function exactly as a KSR TTY. Though all-electronic, it puts out exactly the same type of signal as a TTY and responds to the same input signal, printing one letter at a time at TTY speed on the CRT. A slightly different version of the KSR electronic TTY puts out something called an RS-232 signal, an industry-wide TTL (transistor-transistor logic) compatible signal used for direct connection to computers and some modems; but it's still a "dumb" terminal.

PHONE THE FUTURE

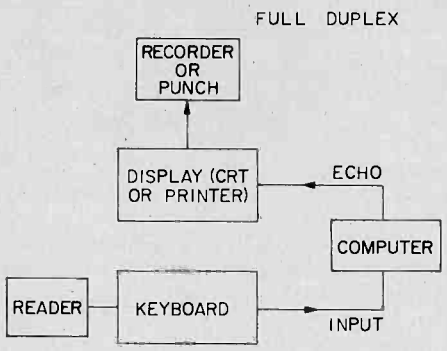
What's a "smart" terminal? An electronic terminal with a built in minicomputer. A smart terminal allows the user to type a full page into storage, examine the page for errors, make corrections, and then transmit the signal. In some smart terminals additional information can be typed into storage as the previously entered information is sent out. On the receiving end, a smart terminal can often store several pages of transmission, allowing the user to electronically roll back to previous pages. (A full screen is usually a page.) Some smart terminals are actually full computers with built in KSR and can store thousands of words, but this is esoteric equipment. The typical hobbyist and time-share user is more likely to use an inexpensive, dumb KSR electronic terminal such as the highly rated Micro-Term ACT-1, which has 300 *baud* (we'll explain *baud* later) RS-232 output that can be fed directly to a hobby computer or into a modem such as the Omnitech 701A (the industry "work horse" available used for about $150) that has both a TTY and RS-232 connection.

For those who need both a direct RS-232 output and a modem, but who don't want the modem as an extra piece of gear with its required wiring there is the ACT-2 terminal shown in the photographs. The one shown is a prototype sent to ELEMENTARY ELECTRONICS for test and evaluation. It is essentially the ACT-1 with a built in modem.

Baud. Whether you go into personal or timeshare computer systems you're going to hear and read much about something termed *baud* or *baud rate*. Very simply, *baud* is expertese for something we used to term *pulse width*, or *time;* it's sort of like when the experts decided to upgrade electronics by deciding we must all call cycle-per-second *hertz*.

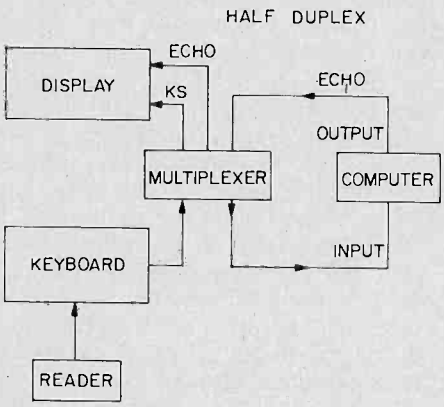


Here it is—the standard of reference for many time-share and personal computer installations. This model 33 teletype is used whenever hard copy, a written record, is required. The model pictured is an ASR—Automatic Send and Receive. Visible to the left is the paper tape punch and reader.



For computer use a terminal—whether TTY or electronic with CRT—is generally arranged in the full-duplex mode, meaning the keyboard and display are independent of each other. In some instances the keyboard will have an associated reader that can provide output from a punched tape (or other player), while the display has an associated recorder, or a punch for paper tape. If there is an associated reader and punch the complete terminal is an ASR (Automatic Send and Receive).

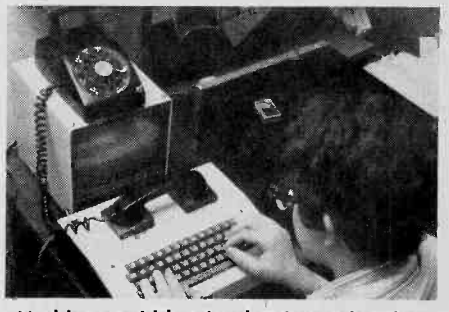
The keyboard sends the characters to the computer which in turn sends back an instantaneous echo to the printer/display. It appears to the user that he is typing directly to the display though there is, in fact, no direct connection between the keyboard and display.



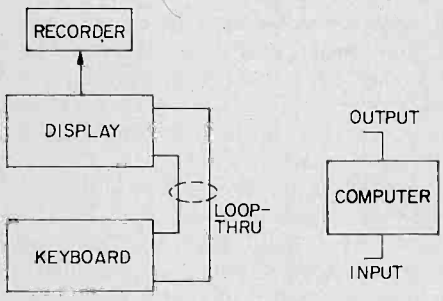
In the half-duplex mode a form of multiplex device somewhere in the overall system—it can be a simple wire from the keyboard—sends the keyboard signal to the display even if the computer's echo is turned off. If the echo is left on the display will show each character twice, once from the direct connection from the keyboard followed by the echo. Half-duplex is generally used when the terminal operates at baud rates too fast for the printer to follow the echo, or too fast for the computer to handle the incoming character plus the echo. In time-share and hobby personal computer systems the echo is usually turned off at baud rates higher than 300.

In order for electronic systems to communicate there must be some form of synchronization; each character or command must be transmitted and received in a specific time interval. If a printer was programmed to receive a character in say, 100 milliseconds (msec.), and it received one and a half characters in 100 msec., obviously it would be confused and display incorrect information, just as it would if it received only half the character information in 100 msec.

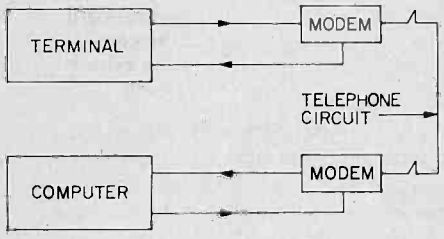
As you might have guessed, we achieve synchronization by transmitting any character in a specific time interval. If you refer to the illustration of an ASCII TTY signal you'll note it consists of 11 bits—the start bit, 7 character bits, parity, and two stop bits—with each bit being precisely 9.09 msec. in width for a total of 100 msec. Now *baud*, or *baud rate* is very simply the reciprocal of the pulse width of each bit. Since the pulse width of each ASCII TTY bit is 9.09 msec the *baud rate* is 1/.00909, or 110. That's all there is to it. We could just as easily



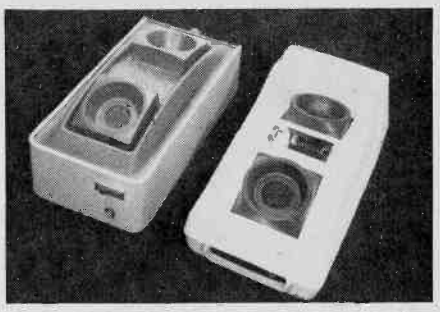
Nothing could be simpler than using the ACT-2's coupler. Just place the telephone handset in its niche and have full access to such systems as Call Data which accommodate virtually all programming languages. Call Data, for instance, can do such things as feed back a cross assembler for your personal computer, or provide access to the Dartmouth University program library.



When a terminal is switched to the local mode the keyboard is connected directly to the display via a loop, and the computer is disconnected. In this way the keyboard entries are fed directly to the printer and tape punch of an ASR TTY, and tapes can be prepared for feed to the computer at a later time. It also permits characters such as control functions to be added to a punched tape that has been previously made from a feed by the computer using the full or half duplex modes. (In half-duplex the computer can feed the display if the keyboard is not in use. This is usually accomplished by sending special control signals to the computer.) In electronic terminal systems with CRT display the recorder might well be a digital tape recorder rather than a TTY-type tape punch.



A terminal can be connected to a computer through voice-grade telephone circuits using a device termed a modem, an acronym for modulator-demodulator. The modem converts the terminal's electrical pulses to tones in the approximate 1000 to 2000 Hz range. When the tones are received by the computer's modem they are converted back to electrical signals. Each modem is a two-way device: the computer's modem converts the computer's signal to audio tones and feeds it to the terminal's modem where it is converted back to an electrical signal for the printer or display. To avoid confusion between the terminal and computer the tones from the terminal are completely different from the tones generated by the computer's modem.



Here we have both the accepted standard of the industry and a promising newcomer. The modem on the left is the Omnitec 701A and originally cost more than $400. It handles both TTY and RS-232 inputs and can be directly connected (hard wired) to the phone line; it also provides half and full duplex switching. Used ones can be had for about $150. On its right is the new Omnitec 501A—specifically made for the model 33 TTY. It is available fully assembled for $150, and as a semi-kit for $100—all PC board wiring complete, it just needs to be placed in its cabinet. It too provides both half and full duplex. Avoid hobby-type modems which do not have a duplex switching option directly available on the front or rear.

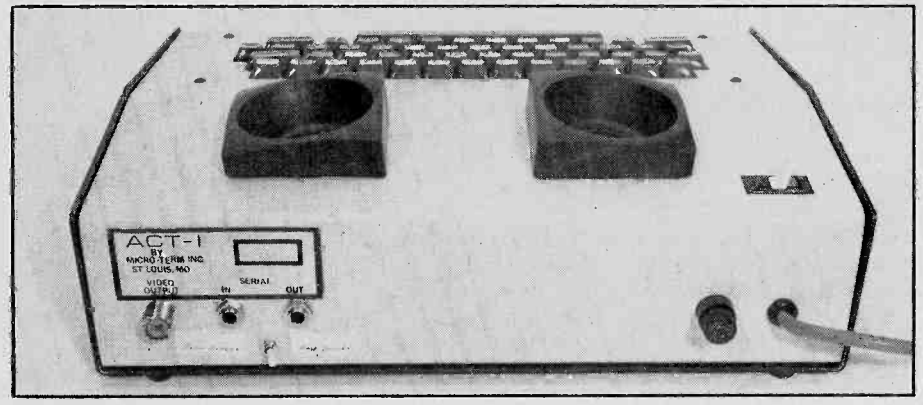
have called it the "Irving rate," the "Gloria rate," or the "9.09 rate." We call it *baud rate*, and a 110 baud rate is always 8-level TTY speed.

Trouble is, the TTY is capable of printing a maximum of 100 words per minute typing rate, which is fine for someone typing away, but slow when getting information back from a computer.

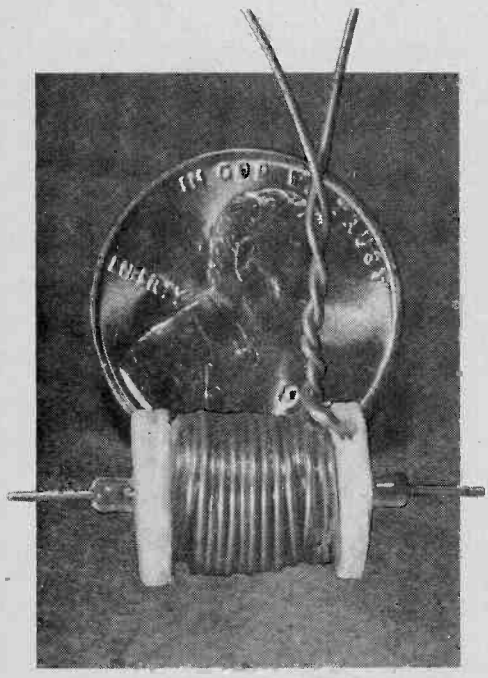
Though there are printers capable of displaying more than 100 words per minute they cannot print faster than the information is transmitted, and the limitation remains the speed at which the ASCII characters are transmitted. But, the ASCII format applies to the sequence of the eight bits making up the character and parity (a self-checking feature). If each bit were shortened each character would take less time to transmit, and that's exactly what is done. By general convention, for most personal and time-share *high speed* terminals the character bit rate is shortened from 9.09 msec to 3.3 msec., Almost three times as much information may be transmitted within a given time interval as compared to a 110 baud TTY. If we find the reciprocal of 3.3 msec. (1/.0033) we get an answer of 300, meaning a 300 *baud* rate. You will find most hobby CRT terminals such as the ACT-1 and ACT-2 to be 300 baud.

The fact that 110 baud means 100 words per minute and 300 baud means 300 words per minute doesn't mean there is a direct relationship between baud rate and words per minute. The close relationship is purely accidental. (If you get out the calculator and start multiplying you'll probably claim a 300 baud rate should produce less than 300 words per minute. The "error" comes in because the TTY signal has two stop bits which take up a total of 18.18 msec. The complete TTY signal is 11 bits; start, 8 characters with parity, 2 stops. The 300 baud system has only one stop bit—ten bits total for the character—so the stop is 3.3 msec,

(Continued on page 99)



This actual prototype of an ACT-2 uses an older ACT-1 (hence the label) with a built-in modem for interfacing to the telephone lines. The video output feeds a TV monitor (CRT) and the two pieces make up a complete terminal. Inputs and outputs are RS-232 and when phone plugs are inserted the modem is automatically disconnected. A switch for full duplex or half duplex is located directly under the phone jacks. Using the modem is just a matter of pulling the plugs and then placing the handset in the coupler.



CUSTOM RELAYS ...AT MASS PRODUCED PRICES

By Erik Hyypia

☐Custom build your experimental relays from magnetic reed switches and save a bundle. The reed switches are very inexpensive and all other components can be found in your junk box. The simplest relay will run you about thirty cents. There are even other advantages. The relays are highly sensitive and can be coupled directly to audio circuits for experimental purposes, their light weight and tiny size make them ideal for model applications, and they are even applicable to high speed switching circuits because of their extremely short response times.

The Basic Relay. Wrap a coil of wire around a reed switch (Radio Shack Cat. 275-034 "Mini" or 275-035 "Micro Mini") and hold it on by end pieces cut from some thin, rigid material such as cardboard. The reed switches—especially the "Micro Mini" size—are quite fragile, so play it safe and wrap the coil around a form of the same diameter as the reed switch (coat hanger wire, for example, for the "Micro Mini") then replace the form with the actual switch when the coil is complete. The length of wire used to wind the coil is not critical; about five feet of #24 gauge enameled magnet wire (Radio Shack Cat. No. 278-004) is sufficient. The coil will hold together better if you coat it with lacquer or model airplane dope.

A relay of this type will respond to as little as 0.5 volt. When connected to an audio signal generator, the relay responds to frequencies approaching 3000Hz and to somewhat higher resonant frequencies.

The basic relay can be modified in a number of ways. Though you will undoubtedly find more, here are a few basic examples.

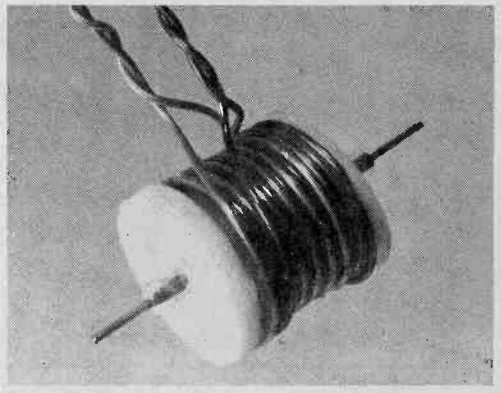
Multi-Pole Relays. Make these by using additional reed switches inside the coil. Four and five pole relays are simple to make, though extra windings may be needed to retain a high degree of sensitivity. If you need a relay with more than five poles, gang several smaller, fully assembled relays together by wiring their coils in parallel.

Latching Relays. Once triggered by a short pulse, this relay will remain on, it can be made by using two reed switches in the coil (see diagram). One switches the load, while the other is wired into the coil power circuit. When the momentary-on switch is pressed, the coil is energized, closing the two reed switches. Once the left-hand reed switch is closed, current will continue to flow through the coil even after the momentary-on switch is released. To turn the relay off, a normally-on, momentary-off switch is pressed to break the flow of current to the coil, thereby cutting off both reed switches.

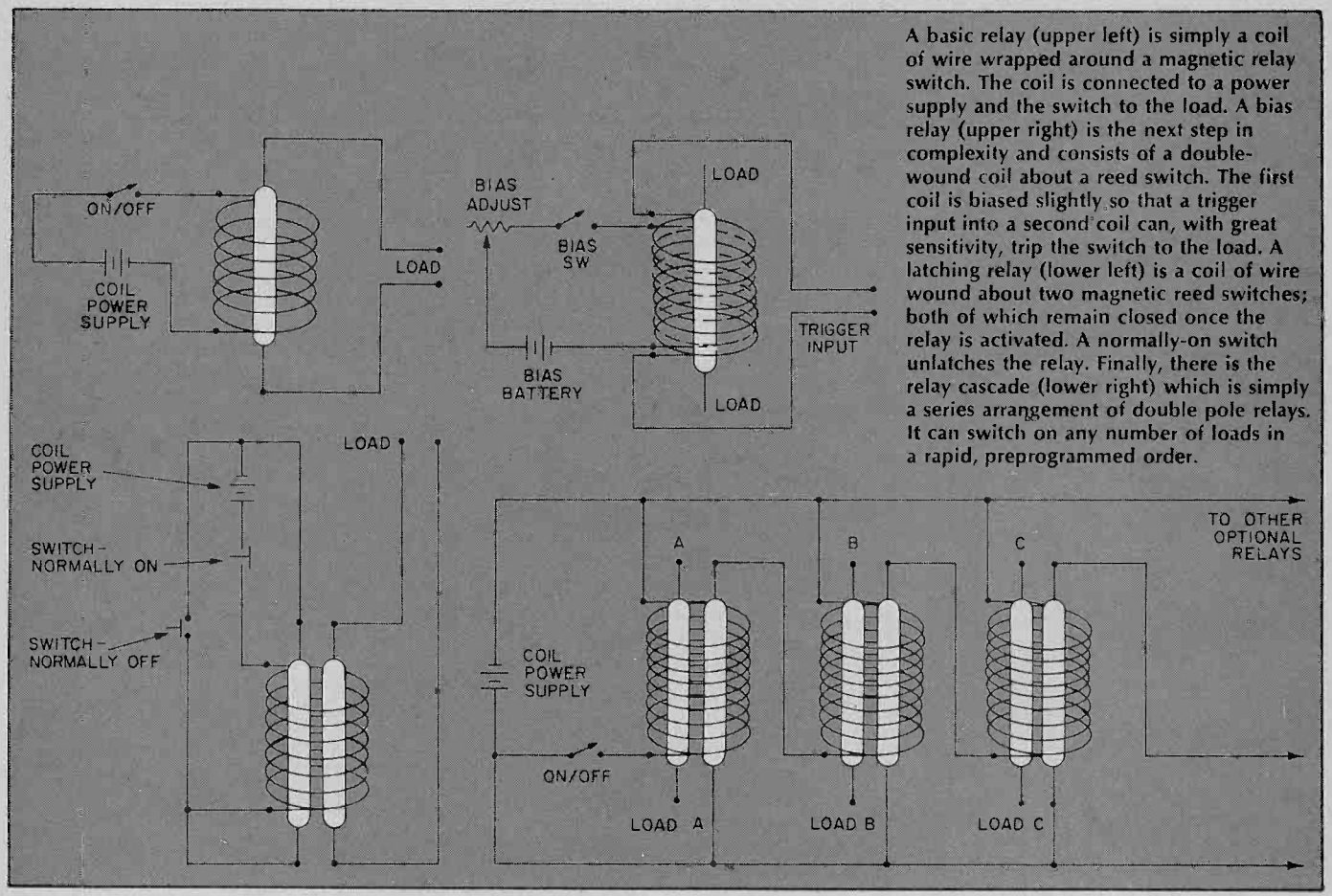
Biased Relays. In the simplest, basic relay the only magnetic field around the switch is that created by the trigger current flowing through the coil and it is this magnetic field that activates the reed switch. The sensitivity of the relay to the trigger current can be increased by biasing the magnetic field with either a permanent magnetic field or an electro-magnetic field.

The permanent magnetic bias is made simply by mounting a small magnet at the proper distance from the coil. To find the best positioning, move the magnet close to the relay until you hear the reed switch click on, then back off a tiny distance. The field created by the permanent magnet should be *almost* strong enough to turn the switch on, but not quite. Now any weak trigger current sent through the coil will be strong enough to kick the magnetic field above the threshold level needed to activate the reed switch.

A more flexible way of creating the magnetic bias is to double wind the coil using two wires instead of one. Connect your trigger input through one, as shown, and connect the other through the bias battery. The rheostat lets you set the bias field to the correct level, which, again, should be almost strong enough to make the reed switch click on. The resistance value of the rheostat will depend on what voltage bias battery you use.



The basic relay is as tiny as many commercial sub-miniature units, a whole lot cheaper, can be designed with greater versatility, and is a lot of fun to build. The basic relay, shown here, is nothing more than a coil of wire wound around a magnetic relay switch.



A basic relay (upper left) is simply a coil of wire wrapped around a magnetic relay switch. The coil is connected to a power supply and the switch to the load. A bias relay (upper right) is the next step in complexity and consists of a double-wound coil about a reed switch. The first coil is biased slightly so that a trigger input into a second coil can, with great sensitivity, trip the switch to the load. A latching relay (lower left) is a coil of wire wound about two magnetic reed switches; both of which remain closed once the relay is activated. A normally-on switch unlatches the relay. Finally, there is the relay cascade (lower right) which is simply a series arrangement of double pole relays. It can switch on any number of loads in a rapid, preprogrammed order.

One side note to all of this: if you use a transformer instead of a battery to power the relay coils, use a full-wave rectifier between the transformer and the relays. Alternating current or half wave D.C. will make the relay buzz on and off at 60Hz.

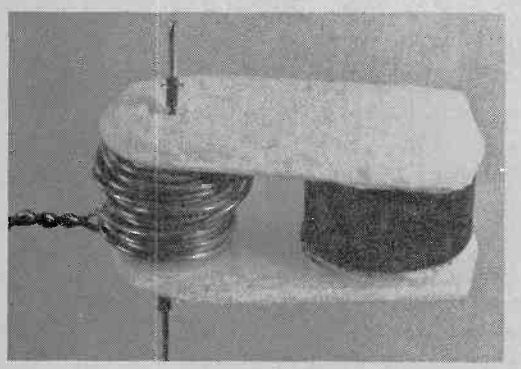
A Relay Cascade. This device lets you turn several items on with one flip of a switch, and have them come on in a specific order, one after another. The coil of relay A (diagram) is wired to the start switch, and the coil of each consecutive relay is wired through the reed switch of the previous relay. Thus, when the On/Off start switch is closed, relay A will come on, then relay B, then relay C, and so on. Theoretically, there is no limit to the number of relays you can cascade this way, although the power source may have to be increased to supply enough current. The current carrying capacities of both types of reed switches is 0.5 amps at 125 VAC.

The relays close and open extremely quickly—a "Micro-Mini" can cycle up to at least three thousand times per second, according to my rough tests, and will respond to resonant frequencies even higher. Thus, the closing time of the relay is, obviously, very short.

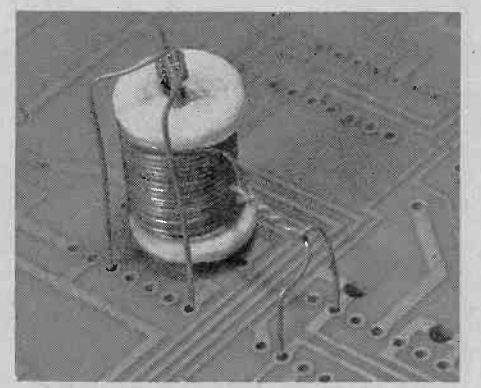
In closing. The applications of these relays are limited only by your imagination and the type of projects you build. Once you design something using one of these miniature marvels you may never again want to use one of the store-bought, bulky variety.

One tip: do *not* forget coating the coil of each relay with at least one good coat of lacquer or model airplane dope. Nothing is more aggravating than, sometime after the project is already built and functioning, having to rewind a relay coil which has spilled out of the form.

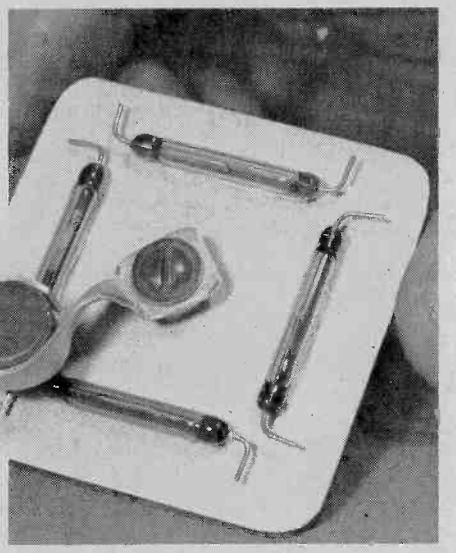
You're sure to find that switching with these relays is nearly as much fun as building them. ■



Here's a permanently biased relay, one of the more sensitive types you can design. Positioning the magnet nearby to the coil reduces the voltage necessary to trip the relay.



Because of their compactness, these home brew relays are easy to mount on a PC board. This particular double pole relay uses two switches within one coil.



CUSTOM SWITCHES ...THAT YOU COULDN'T AFFORD TO BUY.

By Jorma Hyypia

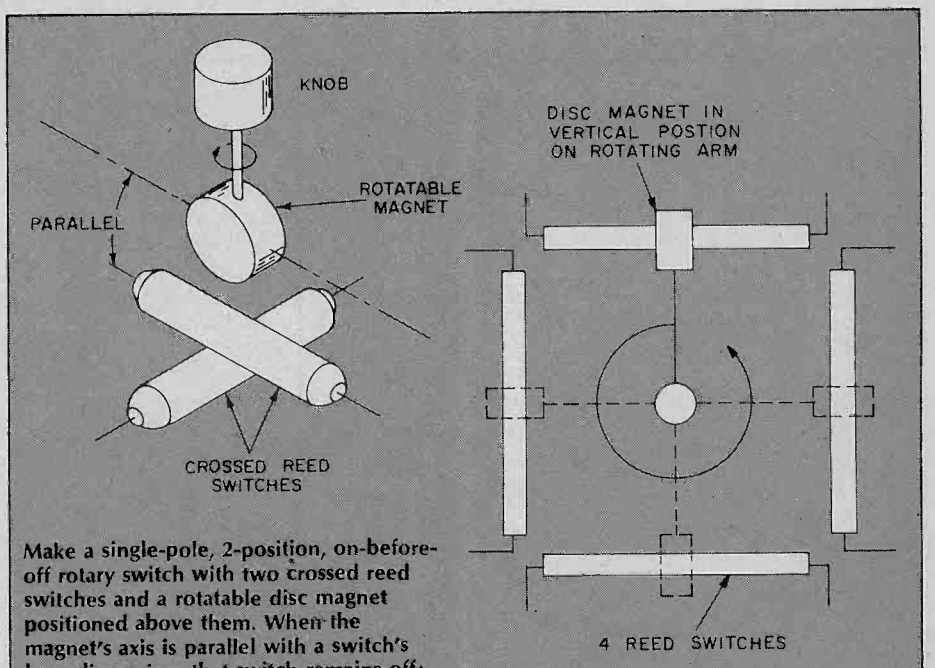
HOW OFTEN HAVE YOU searched fruitlessly for a special switch? Probably dozens of times—if you're at all an active builder. The next time this happens, consider custom-building your own complex switches using inexpensive magnetic reed switches and small ceramic magnets. Such do-it-yourself switches offer several advantages. They are relatively inexpensive, silent, and long lasting, as there are no rubbing contacts and the reed contacts are sealed in glass, away from corrosive atmospheric gases.

You can purchase two sizes of magnetic reed switches and the ceramic magnets from Radio Shack. The larger switch (Cat. No. 275-034; 1¾" overall length) comes in a 4-for-79¢ blister package. The smaller "Micro Mini" switch (275-035; 1⅛" long) comes 10 to a package, for $2.99. The magnets cost 10 cents each, regardless of size. The smallest, ½" diam. disc ("button") magnet is the most useful, but you may need the larger 1⅛" disc or 1" x ¾" rectangular magnets to build really large, complex switches.

The several custom-built switches shown in this article only hint at the virtually limitless design combinations that are possible. Study the drawings to learn how magnet orientation and direction of travel past the reed switches affect switching action.

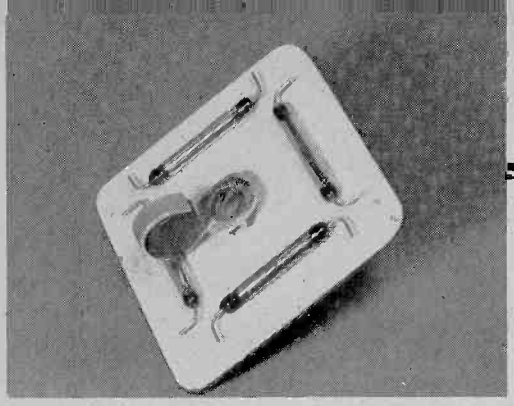
Carpetak Tape, a cloth tape with adhesive on both sides that is used to hold down carpets, is excellent for mounting the reed switches to panels. The switches adhere firmly, yet can be removed without damage. For greater permanence, you may wish to use epoxy cement for mounting once you know exactly where to locate the reed switches. Generally, it is best to locate the magnet and reed switches on the same side of the panel; however, it is also possible to put the switches on one side of a non-magnetic panel and orient the magnet on the other side. The ceramic magnets are of extremely hard material, and you may have poor success if you try to hacksaw them smaller. Try breaking the magnet by clamping in a vise and striking with a chisel; it may not break cleanly across, but grinding on an emery wheel may be practical. When possible, just use the magnets as they are. Mount them in aluminum holders as shown here, or glue to support arms with epoxy adhesive.

The following brief descriptions of various switch types should help clarify the principles of building switches:

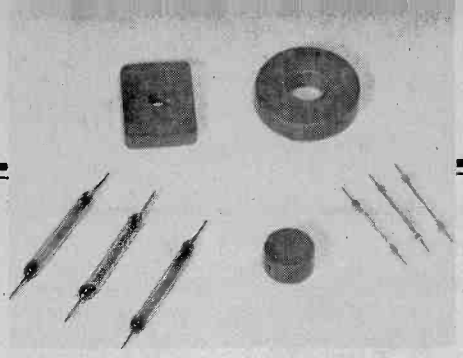


Make a single-pole, 2-position, on-before-off rotary switch with two crossed reed switches and a rotatable disc magnet positioned above them. When the magnet's axis is parallel with a switch's long dimension, that switch remains off; the other switch is simultaneously on. In the intermediate, 45° position, both switches are on. Use this arrangement when the second switch must come on before the first switch turns off.

A single-pole, 4-position switch is accomplished by a vertically-oriented disc magnet passing over four reed switches, which are arranged in a square.



A rotary switch with a 1/2" diam. ceramic magnet mounted vertically turns the switches on individually. The magnet arm is turned by a knob on the other side of the panel, or can be turned continuously with a small motor drive for constant scanning applications.



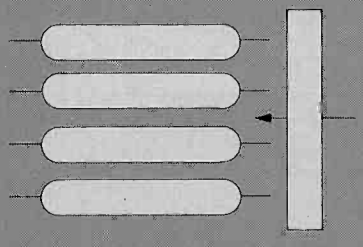
Magnetic reed switches, available from Radio Shack, come in two convenient sizes; the overall lengths, including leads, are 1 1/8" and 1 3/4". Both are rated at 0.56 amperes at 125 volts. The small, 1/2" diam. disc magnet is handiest, but the 1" diam. disc and 1" x 3/4" rectangular magnets may be desirable for building complex, multi-pole switches.

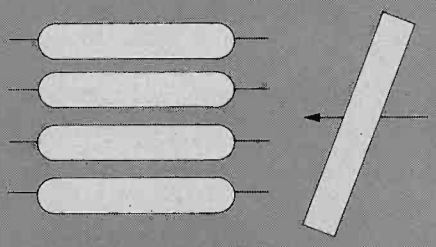
Single-throw, multi-pole. These can be constructed simply by mounting reed switches in parallel, and passing the *edge* of a vertically-mounted magnet over them to trip all switches simultaneously. If you need a sequential switching action, just angle the magnet about 30 degrees so that the parallel reed switches are tripped in 1, 2, 3, 4 order. If the magnet movement continues in the same direction, the switches will go off in the same 1, 2, 3, 4 sequence, on the other hand, if magnet movement is reversed when all switches are on, the switches will go off in the reverse 4, 3, 2, 1 order.

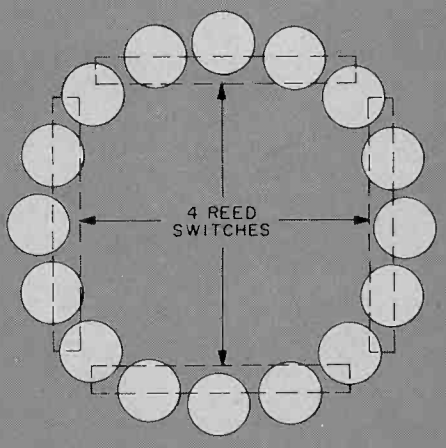
Multi-position, single-pole. Arrange the reed switches one after the other, like cars of a train. You can keep the switch smaller by using two lines of staggered switches, as shown. As the vertically-oriented disc or rectangular magnet passes over the switches, each "on" switch goes off before the next switch comes on.

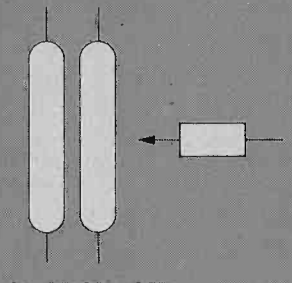
A photograph shows a sliding switch of this general type, but one made to function as a double-pole, single-pole, double-pole sequencer. A simple locking device consisting of a lock washer under the knob on the other side of the panel permits locking the movement at any desired position. Note the "guide" strip near the slot; a square nut that holds the magnet support arm on the knob shaft bears against this guide to keep the magnet properly aligned over the reed switches.

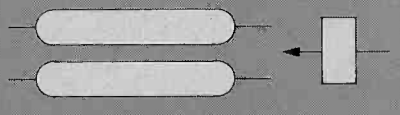
Rotary switches. These are easier to build than slide switches, and there are many ways to achieve special switching characteristics. Note that when the edge (diameter axis) of a disc magnet is aligned with the long axis of a reed switch there is no switching action.

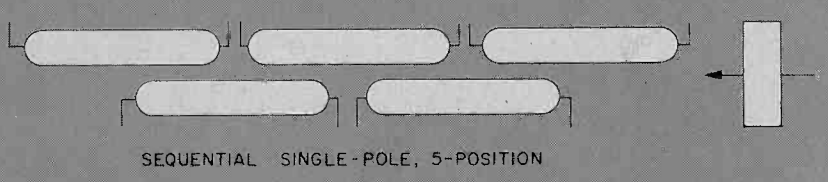


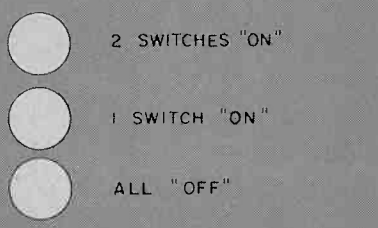








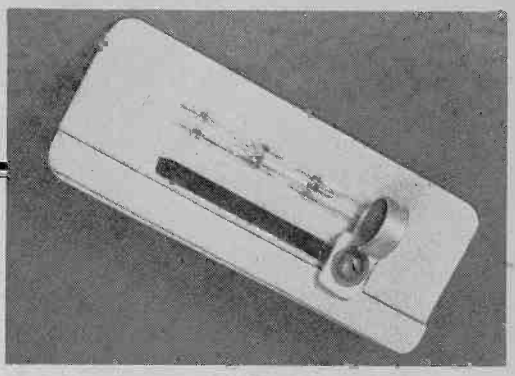




Here are various magnet and reed switch orientations all of which achieve different switching actions. Position the magnets and reed switches exactly as shown, and as further discussed in the text, for best results.

A complex switching method is achieved by passing a horizontally-oriented magnet over a square of four reed switches. When the magnet is in a "corner" two adjacent switches are on; in other positions only one switch is on.

CUSTOM SWITCHES



The ceramic magnet of this sliding switch passes over five 1 1/8" size reed switches to provide double-pole, single-pole sequencing. Separate diagram shows a simple mechanism which permits locking the magnet "on" or any "off" position.

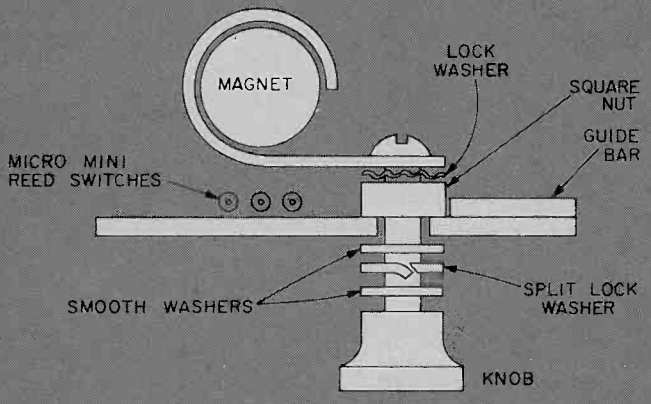
Thus if you mount several reed switches next to each other, and rotate the magnet directly over the center of the switches, you obtain more or less simultaneous on-off action.

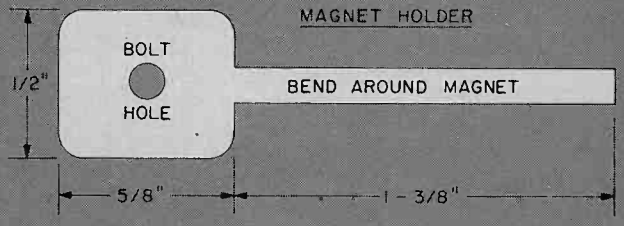
If two switches are crossed a vertically-mounted rotating magnet will turn one switch on and the other off when the magnet axis is parallel to the long axis of one reed switch. In the intermediate position, both switches are on; thus you can have on-before-off action with a very simple physical arrangement. To make a double-pole version, cross four reed switches in pairs.

A 4-pole, 4-position rotary switch can be made by arranging four reed switches in a "square" and adding a vertically-oriented disc magnet so that it can be swung in a circle over the centers of the reed switches. This provides an off-before-on switching action, each "on" switch first going off before the next one comes on.

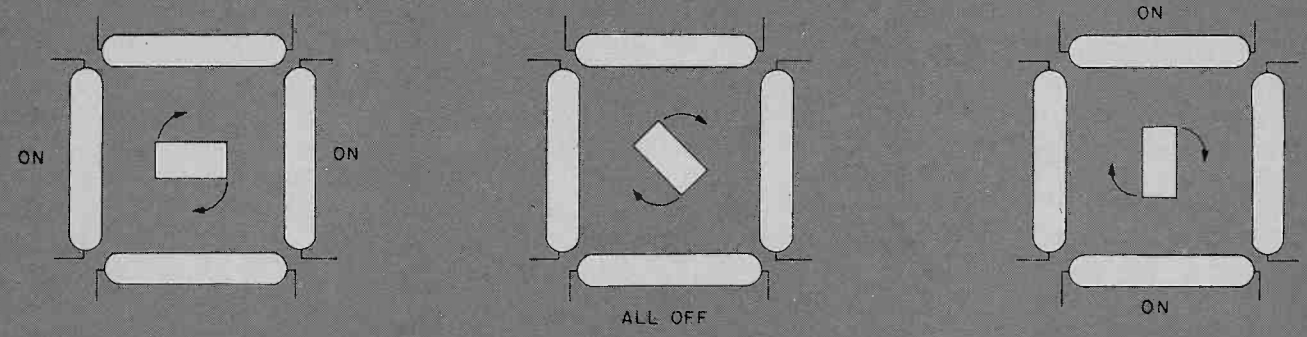
Some strangely useful things begin to happen if you mount the disc magnet horizontally instead of vertically. As the magnet passes over a corner of the square of reed switches so that it is partly over the ends of two adjacent switches, both switches go on. Rotate the magnet a little further, so that it is over just one switch and that switch stays on while the other goes off. Curiously, when the *horizontally* mounted magnet is over the center of a switch, that switch goes off. This is exactly the opposite of the on-action caused by a vertically-mounted magnet. Consequently, this type of rotary switch provides sequential double-pole and single-pole action, with four fully off positions.

Multi-pole Rotary. Such switches can be constructed by stacking additional reed switches atop the first four that make up a basic square. Mount the rotatable magnet inside the "box" formed from the stacked reed switches. When the long dimension of the magnet is perpendicular to stacks on opposite sides of the box, all of those switches will go on; other stacks at 90° to these will remain off because the magnet axis is parallel to them. By using one of the larger rectangular magnets, you can easily stack at least a half dozen switches on a side, for a total of 24 switches; 12 would be on at any one time, 12 off. When the magnet is in the intermediate, 45° position, all switches are off.





Here is a sliding switch designed to function as a double-pole, single-pole, double-pole sequencer. A locking device of a lock washer under the knob on the other side of the panel permits locking the movement at any desired position. The support arm is positioned to keep the magnet aligned properly.



By positioning a rotatable magnet in the center of a square of four reed switches you have a double-pole rotary switch. By stacking magnets on top of the basic four, and using a larger magnet, as many as twelve on-positions are possible at each active orientation.

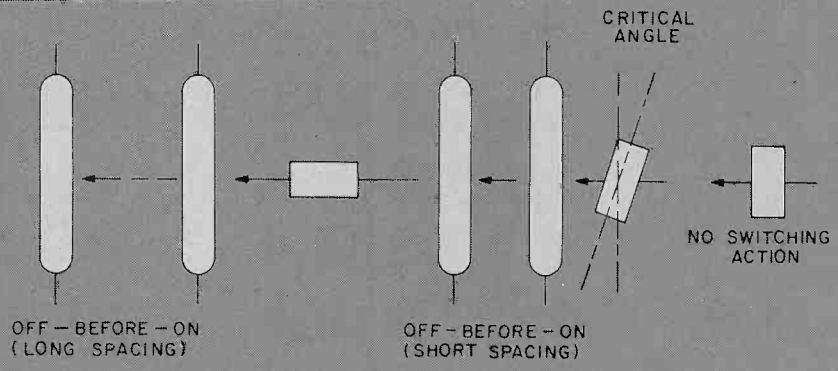
Linear Off-Before-On. Mount parallel switches far enough apart so that, as a vertically positioned magnet approaches the switches from one side, the first switch will go on and off before the next switch is affected. Here's a handy trick that enables you to pull the parallel reed switches much closer together to form a more compact switch: Position a small disc magnet over the center of the first switch so that its long axis (diameter) is parallel to the long axis of the switch. If you have been paying attention, you already know that in this position the magnet has no effect on the switch. Now slowly rotate the switch away from this parallel orientation until you hear the switch click on. Mount the magnet in its sliding holder so that it passes over the center of the reed switch in this slightly angled position. This deliberately weakened magnetic action permits location of the next switch much closer to the first—as close as about ⅜"—and still obtain off-before-on switching.

There's no problem, of course, if you want on-before-off action because then you can mount the reed switches as close to each other as you like. A magnet approaching from the side will turn the first on, then the second, before turning the first off. Bear in mind that if the magnet approaches the pair of switches from the end directions, you obtain approximately simultaneous double-pole switching.

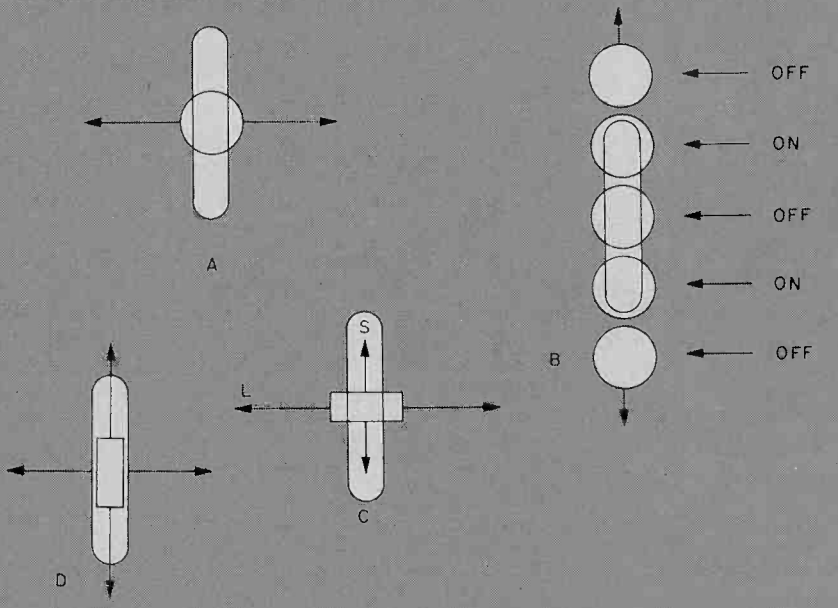
If you have but one reed switch, and the vertically-oriented magnet approaches from one side of the reed switch, it has a longer "reach" and switching action occurs while it is relatively far from the center of the switch. This relative sensitivity, relating to direction of magnet travel, could be an important factor in some switch-design problems.

Special Designs. As you play around with your reed switches and magnets you will undoubtedly discover many variations on the ideas given here. For example, suppose you wanted a sliding multi-pole switch that always switches the reed switches on in the same sequence. As the magnet travels over the parallel reeds, the switches come on in 1, 2, 3, 4 order. But as you slide the magnet back to its original starting position, the reeds would go on in reverse 4, 3, 2, 1 sequence—which is what you do *not* want. So what's the answer? Simply mount the magnet on a holder that permits it to be turned 90° at the end of each sweep. This way the magnet can be in its "active" orientation going one way, and in its "dead" orientation going the other way. Thus it is possible to return the magnet to the starting position, for subsequent normal switching order, without affecting the switches on the return sweep.

I have not tested these ideas, but it seems likely that you could construct such truly off-beat switches as, for example, a level-indicating switch by suspending the magnet on a short pendulum so that it will swing close to either of two parallel magnets to electrically signal tilting. And it may be feasible to create a vibration-detector in much the same manner, but mounting the magnet on the end of a flat or coil spring so that vibrations will swing it in-and-out of the switching range. ■

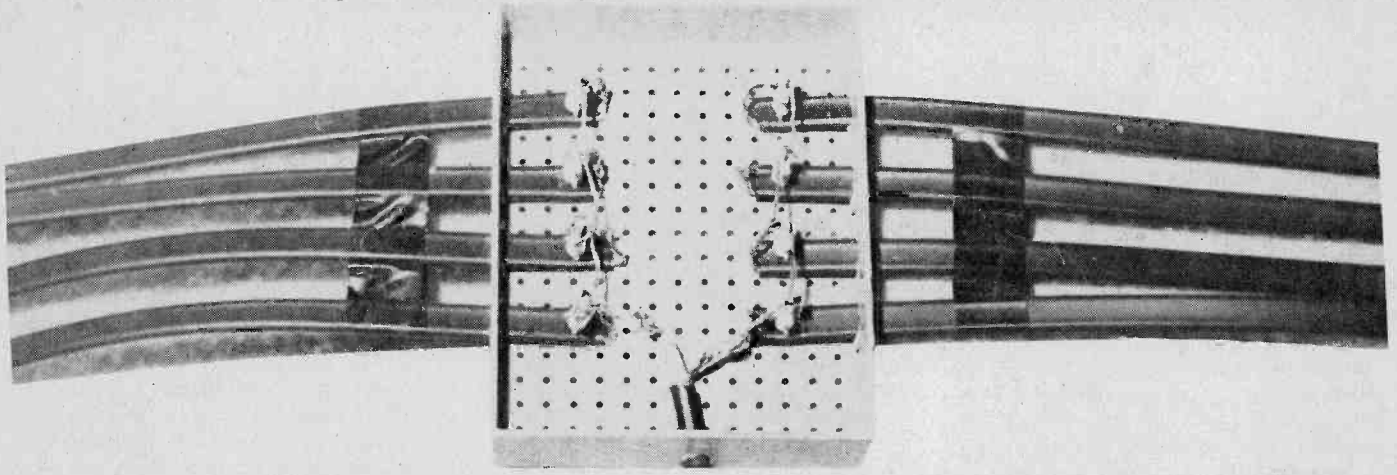


Spacing of adjacent reed switches is important if the first switch must go off before the next turns on. When the magnet is in its strongest orientation (left), the reed switches must be far apart. If the magnet is positioned at an angle slightly removed from where it does not switch, the two reed switches can be closer together and retain the on-before-off action.



Orientation and direction of movement of a disc magnet influence switching action. No switching occurs as a horizontal magnet moves across the reed switch as at upper left. If the magnet passes along the length of the reed (upper right), switching to "on" occurs when the magnet is near either end of the reed, but not when it is directly over the contact points in the center of the reed. Switching occurs if the magnet is vertically oriented as at lower left, but over a shorter range if the magnet moves along the "S" path than along the "L" path. If the magnet is turned 90° (lower right), no switching occurs when it is moved along either of the indicated paths.

Mini-Cost Multiband Antenna



Easy-to-build, inexpensive SWL skyhook covers 8 bands!

by Dan Ramsey

NEARLY EVERYBODY knows that dollar-for-inflated-dollar your best SWL investment is a good antenna system. But, you ask, what is a really "good" antenna? It's one that's easy to construct, inexpensive to build and will pull in stations on all of your favorite bands equally well without a complicated switching system. And that's a good description of our Mini-Priced Multi-Band antenna system.

For less than $20 you can construct this simple-to-build and easier-to-operate antenna on even the smallest of lots. With an overall length of less than 80 feet, this home-made DX chaser will bring in each of the seven major international shortwave bands *plus* CB for fun when nothing else is cooking. A couple of hours on a Saturday afternoon will put it up and you'll soon wonder how you ever eavesdropped the ether without it.

Technically our Mini-Priced Mutli-Band is a resonant dipole antenna with eight different-length half-wave legs and low-loss coax leadin to match. But what makes the system unique is that the antenna needs only 180 feet of popular 300 ohm TV twinlead (lead-in) wire available everywhere. Other easy-to-get parts include a perf-board box to house the center taps, a few solderless terminals to hold things together and 25 to 50 feet of RG-59/U coaxial cable to bring the signal down to your receiver. It's about the simplest, most practical and least costly SWL antenna a hobbyist can build.

Antenna Theory. The resonant-dipole antenna has won universal acceptance, literally, as SWLers the world over rely on its simplicity and sensitivity It's easy to understand why.

A half-wavelength dipole (cut to half the *electrical* length of the incoming shortwave, then tapped in the center) offers the advantage of receiving one group of frequencies, or a band, stronger than others striking your antenna at the same time. It is frequency-sensitive. As opposed to the popular longwire, which is a "general" antenna, the dipole is a *specialized* antenna. It specializes by resonating–being most efficient in receiving a particular band, for which it was designed. It is frequency-selective. And because it is physically little more than a longwire antenna tapped in the center rather than on the end, the dipole is nearly as easy to construct.

However, the dipole does have certain disadvantages. The problem is that, though a dipole is usually most sensitive to whatever signal range you have cut it to receive, its frequency range is rather narrow, and it is much less efficient on outside frequencies than the general-coverage longwire antenna.

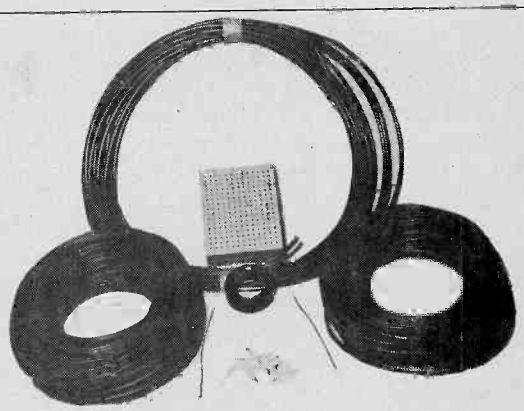
You can turn this fact to your advantage by setting up a resonant half-wave dipole for *each* of your favorite bands. This will insure that you can listen to any one of these bands with top sensitivity while attenuating signals from outside the band so they don't interfere with your listening pleasure. The bands you'll probably choose are the seven international shortwave bands (49, 41, 31, 25, 19, 16 and 13 meters) plus something just for fun, like eavesdropping on the CBers (11 meters).

So what we've designed is an eight-band resonant half-wave dipole antenna. And it's engineered for low cost, selectivity, sensitivity, and efficiency. Now that we've designed our "perfect" antenna, in theory, how can we make it actually fly?

Simple! By using various lengths of 300 ohm TV twinlead wire we can have four parallel sets of double wires that will resonate in the middle of each of the eight bands we've chosen. Why twinlead? It's easy to obtain for one thing. Nearly every town has at least a TV repair shop where you can usually buy twinlead in 50 and 100 foot rolls or cut to specific lengths for about 4 to 9 cents a foot. Also, it offers two insulated antenna wires in one weatherproof package.

When buying your twinlead, you won't want the best, the shielded type, because that would defeat your purpose of getting the signal to the enclosed wire with the least amount of loss. And you won't want a low-grade type either, because of the brittleness of the wire and insulation. About the best wire for a shortwave antenna is 7-strand number 20 or 22 wire. And the better-grade foam-insulated TV twinlead is made up of 7x22 copper wire. Perfect! It's highly-conductive, weatherproof, self-supporting and inexpensive.

Let's go back to resonance. Engineers have come up with a simple formula that will help you decide what length you will want to cut each of your antennas to in order to make them *resonant* (most sensitive to one frequency



Basic parts for your Mini-Priced Multi-Band are two rolls of 300 ohm TV twinlead, about 50 feet of coax cable, perf-board box, electrical tape and solderless spring terminals. The two short pieces of rigid wire are used for making the common connections at center of the antenna array.

range) half-wave dipoles. The formula is:

$$\frac{468}{F\,(MHz)} = \text{½ wavelength.}$$

which means: one-half a wavelength is equal (electrically) to the magic number of 468 divided by the frequency you desire (measured in Megahertz). The answer is in feet. Example: for the 49-meter band (5.95 to 6.2 MHz), use the approximate center frequency (6.075 MHz) in the above formula and you will come up with 77 feet. That's the length of wire you'll need to make your antenna resonant, or most sensitive, to that frequency band. It's a simple process to choose the lengths you'll need for each of the eight shortwave bands we've decided on. (See our *Resonant Antenna Table*)

Construction. Putting the whole thing together is easy. The 49- and 41-meter band wires will be mated in one twinlead, the 31 and 25 meter bands go in another, 19 and 16 share a twinlead, and 13 and 11 meters take the final length.

Steps: Cut each twinlead to the longer of the two resonant lengths (Cut the 49-41 meter twinlead to 77 feet.). Then figure the difference between the two resonant lengths (41 meters should be 65 feet long, so the difference is 12 feet. Divide the difference by two (answer—6 feet) because you are eventually going to cut the whole twinlead in the center to tap it and will want an equal amount of resonant antenna on each side of the center tap. Come in that distance (6 feet) from each end and snip the *bottom* wire of the twinlead at that point. Then go to the closer end, cut the *bottom* wire back, take a firm grip on it and zip it out through the side of the insulation to the point where it was snipped.

Do this with each of the four twinleads according to the lengths in the *Resonant Antenna Table*. Remember, if you have purchased your twinlead in two 100 foot rolls to cut the 77 foot and 21-ft. 8-in. lengths out of the same roll.

To make your antenna a dipole you must tap it in the center. This is done by first folding each twin-lead exactly in half and cutting it. With 178 feet of wire all over the floor, you should tape appropriate sections together and label them as they are cut to avoid later confusion. When you lay the antenna system out on the ground it should look like the spread wings of an eagle, tapered inward from top to bottom and with the center tap cuts all meeting in the middle. Now it's time to tie it all together.

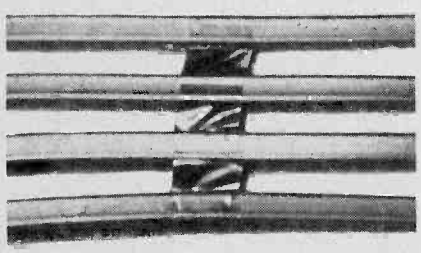
Here's where the other parts come in: the perf-board box, the solderless spring terminals, coax cable and the electrical tape.

First, open up the perf-board box and lay the gray or perforated section open end up. (You can use a hobby box and a perforated board also, but the Archer brand Experimenter's P-Box, distributed by Radio Shack, has a distinct advantage in that necessary holes can be cut in the gray portion of the box with a hot soldering iron.)

Next, cut four holes in each side of the box for the twinlead, and one at the bottom edge for the coax. Then bring the four half-sections of twinlead into each side of the box, strip all wires back about one inch, make a hole in the center of the insulation another ¼-in. back for the spring terminals and insert them into the insulation. Next, put the two loose wires from each twinlead into its respective terminal, push the terminal into the correct holes in the perf-board box and connect the terminals on each side with a common wire. Now you have all wires from one side of the box connected commonly, and all wires from the other side connected at another common point.

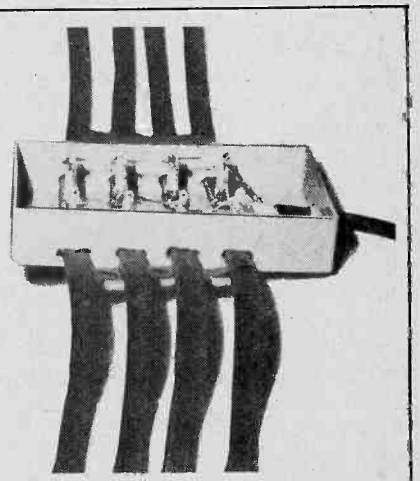
The next step is to bring the coax cable in from the bottom, connect the center wire to one common set of taps and the outer (shield) braid to the other set. You should spot solder the terminals when you've completed your work to assure a good electrical bond. Close the box and seal it with electrical tape. You're just about finished.

Stretch all of the twinleads out in parallel from the box. Every three feet or so, wrap electrical tape from the top to the bottom twinlead leaving about an



Short lengths of electrical tape help space out the twin-leads to keep them isolated and to support them in place properly.

After final assembly the perf-board box is closed and sealed with black plastic electrical tape. Coax cable leadin is shown exiting at center front.



Twin-leads enter box at side—coax exits at bottom. Spring terminals conduct signals, also serve to secure twin-leads.

inch between each one. This is done so the top twinleads will support the bottom ones. For further support, use a short cord to tie the top two ¼-wave legs together on the outside of the box. This will minimize stress on the top twinlead center connections when it is installed.

The next step is rigging up your antenna. You will need 80 feet of space, lengthwise. A strong nylon cord tied from each end (egg insulators not needed) and to a nearby support will do the trick. Make sure you raise the antenna to a height of at least 20 feet and away from obstacles that would attenuate the incoming signals. The higher it is, the better it will be. Carefully run your coax in to the shack, hook it up and stand back.

Signal Tracing. To see how your Mini-Priced Multi-Band works, let's follow an incoming signal. It hits your antenna along with a hundred others, but your dial is tuned to 9.690 MHz in the 31-meter band. Because signals follow the path of least resistance and because the lowest resistance is between your top wire on the second-from-the-top twinlead and your receiver, that particular signal is chosen. It runs towards the center of your dipole. At the same instant, the identical signal is coming in from the other half of your half-wave dipole and rushes towards the perf-box. They haven't met yet.

Even though you are using what's called *300 ohm* twinlead, the actual impedance (resistance of an AC circuit) of each dipole is about *70 ohms* as it is in every center-tapped half-wave dipole antenna. (The impedance would be about 300 ohms if the farthest ends of the twinlead were loaded or connected together, but they are not.) And so your 72-ohm coaxial cable is a near-perfect match. The signal again takes the path of least resistance, down the coax to your receiver.

Some inexpensive communications-*type* receivers have higher input impedance, but most better-quality communications receivers have an input impedance of about 75 ohms. Again, a very close match for your incoming signal and it rushes into your tubes and/or transistors to be amplified, rectified and certified "good SWLing." No loading coils or bandswitches necessary.

RESONANT ANTENNA TABLE

BAND (meters)	FREQ. (MHz)	LENGTH (Ft.)	TRIM (ends)
49	5.95-6.2	77	none
41	7.1-7.3	65	6 ft.
31	9.5-9.775	48⅔	none
25	11.7-11.975	39⅔	4½ ft.
19	15.1-15.45	30⅔	none
16	17.7-17.9	26+2 in.	2¼ ft.
13	21.45-21.75	21⅔	none
11	26.965-27.225	17+6 in.	2 ft.

Hints. Remember that the dipole antenna, while able to detect signals from just about any direction, is most sensitive to signals coming in broadside (at right angles) to the antenna. So try, if you can, to run your antenna basically north and south if you want to receive most signals from the east and west.

Another plus for the dipole is its noise-cancelling characteristic. Each of the ¼-wave legs brings the signal to your receiver as a mirror of the other. One runs down the center wire of the coax and the other moves via the outside coax braid. When they meet in your receiver they mix and cancel much undesired amplitude-modulated impulse noise. Another good reason why the dipole is so popular.

PARTS LIST FOR MINI-PRICED MULTI-BAND ANTENNA

178 ft. 300-ohm foam TV twinlead
25-50 ft., as needed for lead-in, RG-59U coaxial cable
Perfboard box or experimenter's P-box (Radio Shack 270-105 or equiv.)
Solderless spring terminals
Roll electrical plastic tape

You can't listen to all the world if you can't hear all the Bands. Hear all the action with a multi-band dipole antenna!

Horizontal and vertical polarization? Don't worry about it! After skipping off the ionosphere a time or two, it doesn't make any difference whether the station sent the signal out with a horizontal or vertical antenna. It's flip-flopped through the atmosphere enough before it gets to you so the signal is virtually omni-polarized.

While you're installing your Mini-Priced Multi-Band, don't forget the value of an antenna lightning arrester. It may save your receiver from an overload of a few thousand volts. And it doesn't take lightning to make it a useful gadget. It will also discharge the static electricity that can bulid up on a wire during an electrical storm. It's great insurance!

Long-time SWLers know that one dollar in the antenna system is worth about ten dollars in the receiver. So this less-than-$20 project may just inflate your shack's value by almost $200. And that's a good investment in *any* economy! ■

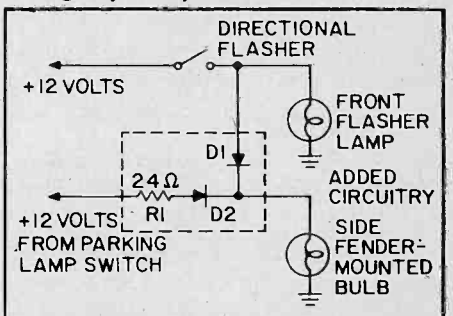
Turn Signals from Side Marker Lights

☐ Side clearance lights are the lamps usually mounted on the front and rear fenders. These lights can be made to provide additional driving safety by adapting them to flash *in unison* with the directional flashers if the auto does not now have rear flashers.

The circuit diagram shows how the present auto or pick-up electric wiring is modified so the side lights will also flash. A 24 ohm resistor is added in series with each side-clearance lamp bulb filament. This reduces the brilliance of the side bulb to about half of what it was originally. An epoxy diode is used to isolate the parking lamp filament from the flashing light circuit.

A separate wire lead is run from the side lamp to the directional flasher lamp on the same side of the auto. The side clearance lamp will then flash in unison with the front directional flasher lamp. A second diode is used to isolate the flasher filament from the parking light circuit so that it will not turn on when the parking light turns on.

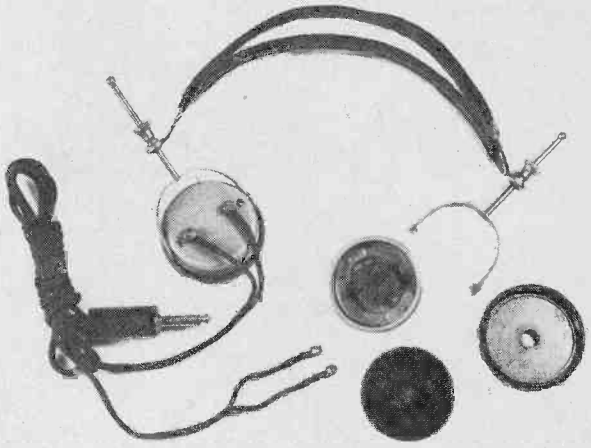
Make good electrical connections by using instant auto electric connectors or soldering with a good soldering iron. Wrap all connections and components with a good amount of black plastic electrical tape so that they will withstand the weather. The side clearance lights will now flash not only with the directional signals but also when the emergency 4-way flasher is turned on. ■



PARTS LIST FOR ADD-ON TURN SIGNALS

D1, D2—Diode 1 amp, 50 PIV or better (Radio Shack 276-1135 or equiv.)
R1—24-ohms, 1-watt resistor (Radio Shack 271-1000 or equiv.)
Misc.—wire, electrical tape.

LOW-COST FILTER IMPROVES CODE RECEPTION



A few snips of aluminum and an old reed make headphones into high quality filter.

by George X. Sand

Amateur radio operators and short wave listeners often find CW (continuous-wave code) reception difficult, if not impossible, when several radiotelegraph stations are transmitting on, or near, the same frequency. Such interference can be eliminated, or at least greatly reduced, by a narrow band electronic filter circuit that can be installed in the radio receiver or transceiver. However, this extra equipment can cost up to $150.

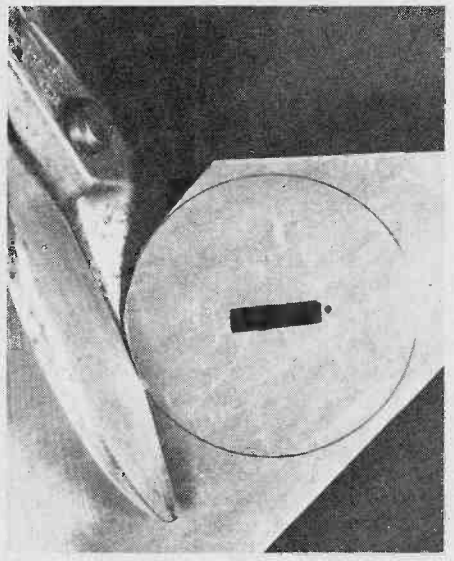
What You Need. A mechanical filter that will do the job can be built for $15, or less. In fact, should you already own a pair of earphones—the old-fashioned kind with metal diaphragms—and have access to a music store that will sell a used steel reed removed from an accordion (the writer was given his at no cost by such a store) you can build this effective filter for practically nothing.

A low-frequency reed should be used. A 440-Hertz (A) reed will work well. In fact, anything from about 300 to 1000 Hertz will be ok.

Should you have access to a steel (not brass) reed from an old harmonica, that could be used, too.

The removed reed is installed in one earphone of the headset so that it vibrates only when an incoming CW signal sets up a beat note at the reed's resonant frequency. All other interfering signals will automatically be eliminated since they will be of a different beat frequency, and the reed will not respond (audibly) to them.

To Get More Volume. Should you wish to have both earphones of the headset operate in this manner, the *matching* reed of the same length (they come in pairs in the instrument) must be installed in the second earphone.



A thin piece of aluminum is cut to same size disc as the original iron diaphragm of the 'phones. Rectangular center opening is for the iron frequency-resonant instrument reed. Small hole at right of rectangle is for rivet (or nut and bolt) to secure reed.

Here's how it's done: Use a pair of tin snips to cut from a thin sheet of aluminum (about 1/32-inch thick) a disc that will replace the earphone diaphragm. At the center of the aluminum diaphragm make an elongated hole that will permit the reed to vibrate freely (see picture) when it is riveted fast at one end of the opening.

In installing the reed it is important that the little strip of steel extend into its opening for the *same* vibrating distance that it did when it was in the musical instrument.

The operation is simple. The aluminum diaphragm, being non-ferrous metal, will not be influenced by the magnets in the earphone. Only the reed will vibrate, instead. In use, only the desired CW signal will be heard loudly as the receiver or transceiver is tuned. The resulting silence can be uncanny!

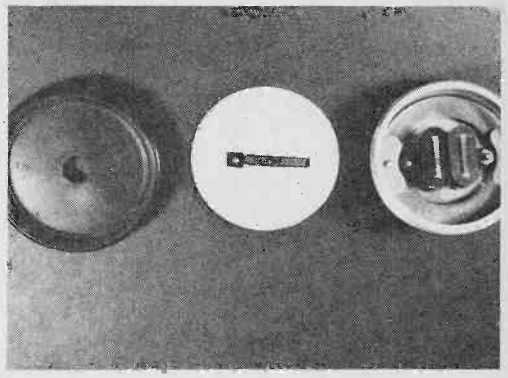
PARTS LIST FOR CW FILTER

Communications-type headphones, 1000-ohms or more. (**Not** stereo headphones, which are all wrong for this project).

Steel reed(s) from accordion or harmonica.

One (or two) small rivets of the same size as were used to hold the reed in place in the instrument.

Use These Tools. You'll need a pair of tin snips or metal cutting shears. An electric (or hand) drill, with bits the right size for drilling out the rivet(s) which secure the reed(s) in the instrument will be needed, and you'll find a small square-edge (or triangular) file good for dressing the opening in the aluminum disc. ■



Original hard rubber cap (left), original magnet and coil assembly (right) and new aluminum diaphragm (center) with steel reed in place.

LET LIGHT/JINN SERVE UP SNAPPIER SNAPSHOTS

This cable-free slave flash uses only two resistors, one LASCR, one choke, and an optional diode bridge.

by C. R. Lewart

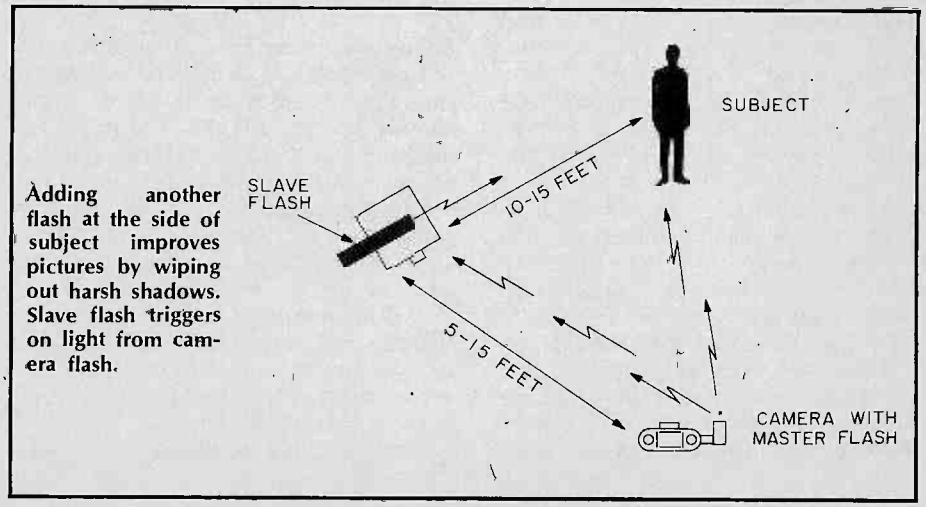
GREATLY IMPROVE your flash pictures by using the flashgun on your camera to control one or more "slave" flashes by means of our Light/Jinn—a magical genie which has no cables to the master flash, but triggers from the light of the camera flash—at your command. You can use two or more Light/Jinns at the same time, but the greatest improvement in your flash pictures will come with the addition of the first Light/Jinn to your regular on-camera flash. The time delay between the master and slave flashes is on the order of 1 millisecond (1/1000 sec) so that you can take pictures at the shortest exposure times your camera permits.

Multiple Flash is Better. If you compare most ordinary flash pictures to other shots taken with photofloods (high intensity incandescent lamps, such as are often used for motion pictures, as well as for professional still pictures) the single flashgun-illuminated photographs usually come out second best. Why? It's not because the quality of the light is particularly inferior, but because the distribution of that light isn't as good. What makes the difference is the number of lights used.

A studio photographer uses photofloods for his lighting (those models sometimes get awfully hot under them!), and he always uses more than one light source, spaced at least several feet apart to fill in the shadows in a pleasing fashion.

Pictures taken with a single, on-camera flash have defects which can easily be noted. If you have subjects up close to the camera they often look washed-out or overexposed, and the shadows are usually harsh and too contrasty, particularly if the subject is near a wall or other large background. Automatic flash units, coming into wider use now, can control some of these problems partially. But the automatic flash can't fill in the shadows it creates. Using bounce flash (aiming the flash at a white ceiling) provides more even illumination, although most on-camera flash units can't readily be aimed at the ceiling. And with bounce flash you must open the lens diaphragm to compensate for the lower overall light level. This decreases the depth of field, which can be another problem. Furthermore, bounce flash with color film can put the color of the ceiling or wall, if not white, into the subjects' faces. All in all, taking flash pictures with a single flash is something you'll learn to avoid wherever possible.

Adding just one more flash, if it's properly placed, will give you shadowless pictures, with greater depth, more modeling of subject's features, and



Adding another flash at the side of subject improves pictures by wiping out harsh shadows. Slave flash triggers on light from camera flash.

clearer details. Or, in other words, your pictures will be a lot closer to studio photographs.

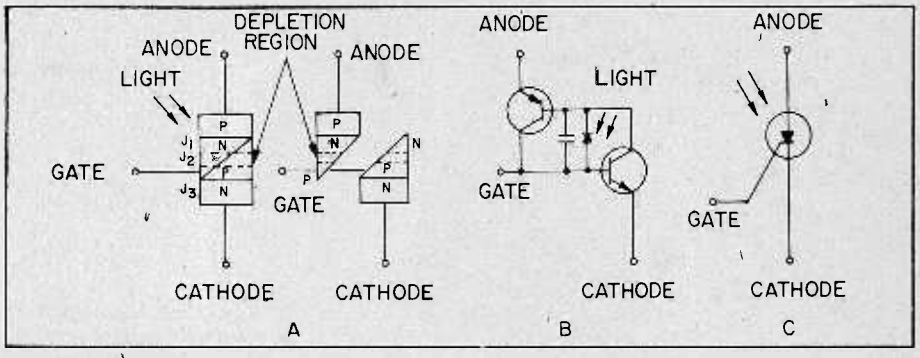
Better Flash Shots. To take such pictures you need one more flash unit and some way to support it, and of course some way to make it fire at the same time as the main flash. The first flash unit mounts in the usual way on the camera (or slightly off it, with an extending bar), while the second flash, which now becomes the "main" light (the primary source of illumination), is placed near the subject and interconnected to flash at the same time as the first flash, in synchronism with the shutter opening.

The usual way to synchronize the two flashes with the shutter is to use a long connecting cord—if your camera or first flash has a receptacle for it (most do not).

Get Rid of Cables. Long cords can lead to problems. They can come loose at either end or both; they can be tripped over; and their length is either too long for most shots, or not long enough for some. But these problems can all be eliminated if you use a flash connected to the main unit by *light!* That's right. You can use the light from the first flash to set off the second one. It takes less than a millisecond (1/1000 of a second) for the second flash to fire. Since you'll be using a 125th or 250th of a second shutter opening, the camera will think both flashes go off at the same time, and the effect is exactly as though they do.

The project is simple to build and inexpensive—the basic parts cost less than $5. Light/Jinn requires no power source; it "borrows" its energy from the flashgun it operates. It also is an improvement over many previously-described similar circuits, because Light/Jinn will not be triggered by even a strong beam of ambient light falling on its sensor. Only another flashgun, or direct sunlight can trigger it. In addition this project will familiarize you with one of the most modern optical semiconductor devices, the *Light Activated Silicon-Controlled Rectifier,* or LASCR for short. The unique properties of this device can lead you to other electro-optical projects which also can be built simply and inexpensively.

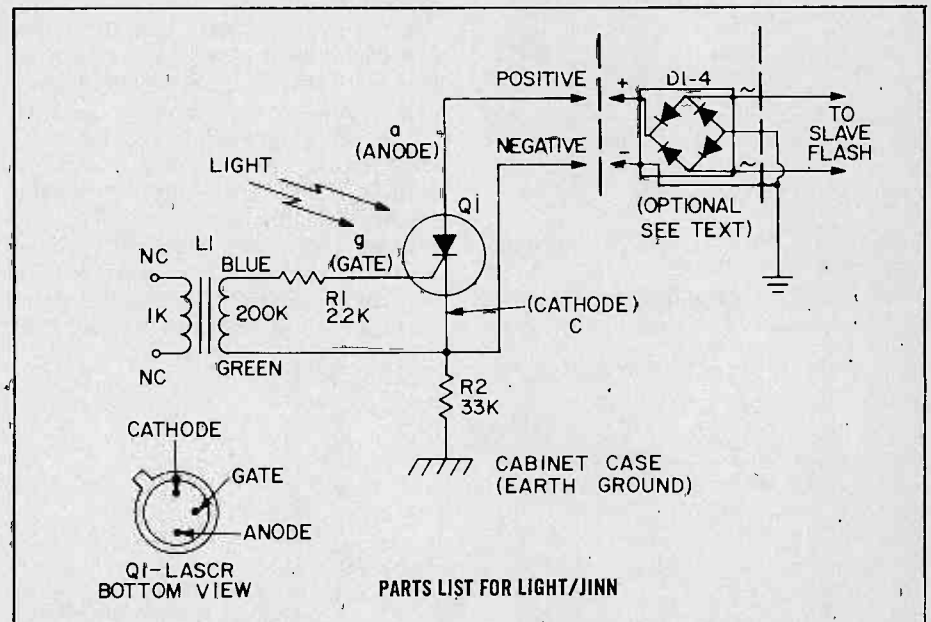
What Is An LASCR? Its tongue-twisting name, Light Activated Silicon Controlled Rectifier, explains its function. It is an SCR (silicon controlled rectifier) operated by light falling on its sensitive area. The LASCR is the brain of our project, the understanding of which, though not essential for successful completion of the project, should nevertheless interest you.



Operation of the LASCR (light-activated silicon-controlled rectifier) is shown above. It's equivalent to combined NPN and PNP transistors, as shown in A and B, above.

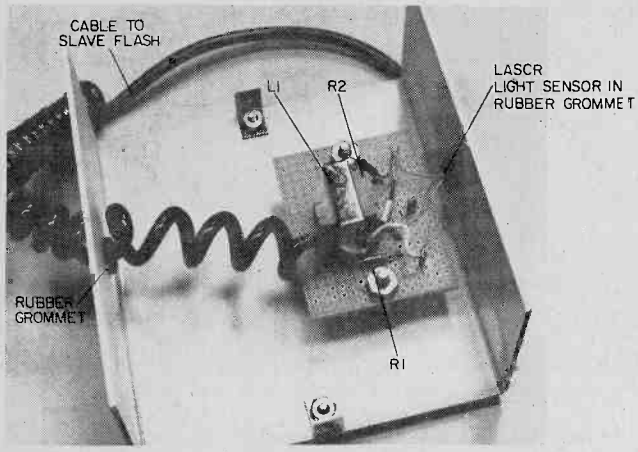
Refer to the three small drawings (above the schematic diagram) marked A, B, and C, for a description of how the LASCR works. With positive voltage applied to the anode, junctions J1 and J3 are forward-biased, and they will conduct if sufficient free charge is present. Junction J2 is reverse-biased however, and it blocks current flow. Light entering the silicon creates free hole-electron pairs in the vicinity of the J2 depletion region which are then swept across J2. As light increases the current in the reverse-biased diode will increase. The current gains of the NPN- and PNP-equivalent transistors also increase with current. At some point the current gain exceeds unity and the LASCR starts conducting.

Slave Flash Circuit. The LASCR is sensitive both to visible and invisible light, and will normally trigger at as low as 200 foot-candles. To limit its response so it responds only to another flash, we put the inductance of a small audio choke L1, and resistor R1 between the gate and cathode terminals of the LASCR. This novel approach prevents the LASCR from being triggered even by strong ambient light. For steady ambient light the inductance of the transformer behaves like a very small resistor and prevents the LASCR from firing by bleeding the charge generated by



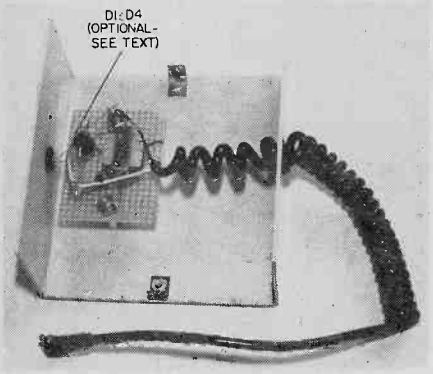
PARTS LIST FOR LIGHT/JINN

D1-4—Diode rectifier bridge module, 400 V, 6A
L1—Small audio transformer, 200K/1K
Q1—Light-operated silicon-controlled rectifier, 200 V, 1.6 A
R1—2200 ohm, ¼- or ½-watt resistor
R2—33,000 ohm, ¼- or ½-watt resistor
Misc.—Case, aluminun, 4-in. x 2-in. x 1½-in. or larger, two rubber grommets, ⅜-in. O.D., flashgun support bracket, flashgun extension cable to match receptacle on flashgun.



Light/Jinn with cover removed showing all the parts except optional diode bridge rectifier. Top cover has flash mount.

light directly to ground (the cathode). A sudden burst of light coming from an electronic or other flash makes the inductance of the transformer appear as a high resistance which causes the LASCR to conduct, triggering Light/Jinn. Finally, resistor R2 connects the circuit to the cabinet and lowers the possibility of flashes caused by static electricity.



This photograph shows the unit including the diode bridge rectifier, which is needed if Light/Jinn will be used with flash units whose polarity is unknown.

An inexpensive audio frequency choke is most readily obtained by using an ordinary audio transformer and leaving the secondary unconnected.

Construction. Although the actual components of the simple circuit for Light/Jinn take very little space we selected a good-sized box (4-in. deep by 4½-in. wide by 2-in. high) to provide a substantial stand for the slave flash. A flash gun mounting shoe and flash gun extension cable can be obtained in most photo supply stores. Mount the flashgun shoe on top of the cabinet. Cut off and throw away the male jack on the flash gun extension cable and strip the two wires leading to the female jack. If the flash gun you are planning to use for Light/Jinn has a "hot" shoe you will not need the extension cable. You should now determine which wire is positive. In most, but not all, flash guns the positive is the one which leads to the inner part of the jack (the center lead). If you plan to use Light/Jinn with a slave flash whose polarity you do not know, add the bridge rectifier (labeled "optional") at the right hand of the schematic. Then the polarity does not matter.

Using Light/Jinn. Mount the second flash unit on Light/Jinn, connect it to the cable extension, and charge the gun from its built-in batteries (or AC). It may flash once or twice by itself, but then it should stabilize. If it keeps going off spontaneously check the circuit for mistakes. If the wiring looks OK you may have to try another LASCR. This is because they have different sensitivities, and some trigger more easily than others.

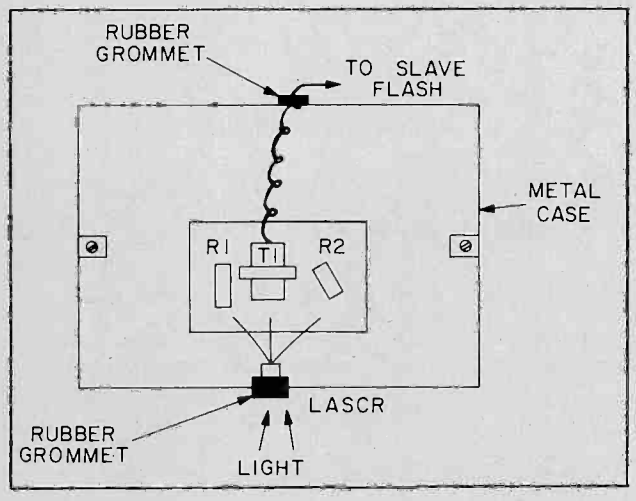
For the best pictures set Light/Jinn five to ten feet to one side of the subject, with the sensor (LASCR mounted in rubber grommet) pointing directly at your camera, and Light/Jinn's flash unit pointing directly at the subject. Make sure that neither the slave flash nor its reflections are in the picture. Test the setting by looking in the camera viewer and releasing the master flash before taking a picture. If Light/Jinn does not go off, point the LASCR at the camera or move it closer. Light/Jinn can be set 10-15 feet away from the camera depending on the strength and direction of the master flash. If your camera has various flash settings (X, M, F) use the setting recommended for the master flash (X for electronic flash, M or F for flash bulbs).

The key to success in multiple flash photography is correct placement of the flash units. If you follow the basic rules for good studio photography you'll be able to take much improved flash photographs. The basic studio setup calls for just two lamps. In our setup the basic, on-camera flash becomes the "fill" light, and the second, added flash unit becomes the main light source. This is often called the *key* light, and its placement is critical to the production of a good photograph.

The key (off-camera) flash must be mounted on a chair, tripod, or something similar, such as a chair back or bookcase. If all else fails have a friend hold it for you. Putting this light high, and off to one side, about 45 degrees, will provide both depth and modeling. The on-camera flash, being much further away from the subject than the key flash, will be much weaker, and need not be considered when figuring the correct camera aperture.

Since the key light is the only one that matters (in figuring the exposure) the calculation is quite straightforward. You just divide the number of feet from the key flash to the subject into the flash guide number. This gives the approximate *f* stop for the key flash mounted on Light/Jinn.

Caution. A charging flashgun may develop as high as 200 Volts, so keep the cabinet closed when the circuit is in operation. Also, do not get the flash gun close to your eyes, because when it is charged it may go off accidentally due to static electricity pulses. ■



Drawing at left shows there is much spare space in the metal enclosure. This is because the box must be large enough to provide a substantial mounting base for the flash unit.

BUILD TOUCH 'N' DIM CONTROLLER

by
Stephen Daniels

Two ICs and a handful of components let you turn lights on and off with a flick of the finger.

TOUCH CONTROL SWITCHES have fascinated experimenters for many years, but the circuits usually seen haven't been practical for household use. Typical problems include, excuse the expression, touchy adjustments or lack of power-handling capability, as well as expensive components or overcomplicated circuitry.

Our Touch 'N Dim controller has been designed specifically for controlling a table lamp. It uses modern ICs and a Diac/Triac phase control to provide relayless, Touch-On Touch-Off operation, and full-range dimming capability for loads up to 200 watts. We constructed it as an outboard accessory, but the circuit is small enough so that it could readily be built into the hollow body of a suitable lamp, making a most effective conversation piece.

How It Works. Some circuits use body capacitance to detune an oscillator and thus achieve control. This can be very sensitive, but it is much easier for our purpose to sense the 60 Hz noise that one's body is always picking up and use that as the control signal. Referring to the schematic, IC1A is connected as a standard amplifier with a gain of about 50. Noise voltage on the touchplate (a penny or dime) is amplified, rectified by D1 and filtered by C2 to provide a small voltage change across R4. This becomes a change in current through R5 and the inverting input of IC1B. IC1B is a signal comparator; if the current into the inverting input is greater than the reference current into pin 1, the output switches quickly from about 4-VDC to nearly zero. This rapid changeover will cause IC2, a flip-flop, to change state and extinguish lamp I1. I1 normally holds photocell PC1 at a very low resistance, thus bypassing the signal for Diac Q1 to ground. With I1 off, the photocell is essentially out of the circuit and the dimmer represented by Q1, Q2 and associated parts will operate normally. To turn the load off, IC2 is reset by activating the *Off* amplifier channel consisting of IC1C and IC1D.

Construction. The touchplates will be required later to check out the amplifier circuits, so it's best to make them now. I found it best to use coins as shown in the photos since, even though they are small, their size has great influence on circuit sensitivity. Cut the heads off a pair of 6-32 x ½-in. screws using a bolt cutter or hacksaw and save the shanks. File the cut edges flat and tin with a heavy, hot soldering iron. Prepare two dimes by cleaning the head side of one and the tail of the other with steel wool. Tin a small area in the center of each prepared side and sweat the screw shanks to the dimes. Be careful to get the shanks as nearly perpendicular to the coins as possible. When the touchplates have cooled down, add a nut and solder lug to each and put them aside.

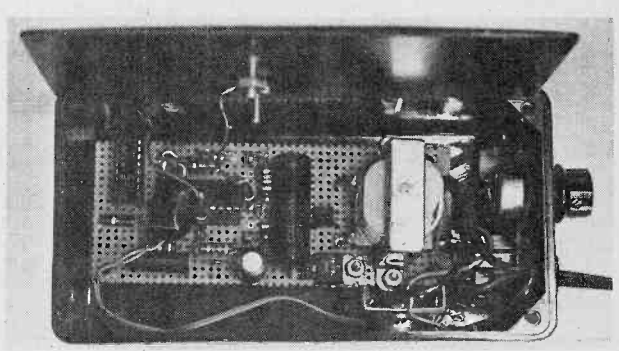
The bulk of the circuitry is assembled on a piece of perfboard about 4¼-in. by 2-in. The layout is critical in only one respect: Don't put any of the dimmer components except PC1 near the ICs. The reason is that switching noise from the Triac can affect the operation of the logic. Use the parts placement shown, or plan your own very carefully beforehand, since space is limited. I found it convenient to set up the power supply first and then do one stage at a time, testing as we went along. Also, get ¼-watt resistors if possible—it will alleviate a lot of the crowding.

Wire the power supply, paying close attention to polarities of the bridge, capacitor, and regulator. Apply line voltage temporarily to the transformer and check for a reading of about +5 volts from pin 3 of the regulator to ground. Once you have supply voltage, wire the sockets for the ICs into the supply lines. Remember to leave a note for yourself as to which way the ICs are to be inserted.

Now hook up the first amplifier stage and stop when you have wired in R4. Connect one touchplate to the input with a short length of wire. Install IC1, hook a VOM across R4, and again temporarily apply power.

Check the Voltages. The quiescent voltage across R4 should be about +.25 volts and should go to about +3.5 volts when you touch the plate. If there is no reaction or the readings are drastically off, you probably have a wiring error. If the output voltage is more or less correct and does rise, even if not quite to 3.5, proceed; you may need to trim R4 slightly later. Wire in the comparator stage IC1B. Use 5% resistors for R5 and R6 if possible

Connect power again and measure the voltage from pin 5 of IC1 to ground. It should be about 4 volts with no finger on the input. A finger on the touchplate should send it quickly to +.6 or +.7. If the output is at or near this with *no input,* either you wired the comparator wrong or there is too much current going into pin 6. In the latter case, either raise the value of R5 or lower the value of R4 to give a quiescent +4 volt output. If the quiescent



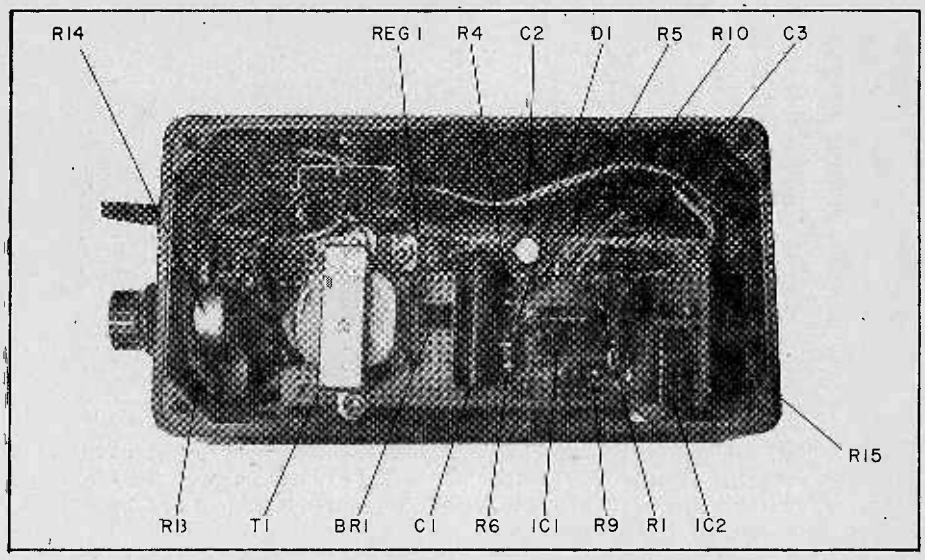
Touch 'N Dim prototype with cover removed shows parts mounted on perf board. Rheostat control at right adjust brightness of lamp. Note the ICs are mounted in holders, not directly soldered.

TOUCH 'N' DIM

output is about +4 volts but won't go down, R5 should be lowered until a touch on the input sends pin 5 to +.6 to .7 volts. When both stages are working together correctly, wire and test IC1C and IC1D similarly. Now make the final connections to the socket for IC2 and install both the chip and I1. With power applied, I1 should go on and off in response to a touch on the proper plate. If this much is happening, you are pretty well home free.

Putting It In the Case. Prepare the case by locating and making mounting holes for the line cord, potentiometer R14 and receptacle SO1. Mount these two parts. The mounting arrangement you select for Triac Q2 depends on the

(Continued on page 99)

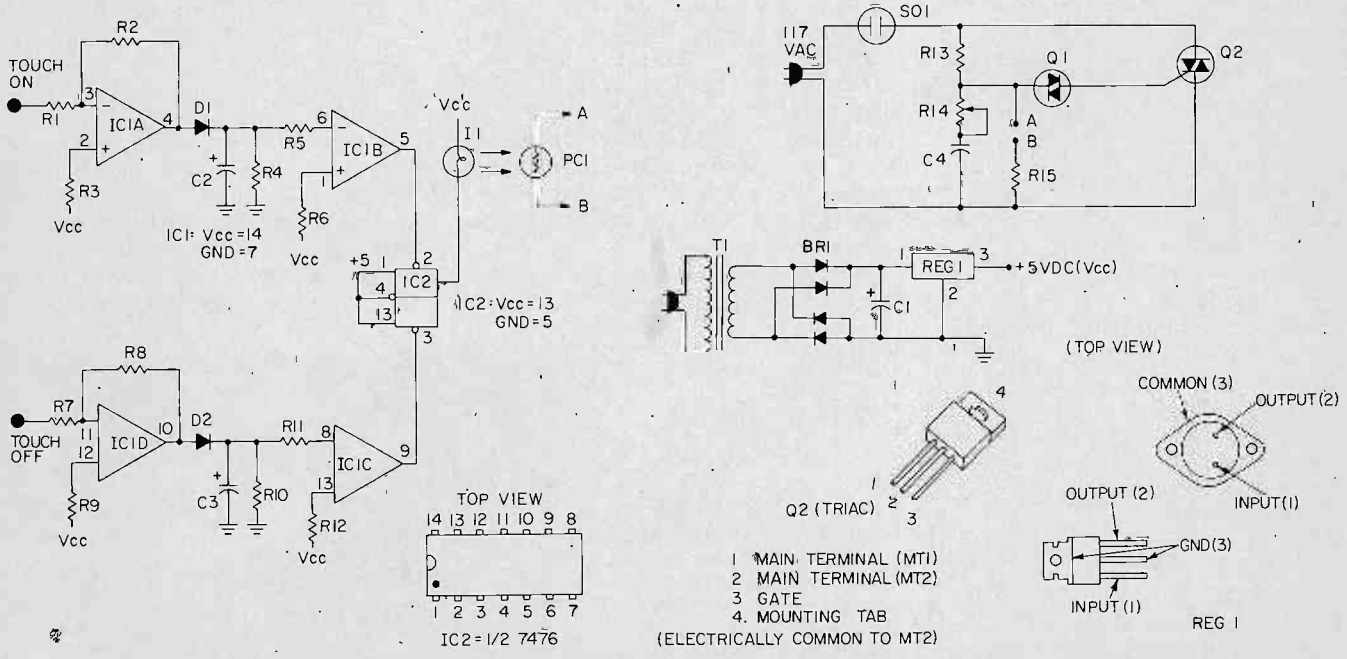


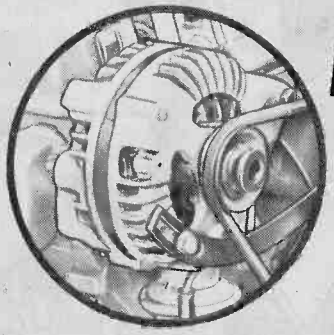
Parts layout on perf board shows all components are on the one board, with exception of brightness adjust control rheostat, R14. Any convenient layout may be used, depending on size of parts used in the project.

PARTS LIST FOR TOUCH 'N DIM CONTROLLER

BR1—Bridge rectifier module, 50-PIV, 1-A
C1—200-uF, 25-VDC electrolytic capacitor
C2, C3—20-uF, 15-VDC electrolytic capacitor
C4—.22-uF, 250-VDC capacitor
D1, D2—1N914 or similar, silicon diode
I1—6-volt, 25-mA, miniature lamp
IC1—LM3900 quad IC amplifier
IC2—7476 IC Flip-Flop
PC1—Cadmium sulfide photocell
Q1—Diac switch
Q2—Triac switch, 200-volt, 3-A or more
REG1—5-VDC volt regulator
R1, 7—100,000-ohm, ½-watt resistor
R2, 8—4.7-megohm- ½-watt resistor
R3, 9—10-megohm, ½-watt resistor
R4, 10—3900-ohm, ½-watt resistor
R5, 11—560,000-ohm, ½ watt (5 percent preferred, not essential) resistor
R6, 12—1 megohm, ½-watt (5 percent preferred, not essential) resistor
R13—6800-ohm, 1-watt resistor, or use two 15,000-ohm, ½-watt resistors in parallel
R14—100,000-ohm potentiometer
R15—1000-ohm, ½-watt resistor
T1—Power transformer, 117-VAC to 12-V secondary, 300 mA or more
SO1—AC socket, chassis mounting
Misc.—Perfboard, flea clips for mounting parts to board, mounting screws, IC sockets, chassis box 3-in. x 6-in. x 2 in. or more, preferably non-metallic, solder, etc.

Make the switch—to a Touch 'N' Dim controller, and to a futuristic means of control to lighting up your life. Our little Touch 'N' Dim circuit was designed with the express purpose of controlling a table lamp but it can be adapted to other uses as well, up to controlling 200 watts of power. Some circuits use body capacitance to detune an oscillator, but Touch 'N' Dim will sense the 60 Hz noise the body is always picking up and use that as the control signal. The construction of this switch is unique and quite interesting as well. The touchplates are fashioned from dimes rather than more expensive, and less eye-catching means.





ALTERNATOR TESTER

Your alternator may be building for a big breakdown without your knowing it. This simple circuit lets you check it out.

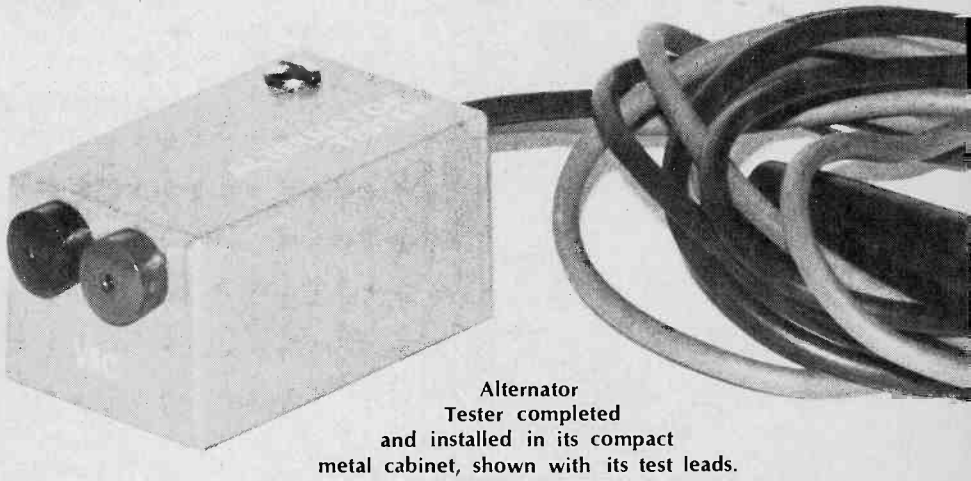
by Anthony Caristi

AUTOMOBILES have been coming off the production lines with alternators instead of generators for some 13 years now, and these units have proven to be reliable and superior to the ones they replaced. Being alternating current machines, they are inherently more complicated than generators and require slightly more sophisticated testing procedures to indicate their condition. This problem is brought about by the fact that automotive alternators are three phase machines, with full wave rectification of the output to produce direct current as required by the automobile and its battery. The schematic shows a typical automotive alternator connected to its three-phase full-wave rectifier circuit.

Rectification is accomplished by six high-current silicon diodes in the alternator, and this is where the problem comes in. Many of the troubles encountered with automotive alternators are due to failure of one or more of the diodes, either by opening or shorting. Neither of these conditions will result in an inoperative alternator, and no doubt some of the automobiles on the road today have just such a problem. A shorted diode is the more serious of the two conditions, since it will result in the loss of about 50 per cent of the output capability of the alternator. Such a condition is easily detected by an ordinary output test on the alternator. However, an open diode is another matter. This condition will result in loss of only a few amperes of output capability of the alternator due to the fact that only one half of one phase of the machine is disabled. Some of this lost capacity is carried by the other two phases, which will be overloaded when the alternator is required to produce full output as demanded by the automotive electrical system. Such a condition may well result in further failure of more diodes. An ordinary output test of an alternator with an open diode generally will not detect any malfunction. Because of those testing problems, another test method to determine the condition of alternators has been developed, and the construction of the Alternator Tester is the subject of this article.

The ability of Alternator Tester to detect defective diodes, both open and shorted, depends on the fact that the output ripple voltage of an alternator with a defective diode rises dramatically higher than that produced by a normally-operating alternator. When the pulsating DC waveform output voltage of an automobile alternator is measured the magnitude of the ripple voltage is about 0.2 to 0.5 volts, peak-to-peak. When one of the diodes in the alternator fails the ripple voltage increases to 1-volt peak-to-peak or more. The Alternator Test measures the peak-to-peak ripple voltage so that the condition of the alternator can be determined.

Construction Details. In order to keep construction costs low, the Alternator Tester was designed to be used with an ordinary VOM or VTVM as the indicating device. Since the output impedance of the test instrument is close to zero, any meter of at least 1000-ohms-per-volt sensitivity can be used. The circuit is constructed on a small printed circuit board and fitted into a metal or plastic cabinet. Two tip jacks are mounted in the cabinet which serve as the connection to the VOM. A pair of test leads is brought out through a grommet and these provide the DC power to operate the circuit



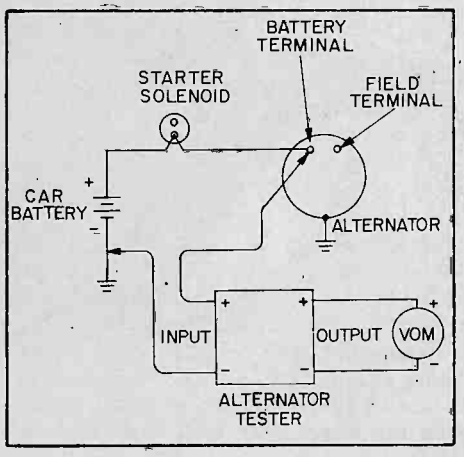
Alternator Tester completed and installed in its compact metal cabinet, shown with its test leads.

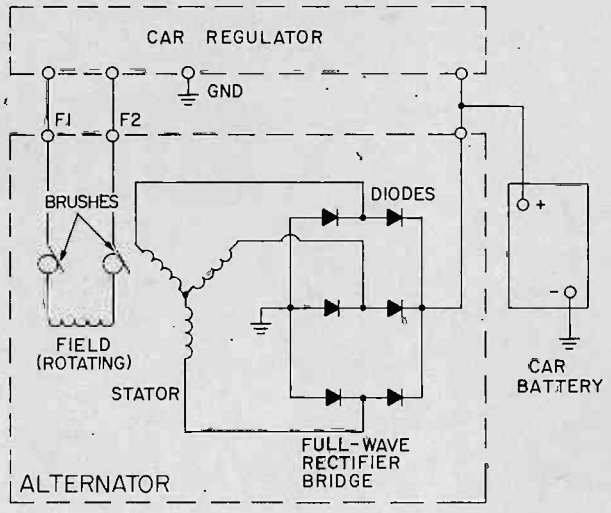
ALTERNATOR TESTER

as well as the connection to the alternator output (battery) terminal where the ripple measurement is to be made.

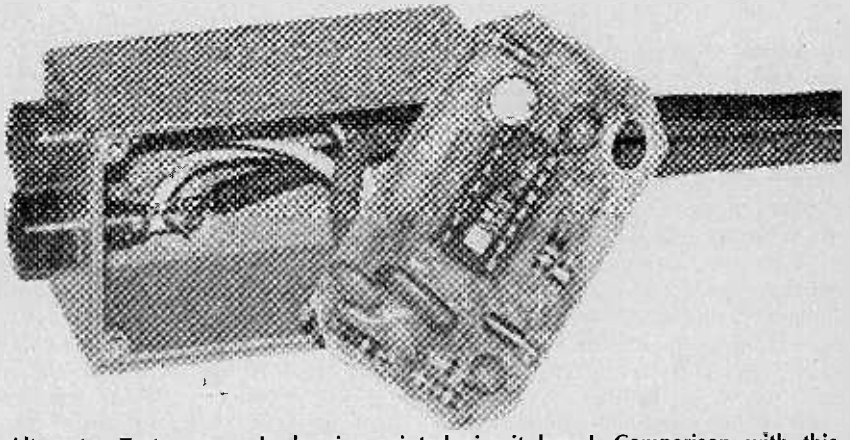
About the Circuit. The Alternator Tester is basically a peak detector circuit which responds to the peak-to-peak value of an AC voltage fed to its input terminal. Power to operate the circuit is derived from the output of the alternator on the same lead which feeds the ripple voltage to the input of the peak detector. The DC output of the alternator is blocked by C1, which allows only the ripple voltage to pass through.

Operational amplifier IC1A and IC1B are connected together to form a peak detector circuit. The ripple voltage from the output terminal of the alternator is fed to the positive input of IC1A after the DC voltage of the alternator is blocked by C1. D1 clamps the ripple voltage to ground, so that it varies between zero and some positive value. Op amp IC1A charges C4 to the peak value of the ripple voltage. Op amp IC1B is a voltage follower which feeds back the peak value of the ripple voltage to the negative input of IC1A. This stabilizes the circuit so that the voltage appearing at the output of IC1B holds to the peak-to-peak value of the ripple voltage fed to the input of IC1A. Capacitor C4 is prevented from discharging through IC1A by D2, and can discharge only through R4 at a rate much slower than the ripple frequency of the alternator. This holds the meter reading constant between voltage peaks of the alternator. Amplifier IC1C has an adjustable gain of slightly more than unity to compensate for the slight error (loss) caused by D2, as well as providing a means for calibration of the instrument. Voltage follower IC1D

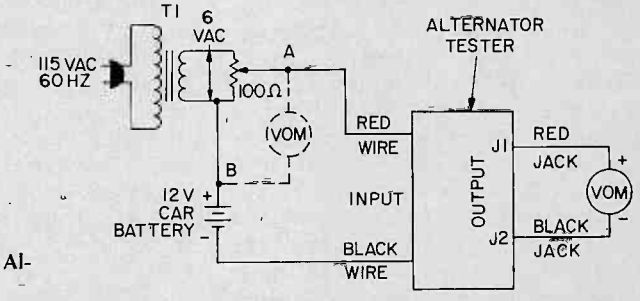




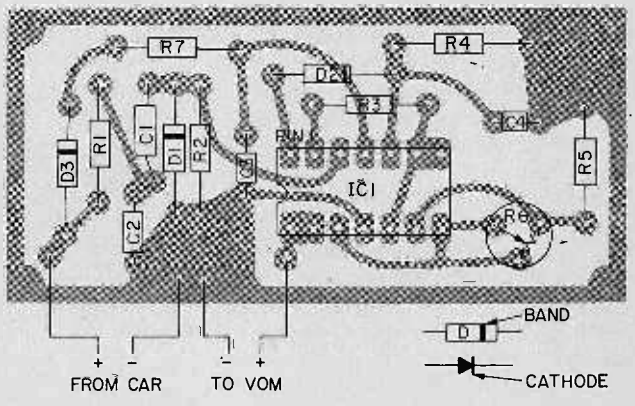
Typical automotive charging circuit. Latest model alternators have solid-state regulator circuit built into alternator frame.



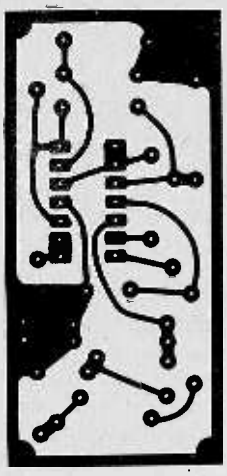
Alternator Tester opened, showing printed circuit board. Comparison with this early version of printed circuit board reveals improvements made by the editors.



Calibration of the Alternator Tester.



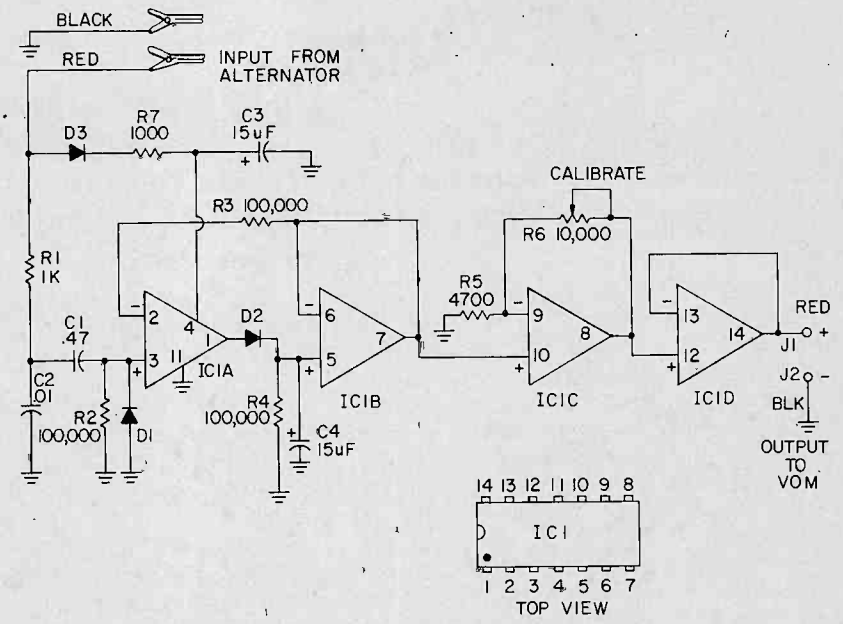
This shows the parts placement on the printed circuit board. Shown larger than actual size for clarity.



This pattern shows the printed circuit board (foil side up) for the Alternator Tester. You can construct the unit on a perf board if printed circuit board fabrication seems too touble.

provides an extremely low output impedance to drive any meter of 1000-ohms-per-volt or more. Power for the circuit, about 2 mA, is taken directly from the alternator output terminal. Diode D3 prevents damage to the circuit in the event of any reverse polarity connections.

Calibration of The Instrument. Calibration of the Alternator Tester is accomplished by feeding an AC voltage of known amplitude between the input terminal and ground, and adjusting R6 for the correct meter reading. The calibrating AC voltage input can be measured by the AC voltmeter function of the VOM, which reads RMS volts. To convert RMS to peak-to-peak voltage multiply the value by 2.83. The calibration circuit uses a 6-volt filament transformer and potentiometer as a source of low voltage AC. To calibrate the instrument connect the filament transformer, potentiometer, and alternator test circuit as shown, using any twelve volt DC supply for power. (Be sure there is no ripple voltage on the output of the supply, since this will cause an error in the calibration.) Set the VOM to read AC volts, and connect it between points A and B as shown. Set the potentiometer so that the VOM reads 0.35 volts RMS. This is equivalent to 1 volt peak-to-peak. Disconnect the VOM, set it to a 1.5 to 3 volts DC scale, and connect it to the output terminals of the Alternator Tester. Calibrate potentiometer reading of 1 volt. This completes calibration of the Alternator Tester.



PARTS LIST FOR ALTERNATOR TESTER

C1—0.47 uF ceramic capacitor (Radio Shack 272-1071 or equiv.)
C2—0.01 uF ceramic disc capacitor (Radio Shack 272-131 or equiv.)
C3, C4—15 or 22 uF, 25 VDC tantalum capacitor (Allied Electronics 852-5671 or equiv.)
D1—1N34A, 75 VDC, 5 mA germanium diode (Allied Electronics 578-0034 or equiv.)
D2, D3—1N487, 75 VDC, 100 mA silicon diode (Radio Shack 276-1102 or equiv.)
IC1—LM324 (Quad 741) operational amplifier (James Electronics, or equiv.—address below)
J1, J2—red, black tip jacks (Allied Electronics 920R0181, 2, or equiv.—address below)
R1, R7—1,000-ohm, ¼-watt resistor (Radio Shack 271-1300 or equiv.)
R2, R3, R4—100,000-ohm, ¼-watt resistor (Radio Shack 271-1300 or equiv.)
R5—4,700-ohm, ¼-watt resistor (Radio Shack 271-1300 or equiv.)
R6—10,000-ohm potentiometer (Allen Bradley Type A, Radio Shack 271-218, or equiv.)
Misc.—2¾ x 2⅛ x 1⅝" utility box (Radio Shack 270-235 or equiv.), hardware, 14-pin IC socket (Radio Shack 276-1999 or equiv.), printed circuit board or printed circuit kit (Radio Shack 276-1576 or equiv.), red, black test leads with alligator clip terminals.

Allied Electronics' address is 401 E. 8th St. Fort Worth, TX 76102.

James Electronics' address is 1021 Howard Ave. San Carlos, CA 94070.

Alternator Testing. The testing of an automotive alternator consists of two parts. The first test is the output test, which determines if the alternator can deliver the full current that it was designed to produce. Bear in mind that the following procedure tests both the alternator and voltage regulator at the same time, and failure of the alternator to deliver rated output also may be caused by a defective voltage regulator. Before making the following tests inspect the connections to the alternator and battery to be sure they are tight. A loose or bad connection between the alternator and the battery may cause an excessive ripple measurement even though there are no defective diodes in the alternator.

The alternator output test requires the use of only the VOM which is set to read DC volts on a 0 to 15 volts or greater scale. Connect the VOM directly across the battery, observing correct polarity. Start the engine and turn on the headlights (high beam), windshield wiper, blower motor (high speed), and radio. Race the engine to a moderate speed (about 2000 RPM) and note the reading of the meter. A properly operating charging system should maintain at least 13.5 and not more than 15 volts across the battery. Voltage readings below 13.5 indicate a defective alternator or voltage regulator. Voltage readings above 15 indicate a defective voltage regulator. Some automobiles have voltage regulators which can be adjusted. Refer to the service manual for your car for voltage regulator tests and adjustments. If the above test indicates satisfactory performance proceed to the ripple voltage test, using the connections shown in the testing diagram. Note that the posi-

(Continued on page 91)

RF from your Calculator

Your pocket calculator can save you sums, when you use it as an RF signal generator.

by Bob Baxter

☐ The virtues of portable electronic calculators are by now so well-known and their prices have dropped so low that the units are found almost everywhere. Many presently-available machines—especially those employing LED displays—can be used as quick troubleshooting aids in addition to performing their usual day-to-day calculating chores. Whenever you need a fast, convenient, and portable amplitude-modulated RF source for equipment checkout, your calculator can often fill the bill.

Here's why. Just about all battery-powered calculators emit strong, wideband RF signals which extend well up into the tens of megahertz. These signals are generated primarily as side-effects by the operation of two components of the calculator: the power supply's DC-to-DC converter and the multiplexed LED digital readout.

Not every calculator has a DC-to-DC converter. But those operating from two or three penlight or nicad cells usually do, using it to step the low battery voltage up to a higher level more suitable for operating the MOS ICs which do the arithmetic. The converter produces a harmonic-rich square-wave output at a fundamental frequency typically between 20 kHz and 100 kHz—but the harmonics extend well up into the megahertz region.

Even if your calculator is one of those without a DC-to-DC converter, it's still almost certain to use a multiplex system to drive the output digital display. Multiplexing means that each selected segment of the digital readout is rapidly turned on and off many times each second rather than staying on continuously. When this switching is done rapidly enough, the readout appears to stay on all the time because of the relatively slow response time of the human eye. Readout devices are multiplexed for two reasons. First, multiplexing drastically reduces the power required to operate the readout at any given *apparent* brightness level because the readout is actually on and drawing current for only a small percentage of the time. As a consequence, batteries last much longer. Secondly, multiplexing permits a great reduction in the total number of IC's needed to actuate the calculator's readout display with an attending cost reduction at the time of purchase.

With a standard calculator's seven-segment LED readout and anywhere from 8 to 12 display digits, the multiplexing frequency is typically around 100 kHz. When currents of 20 mA or so are abruptly switched on and off through the LED display segments, significant amounts of RF energy at multiples of the multiplexing frequency are generated. These harmonics may extend well into the tens of megahertz. In fact, this harmonic radiation is one of the main reasons there are so few AM clock radios with LED time displays on the market today. The standard AM broadcast band is almost totally obliterated if the receiver's RF sections are within a foot or so of the multiplexed readout display unless extensive shielding is employed. Fortunately, there are two more practical and less expensive solutions than shielding. The first is the addition of resistance-capacitance networks to slow the rise and fall times of the multiplex waveform—and consequently filter out most of the higher-order harmonics. The second method is to drive each display digit directly and not use multiplexing at all. This second technique is much more practical in a clock radio than in a calculator for two reasons. First, clock radio displays normally have considerably fewer digits than most calculators; hence, the circuit problem isn't nearly so complex. And secondly, with a clock operated from the AC power line, the problem of rapidly discharging the batteries unless the output is multiplexed is eliminated. National Semiconductor Corporation has recently introduced a clock chip with direct drive of all readout segments to eliminate RF interference. It was designed with clock radio applications in mind.

One of the many uses for your calculator other than calculating. Here it is being used to check a windshield antenna.

But now back to your calculator, which almost certainly is multiplexed and unfiltered and produces a rich harmonic output. Turn it on and slowly bring it near a standard AM radio which is tuned either to a weak station or between stations. You should hear a mixture of buzzes and tones as the calculator is brought within several inches of the radio or its antenna. These tones probably will shift in frequency if you key different numbers into the display.

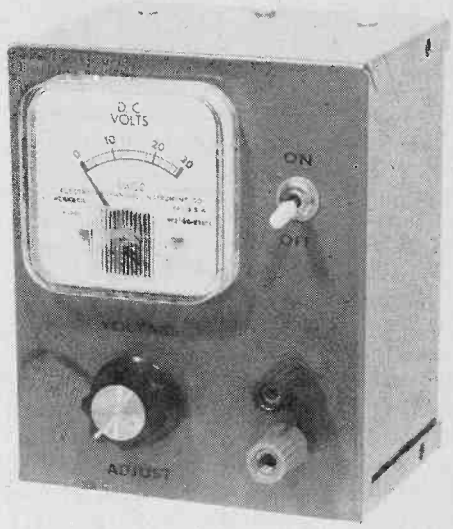
Now that you've verified that your calculator is a portable, wideband, RF source, what can you use it for? Well, a number of applications are obvious. Anytime you need a quick check to see if the RF and IF stages of an AM receiver are working, your calculator can provide a test signal. Probably its handiest use, though, is in continuity testing antennas and connecting cables. Auto antennas and their accompanying cables and connectors are easily tested for opens and shorts by bringing the calculator near the antenna while monitoring the radio output. Perhaps the ultimate example of this technique you can perform in your automobile. Place a calculator near the windshield antenna of a late model General Motors car. In cases of poor or non-existent reception, one or both of the two thin antenna wires imbedded inside the glass may be broken. By carefully tracing the path of each individual wire, a break or faulty connection can be located when the radio's output changes abruptly.

And one final thought. Those of you with LED digital watches might experiment with them. The power is much lower, and the metal watch case provides a lot of shielding, but there just might be enough RF coming from the display to be useful. ■

THE JUNK BOX SPECIAL

Power your projects, spend pennies for parts.

by Herb Friedman

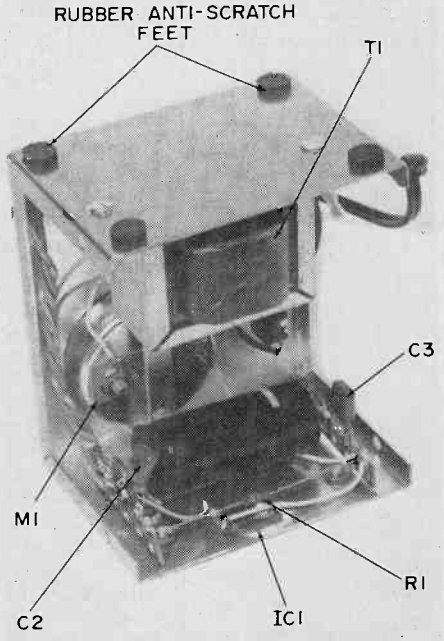


Between 555 timers, TTL, CMOS, opamps and run of the mill transistor projects, the average experimenter is often faced with the need for a regulated power supply with a range of about 5 to 15 volts–just to try out a breadboard project. If you've priced any regulated supplies lately you know they don't come cheap. Maybe, just maybe, you might get one for $30 or $35.

With a little careful shopping, a reasonably stocked junk box and one or two "brand new" components you can throw together a regulated supply costing less than $10 that will handle most of your experimenter power supply requirements. One of these Junk Box Specials is shown in the photographs and schematic. The range of this model is 5 to 15 volts DC at currents up to 1 ampere. One of the common, 3-terminal regulators which are now flooding the surplus market provides everything in the way of regulation. Depending on the source, the regulator will cost you from $1 to $2.50; the higher prices often include an insulated mounting kit (worth about 25-cents).

5 to 15 volts from one 3-terminal regulator? Correct. If regulator IC1's collector terminal is connected to a voltage divider across the output–R1 and R2–the output voltage will be that at the junction plus the volage rating of the regulator, which in this instance is 5 volts. So, when potentiometer R2 is adjusted so its wiper is grounded the power supply's output is that of the regulator, 5 volts–perfect for TTL projects. As R2 is advanced, increasing the resistance from IC1's collector to ground, the voltage output increases.

Getting the parts. There are plenty of parts around to build this supply for under $10. If you go out and round up "all new" components the cost is likely to go well over $30, so forget about new parts. Power transformer T1 can be 18 volts at 1 ampere (or rated at higher current, though the supply's maximum output is 1 ampere), or 36 volts center-tapped at 1 ampere or more. Both the 18 volt and 36 volt transformers are glutting the surplus market. If you get an 18 volt transformer use the bridge rectifier shown in the schematic. If you get a 36 volt C.T. transformer use the full-wave rectifier shown below the schematic. The diode rectifiers, SR1 through SR4, are type 1N4001, 1N4002, 1N4003, or 1N4004, which are also glutting the surplus market. Just to show you the savings possible, at the time this article is being prepared you can buy fifteen surplus 1N4001s for $1. Just one single "general replacement" for the 1N4001 from a national supplier is selling for over 40-cents. Get the idea how to save costs on this project?



To prevent scratching your workbench apply rubber anti-scratch feet or bumpers on the bottom of the cabinet. They are available in most hardware and houseware stores.

Capacitor C1 can be anything from 2000 to 4000 uF at 25 volts or higher. Look for an outfit selling surplus computer capacitors. If worse comes to worse you can get the value specified in the parts list in a Radio Shack store.

The 3-terminal, 5 volt regulator is another item easily found on the surplus market. With an adequate heat sink–such as the cabinet itself–the device can safely deliver 1 ampere. The unit shown in the photographs is a Motorola MC7805 (though you can substitute any similar type) obtained for $2.50 from Circuit Specialists. We have seen similar devices from other manufacturers selling for $1. The terminals B, C and E are indicated directly on the device or on the terminals–where they join the case. The collector (C) lead is connected to the IC's metal tab, and is normally grounded. Note that in this project, however, the collector terminal, and therefore the tab, is not grounded. You must use an insulated mounting kit consisting of a mica insulator and a shoulder washer. Place the insulator between the IC's body and the cabinet, or the tab and cabinet, and slip the shoulder washer into the opening (hole) in the body or tab. Pass the mounting screw from outside the cabinet through the mica washer, through the IC, and

JUNK BOX

through the shoulder washer. Secure with a ¼-inch (or smaller, not larger) nut hand-tightened against the shoulder washer. Before going any further check with an ohmmeter to be certain the collector terminal is insulated from the cabinet.

Connecting wires are soldered directly to IC1's terminal leads; use a heat sink such as an alligator clip on each terminal if you have a large (greater than 40 watts) iron. Since the layout is not important, we suggest the arrangement shown, with IC1 positioned between two mounting strips so R1 can span across the strips and be soldered to IC1's collector terminal.

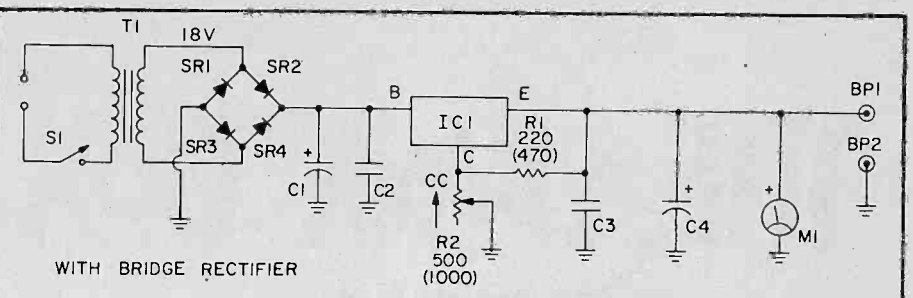
Finally, we come to the meter, a device that has become slightly more expensive than a barrel of Arabian oil. Any meter that can indicate at least the range of 0 to 15 VDC is adequate. The EMICO 0-30 VDC meter shown in the photographs was selling in one local store for $7.95, while we bought ours almost down the block as "surplus" for $2.99. A good source for surplus meters is Fair Radio Sales. You might not end up with a meter case that looks suitable for NASA, but the output voltage doesn't care two hoots whether the meter is a modern $25 dollar model or a surplus-special for a buck ninety-nine.

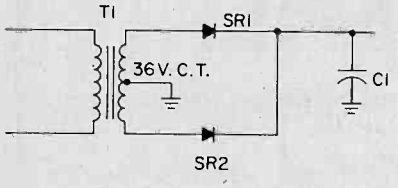
Power switch S1 can be a separate SPST as shown in our project, or it can be part of R2. But keep in mind that a separate S1 allows you to turn the supply on and off without affecting voltage control R2's adjustment.

Finally, we come to R1 and R2. You will note that the schematic shows two values for each. One value for each resistor is in brackets (parenthesis). You can use either set of values as long as they are matched. If R2 is 500 ohms R1 is 220 ohms; if R2 is 1000 ohms R1 is 470 ohms. The reason we show both sets of values is because 500 and 1000 ohm potentiometers appear on the surplus market from time to time, but usually not together. This way, you can use whatever is available at low cost.

CHECKOUT. Set potentiometer R2 so the wiper shorts to the end connected to IC1's collector terminal, thereby connecting the collector directly to ground.

(Continued on page 99)



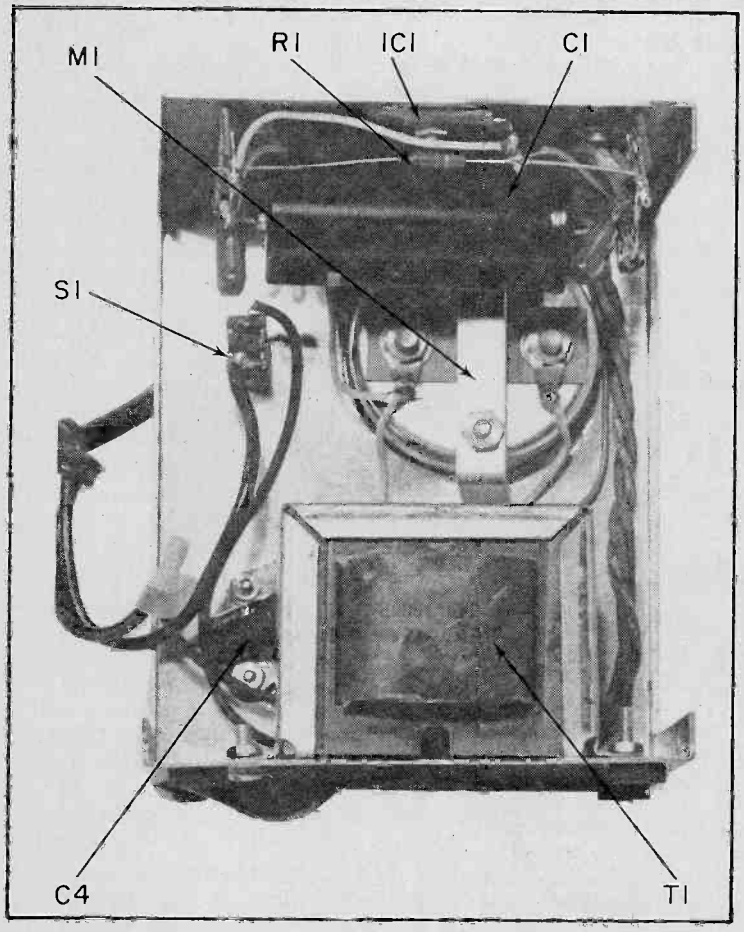


ALTERNATE FULL-WAVE RECTIFIER

Virtually any DC voltmeter that can display the range of 0 to 15 volts can be used. The surplus market is loaded with less-than-$5 meters that are suitable if you don't mind a little extra scale coverage.

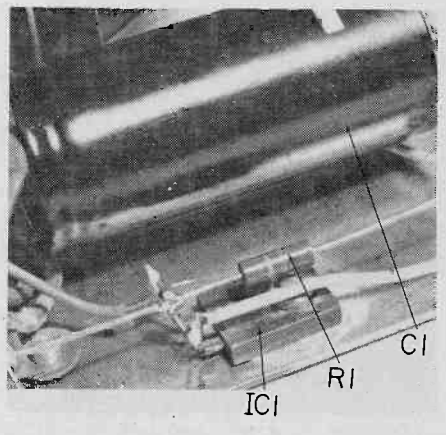
PARTS LIST FOR JUNK BOX SPECIAL

R1—220 or 470-ohms, ½ watt, 10% (see text)
R2—Potentiometer, 500 or 1000-ohms (see text)
C1—3300-uF, 35 VDC (see text) (Radio Shack 272-1021 or equivalent)
C2, C3—0.1 uF Mylar
C4—25-uF, 25 VDC or higher
M1—DC voltmeter (see text)
IC1—Motorola MC7805, 5 volt 3-terminal regulator (see text)
T1—Power transformer, secondary 1 ampere at 18 volts or 36 volts C.T. (see text)
SR1, SR2, SR3, SR4—Silicon rectifiers (see text)
S1—SPST switch
BP1, BP2—5-way binding posts
Misc.—Cabinet, terminals strips, etc.



If you've had experience with assembly in tight quarters, you can shoehorn the power supply into a standard 3 x 4 x 5-inch Minibox. If your soldering iron is so big it burns adjacent wires when you make a connection, use a larger size cabinet.

In order to handle a full ampere, the IC regulator must be heat sinked to the cabinet. Make certain the collector and its attached sink tab (the back of the package) is insulated from the cabinet. Use silicon grease to insure heat transfer from the IC to the cabinet.



Which of these fascinating electronic gadgets would you like to build?

A photo print-timer that does everything but turn out the lights! Designed by a darkroom craftsman, it features instant reset, backlighted digit-set dials, pushbutton stop and start.

A battery-operated dickey flasher —guaranteed to liven up **any** party! Suddenly, your shirt buttons start flashing sequentially! Some people laugh. Others just stare. But it's funniest when they try to ignore you!

A shortwave station finder/marker. Suppose you pick up an interesting but elusive station in Papeete, Kuwait or Kinshasa. This stable wide-band oscillator lets you relocate it any time you like—**without** hours of searching.

A nostalgic crystal radio set—just like the one your grandad had. You make it with a Quaker Oats box.

A futuristic pulse-width modulated mini-audio amplifier. It can boost the volume of a pocket radio to dancing level!

A solid-state wind-chill factor meter that can tell you instantaneously just how cold you feel!

A compact, portable gas alarm for home, trailer, car or boat. It detects many kinds of dangerous fumes—and could easily save your life!

Elementary Electronics features low-cost, practical projects like these in every issue!

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And Kathi Martin, KGK3916, our Citizens Band Editor. She writes "Kathi's CB Carousel"—the most entertaining and informative CB feature you'll find anywhere!

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LITERATURE LIBRARY

301. Get acquainted with the new *EICO* products, designed for the professional technician and electronics hobbyist. Included in brochure are 7 IC project kits, *EICO's* "Foneaids," security products and many varied kits.

302. *International crystal* has illustrated folders containing product information on radio communications kits for experimenters (PC boards; crystals; transistor RF mixers & amplifiers; etc.).

303. *Regency* has a new low cost/high performance UHF/FM repeater. Also in the low price is their 10-channel monitoradio scanner that offers 5-band performance.

304. *Dynascan's* new *B & K* catalog features test eequipment for industrial labs, schools, and TV servicing.

305. Before you build from scratch, check the *Fair Radio Sales* latest catalog for surplus gear.

306. Get *Antenna Specialists'* catalog of latest mobile antennas, test equipment, wattmeters, accessories.

307. Want a deluxe CB base station? Then get the specs on *Tram's* super CB rigs.

308. Compact is the word for *Xcelite's* 9 different sets of midget screwdrivers and nutdrivers with "piggyback" handle to increase length and torque. A handy show case serves as a bench stand also.

310. *Turner* has two booklets on their Signal Kicker antennas. They give specifications and prices on their variety of CB base and mobile line. Construction details help in your choice.

311. *Midland Communications'* line of base, mobile and hand-held CB equipment, marine transceivers, scanning monitors, plus a sampling of accessories are covered in a colorful 18-page brochure.

312. *The EDI (Electronic Distributors, Inc.)* catalog is updated 5 times a year. It has an index of manufacturers literally from A to X (ADC to Xcelite). Whether you want to spend 29 cents for a pilot-light socket or $699.95 for a stereo AM/FM receiver, you'll find it here.

313. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools, and instructions included.

316. Get the *Hustler* brochure illustrating their complete line of CB and monitor radio antennas.

317. *Teaberry's* new brochure presents their complete lines of CB and marine transceivers and scanners for monitoring police, fire and other public service frequencies.

318. *GC Electronics* offers an "Electronic Chemical Handbook" for engineers and technicians. It is a "problem solver" with detailed descriptions, uses and applications of 160 chemicals compiled for electronic production and packaging. They are used for all types of electronic equipment.

319. *Browning's* mobiles and its famous Golden Eagle base station, are illustrated in detail in the new 1977 catalog. It has full-color photos and specification data on Golden Eagle, LTD and SST models, and on "Brownie," a dramatic new mini-mobile.

320. *Edmund Scientific's* new catalog contains over 4500 products that embrace many sciences and fields.

321. *Cornell Electronics'* "Imperial Thrift Tag Sale" Catalog features TV and radio tubes. You can also find almost anything in electronics.

322. *Radio Shack's 1977* catalog colorfully illustrates their complete range of kit and wired products for electronics enthusiasts—CB, ham, SWL, hi-fi, experimenter kits, batteries, tools, tubes, wire, cable, etc.

323. Get *Lafayette Radio's* "new look" 1977 catalog with 260 pages of complete electronics equipment. It has larger pictures and easy-to-read type. Over 18,000 items cover hi-fi, CB, ham rigs, accessories, test equipment and tools.

327. *Avanti's* new brochure compares the quality difference between an Avanti Racer 27 base loaded mobile antenna and a typical imported base loaded antenna.

328. A new free catalog is available from *McGee Radio.* It contains electronic product bargains.

329. Semiconductor Supermart is a new 1977 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors—all from *Circuit Specialists.*

330. There are nearly 400 electronics kits in *Heath's* new catalog. Virtually every do-it-yourself interest is included—TV, radios, stereo and 4-channel, hi-fi, etc.

331. *E. F. Johnson* offers their CB 2-way radio catalog to help you when you make the American vacation scene. A selection guide to the features of the various messenger models will aid you as you go through the book.

332. If you want courses in assembling your own TV kits, *National Schools* has 10 from which to choose. There is a plan for GIs.

333. Get the new free catalog from *Howard W. Sams.* It describes 100's of books for hobbyists and technicians—books on projects, basic electronics and related subjects.

334. *Sprague Products* has L.E.D. readouts for those who want to build electronic clocks, calculators, etc. Parts lists and helpful schematics are included.

335. The latest edition of the *TAB BOOKS* catalog describes over 450 books on CB, electronics, broadcasting, do-it-yourself, hobby, radio, TV, hi-fi, and CB and TV servicing.

337. *Pace* communications equipment covers 2-way radios for business, industrial and CB operations. Marine radiotelephones and scanning receivers are also in this 18-p. book.

338. "Break Break," a booklet which came into existence at the request of hundreds of CBers, contains real life stories of incidents taking place on America's highways and byways. Compiled by the *Shakespeare Company,* it is available on a first come, first serve basis.

342. *Royce Electronics* has a new 1977 full line product catalog. The 40-page, full-color catalog contains their entire new line of 40-channel AM and SSB CB transceivers, hand-helds, marine communications equipment, and antennas and accessories.

344. For a packetful of material, send for SBE's material on UHF and VHF scanners, CB mobile transceivers, walkie-talkies, slow-scan TV systems, marine-radios, two-way radios, and accessories.

345. For CBers from *Hy-Gain Electronics Corp.* there is a 50-page, 4-color catalog (base, mobile and marine transceivers, antennas, and accessories). Colorful literature illustrating two models of monitor-scanners is also available.

350. Send for the free *NRI/McGraw Hill* 100-page color catalog detailing over 15 electronics courses. Courses cover TV-audio servicing, industrial and digital computer electronics, CB communications servicing, among others G.I. Bill approved, courses are sold by mail.

352. Send for the free descriptive bulletin from *Finney Co.* It tells all about their new auto FM radio signal booster (eliminates signal fading).

353. *MFJ* offers a free catalog of amateur radio equipment—CW and SSB audio filters, electronic components, etc. Other lit. is free.

354. A government FCC License can help you qualify for a career in electronics. Send for Information from *Cleveland Institute of Electronics.*

355. New for CBers from *Anixter-Mark* is a colorful 4-page brochure detailing their line of base station and mobile antennas, including 6 models of the famous Mark Heliwhip.

356. Send for *Continental Specialties* new breadboarding prototest devices. They vary in prices from a mini-budget kit at $19.95. Featured is the new logic monitor, giving information on what it does, how it works, and how to use it.

358. *PixTronics* announces its new Model 200 Super Sensitive Electronic Darkroom Exposure Meter, used to determine the correct exposures of all black-and-white and color negatives. Useable with any enlarger.

359. *Electronics Book Club* has literature on how to get up to 3 electronics books (retailing at $58.70) for only 99 cents each . . . plus a sample Club News package.

360. *Cornell-Dubilier* has a 4-color, 4-page, brochure on its Ham II, CD-44, and Big Talk rotor communication systems. Exploded half tones detail interior rotor construction, and tables list specs.

361. "Solving CB Noise Problems" is published by *Gold Line* and tells you how to reduce the noise and get a clearer signal. In discussion and diagram you can find out about the kinds of noise, their sources, and the remedies.

ELECTRONICS HOBBYIST
Box 1849, G.P.O.
New York, NY 10001

FALL/WINTER 1977
Void After February 27, 1978

Please arrange to have the literature whose numbers I have circled below sent to me as soon as possible. I am enclosing 50¢ for each group of 5 to cover handling. (No stamps, please.) Allow 4-6 weeks for delivery.

301	302	303	304	305	306	307	308	310	311	312	313
316	317	318	319	320	321	322	323	327	328	329	330
331	332	333	334	335	337	338	342	344	345	350	352
353	354	355	356	358	359	360	361				

NAME (print clearly) _____

ADDRESS _____

CITY _____ **STATE** _____ **ZIP** _____

CB New Products

(Continued from page 55)

and incorporates 600 volt construction to guard against high voltage inductive spikes present at the coil terminal. Minimum suggested advertised price is $4.95. For further information, write to Cornell-Dubilier Electronics, 150 Avenue L, Newark, NJ 07101.

Omni-Directional for Limited Space

S&A Electronics' new Target BS-110 omni-directional CB antenna with end feed is designed for minimal space applications including portable base station, apartments and marine use. The sturdy Target BS-110 will withstand winds of over 100 mph. It has no radial elements to bend or coils to burn out or detune. The half-wave dipole antenna is lightweight. Construction is all fiberglass with nickel chrome-plated ferrules. The two-piece construction makes installation easy. Simply assemble the upper section to the lower section and mount the BS-110 to the mast. Target's BS-110 comes complete with mounting bolts and matching harness that mates with the standard PL-259 type UHF connector. It has a frequency of 27 MHz and VSWR across 40 channels of 1:1.5 or less. Gain is 3.75 dB. Overall height reaches 15-ft., 9-in. with assembled weight at 3.5 lbs. Sells for $46.60. The Target BS-110 end feed, omni-directional TV antenna is a product of S&A Electronics, 202 W. Florence Street, Toledo, OH 43605.

CIRCLE 62 ON READER SERVICE COUPON

Adapter Connector for Mikes

Avoid soldering new connectors and plugs to your power mikes and/or CB rigs. Mura has the answer with its new MikeMate microphone adapter system. It's difficult for CBers to set up accessories and power microphones because they come without connectors. The CBer has had to buy a connector (if he could find it) and solder it on himself. Because of the very fine wires used in CB cables and because of the very small size of CB Mike connectors, even skilled CB hobbyists have trouble properly attaching these connectors. The MikeMate, featured on all Mura microphones, uses a simple adaptor and master connector on each microphone to solve this problem. CB dealers now have a cross reference guide to show the CBer which Mura adapter fits his CB transceiver. The CBer selects a Mura microphone of his choice, purchases the appropriate adapter, and plugs both into his transceiver for immediate operation! Although there are dozens of different CB mike connectors, CB dealers will stock the most popular adapters which will connect to most CB transceivers. The remaining special adapters can be ordered by dealers so that a customer can fit any Mura CB microphone to every CB transceiver without difficulty. The adapters are priced to sell at $5.95. For further information, write to Mura Corporation, Westbury, NY 11590.

CIRCLE 70 ON READER SERVICE COUPON

Add Tone to Your Phone

(Continued from page 23)

The meter indicates RMS in terms of the average voltage of a sine waveform so the reading is slightly off because there are two sine waves. The 'scope sees the vector addition of the two tones, and when the tones are in phase the peak value is greater than the peak value of the individual tones. So to avoid blowing any associated transistor equipment just remember that the maximum pad output is nominally 3.5 volts peak to peak regardless of what your VOM or VTVM indicates.

No Adjustments. Unlike some of the electronic touch-tone encoders the Western Electric telephone dialer pads require no adjustment, nor do they drift. Just install one and it works. ■

Touch 'n Dim

(Continued from page 90)

8" long for connection to PC1, the whole dimmer circuit can be wired and tested separately. When you are satisfied that the dimmer works, mount the circuit board in the case on a couple of spacers and solder its AC line input terminals in place. Tape I1 and PC1 together as shown in the photo. Wire in PC1, turn R14 up for maximum intensity and plug the unit in. The touch control and dimmer should now function independently of each other. The only other step in construction is to make a particular unit that you use In general, a small heat sink is desirable. *Be sure that nothing carrying line voltage protrudes outside the case.* I mounted the Triac in the prototype on a small piece of sheetmetal and held the assembly down with quick-drying epoxy. Be sure to roughen the space on the plastic where you put the cement.

I soldered Diac Q1 directly to the gate lead of the Triac and covered the connection with heat shrink tubing. If you just leave two thin wires about couple of mounting holes in the top of the case for mounting the touchplates.

For convenient operation and adding atmosphere to kitchen or living room, Touch 'N Dim is a hard combination to beat. As noted above, the circuitry can also be fitted into a lamp having a non-metallic base. Just take care that you use the same touchplates as are in the prototype. That way you won't have any problem, due to improper capacitance. Enjoy! ■

Junk Box Special

(Continued from page 96)

If you wired R2 correctly it should be full counterclockwise. Then set S1 to *on*. The meter should rise instantly to 5 volts DC. As R2 is adusted clockwise the output voltage should increase to 15 VDC or slightly higher. If R2 can adjust the output voltage only over the range of approximately 12 to 15 VDC, or 12 to 15+ VDC, IC1 is defective, or has been damaged.

Phoning the Future

(Continued from page 75)

which is less than one-third the time of the 110 baud stop bits.)

Baud rates can be intermixed for storage. Assume you have a Southwest Technical Products MC6800 personal computer such as the one E/E will use for our personal computing series. You might type in your program using a 110 baud model 33 teletype. Allow for corrections, proofing and changes and assume you have worked one hour loading the program. The final program—error free—if punched out on paper tape through the TTY might take 10 or 15 minutes to load it back in the next time you want to use it. But you can have a "hobby standard" 300 baud recorder connected to the computer, and instead of dumping the program out to the TTY you dump to the recorder at three times the TTY speed. The recording will take only some 3 or 4 minutes to save

(Continued on page 101)

CLASSIFIED MARKET PLACE

ELECTRONICS HOBBYIST—PUBLISHED ANNUALLY. The rate per word for Classified Ads is $1.00 each insertion, minimum ad $15.00 payable in advance. Capitalized words 40¢ per word additional. To be included in next issue, write to: R. S. Wayner, DAVIS PUBLICATIONS, INC., 229 Park Ave. So., N.Y. 10003.

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BATTERIES & GENERATORS

REPAIR Alternators! Generators! Batteries! Motors! Modelec, Box 7266, Kansas City, MO 64113.

BLUEPRINTS, PATTERNS & PLANS

NEW CRAFT PRINT CATALOG—Choose from over 100 great easy-to-build plans. Send $1.25 (completely rfeunded with your first order). BOAT BUILDER, (CP Div.)—229 Park Avenue South, New York, NY 10003.

BUSINESS LOANS

BUSINESS loans for any purpose $25,000 to $10,000,000. Quick reply. James Ambrose Co., 2619 La Mesa Way, Sacramento, CA 95825.

BUSINESS OPPORTUNITIES

MAKE Magnetic Signs. Big profits. Details, Universal, Lenora, KS 67645.

$25.00 DAILY possible stuffing envelopes! Details Free. Service, Box 715-D, Lynbrook, NY 11563.

$30.00 HUNDRED Stuffing Our Circulars into Stamped Addressed Envelopes. Imediate Earnings. Beginners Kit $2.00. COLOSSI, 1433-61 Street, DC-10, Brooklyn, NY 11219.

HOMEWORK! BIG MONEY addressing mailing envelopes. Exciting offer 10¢. Linco Services, 3636 Peterson, Chicago, IL 60659.

1000% PROFIT Bronzing Baby Shoes. Free Literature. NBC, Box 1904-DG, Sebring, FL 33870.

$3000.00 MONTHLY. Immediate income. Stuff envelopes at home. Information, send self-addressed stamped envelope. Cottage, Box 730-DFK, Baldwin Park, CA 91706.

$500.00 profit stuffing 1,000 envelopes. Details $1.00 (Refundable). Elamco, Bel3337 D11, Waldo, AR 71770.

"999 SUCCESSFUL LITTLE KNOWN BUSINESSES" information write, Gentry Distributors, Dept. DP Box 511, Pascagoula, MS 39567.

GUARANTEED $178.00 WEEKLY. Work one hour daily. Free Brochure. FAS, Box 13703, San Antonio, TX 78213.

$350 weekly mailing letters. Free details. Bronxville House, Box 311 D, Bronxville, NY 10708.

HOW TO RECRUIT COMMISSION SALES-PEOPLE! Free details! Success publications, 35 Interlachen Place, Excelsior, MN 55331.

CABLE/FM Broadcast station. No investment. Operate from home, church, school. Excellent income. Free Details. CAFM, Box 5516-GK, Walnut Creek, CA 94596.

AMAZING! Home Enterprise Opportunity guaranteed. Details 35¢ Ivanna, 5052 North Ashland, Chicago, 60640.

$200 weekly mailing circulars. Start Immediately. Complete program—$2.00. Guaranteed! M/L, Box 68011, Seattle, WA 98188.

SPECTACULAR home business opportunity. Details Free! Brandon, P.O. Box 2013, Newport News, VA 23602.

COLLECT names for $1, each, instructions $2, Leroy Williams, 81 South Sixth, Newark, NJ 07107.

STARTLING NEW REPORT CAN CHANGE YOUR LIFE! BIG MONEY can be YOURS! Includes tips on creative thinking, how to PROTECT and MARKET your ideas. Send $1.50, Moneygetters, Dept. 117-EH, 5806 Dryad, Houston, TX 77035.

AMAZING profits in real estate. New report tells how, where. Tips for buying rural land. Only $1.50. Wesley Leonard, 187 North Main, Hancock, Maine 04640.

BUY IT WHOLESALE

SAVE money! Buy low cost quality Christmas Gift Items (5) catalogs $3.00. Winchester Enterprises Inc. 2807 SS Hargrave Street, Phila., PA 19136.

DETECTIVES

POLICE SECURITY INVESTIGATIVE schematics and equipment listings. Quimtronix, Box 548-DV, Seattle, WA 98111.

EDUCATION & INSTRUCTION

UNIVERSITY DEGREES BY MAIL! Bachelors, Masters, Ph.D.s. . . . Free revealing details. Counseling. Box 389-EH-11, Tustin, CA 92686.

ELECTRICAL EQUIPMENT & SUPPLIES

GIANT Bargain Packed Canadian Surplus Catalogs $1.00. Etco Electronics Dept. DG, 183G Hymus Blvd., Pointe Claire, Quebec H9R 1E9.

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GIFTS THAT PLEASE

DISCOUNT gift catalog! 1,500 items. $2.00 Kel-Rico, RFD, Box 400, Anacoco, LA 71403.

STARFISH JEWELRY. Designed by Mother Nature every detail intact as if fronzen in gold. Earrings pierced or screwback. Pendant $7.95, earrings $7.95. Midwest Mail-Order, 716 North Third Street, Aberdeen, SD 57401.

OPTICAL ILLUSION PICTURES. What you see is not necessarily what it is. A closer look will show you a completely different picture. Great conversation item 8½ x 14, $2.00 each or four different for $5.00. Rodger's Illusion's, Box 59, Sparta, NJ 07871.

HANDSOME SOLID BRASS CRAB ASHTRAY. 7½". $10.98. SATISFACTION GUARANTEED. POSTPAID. KEN-BAR GIFTS, IO, 4452 NORTH ASHLAND, CHICAGO, IL 60640. ILLINOIS RESIDENTS 5% SALES TAX.

HOME WORKSHOP SUPPLIES

VINYL care kit, $12.95, send check, money order, master charge, Bankamericard numbers, and expiration date to. Jim's Vinyl Restoral, 35040 Renfrew, Mt. Clemens, MI 48045.

HYPNOTISM

FREE Fascinating Hypnosis Information! Startling! DLMH, Box 487 Anaheim, CA 92805.

MISCELLANEOUS

OLDTIME Radio Programs on quality tapes. Free catalogue. Carl D. Froelich, Route One, New Freedom, Pennsylvania 17349.

EXPERTLY avoid income tax$s. Postcard with name brings details. Jon Tanizaki, 12215 Aneta Street, Culver City, CA 90230.

TRUTH about UFO's, send self addressed envelope. Thank you. Box 1023BK, Truth or Consequences, New Mexico 87901.

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$500.00 profit stuffing 1000 envelopes. 25 cents details: Canabro Enterprises, Box 215, Station "H", Montreal, Que., Canada.

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JAPANESE Girls Make Wonderful Wives. We have large number of listings. Many interested in marriage. Only $1.00 brings application, photos, names, descriptions, questionnaire, Etc. Japan International, Box 156-AA, Carnelian Bay, CA 95711.

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"CRYSTAL Experimenter's Handbook"—50¢. "20 Crystal Set Plans" Handbook—50¢. Catalog 25¢, refundable. Laboratories, 1477-EH, Garden Grove, CA 92642.

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Phoning the Future

(Continued from page 99)

and reload into the computer. Some personal computing hobby recorders run 1200 baud, and that 10 or 15 minute program can be saved and loaded in a few seconds. (There are even higher baud rate recorders)

Summing Up. Your first requirement for both personal and time-share computers is the terminal. With the personal computing marketplace growing at a rate exceeding Jack's beanstalk there are more and more ads from more and more companies offering surplus TTYs and CRT terminals, both kit and wired. Like the early days of anything, many won't be around tomorrow when you need service or parts, and some of what will be sold won't work too well. In selecting a terminal, stick to the well-known brands from companies that have deserved reputations. For example, you can always get parts and service for a model 33 TTY at reasonable prices. This is not necessarily true of any other TTY. If you're purchasing a used model 33 (which is about the only way to get one, because the waiting list for a new one dircet from Teletype is months and months) make certain you get it from a company specializing in rebuilt models, such as National Teletype.

If you opt for a CRT terminal the proven one is the ACT-1; if you want to go the build-it-yourself route Southwest Technical Products is probably your best bet at this time.

For modems, Omnitec is considered by many the industry's workhorse. A used model 701A is available for about $150 and handles both TTY and RS-232 inputs. They have newer TTY models available in both semi-kit and wired versions for prices between $100 and $160.

In later articles we will cover other equipment such as TTY tape readers, high baud rate recorders, splicers, storage systems, etc.

The age of personal computing is upon us so you might as well climb aboard at the beginning. ■

Lone Ranger Light

(Continued from page 49)

and the case is covered. Solder the positive lead from the battery clip to one side of S1. To the other terminal of S1 solder the short lead from the circuit board. Finish off by mounting the cover and applying press-on decal labels as desired.

Calibrating Lone Ranger. Set the range selector to the low-light measurement position (the larger hole), then point the meter towards a bright light bulb and depress S1. One or more LEDs should light, depending upon the brightness of the source. If not, go back and check whether any components have been improperly oriented. When all is working well, only the calibration of the meter remains. Borrow a good light meter for this task. Choose a large, preferably blank wall and evenly illuminate it (avoid using fluorescent light sources, however). Adjust the light source and the distance until your reference meter indicates f/8 at ASA 125 and 1/30 sec. When you have obtained the correct reading on your reference meter, hold your Lone Ranger in the same spot and point it in exactly the same direction that the reference meter had been facing. Press S1 and adjust R2 so that LED4 (the one farthest) extinguishes. Now turn R2 back the other way until LED4 just comes back ON. The meter is now calibrated. To use the meter with different film and shutter speeds, consult the Table.

Film Speed ASA	Exposure Correction
400	+2
250	+1
125	0
65	−1

Shutter Time	Exposure Correction
1/125	−2
1/60	−1
1/30	0
1/15	+1
1/8	+2

ASA = 125
+ — go to higher f-stop
− — go to lower f-stop

Additional Circuit Uses. You may have noticed that the comparator circuit preesnted here has great potential. A thermistor might be submitted for photocell PC1 and the circuit becomes an electronic thermometer. Or mount a potentiometer so that its control shaft spins as another shaft rotates. The LED display would then indicate angular position, perhaps for an antenna rotor. The information here plus your own imagination should produce many new devices. ■

Alternator Tester

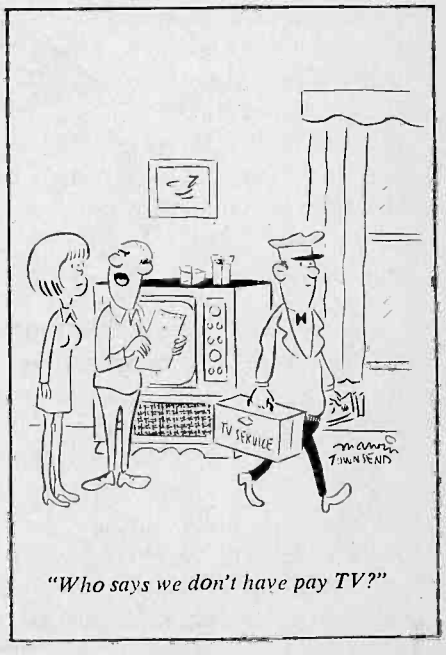
(Continued from page 93)

tive lead of the Alternator Tester is connected directly to the battery terminal of the alternator. The reason for this is that the ripple measurement depends upon the small, but finite, resistance between the alternator and battery. In order for the ripple test to be accurate, the alternator must be delivering a sizeable current. This is accomplished by slightly discharging the battery. Before starting the test shut the engine off and turn on the car headlights for about ten minutes. During this time you can connect the Alternator Tester to the car. Leave the headlights on while making the test. Start the engine and bring the RPM up to about 2000. Note the reading of the meter. An alternator in proper operating condition will have a ripple voltage somewhere between 0.2 and 0.5 volts peak-to-peak. Should one or more of the diodes be defective the ripple voltage will increase to 1 volt peak-to-peak, or more. If this is the case you will have to remove the alternator from the car to disassemble it and locate the defective diode. ■

Computer New Products

(Continued from page 52)

tures the well-known PDP-11 instruction set. The H11 includes a 16-bit LSI central processing unit (fully wired and tested) with 4K x 16 dynamic RAM. Memory is expandable to 20K. The unit includes built-in backplane, power supply with switching regulators and full circuit protection, and flexible I/O interface accessories. A complete DEC system software package is included; it contains editor, PAL-11 assembler, linker, on-line debug package (ODT), input/output executive, BASIC and FOCAL. Mail order price of the H11 is $1,295. Accessories: 4K x 16 static RAM memory board, $275; a flexible serial interface, $95; parallel interface, $95. Other items in Heath's new computer line include: DEC Writer II Keyboard Printer Terminal, H9 CRT Terminal, H10 Papertape Reader/Punch. Circle 31 on Reader Service Coupon. ■



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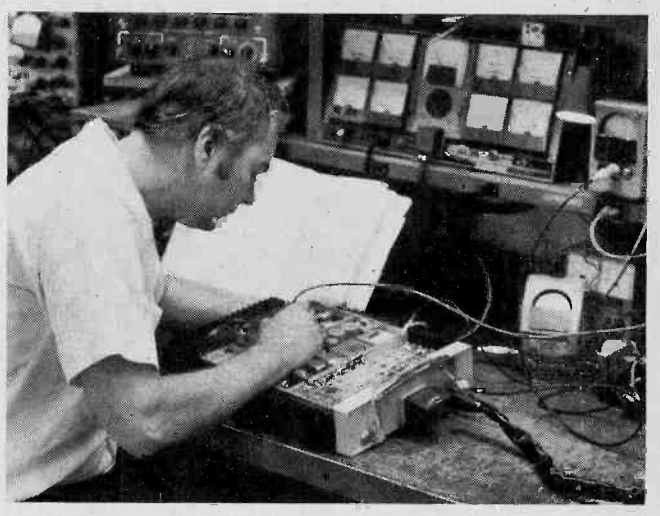

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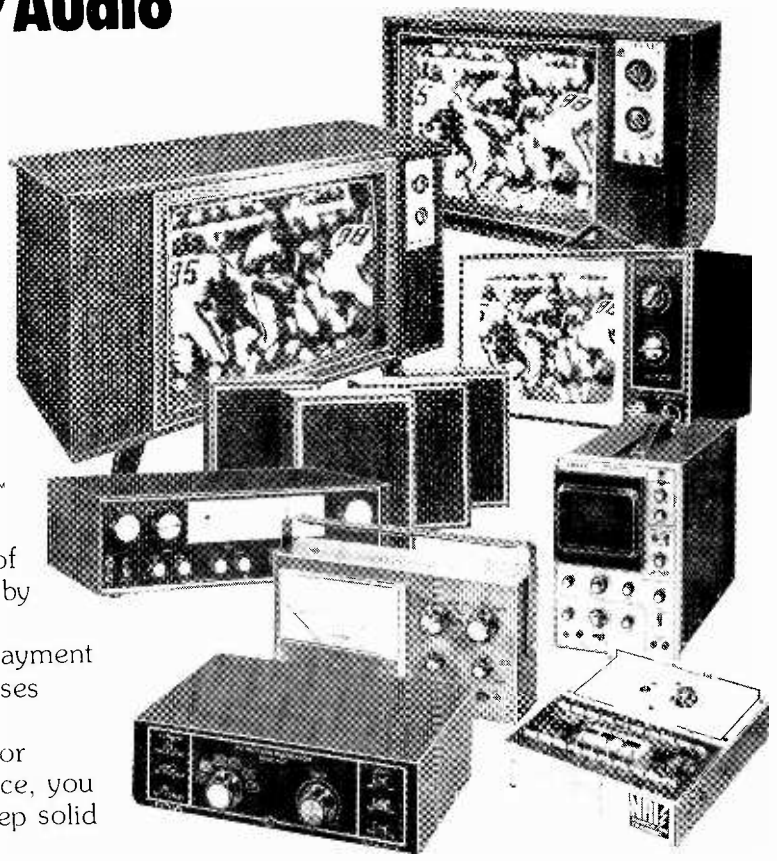

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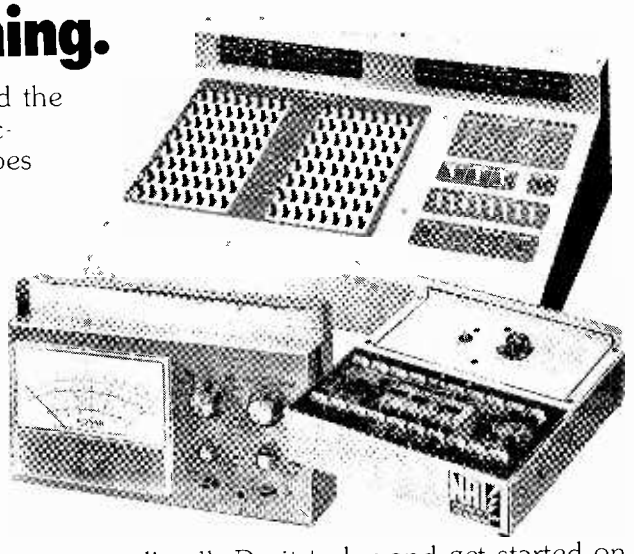

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You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester, Square Wave Generator and the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build Receiver, Transmitter, Square Wave Generator, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

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FROM OUR MAIL BAG

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Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

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