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SPECIAL

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for Beginners, Pros, CBers, Mechanics, Photographers, Shortwave Listeners, and more!

5 automotive gadgets
4 communication rigs
3 antique radio ideas
2 photographic projects
1 speaker construction
28 total projects!

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Tell Time Digitally • Guard Against Gas Leaks • Snoop on Snails! • Cut Battery Costs • Boost Shortwave Signals • Tune-up Cars • Listen to VLF • Full story on page 4

By the Editors of ELEMENTARY ELECTRONICS

A DAVIS PUBLICATION

Our 10 Best Selling Craft Projects

NOW YOU CAN ENJOY CLASSIC-DESIGN FURNITURE AT A FRACTION OF STORE RETAIL PRICE! BUILD WITH CRAFT PLANS! Craft Plans are the hottest thing going today! Yes, thousands of spare-time craftsmen are finding they can easily move up to making a style of furniture they believed beyond their ability to handle. Well-known designers have now created a variety of plans that are exceptionally easy to follow and will assure you beautiful, finished pieces, at tremendous savings!

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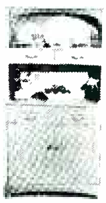
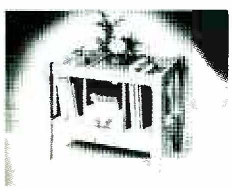
D-3
Child's Footlocker
No specialized tools are required to make this attractive child's footlocker. Spindles are assembled from stock items and except for some scroll cuts made with a saber saw, construction is done with hand tools. Lumber-plywood combination eliminates the usual craftsmen problems.



D-8
Colonial Hutch
This fair-sized hutch is dimensioned so that it can be built by using one panel of 4′ x 8′ plywood for the main assembly. Basic colonial design is revised so it blends in with any decor. Upper section has two good-sized shelves and a wide single drawer disguised as a double one.

D-10
Trestle Table Set
This Early American table and bench set sells for well over $250 in fine furniture stores, but you build it for about $60, even less! Carefully select lumber, choosing boards that are fairly flat and avoid those with sap streaks.



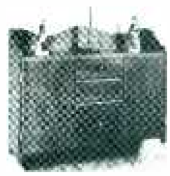
D-13
Magazine End Table
You build this fine piece of furniture from pine or the wood of your choice without fancy equipment—just with simple tools. Even the Italian provincial legs are not difficult; they are built-up using a technique called post blocking.

D-16
Corner Bookcase-Desk
This dual-purpose piece fits neatly into wasted corner space. Easy to build from pine with ordinary tools and ready-made turnings. Desk top has ample writing space and storage for stationery supplies. Two bottom shelves hold books within easy reach.

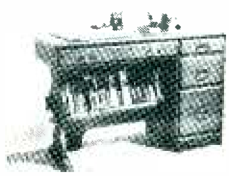
D-18
Colonial Dry Sink
You can build this versatile and serviceable piece of Americana inexpensively from pine. With its recessed lined well, it can be used as a bar, a buffet-server, a plant stand, or a simple storage cabinet. Easy to work with pine. Stain or antique it.

D-22
Captain's Trundle Bed
Common lumber is used to build this fine piece of furniture which has a lower drawer that rolls out to be used as an extra bed or as a bin for clothes, bedding, toys or whatever. Both upper and lower sections take a 39″ x 75″ mattress (standard twin size).

D-23
Elegant Bar
Originally built from plywood for less than $27! It would cost you about $125 to buy this handsome bar ready-made! Special features include padded vinyl rails, padded front panel and a brass foot rail. Decorative self-adhesive plastic can eliminate finishing.



D-25
Wall-Hung Sewing Center
This attractive colonial wall-hung sewing center stores all things needed for a well organized sewing room. It also delights those sewers who have limited floor space. There is no stooping to find things as drawers and storage shelves are at eye-level.



D-26
Colonial Desk with Book Rack
This attractive and functional desk enhances any room in your home. It has four roomy drawers, the largest one at the bottom made to hold letter-size folders. Pedestal support serves as book rack to hold a good supply of reading materials.

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EHFW75

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completely satisfied!

I have checked the appropriate box below and have enclosed payment. ALL PLANS $2.50 each, plus 50¢ for one plan (first-class) postage and handling, two or more $1.00.

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CIRCLE 15 ON READER SERVICE COUPON

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ELECTRONICS HOBBYIST

PROJECTS

FALL—WINTER 1975

SNAPPY PROJECTS

COLUMNS AND FEATURETTES

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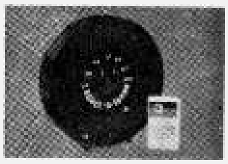

New antenna assist turns a tiny transistor into a tiger, has pulled in stations 1000 miles away! Just set it beside your radio (no wires, clips, grounding) and fine-tune Select-A-Tenna's dial to same frequency—"Gangbusters"! Terrific for sportsmen, vacationers. Great for clearing weak signals in radio depressed areas, off-coast islands, stations in crowded frequencies. Solid state—uses no electricity, batts., tubes. Works almost forever.
Stock No. 72,095GT .... $15.95 Ppd.

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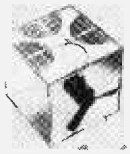
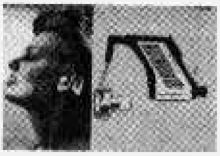


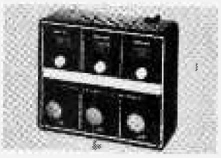
Unique demonstrator dramatically shows how sunlight converts to kinetic energy. Clear plastic Solar Energy Cube placed in the sun with its 3 highly efficient silicon solar cells powers the motor to whirl the propellor! Unit actually produces 1.5v DC, 825ma. Same cells found in our mighty panels. Speed directly related to sunlight available. Nothing to wear out! Great for executives, hobbyists, teachers.
No. 42,287GT (4 X 4 X 4") .... $19.95 Ppd.

AM RADIO FITS IN/ON YOUR EAR!



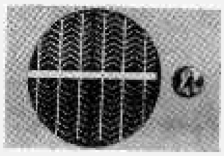
Wear it inconspicuously everywhere, listen as you work (lawn, yard, office), watch (game, beach) or wait. Instant music, news, sports. No gimmick-6/10 oz. technological wonder w/integrated circuit, 11 transistors, patented ferrite antenna/tuner/volume dial. Works best outdoors. Uses hearing aid batt. (incl.)-up to 100 hrs. playing. New batt. to slip in avail. at drug stores (about 50¢). No lengthy wires, bulky cases, or power-packed!
Stock No. 42,275GT .... $14.95 Ppd.

3-CHANNEL COLOR ORGAN KIT



Easy to build low-cost kit needs no technical knowledge. Completed unit has 3 bands of audio frequencies to modulate 3 independent strings of colored lamps (i.e. "lows"-reds, "middles"-greens, "highs"-blues. Just connect hi-fi, radio, power amp etc. & plug ea. lamp string into own channel (max. 300w ea.). Kit features 3 neon indicators, color intensity controls, controlled individ SCR circuits; isolation transformer; custom plastic housing; instr.
Stock No. 41,831GT .... $18.95 Ppd.

The MOST POWERFUL SOLAR CELL!



World's biggest (3" dia.), strongest silicon cell delivers over 1 amp. @ .5v D.C. or 1/2W. 5 times more efficient per cost than ever before! Only 1 mil thick. Tab leads for any circuit, 100's of applications. Hook in series for more voltage; parallel—more current. Real breakthrough!
No. 42,270GT .... $19.95 Ppd.
2" DIA. 500 mA. @5v No. 145GT .... $ 9.95 Ppd.
PIE-SHAPED ¼ 2" DIA. 100 mA. @ .5v No. 42,146GT .... $ 5.50 Ppd.

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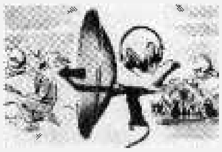
Beat the energy crisis—build a modern 10 room solar heated & air conditioned home designed by famous ecological architect Malcolm B. Wells! Its 10-yr.-proven Thomason "Solaris System" can cut conventional heating costs as much as 2/3! Your builder can modify or use as-is the complete blueprints included with "Solar House Plans III" (by Edmund, Homan, Thomason & Wells). Estimated $40,000 building cost. 48-pg book shows all pro's and cons. Illustrated.
No. 9469GT (8½ X 11" PPRBK) .... $24.95 Ppd.

PRO ELECTRONIC SOUND CATCHER



Parabolic mike w/ 18¾" reflecting shield & 2 I.C.'s in amplifier magnifies signals 100X that of omni-directional mikes. Catch a songbird ½ mile off; QB's huddle strategy; sounds never before heard. Super directivity gives highest signal to noise ratio poss. Safe: auto. cuts off ear damaging noises. Earphones, tape recorder output, tripod socket. Req. two 9v trans. batt. (not incl).
No. 1649GT (5½ LB.) .... $299.00 Ppd.
BIG EAR "TOY" MODEL #80,176GT .... $ 32.25 Ppd.

ELECTRONIC DIGITAL STOPWATCH: $69.95

A price breakthrough! New pocket size 4 oz. timer acc. to ±2% of last digit (1/100 sec. increments). Compares with others twice the price! Instant error-free readouts to 9999.99 sec. (over 2¾ hr). Starts, stops, restarts (accumulates). Mechanical pushbutton & electrical remote on/offs w/ any 3.5-150v AC/DC source. Plug-in jack. Incls. 9v batt. Solid state.
No. 1943GT (2¼ X 4½ X ⅞") .... $69.95 Ppd.
DELUXE 2 EVENT STOPWATCH (±0.01% OF LAST DIGIT)
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New Products

Automatic Organ

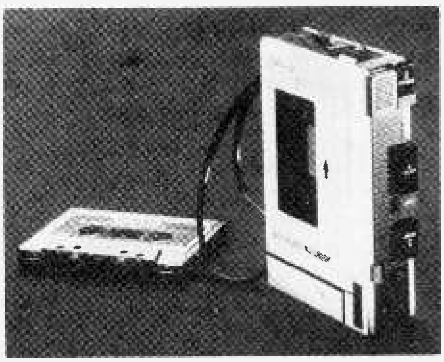
ISC Audio, a division of Benjamin Electronic Sound Company, has introduced the easy-to-play, fully automatic "Bantam" organ model to their popular line of organs and electric pianos. The "Bantam" features five separate voices (flute-diapason-trumpet-reed-string) and has an excellent combination of sound as well as a vibrato and Hawaiian glide. Four

CIRCLE 18 ON READER SERVICE COUPON

automatic rhythms and 16 full automatic chords with an alternating bass pattern are also included within a superb all-walnut veneer cabinet with a deep burgandy grill cloth. The "Bantam" also comes equipped with an earphone input jack for private listening. The suggested retail price for the "Bantam" is $399.00, which includes a padded deluxe bench. For additional information write to Dept. AP-VP, ISC Audio, 40 Smith Street, Farmingdale, NY 11735.

Mini Record System

Craig Corporation introduces their Electronic Notebook, Model 2625, which is probably the world's smallest portable cassette recorder using standard, readily available compact cassettes. The 2625 is easy to slip into a pocket or purse. It



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provides for recording of notes or dictation of letters anywhere. The 2625 is completely self-contained with built-in condenser microphone, loudspeaker, and rechargeable battery pack. In addition, automatic shut-off in all modes, digital tape counter, battery condition indicator (LED), vinyl carrying case, AC adapter, and an earphone for private listening are included. A pause button gives time to create the right phrase without the inconvenience of having to stop and start again while dictating. The review mode provides instant repeat and backspace to re-evaluate on's thoughts when interrupted. A unique feature on the 2625 is the *record/edit button*, which allows instant and accurate correction of any mistakes. Also a beep tone alarm indicates end of the tape in the record mode. Extended recording or playback when AC is not available is provided with the use of optional rechargeable battery packs. A battery pack can be completely recharged overnight. An external jack is provided for use with an optional remote controlled microphone. Priced at $149.95. Get all the facts by writing to Craig Corp., 921 W. Artesia Blvd., Compton, CA 90220.

For Road Runners

The Pace Trucker CB 2-way radio, Model 2376B, is completely ruggedized for positive or negative ground applications. Operating on 23 channels, the rig offers more talk power: a transmitter equipped with rugged silicon output and driver transistors for conservative delivery of maximum legal power output and a 100% modulation to ensure full utilization of RF power and communications

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range. A greater receiving range has been obtained through a sensitive dual conversion superheterodyne narrow band receiver for greater adjacent channel rejection; a shaped audio response for best voice clarity; and a superior series gate impulse noise limiting for processing very weak signals. Other value features include: public address circuit, separate jack for remote speaker, local/distance sensitivity control for range adjustment, ceramic high performance

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We would like to know about you. Please help us by placing an "X" in the appropriate boxes. • Do you own a CB transceiver? 76 ☐ Yes 77 ☐ No • If your answer is Yes, please check appropriate boxes below if you have one or more of the types indicated. 78 ☐ Base Station 79 ☐ Mobile Unit 80 ☐ Portable • Do you use CB in your work? 81 ☐ Yes 82 ☐ No

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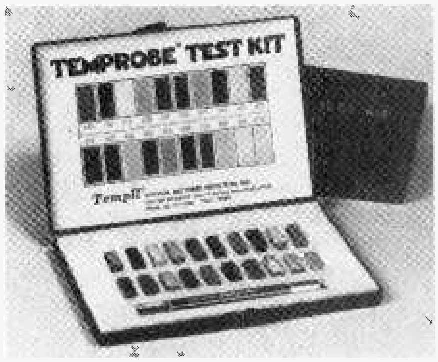
New Products

microphone, S-meter for monitoring incoming signal strength, and locking mounting bracket. Suggested user price is $179.95. For more information, write to Pace Communications, 24049 So. Frampton Avenue, Harbor City, CA 90710.

Temperature-Indicating Crayons

Temprobe°, a temperature-indicating crayon that melts at pre-determined temperatures, with many applications for sculptors, hobbyists, do-it-yourself craftsmen and in home workshops, schools, and garages, is now available in an inexpensive, convenient Test Kit for amateur and non-industrial use. The Temprobe° Test Kit consists of a special holder and 20 crayon inserts, each of which melts at a different specific temperature, ranging from 125°F. to 800°F. The individual crayons can be used to



CIRCLE 21 ON READER SERVICE COUPON

accurately test temperature for many different projects that require boiling, baking, welding, soldering and other heat-based operations. Applications include model building, sculpting, auto repairs, radiator work, electrical wiring, enameling, etc. All you do is mark the surface to be heated with the appropriate crayon and when the mark turns into a liquid smear, you know the critical temperature has been reached. Temprobe° Test Kits retail at $10.00 each. Additional information can be obtained from Tempil° Division, Big Three Industries, Inc., 2901 Hamilton Blvd., So. Plainfield, NJ 07080.

Amplifier Booster for Scanner

Fanon/Courier has added Model SCMA-1, to expand the utility of its Cop-Scan 4 channel hand-held FM monitor scanners. With the new unit, Cop-Scan users can adapt their hand-held units to mobile operation. The SCMA-1 amplifies output audio to 2.5 watts and provides sound output through a large built-in speaker.

CIRCLE 22 ON READER SERVICE COUPON

The new Courier Mobile Amplifier also provides operating power for and can charge an internal Nicad battery pack in Cop-Scan units. In use, Cop-Scan hand-helds are placed into the front panel slot and a one-piece molded connector is plugged into the power, charger, and external speaker jacks located on Cop-Scan's side. The Cop-Scan then operates in a normal manner. Scanners may be quickly removed for portable operation. Sells for only $34.95. Get all the facts by writing to Fanon/Courier Corp., 990 South Fair Oaks Avenue, Pasadena, CA 91105.

3-Digit DMM

B&K has released its new Model 280 3-digit digital multi-meter (DMM). This latest B&K DMM is a battery operated portable that carries a list price of $99.95. The eleven reasons for considering the purchase of a Model 280 are: (1) high accuracy; (2) large, easy-to-read LED readout; (3) Hi-Lo power ohms

CIRCLE 23 ON READER SERVICE COUPON

ranges; (4) 1 mV, 1 microamp, and 0.1 ohm resolution; (5) 22 scales for measuring AC and DC volts and current, and ohms; (6) automatic polarity; (7) automatic decimal positioning and out-of-range indication; (8) full overload protection; (9) 10 megohms input impedance; (10) battery operation and compact design for complete portability; (11) selling price just under $100.00. In addition, the 280 has a built-in battery check, is housed in a high-impact Cycolac case, and has a fast settling time of typically 0.5 second. Ranges are as follows: DC and AC volts, 0-1000 mV, 10,

LITERATURE LIBRARY

153. *MFJ* offers a free catalog of amateur radio equipment—CW and SSB audio filters, electronic components, etc. Other lit. is free.

101. Kit builder? Like weird products? *EICO's* 1975 catalog takes care of both breeds of buyers at prices you will like.

102. *International Crystal* has a free catalog for experimenters (crystals, PC boards, transistor RF mixers & amps, and other comm. products).

103. See brochures on *Regency's* 1975 line-up of CB transceivers & scanner receivers (for police, fire, weather, & other public service emergency broadcasts).

104. *Dynascan's* new B & K catalog features test equipment for industrial labs, schools, and TV servicing.

105. Before you build from scratch, check the *Fair Radio Sales* latest catalog for surplus gear.

106. Get *Antenna Specialists'* cat. of latest CB and VHF/UHF innovations: base & mobile antennas, test equipment (wattmeters, etc.), accessories.

107. Want a deluxe CB base station? Then get the specs on *Tram's* super CB rigs.

108. 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.

115. *Trigger Electronics* has a complete catalog of equipment for those in electronics. Included are kits, parts, ham gear, CB, hi fi and recording equipment.

111. *Midland's* line of base & mobile CB equipment, marine transceivers & accessories, and scanner receivers are illustrated in a new full-color 16-page brochure.

112. 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.

113. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools, and instructions included.

116. Get the *HUSTLER* brochure illustrating their complete line of CB and monitor radio antennas.

117. *Teaberry's* new 6-page folder presents their 6 models of CB transceivers (base and mobile): 1 transceiver for marine-use, and 2 scanner models (the innovative "Crime Fighter" receiver and a pocket-size scanner).

118. CBers, *GC Electronic's* 8-page catalog offers the latest in CB accessories. There are base and mobile mikes; phone plugs; adaptors and connectors; antenna switchers and matchers; TVI filters; automotive noise suppressor kits; SWR Power and FS meters, etc.

152. Send for the new, free descriptive bulletin from *Finney Co.* It features the Finco line of VOM multi-testers (and accessories) for electronics hobbyists and service technicians.

128. A new free catalog is available from *McGee Radio*. It contains electronic product bargains.

119. *Browning's* mobiles and its famous Golden Eagle base station, are illustrated in detail in the new 1975 catalog. It has full-color photos and specification data on Golden Eagle, LTD and SST models, and on "Brownie," a dramatic new mini-mobile.

120. *Edmund Scientific's* new catalog contains over 4500 products that embrace many sciences and fields.

121. *Cornell Electronics'* "Imperial Thrift Tag Sale" Catalog features TV and radio tubes. You can also find almost anything in electronics.

122. *Radio Shack's* 1975 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.

123. Get *Lafayette Radio's* "new look" 1975 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.

154. A government FCC License can help you qualify for a career in electronics. Send for information from *Cleveland Institute of Electronics.*

110. *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.

127. There are *Avanti* antennas (mobile & base) for CB and scanner receivers, fully described and illustrated in a new 16-page full-color catalog.

129. Semiconductor Supermart is a new 1975 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors—all from *Circuit Specialists.*

130. There are over 350 kits described in *Heath's* new catalog. Virtually every do-it-yourself interest is included—TV, radios, stereo & 4-channel, hi-fi, etc.

131. *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.

150. 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.

132. If you want courses in assembling your own TV kits, *National Schools* has 10 from which to choose. There is a plan for GIs.

133. 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.

134. *Sprague Products* has L.E.D. readouts for those who want to build electronic clocks, calculators, etc. Parts lists and helpful schematics are included.

135. The latest edition of *Tab Books'* catalog has an extensive listing of TV, radio and general servicing manuals.

137. *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.

138. *Shakespeare's* new pocket-size catalog lists and describes their full line of fiberglass CB antennas, mounts and accessories offered in 1975.

144. 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.

145. 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.

147. *Telex's* 4-page, 2-color folder illustrates their new line of boom microphone head-sets for CBers and hams, as well as their line of communications headphones.

142. *Royce Electronics'* new full-color catalog updates information on their CB transceivers (base, mobile, handheld). It also describes new product lines—CB antennas and a VHF marine radiotelephone.

Electronics Hobbyist, Box 886
Ansonia Station, New York, N.Y. 10023

F/W 75

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.

Indicate total number of booklets requested. ______

Not Valid After January 23, 1976

101	102	103	104	105	106	107	108	111	112	113	115
116	117	118	119	120	121	122	123	124	125	127	128
129	130	131	132	133	134	135	137	138	142	144	145
147	150	152	153	154	110						

NAME (print clearly ______

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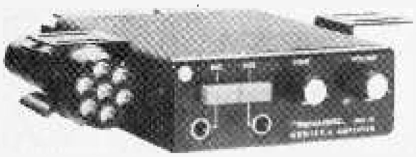
New Products

100, 1000 V (± on DC), DC and AC current, 0-1000 microamps, 10, 100, 1000 mA; ohms, 0-100 (Lo), 1000 (Hi), 10k (Lo), 100k (Hi); 1 megohm (Lo) and 10 megohms (Hi). For more information on the B&K Model 280 DMM and optional accessories write to B&K, 1801 W. Belle Plaine Ave., Chicago, IL 60613.

Mobile Yack-Yack

New from Radio Shack is the Realistic MPA-10 solid-state 10-watt mobile public address amplifier designed for 12-volt operation in cars, trucks, campers, boats or anywhere that an AC power source is not available. The MPA-10 is only 1½ x 4⅛ x 6½-in. for easy mounting in or under dash, in a glove compartment, under a seat or in any convenient location. Comes with a ruggedly designed dynamic mike and hanger for clipping it to the side of the unit. Separate microphone and auxiliary input jacks allow you to connect a tuner, ceramic phono or tape player to the amplifier with push-button selection of either or both for paging over music. A tone control allows adjustment for best tonal quality of sound. Response is given as 200 to 10,000 Hz at full power. Rated 10 watts rms at 8 ohms. The Realistic MPA-10 Mobile PA Amplifier is priced at $39.95 complete with microphone and mounting hardware. Realistic products are available exclusively from more than 3,000 Radio Shack stores and authorized sales centers in all 50 states and Canada.



CIRCLE 24 ON READER SERVICE COUPON

Dual CB Antennas

A new generation of high performance, clean silouette CB mobile antennas was unveiled by Antenna Specialists with the launching of a new dual mirror mount system for over-the-road vehicles, model M-315 "Minnie Momma." Utilizing the vise-like cast aluminum mirror mounts first introduced on the company's "Big Momma" twin antennas, the M-315 employs completely new design and manufacturing techniques to integrate the stainless steel whips and slender, pressure-molded loading coils into single, weather-proof, vibration-resistant units. A unique new tuning scheme eliminates the need for whip trimming, permitting retuning within full original limits—particularly important when the antennas may be utilized for different vehicles such as the over-the-road trucks. Tuning is accomplished by means of up-or-down sliding adjustment of the oversize static balls at the antenna tips, which are secured with allen screws. Model M-315 includes a factory tuned phasing harness with ample cable length for the largest trucks and motor homes. The suggested list price is $39.95. Further details may be secured from The Antenna Specialists Company, 12435 Euclid Avenue, Cleveland, Ohio 44106.

CIRCLE 25 ON READER SERVICE COUPON

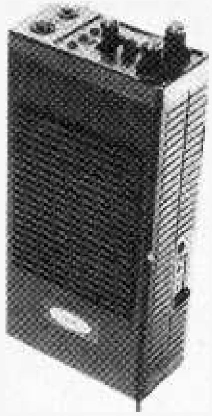
Small-Size CB Rig

The PACE Model CB-143, 23 channel citizens 2-way radio features full power AM output in a small package: 5 x 7 x 1¼-in. A 6-section tuned filter provides for exceptional noise limiting so that a sensitivity of 1.0 uV is utilized. Adjacent channel rejection is rated at 50 dB. The CB-143 offers the user extreme ruggedness and versatility. An S/RF meter monitors accurate measurement of incoming signals and relative output power. A separate light indicates if the unit is in transmit mode. Controls include an easy-to-read indicator for quick channel identification, volume, and squelch. Remote speaker and public address features are also provided. The PACE CB-143 operates on positive or negative ground, 12-14 VDC systems. Unit is FCC type accepted. The suggested user price is $129.95. For more information, write to PACE, 24049 So. Frampton Ave., Harbor City, CA 90710.

CIRCLE 20 ON READER SERVICE COUPON

High and Lo Band

Cop-Scan VHFHL is a new Fanon/Courier dual band 4-channel portable FM monitor receiver for public safety, weather or other broadcasts on low band VHF (25-54 MHz) or high band VHF (146-175 MHz). The new Courier design uses dual crystal sockets to permit any channel to be assigned to either high band or low band use. All Cop-Scan units exhibit superior protection against intermodulation and feature superior selectivity and sensitivity with excellent adjacent channel rejection characteristics. Cop-Scan VHFHL utilizes dual conversion superheterodyne circuitry with both high fre-

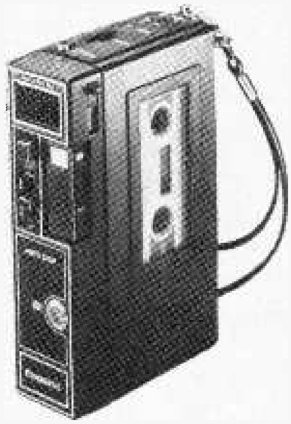


CIRCLE 22 ON READER SERVICE COUPON

quency crystal filter and ceramic IF filter. A screw mounted flexible antenna is provided as standard equipment and the unit comes equipped with provision for earplug, 6-volt power supply, and external battery charger operation if an optional nickel-cadmium package is employed. Priced at $134.95. Get additional information by writing to Fanon/Courier Corp., 990 South Fair Oaks Avenue, Pasadena, CA 91105.

Mini Cassette Recorder

Panasonic has added an AC/battery mini cassette recorder with a built-in condenser microphone to its tape recorder line. Model RQ-218S has a quick battery charge system that takes approximately 5 hours with included AC adaptor/charger RP-667 and rechargeable battery pack RP-093, as well as one-touch recording button, Easy-Matic circuitry to help ensure quality recording results,



CIRCLE 26 ON READER SERVICE COUPON

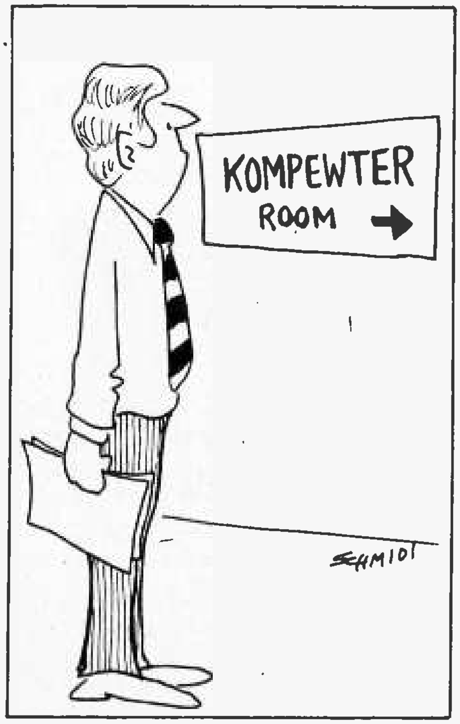
Auto-Stop that automatically shuts the unit off at the end of the cassette, AC/battery operation with AC adaptor/charger (RP-667) and rechargeable battery pack RP-093, optional car adaptor (RP-915), fast forward and rewind, lockable pause control, level/battery meter that indicates recording level and battery strength, and digital tape counter. Complete with carrying case, AC adaptor/charger, erase plug, rechargeable battery pack, earphone and carrying strap, model RQ-218S has a manufacturer's suggested retail price of $159.95. Available at retail outlets throughout North America. For more info, write to Panasonic, One Panasonic Way, Secaucus, NJ 07094.

CD with Auto Protection

Automatic Radio now offers its new CD Electronic Ignition Model CDI-2049. This capacitive discharge electronic ignition has an exclusive built-in feature called "Electro-Key" for auto theft control. This key is a printed circuit device which when

CIRCLE 27 ON READER SERVICE COUPON

removed prevents the engine from being started. Automatic Radio claims the "Electro-Key" capacitive discharge ignition will increase gas mileage up to 25%, up to 8 times longer between engine tune-ups, better engine performance u pto 25%, 10 times longer point life, 8 times longer spark plug life and gives over-all faster all-weather starts. The CDI-2049 sells for $84.95. Automatic Radio will send information on their full line of products if you write them at Melrose, MA 02176. ■



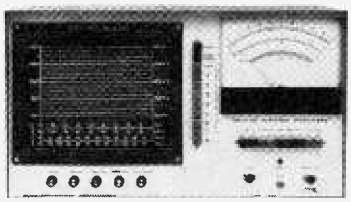
Your NEW Heathkit Catalog is ready

waiting to serve you with more values, more new kits, than ever before

Now over 400 do-it-yourself electronic kits for home, hobby, and industry. All designed to give you more for your money...more value, more performance, more satisfaction. All designed so even beginners can build them. Send for your free catalog today.

New — Two-Way Telephone Amplifier Kits

Now, hands-free telephone use with amplified "talk" and amplified "listen" — with or without dialer. Talk & listen from 10′ away. Voice-actuated circuitry switches from talk to listen without feedback or clipped words. Listen button lets you monitor line without built-in microphone activated. Dialer model may be used with or without regular telephone. Includes 4-prong jack & phone coupler connector. Battery powered. Kit GD-1112 (no dial) $49.95; Kit GD-1162 (w. dial) $69.95.



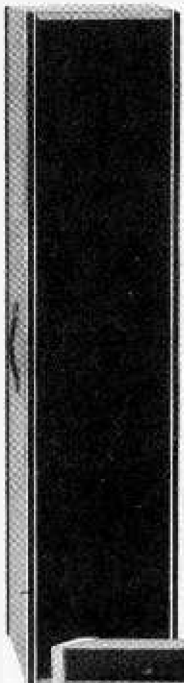
New Professional 12″ Ignition Scope — Kit or Wired

Does more than others for $1000 less. Spots tough ignition problems on all types of systems in 3, 4, 6, 8 cyl. or 2-rotor Wankel engines; sets itself automatically for no. of cylinders. Big 12″ screen has 2 calibrated primary and secondary voltage grids plus dwell angle indications. Special circuit maintains trace length regardless of RPM. Displays "superimposed" patterns, single cyl. pattern, primary or secondary "parade" patterns. "Power balance" feature even helps spot bad valves or rings. 8″ meter with tach & DCV ranges. Optional low cost timing light, alternator adaptor & cart. Kit CO-2500 $379.95; Assembled WO-2500 $695.

New Programmable Digital Stop Watch Kit

Another "first" from Heath. 2 IC counters, 8 digits & 7 functions with typical accuracy to ±0.003% and resolution to 1/100th of a second. Function 1 (Start/Stop Elapsed) times individual events while also counting total. Function 2 (Sequential) times each part of event & displays each separately while timing overall event. Function 3 (Total Activity) accumulates total elapsed time of a series, excluding time between events. Function 4 (Split) displays cumulative time to each "split" point while continuing overall event time. Function 5 (Start/Stop Activity) shows separate time for each event & totals all individual times. Function 6 (Programmed Upcount) counts up to "learned" time. Function 7 (Programmed Downcount) counts down from "learned" time. Stop watch can "learn" time from other functions or be programmed up to 9 hours, 59 minutes, 59 seconds. Has jacks for external triggering devices and alarms. Includes nickel-cadmium batteries & charger. Kit GB-1201, $99.95.

New Public Address Sound System Kits



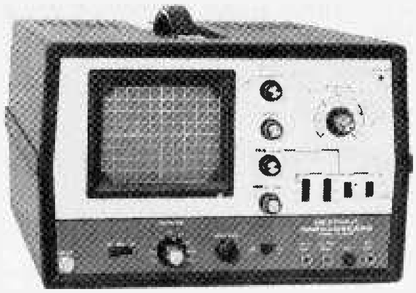
Outperforms those costing twice as much. TA-1620 Control/Amp. takes 6 low impedance mikes, each with level, bass & treble controls & reverb sw. Has VU meter, 4 switched response "shaper" circuits, exclusive bass filter, 100 rms watts drives 2 speaker columns. **TA-1625 Booster Amp.** 100 rms watts to drive 2 extra speaker columns. **TS-1630 Speaker Column.** Six 8″ full-range drivers response tailored for voice; 60 watt rms rating; 12 ohm impedance. Kit TA-1620 $449.95; Kit TA-1625 $179.95; Kit TS-1630 $199.95.

New Automobile Intrusion Alarm Kit

Total Protection. Alarm mounts anywhere; connects to switches on doors, hood, & trunk. Underdash switch arms or disables unit. Adjustable delay time allows you to quickly enter or leave car without triggering alarm, but opening trunk or hood triggers alarm instantly. Alarm sounds car horn in repeated 2-minute cycles. Kit GD-1157 Alarm $24.95; Kit GDA-1157-1 Siren (gives yelping sound louder than car horn) $19.95.

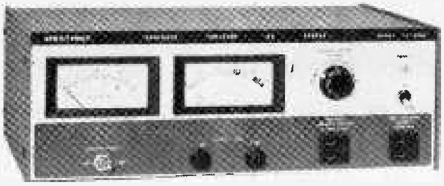
New Digital Wind Speed & Direction Indicator Kit

Unique. Two big, bright digits show wind speed to 99 mph. As you build, choose 2 readout modes: miles, knots, or kilometers per hour; front panel light shows mode in use. 8 incandescent lights show wind direction at principal compass points; adjacent lighted bulbs give 16 point resolution. Remote transmitter boom clamps to TV mast. Styled in black plastic to match Heathkit GC-1005 Digital Clock and ID-1390A Digital Thermometer. Kit ID-1590, $69.95 less cable.



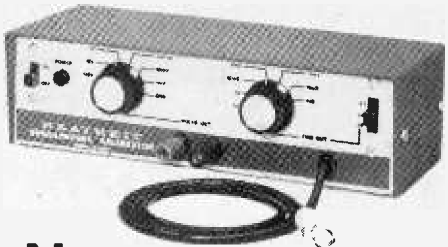
New DC-5 MHz Triggered Scope — Kit or Wired

Best scope value today. Wide bandwidth, 20 mV sensitivity, & stable triggering — ideal for TV, audio and RF servicing. Easy-to-use controls. Trigger circuit (not recurrent type) has normal & automatic modes, switched AC & DC coupling, & front panel external inputs (special TV position allows low freqs. to pass while rejecting high freqs. for easy triggering on complex TV signal. 7 calibrated time bases from 200 ms to 0.2 μs/cm. 20 mV/cm vertical sensitivity with 9 calibrated attenuator positions up to 10 v/cm, plus variable control. 5″ round flat-face CRT (8 x 10 cm graticle). Lightweight, durable blue plastic cabinet with white panel. Kit IO-4540 $179.95; Assembled SO-4540 $275.



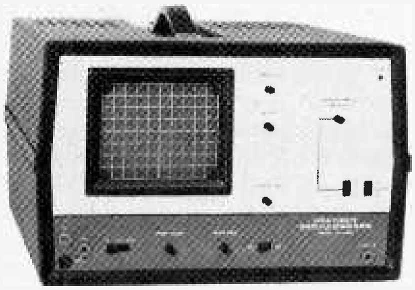
New Variable Isolated AC Supply

What every tech & hobbyist needs. The IP-5220 isolates equipment under test from the AC power line and provides an AC output which is variable from zero to 140 volts. Great for locating circuit faults caused by high or low voltage or testing equipment with unknown power requirements. Power rating is 360 volt-amperes, continuous. Variable output current rating: 3A. max. Direct output curent rating: 10A. Two meters: voltmeter 0-150 VAC; ammeter: 0-1 & 0-3A. Ammeter and variable output socket are fused. Kit IP-5220, $109.95



New Oscilloscope Calibrator Kit

For time calibration, it generates a 0.5 second to 1 μsec square wave in 1-2-5 sequence accurate to 0.01% with 200 mV peak (⩽3% overshoot) and ⩽4 ns rise time. Voltage calibration ranges are 1 mV to 100 v. in decade sequence, accuracy within 2%, DC plus variable 2 Hz to 10 kHz in 1-2-5 sequence (internal stnd. accuracy within 1%). Use it to calibrate scopes up to 35 MHz and voltmeters; it's also a fast rise time squarewave generator and good bench freq. standard. Kit IG-4505 $44.95



New — Lowest cost Triggered 5 MHz Scope Kit

The scope everyone can afford, and it has the performance you need. DC-5 MHz band width, 100 mV vertical sensitivity with X1, X10 & X100 attenuation, AC or DC. Automatic, positive locking horizontal sweep continuously adjustable from 20 ms to 200 ns/cm. Stable displays due to zener regulated amplifiers and sweep. 5″ round flat-face CRT with 8 x 10 cm graticle. Simplified controls and switches make it easy to use. Lightweight, durable blue plastic cabinet; white panel. It's the best instrument buy in years. Kit IO-4560 $119.95

New 21″ (diag.) Digital Design Color TV Kit

All the advanced technology of digital circuitry in a smaller screen size. **Electronic touch-to-tune** varactor front end (nothing mechanical to wear out) with computer-like programming board for up to 16 channels. **On-screen channel numbers,** adjustable in brightness, position, and duration. **On-screen digital clock;** a low-cost option; programmable in 12 or 24 hour format, displays 4 or 6 digits. **Fixed-filter IF,** a Heath exclusive that assures better pictures longer, never needs instrument alignment. **100% solid state** — more ICs than any other — sophisticated circuitry that results in less interference, better color tints, improved sensitivity, greater noise immunity, improved picture definition. **Black negative matrix 21V picture tube** for brighter, sharper pictures. **Total touch-tune remote control** — low cost option that operates all functions, including recall of time & channel.

Easier to build & service — thanks to extensive modular design and built-in servicing tools including digital-design dot generator, front access slide-out Service Drawer, new picture centering and pin-cushioning correction circuits, and Test Meter. **Enjoy the best in TV design** — now in smaller size at lower cost. Kit GR-2050 $599.95. Kit GRA-2000-6, remote control, $89.95. Kit GRA-2000-1, digital clock accessory, $29.95. Contemporary or Mediterranean cabinets from $119.95.

New catalogs and kits also available at

HEATHKIT ELECTRONIC CENTERS — Units of Schlumberger Products Corporation Retail prices slightly higher.

ARIZ.: Phoenix; CALIF., Anaheim, El Cerrito, Los Angeles, Pomona, Redwood City, San Diego (La Mesa), Woodland Hills; COLO.: Denver; CONN.: Hartford (Avon); FLA.: Miami (Hialeah), Tampa; GA.: Atlanta; ILL.: Chicago, Downers Grove; IND.: Indianapolis; KANSAS: Kansas City (Mission); KY.: Louisville; LA.: New Orleans (Kenner); MD.: Baltimore, Rockville; MASS.: Boston (Wellesley); MICH: Detroit; MINN.: Minneapolis (Hopkins); MO.: St. Louis (Bridgeton); NEB.: Omaha; N.J.: Fair Lawn; N.Y.: Buffalo (Amherst), New York City, Jericho (L.I.), Rochester, White Plains; OHIO: Cincinnati (Woodlawn), Cleveland, Columbus, Toledo; PA.: Philadelphia, Pittsburgh; R.I.: Providence (Warwick); TEXAS: Dallas, Houston; VA.: Norfolk (Va. Beach); WASH.: Seattle; WIS.: Milwaukee.

Use coupon below to order your favorite new kit or to get your FREE new Heathkit Catalog.

HEATH Schlumberger

Heath Company
Dept. 26-08
Benton Harbor, MI 49022

☐ Please send my free 1975 Heathkit Catalog.

☐ Enclosed is $________ plus shipping.

Please send model(s)________________________.

NAME ____________________

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CIRCLE 1 ON READER SERVICE COUPON

BUILD IT FAST...

AUDIO FUN-DAMENTALS WITH THE 741

TELEPHONE VOICE

☐ The "telephone voice" effect is usually created by passing a voice signal from a high quality microphone through a bandpass amplifier—a device that attenuates the frequencies on both sides of a selected frequency. Bandpass amplifiers are also effective at providing mid frequency boost—presence, as it's called in hi-fi terms.

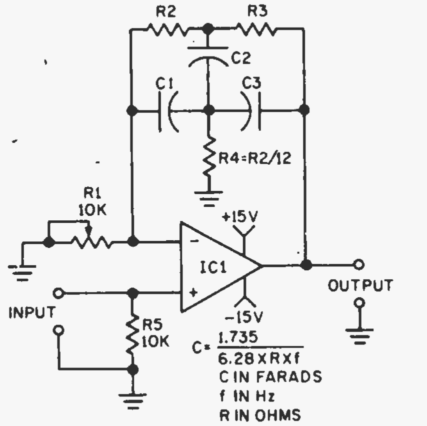
The center frequency of this bandpass amplifier is determined by the values of C1, C2, C3, R2, R3, and R4. The exact frequency can be determined from the formula shown. To start, assign a value of 100,000 ohms to R2 and R3 (use ½-watt resistors). To avoid hum pickup, the unit should be assembled in a metal cabinet. Potentiometer R1 serves as the Q-control; it determines the degree of boost at the center frequency.

R5 connects to the non-inverting (+) input of the IC, R1 between ground and the inverting (—) input. No pin connections are given because the IC is available in many different configurations.

Of course, you could find a carbon microphone "button" and matching transformer to create the effect naturally, but that's not how it's done in the big city, bub! ■

PARTS LIST FOR TELEPHONE VOICE

- C1, C2, C3—(C1 equals C2 equals C3, see formula)
- IC1—Type 741 opamp
- R1—10,000-ohm pot
- R2, R3—(R2 equals R3, see text)
- R4—R4=R2/12
- R5—10,000-ohm, ½-watt resistor



MAG TAPE AMP

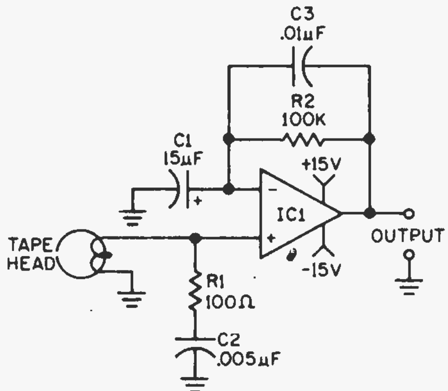
☐ From time to time surplus dealers offer complete tape or cassette mechanisms—everything ready-to-go except for the electronics, and at rock-bottom prices of $10, $15 or $20. Often, all the mechanism needs is this equalized tape head preamplifier.

Though the power supply is rated at ±15 VDC, almost optimum results will be obtained with supply voltages as low as ±7 VDC. Two ordinary 9-volt transistor radio batteries will power the preamp for many hours.

As with all these projects, the 741IC is internally compensated and no special wiring practices are needed; the preamp can be built in just about any enclosure. ■

PARTS LIST FOR MAG TAPE AMP

- C1—22-uF electrolytic capacitor, 25-VDC or better
- C2—0.005-uF disc capacitor, 25-VDC or better
- C3—0.01-uF capacitor, 25-VDC or better
- IC1—Type 741 opamp
- R1—100-ohms, ½-watt resistor
- R2—100,000-ohms, ½-watt resistor



RC FILTER OSC

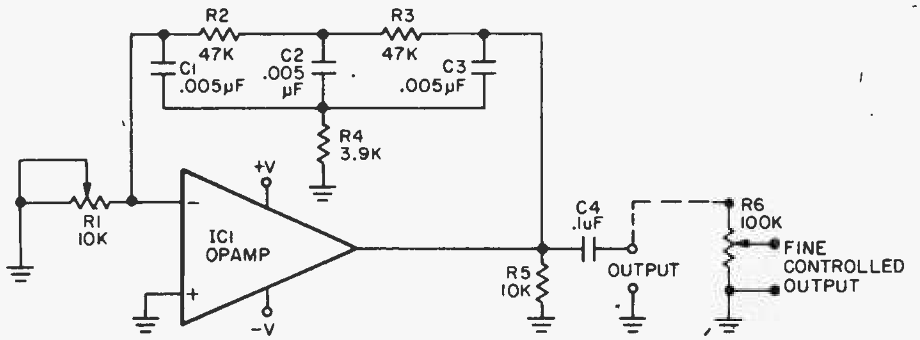
☐ An experimenter has many uses for a basic 1000-Hz oscillator. If you're an experimenter you know how many and can make up more. Even audio buffs find an increasing interest in test signals for speaker balance and phasing. In this circuit, a resistor/capacitor filter tuned to 1000 Hz is connected between input and output of IC1 to sustain selective (1000 Hz) feedback. It's suitable for testing audio equipment, signal tracing or tape recorder bias adjustments.

The 1-kHz "notch filter" from the amplifier output to the inverting or negative (—) input determines the output frequency. Non-inverting or positive (+) input is grounded. The power supply is bi-polar; use any voltage up to ±15 VDC. While resistor R5 is not needed, in many instances its use insures your project's success.

If fine output control is desired, add potentiometer R6. When your oscillator is connected to a DC circuit, connect a DC blocking capacitor in series with R6's wiper arm. If the oscillator is to drive circuits of less than 10 k-ohm impedance, substitute a 1 uF non-polarized capacitor for C4, rated to the power supply's voltage. ■

PARTS LIST FOR RC FILTER OSCILLATOR

- C1, C2, C3—0.005-uF, 75-VDC (Radio Shack 272-130 or equiv.)
- C4—0.1 uF (see text)
- IC1—741-type operational amplifier (Radio Shack 276-010 or equiv.)
- R1—10,000 ohms pot
- R2, R3—47,000-ohms, ½-watt
- R4—3,900-ohms, ½-watt
- R5—10,000-ohms, ½-watt (see text)
- R6—Potentiometer, 100,000-ohms, audio taper (see text)



TRACE SIGNALS WITH YOUR TAPE RECORDER

by Hugh Gordon

☐ A signal tracer can be easily improvised by using a cassette tape recorder (any tape recorder will do), a capacitor, and an earphone (or loudspeaker), connected as shown in the diagrams. Use the "monitor" switch to hear the output, or connect a loudspeaker or earphones, as shown. Connect the input to the auxiliary jack if tracing high level signals, and to the microphone jack if tracing low level signals.

Switch the recorder to the *record* mode to trace signals. It may be necessary to defeat the "erase protect" sensing lever in cassette recorders by pressing on it before pushing down on the *record* button. Otherwise, operate the recorder with a cassette in place.

How It's Done. Probing with the capacitor lead at the collector and base of each transistor in a circuit, in turn, allows the signal to be traced through the circuit; and faults, such as a dead stage, can be found in a few minutes.

If the amplitude of the input signal is too high, simply connect an attenuator (Fig. 2) across the input terminals to the tracer, as shown, and adjust the potentiometer for correct volume.

While the circuit is useful for tracing the audio sections of an amplifier or receiver, you may also want to trace the radio frequency (RF) sections. This may be done by replacing the capacitor with a simple diode demodulator probe, a sketch of which is shown in Fig. 3.

Safety First. One good guide by which you should govern yourself when puttering about an apparently defective TV set, is not to perform any adjustment, poking, prying, snooping, cleaning, etc., that you would not permit a six-year-old child to do. After all, why is a child's life dearer than yours when TV service technicians are available to do the task efficiently and safely? ■

Fig. 1

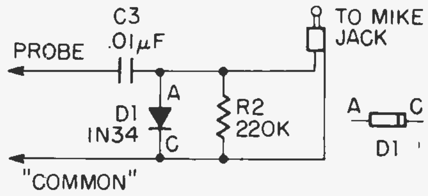


Fig. 2

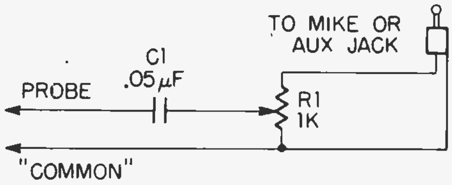
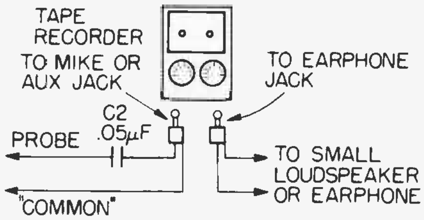


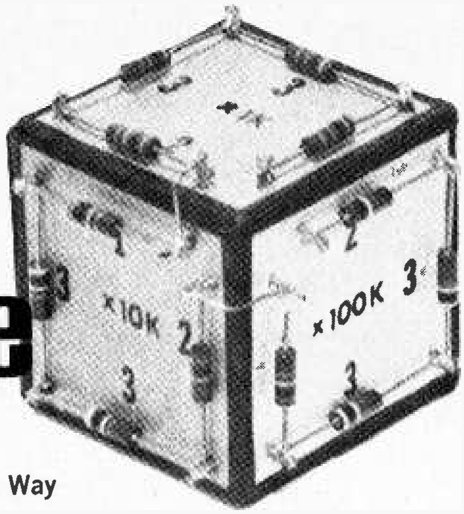
Fig. 3



PARTS LIST FOR A SIGNAL TRACER

C1, C2—0.05-uF disc capacitor
C3—0.01-uF disc capacitor
D1—1N34, general purpose germanium diode
R1—1000-ohm potentiometer, any available type
R2—220,000-ohm, ½-watt resistor

R-Cubed lets you Shoot the Works



by R. L. Way

LOOKING for the right resistor during a circuit mockup, or breadboarding, sometimes becomes annoying: dim light makes color band reading impossible; fumbling fingers can't pick up ¼-watt resistors fast enough; and, of course, you are always out of the resistance size you want to use. So get with it with R-Cubed—the experimenter's toy block that makes bench work seem like child's play.

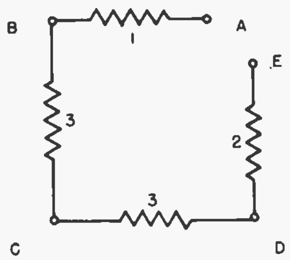
R-Cubed is not so much a device as it is a method for keeping on hand, in an orderly manner, a collection of standard-value resistors that can be used singly with clip-leads, or in series with clip-leads to provide most needed values of resistance. The 24 resistors that can be mounted and series-connected on the faces of a small cube will give resistance values of 1 to 9 ohms and all multiples of 10 of these values through 100,000. Thus, if all 24 resistors are used, resistance values from 1 ohm to 900,000 ohms will be available. The author's unit contains only 12 resistors, since only values from 1000 to 100,000 ohms were desired. In addition, some intermediate values of resistance (for instance, 42 ohms, 780 ohms, 95,000 ohms, etc.) can also be obtained from the R-Cube arrangement, as will be explained later.

One-half-watt, 5% resistors were used to keep down the cost, but the same idea can be applied to 1% resistors, or to 1- or 2-watt resistors. The only other expense, aside from cardboard for the cube, paint, etc., is for a box of vectorboard mini-clips, and a pair of alligator clip-leads. (The Editors took exception to the author's construction technique and went their own way using a child's toy play block and some brass brads—but more on this later.)

Knocking It Together. Four resistors form a *decade* (10, 100, 1000, 10K, 100K, and 1M), and each decade is mounted on one of the six faces of the cube. The resistors are all multiples of 1, 2, and 3 (that is, 10, 100, 1000, etc., 20, 200, 2000, etc., and 30, 300, 3000, etc). Henceforth, all numbers in a decade will be stated as 1-digit numbers, with the understanding that they are multiples of 10, 100, 1000, etc., according to the decade in which they are used. By wiring the four resistors of a decade end-to-end in the order 1, 3, 3, 2, as shown in Fig. 1, any value of 1 to 9 can be obtained by connecting clip-leads between the appropriate mini-clips. This can be better understood by looking at Fig. 1 and its accompanying table.

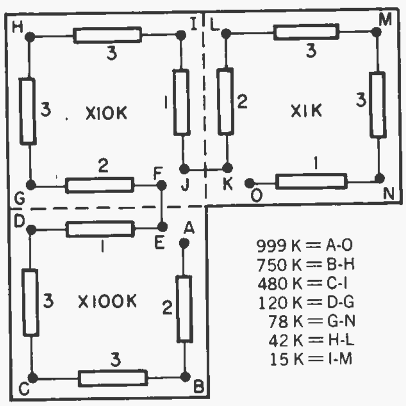
In order to get resistance values between those available on a single decade, the decades are connected to each

(Continued on page 101)

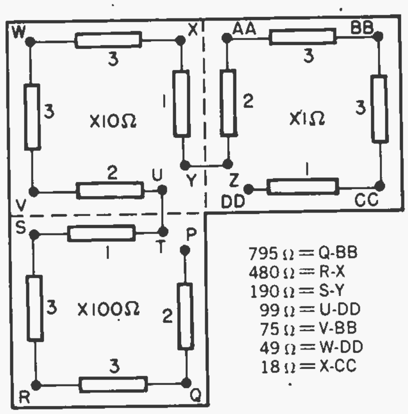


TO OBTAIN	CONNECT LEADS AT
1 ohm	A and B
2 ohms	D and E
3 ohms	B and C
4 ohms	A and C
5 ohms	C and E
6 ohms	B and D
7 ohms	A and D
8 ohms	B and E
9 ohms	A and E
10 ohms	Go to next higher decade

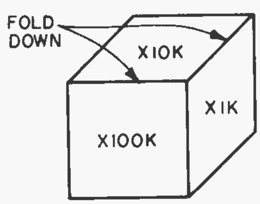
The resistors in each set for each face are valued at 1, 3, 3, 2-ohms each multipled by a factor for that face. The diagram at right is for the X100K face of the cube. Therefore each resistor is valued at 100,000-ohms or a multiple thereof.

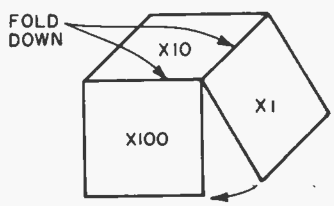


999 K = A-O
750 K = B-H
480 K = C-I
120 K = D-G
78 K = G-N
42 K = H-L
15 K = I-M



795 Ω = Q-BB
480 Ω = R-X
190 Ω = S-Y
99 Ω = U-DD
75 Ω = V-BB
49 Ω = W-DD
18 Ω = X-CC





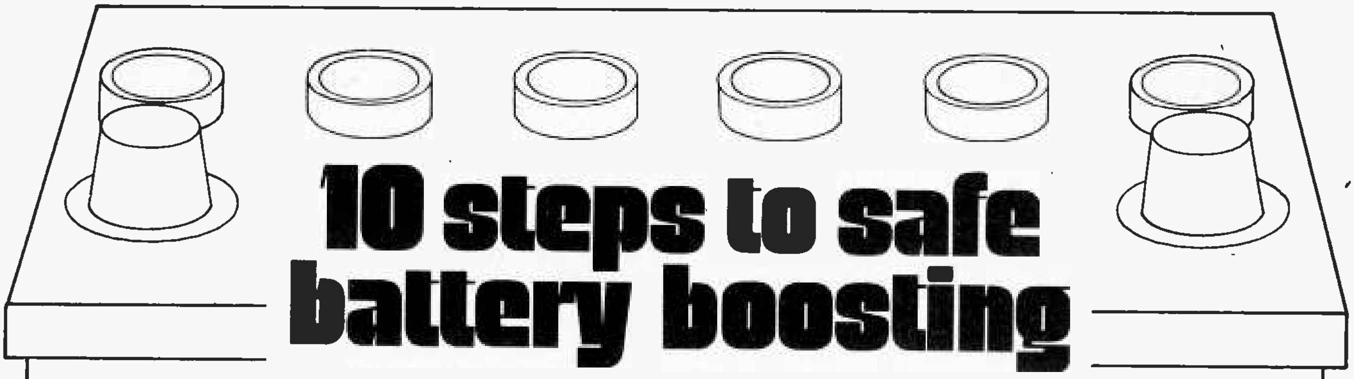
Here's how the cube fits together and what resistors go on what face. Note that terminals E-F, J-K, U-T and Y-Z are connected by means of a jumper.

IT IS A LITTLE KNOWN FACT, but the simple act of using jumper cables to start (boost) a car with a dead battery can lead to severe personal injury. It's true!

A good Samaritan in California was helping his neighbor start his car by jumping the battery. The battery exploded and our hero got a face full of sulfuric acid for his trouble. A man in Pennsylvania noticed another charging his battery incorrectly. When he attempted to rearrange the cables from the charger there was some sparking, and the battery exploded.

The reason for both of these accidents, and many others, is the fact that a battery being charged produces hydrogen gas, a very combustible and explosive element. The longer a battery is charged the greater the accumulation of hydrogen, and the greater the danger of a serious explosion. All that is required is a single spark as one connects either of the jumper cables to a battery post.

How does one avoid such an occurrence? Simple. Just follow the step-by-step procedure given below whenever you need to jump one battery to another.



10 steps to safe battery boosting

By Thomas R. Sear

1. Ensure that the ignition switches and all electric accessories, including the lights, are turned off in both cars.

2. Verify that both batteries are rated for the same voltage. Most automotive-type batteries are 12-volt models these days; but many older cars, as well as some of the smaller models, may have a 6-volt battery.

3. Remove the dustcaps from each cell of both batteries, and make certain that the electrolyte reaches the FULL-mark. If not, ordinary tap water can be used to top-off each cell if distilled water is not available. If the dead battery is to be recharged, the dustcaps should be left off to prevent any buildup of pressure due to the rapid release of hydrogen gas from the battery fluid.

4. Cover the battery openings to prevent any splashing acid from reaching your skin or clothing. Your handkerchief will suffice.

5. Attach only one jumper cable at a time. Connect one end of the *red* jumper cable to the positive terminal of the good battery first. This is the terminal marked with a +, a P, or POS. Then connect the other end to the positive terminal of the dead battery.

6. Connect one end of the *black* jumper cable to the negative terminal of the good battery. This is the terminal marked with a –, an N, or NEG. Then connect the other end to a point on the frame of the car with the dead battery at least 18 inches from the battery.

7. Start the engine of the car with the good battery. Allow the car to warm up for a few minutes, holding engine speed to a fast idle.

8. Start the engine of the car with the dead battery. If the engine starts, proceed to Step 9. If it doesn't, turn off the ignition and wait several minutes. Don't flood the engine with too much gasoline. If the battery is completely dead, wait about half an hour so the battery may be charged by the running car. Try to start the dead car again. Now, if successful, proceed to Step 9. If the car cannot be started, see a mechanic.

9. Disconnect the jumper cables by reversing the order in which they were connected. Keep the car with the bad battery running at a fast idle until it is warmed up. The chance of stalling is thus greatly reduced.

10. Replace the dustcaps on the dead battery.

Some final notes: It's always best to determine why the car didn't start in the first place and have the car adjusted or repaired. Repeated battery boosts are unwise and unsafe. Also, because of the hydrogen gas present when batteries are involved, *never* smoke a cigarette near a battery that is being charged. ■

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**

Wants Many

Hank, I need several schematic diagrams of Television receivers from time to time. You see, my hobby is fixing TVs for friends. Where is there a good source I can go to for a diagram without buying a whole book?

—E. D., Mobile, AL

A diagram and service material for practically any television, radio, or stereo set can be secured from Supreme Publications for a very reasonable price. I understand that this firm supplies such material from its own manuals, Sams' Photofacts, old Rider's, and its bulging files of original factory data accumulated over many years. Such data goes all the way back to antique radios and early TVs, as well as material of all manufacturers of recent past, and right up to sets of the '70s. Supreme Publications promises to quote by return mail. Most prices are about $2, some lower and a few higher. Supreme Publications' address is 1760 Balsam Road, Highland Park, IL 60035.

Look What He Stepped On

After finding several weather balloons, I would like to know where I can get a receiver to tap Uncle Sam's Radiosondes. Can you help?

—G. A., Richmond, TX

I don't know. But why don't you ask the people to whom you return the Radiosondes. Their name and address is printed on each unit. The few receivers I saw in operation were special units featuring a self-tracking parabolic antenna system. I guess the signals from these small balloon transmitters are too weak for conventional antenna systems to sense and send to a receiver.

20 Million Is Enough

I notice that in all digital volt-ohm meters they only test up to 10 or 20 megohms. Why?

—W. M., Ironton, OH

In any transistor radio, hang a 20 megohm resistor between any two points in the circuit and the radio will continue to function normally. You see, for most electronic circuits 20 megohms is equivalent to an open circuit. In fact, I can't think of a service measurement in a radio or TV where an indication of 22, 33, or 47 megohms is critical. Did you ever notice that most VOMs can't measure 50,000 volts?

Can You Help Out?

▲ Tommy Reagan can't seem to locate a copy of the schematic diagram for a tube-type multi-band Blaupunkt-Naivobi with case No. 2372-723068. Write to Tommy at 312 East French, Temple, TX 76501.

▲ F. H. Heberling of Bakerstown, PA 15007 would like to know battery requirements, connection and tube types for the Remler Infradyne Amplifier, Type 700, manufactured by Gray & Danielson Mfg. Co.

▲ Anybody have diagrams for the Decca Model DR-343 and International Transistor Corp. Model FAP-314 radios? If so, write to Emanuel Cattolica, 7861 Barbi Lane, La Palma, CA 90623.

▲ Here's an odd request—John Fiorino would like to obtain blank recording discs so he can use his General Instrument Record Cutter. He prefers 10 or 12-in. blanks. Write to 518 85th Street, Brooklyn, NY 11209.

▲ Got a Service Manual for a Webcor Royalite Tape Recorder, Model EP-2001-1? Donald Richard of 101 Cumberland St., Manchester, NH would like it or a copy. Write to Don.

▲ Urgent request: Chase Ambler would like to obtain silver-oxide/zinc batteries, or information on where they can be obtained. Write to him in care of Physics Dept., Asheville School, Asheville, NC 28806.

▲ Can anyone spare a National HRO-60 operator's manual? If yes, write to Dennis Gibbs, 9214 Venetian Way, Richmond, VA 23229.

▲ Bill Forehand wants a service manual or copy of one for the Precision Vacuum Tube V Multi-Meter, Series EV-10A. Write to Bill at 706 Plaid Street, Burlington, NC 27215.

▲ Anyone have a schematic diagram for a B&K Cathode Ray Tube Tester and Rejuvenator, Model 400 and its adaptor, Model C40? Then write to Lester W. Kroepel, 803 North Morrison St., Appleton, WI 54911.

▲ Juan Rivera, 8417 Trumbell S. E., Apt. A, Albuquerque, NM 87108 picked up a Silvertone radio made by RCA of 1930 vintage in good working order at a flea market. He would like to get a schematic diagram and spare tubes (just in case). Help him out, boys.

▲ A Bell 2325 Amplifier schematic diagram is wanted by Mark Harris, 901 Dixon, Missoula, MT 59801. Can anyone help?

▲ P. J. Carroll across the border is look-

(Continued on page 99)

SUB-BASEMENT RADIO

EXPERIMENTER'S DELUXE FET/IC VLF RECEIVER

JUST AS MANY of the "cliff dwellers" in modern multi-story apartment buildings have little-known basements and sub-basements, the radio spectrum has a "basement" LF (low frequency) band and a mysterious "sub-basement" VLF (very low frequency) band, little known to many electronics hobbyists and experimenters. The LF band goes from 300 kHz down to 30 kHz, and the VLF band from 30 kHz down to 3 kHz.

The lower portion of the LF band, from about 60 kHz to the upper portion of the VLF band (about 18 kHz), is used by the National Bureau of Standards to transmit coded, standard-frequency signals (similar to WWV). Special receivers are used for proper reception of these signals, which automatically adjust electronic laboratory generators to coincide with the standard frequencies. The U.S. Navy has found that the VLF band signals will penetrate into salt water and has established giant high powered transmitting stations that communicate with submerged submarines anywhere in the world.

Other nations maintain transmitting stations in the LF/VLF region for scientific and navigational purposes. These stations are subject to changes in frequency, power, and time of broadcast since there is still considerable experimentation. The stations usually transmit their call signs in CW at periodic intervals for identification.

Receivers for the LF/VLF "basement" transmissions are usually quite complex, but you can sample the activity in this portion of the rf spectrum with our simplified receiver project which covers the most popular portion of the bands from 20 to 50 kHz. This frequency coverage can be changed by using different values of inductances than specified in our plans. Plans are also included for a VLF-style loop antenna to be used with the receiver instead of the usual outdoor dipole antenna used in the higher frequencies. Inasmuch as VLF wavelengths are many miles long, a half wave antenna dipole is impractical at these frequencies.

The receiver uses two ICs and three FETs in a simplified regen detector circuit with a two-stage rf amplifier. Good audio volume is provided for earphone reception, and the receiver is housed in a compact metal utility box. Perf board style construction is used for ease in building the receiver.

The Circuit. Very low frequency signals picked up by the loop antenna are fed through coax cable to the input of IC1, the rf amplifier stage. The amplified signals are fed through C3 to the coil L1 and the second rf amplifier stage, IC2. L1 and the input capacity of IC2 act as a broadly tuned circuit for VLF signals: R2 controls the rf amplification.

Capacitor C6 couples the amplified rf signals to the oscillating detector stage of FET Q1. These signals are tuned by L2 and the S1 switch-selected capacitors of C8 to C18. Variable capacitor C7A/B acts as a fine tuning control for the VLF signals, and R5 controls the oscillation point and, therefore, the sensitivity of the detector stage.

The detected audio signals are fed through the low pass filter R7/C20 and coupling capacitor C21, to the audio gain control R8 and audio amplifier stage Q2. The amplified audio signals are coupled via the L3/C23 peak filter to the second audio amplifier stage of FET Q3. The peak filter is tuned to approximately 800 Hz to provide better receiver selectivity of the

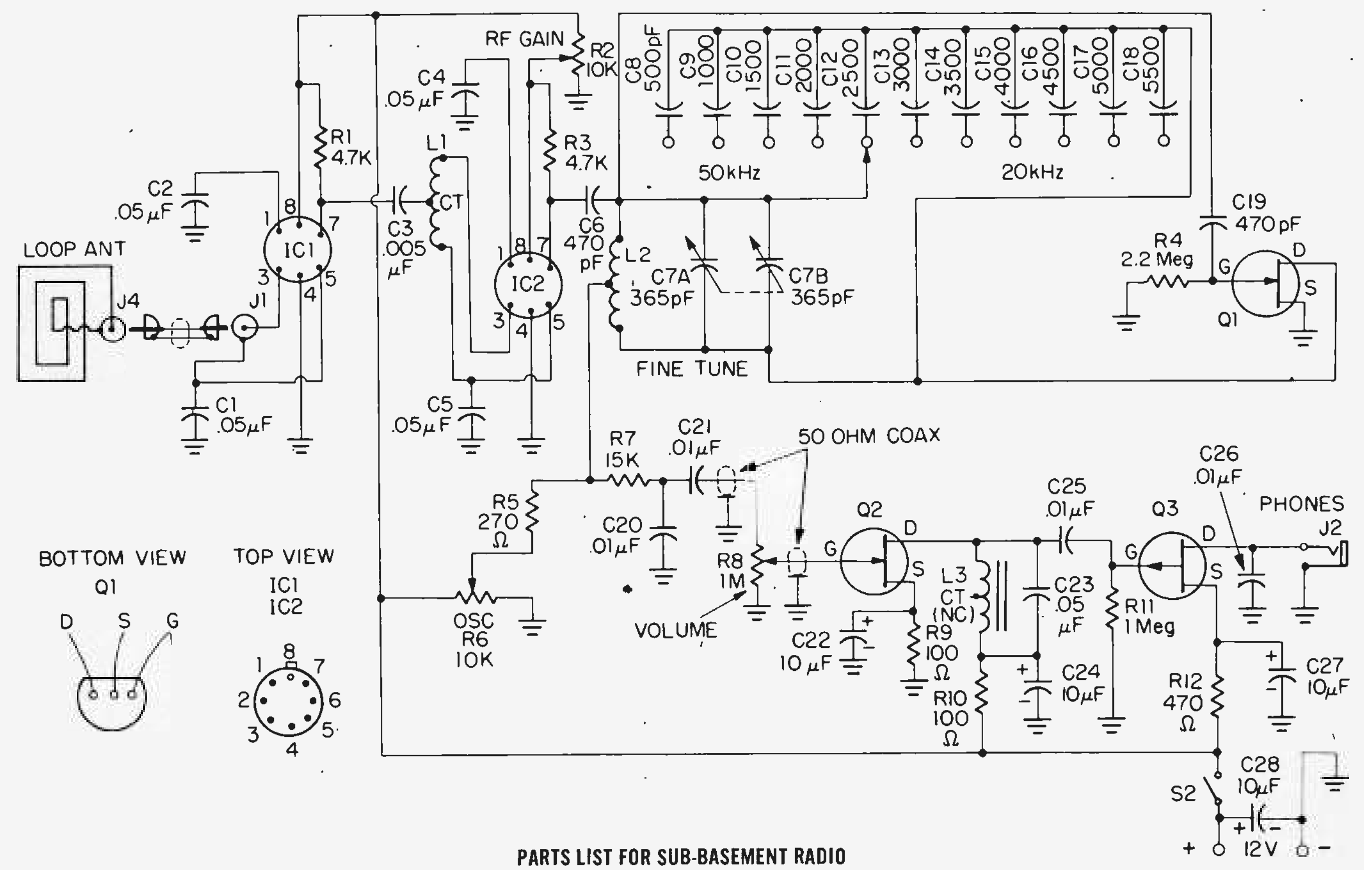
SUB-BASEMENT RADIO

VLF signals. The amplified signals are fed from the drain circuit of Q3 to J2 and can drive high impedance earphones (2000-ohm type).

Field effect transistors Q2 and Q3 form the audio amplifier stages. Q3 is a P-channel FET and therefore requires a relatively negative potential on its "drain" terminal. This is accomplished by grounding the drain through the earphone and returning the "source" to the positive power supply terminal.

Construction. Coils L1 and L2 are made from miniature transistor audio transformers by removing the laminated iron core. We used 10,000-ohm to 2,000-ohm center-tapped transformers for the coils in our receiver. The connections are made to the 2,000-ohm center-tapped winding only; the leads to the 10,000-ohm winding should be cut off close to the coil form. Coil L3 is a 1,000-ohm CT to 8-ohm miniature output transformer and is used *with* its iron core intact. The 1,000-ohm winding is used (no connection is made to the center tap), and the 8-ohm and center tap leads should be cut off close to the coil form.

The receiver operation is at low rf frequencies, but the wiring of the receiver should still be carefully done. For best results, follow our component layout as shown in the photos. Your best way to start construction is to cut a 4¼ x 7⅞-in. section of perf board and install it approximately halfway up the LMB-146 aluminum box. We used two 4¼-in. lengths of sheet aluminum



PARTS LIST FOR SUB-BASEMENT RADIO

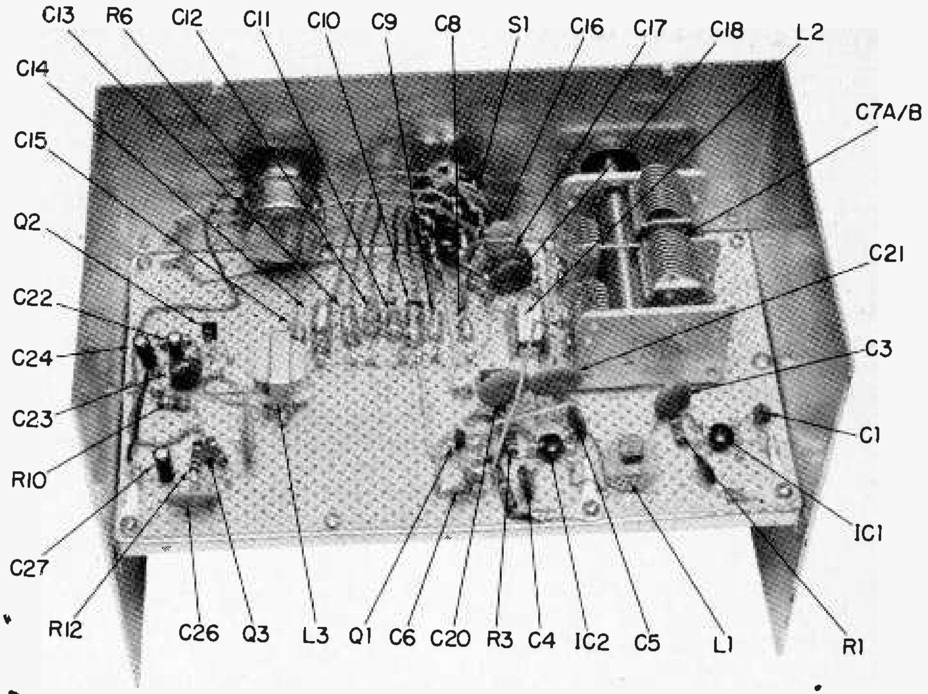
C1, C2, C4, C5, C23—0.05-uF capacitor, 12-VDC or better
C3—0.05-uF capacitor, 12-VDC or better
C6, C19—470-pF capacitor
C7A/B—dual-gang 365-pF variable capacitor (TRW 273 or equiv.)
Note—A dual-gang 365-pF variable capacitor may be difficult to obtain. You can go the same route as pioneer radio builders by using two single-gang 365-pF variable capacitors and operate them in tandem (turn each knob the same amount).
All capacitors 15-VDC or better
C8—500-pF (see text for all capacitors, C8 to C18)
C9—1000-pF
C10—1500-pF
C11—2000-pF
C12—2500-pF
C13—3000-pF
C14—3500-pF
C15—4000-pF
C16—4500-pF
C17—5000-pF
C18—5500-pF
C20, C21, C25, C26—0.01-uF capacitor
C22, C24, C27, C28—10-uF electrolytic capacitor, 16-VDC
IC1, IC2—703-type integrated circuit
J1, J3—insulated phono jack, RCA type (see text)
J2—two-conductor phone jack
L1, L2—inductors made from small 10k to 2k audio driver transformers
L3—inductor made from small 1k to 8-ohm audio output transformer (see text)
Q1—N-channel FET, HEP-802 (Motorola)
Q2—N-channel FET (see text)
Q3—P-channel FET (see text)
R1, R3—4700-ohm, ½-watt resistor
R2, R6—10,000-ohm potentiometer, linear taper
R4—2.2 meg, ½-watt resistor
R5—270-ohm, ½-watt resistor
R7—15,000-ohm, ½-watt resistor
R8—1 meg potentiometer, audio taper
R9, R10—100-ohm, ½-watt resistor
R11—1 meg, ½-watt resistor
R12—4700-ohm, ½-watt resistor
S1—single pole, 11 position rotary switch (Calectro E2-161 or equiv.)

Misc.—aluminum cabinet 8-in. x 6-in. x 4½-in. (Author used LMB 146), perf board, push-in clips, 50-ohm coaxial cable, knobs, hook-up wire, No. 28 enameled wire, plastic tape, solder, etc.

bent into brackets with sides approximately ¼ x ½-in. (½-in. side mounted to the box wall, and the ¼-in. side mounted to the perf board). Additional lengths of ¼-in. wide sheet metal stiffeners were added to the side of the perf board to increase the rigidity of the board. This may not be necessary in your unit.

More Mechanics. Locate C7A/B on the front panel as shown in the photos, and then cut a ½-in. or larger hole for the shaft. This will allow the frame of C7A/B to be mounted to the perf board and allow the shaft to protrude through the front panel without touching the metal panel. Note that the shaft *must be* insulated from the panel, or it will short the B+ at the detector circuit. If necessary, you can use an insulated coupling for the shaft. Make sure that you use a plastic tuning knob to minimize the possibility of short circuits.

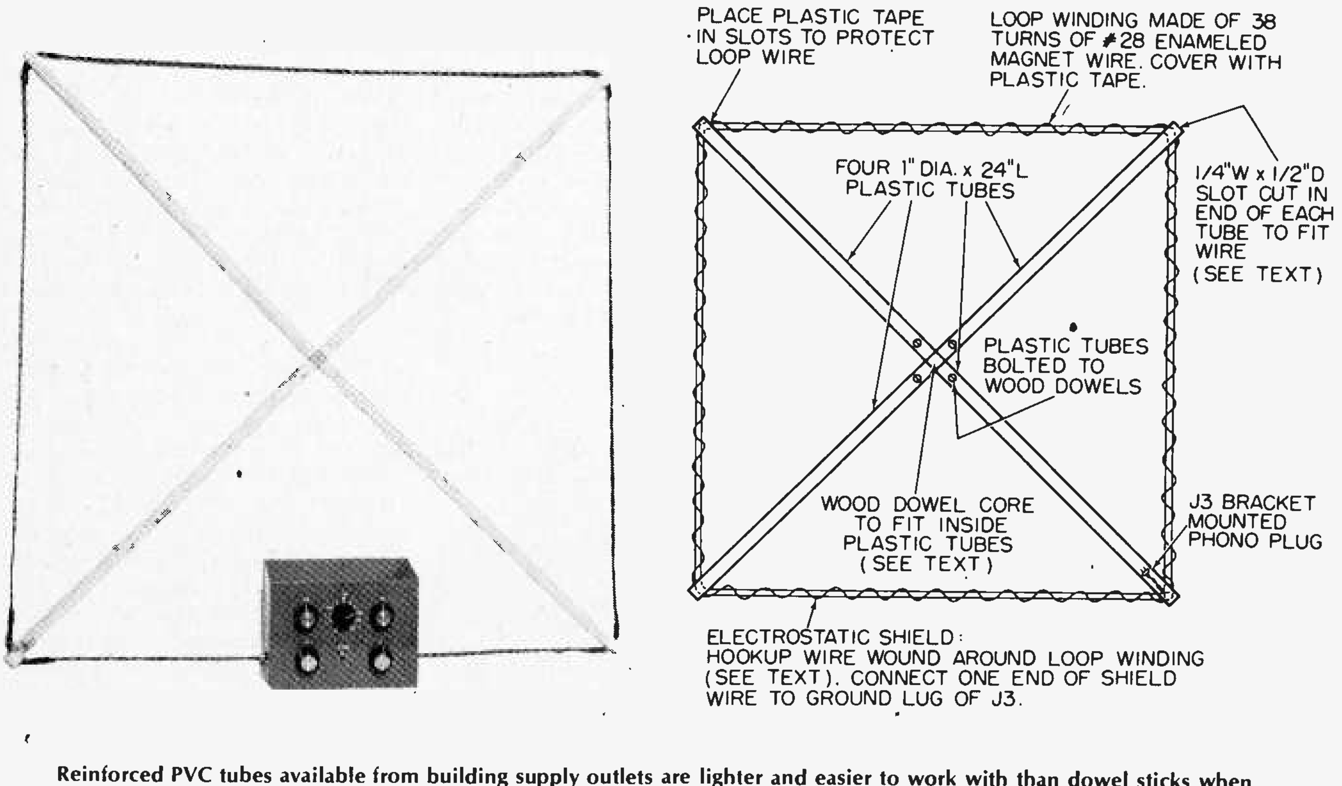
Locate and install the remainder of the front and side panel controls and components as shown in the photos. Make sure that you install serrated washers between the control bushings and the inside of the panels to prevent accidental disturbance of the position of the controls. Also, use insulating washers for J1 to keep the jack body from electrical contact with the box panel and electrical ground.



These are the major parts locations for the perf board. Note dual-gang cap C7A/B.

Most of the components on the perf board are connected to push-in clips. Keep the component leads as short as possible and group them around their particular IC or FET as shown in the photos. Wire the components as indicated in the schematic drawing and position the leads as shown in the board photo.

Coil forms L1 and L2 can be either cemented to the top of the perf board, or (as in our unit) held with an application of hot plastic glue from an electric glue gun. Use short lengths of coax or shielded wire to connect R8 to the perf board components as shown in the

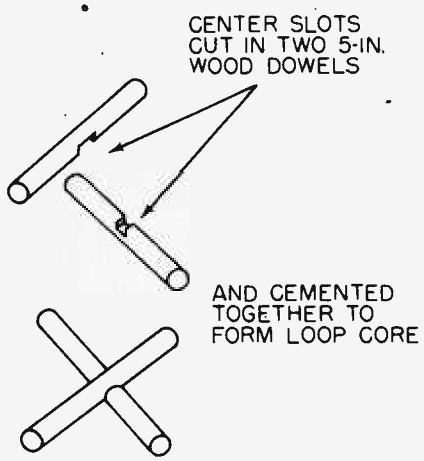


Reinforced PVC tubes available from building supply outlets are lighter and easier to work with than dowel sticks when building an open air antenna support frame. The RCA-type phono connector makes a convenient way to use standard audio cable.

SUB-BASEMENT RADIO

photo. Connect ground lugs at the board corners and on the C7A/B mounting screws for the necessary electrical circuit connections.

Capacitors C8 to C18 should have as accurate a capacity value as possible (select them on a capacitor bridge if possible), and they can be either ceramic or polystyrene types. Mount them with short leads around S1 and connect them with straight direct leads to the S1 lugs. If necessary, you can parallel capacitors to make up the required capacity values. Connect the remainder of the front and side panel controls and jacks to the board circuits, and position the leads as shown in the photos.

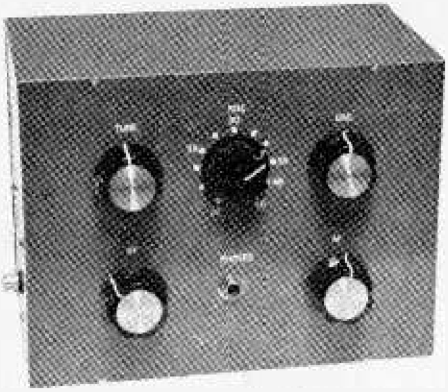


Dowel sticks for this assembly are available from lumber yards, hardware store and hobby shops. Notch with a wood chisel or a keyhole saw or whittle with a pocket knife.

The Loop Antenna. As shown in the drawing, the loop antenna is composed of four 1-in. diameter x 24-in. long plastic tubes. We used polyvinyl chloride (PVC) tubes that can be obtained from a building supply store. Or any type of plastic tube can be used as well. The plastic tubes are fitted over a wood-dowel center core as shown in the drawing, and the loop antenna wires are wound over the slots in the tube ends.

Begin construction of the loop antenna by cutting center slots in two 5-in. long wood dowels (of a diameter to fit snugly into the plastic tubes), and cement them together as shown in the drawing. Wood screws can be used in place of cement, or hot glue from an electric glue gun can be used as we did in our model.

Cut the plastic tubes to size and then



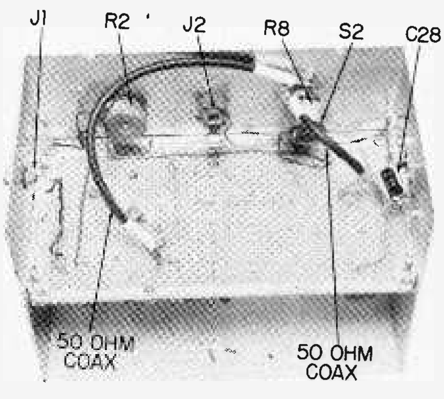
The front panel control knob "osc" sets the regenerative feedback point of the detector FET Q1 (it sets the audible "plop" point!). That "tune" knob is actually a fine-tune of the bandswitch-like "kHz" (course) control.

cut a ¼-in. x ½-in. deep slot on one end of each tube. Then mount the tubes to the wood dowel core with the slotted ends outward and parallel to allow the loop antenna wires to be wound around the ends as shown in the drawing.

Place plastic tape in the tube slots to prevent the wire from being abraded, and wind the loop with 38 turns of #28 enameled magnet wire, and cover the wires with a layer of plastic tape. Connect the loop leads to a phono jack (J4) mounted on the end of one of the plastic tubes.

To minimize noise pickup, wind an electrostatic shield composed of a spiral winding of hookup wire around the antenna loop. Leave about 1-in. spacing between the electrostatic shield wire turns, and connect one end of the wire to the "low" side (shell) of J4. The other end of the electrostatic shield wire should be taped so that it will not cause any accidental short circuits.

A length of good quality phono or coax can be used to connect the loop antenna to the receiver. Make sure that the "low" sides of P4 and J1 are con-



Experimenters should use a short length of 50-ohm coaxial cable for vol. control R8 connections (mini-type RG-174U or RG-58 U).

nected together (the outside shells of the jacks).

Range and Panel Markings. We used rub-on decals for the panel markings for our receiver model, but neatly drawn pen and ink markings on white tape can be used as well.

The receiver does not require any calibration for exploratory operation on the VLF band, and you can designate the approximate frequency of the S1 kHz switch as follows: 20 kHz (C18=5500 pF), 25 kHz (C15=4000 pF), 30 kHz (C13=3000 pF), 35 kHz (C10=1500 pF), 40 kHz (C9=1000 pF), 45 kHz (C8=500 pF).

For more accurate calibration with the transformers you used for L1 and L2, connect an audio oscillator to J1 through an isolating audio transformer.

Testing and Operation. The loop antenna can be suspended with a length of cord from one of the plastic tubes for easy rotation and operation indoors. Or the loop can be placed on a wooden chair for temporary operation. Note, however, that the loop should be away from AC appliances for best performance.

Set all controls to the extreme counter-clockwise position, and connect the receiver to a 12 volt DC power supply or battery. Connect the loop antenna to J1 with either coax or a length of good quality phono cable, and plug in a set of high impedance earphones at J2.

Adjust the *audio gain* (R8), *rf gain* (R2) and *fine tune* (C7A/B) controls to mid-range. Adjust the *osc* control (R5) clockwise until the detector circuit (Q1) is oscillating. There will be a "click" or "plopping" sound in your earphones when the detector stage first falls into an oscillating condition. Keep adjusting the *osc* control (R5) near this point for best sensitivity when tuning for signals. Adjust R8 and R2 for best reception of signals.

Adjust the *fine tuning* control (C7A/B) for each setting of S1 as you listen in on the VLF band from 20 kHz to 50 kHz. Reposition the loop antenna as necessary for best reception of signals. Practice is required to obtain the proper "feel" for operating the receiver controls. You can also try different loop antenna assemblies with different turns of wire for best results in VLF reception over different portions of the band. You can experiment with the tuning range by changing the values of L1 and L2.

Remember, this is an experimenter's project exploring the little-known, little-tuned very low frequencies. It's a good first-step project into VLF; why not "kick in" right now! ■

YOUR CB CAN TELL TIME

Tired of all those fancy experimenter projects good for everything but a CB shack? Here's a goof-proof project that puts SW broadcasts on a CB without modifications!

by Malcolm K. Smith

THE receiver in your CB transceiver is almost certainly an excellent signal grabber with good selectivity and sensitivity. But, it's crystal controlled to receive only the CB channels. There is, however, a simple way to make your CB serve as a high quality rig for VHF monitoring, short wave listening, checking the National Weather Service forecasts, or getting an accurate time and frequency signal. All you need is a simple device called a converter that requires no changes to the inside of your rig. And, best of all, building a converter is a breeze, because it can be made from low cost modules available in kit form.

There are many exciting signals you can receive on your CB with a converter, but the most useful ones are the precision time and frequency broadcasts sent out by CHU in Canada and the National Bureau of Standards station WWV in Fort Collins, Colorado. Let's say you've just built the e/e MAXICLOCK—a first class digital clock; surely you need something better than a DJ's idea of the time to set your clock. Or, if you're interested in accurate calibration of a receiver or transmitter, you need the precision standard frequency given by WWV. And now, if you'd like to tell time with your CB using a converter, what is a converter, and how does it work?

A converter mixes together an input signal—let's say CHU at 7.335 MHz—with a signal from a "local oscillator" (LO) in the converter itself. When two signals are mixed, out come new signals at the sum and difference of the original frequencies. Suppose you mix the 7.335 MHz signal from CHU with an LO signal of 19.730 MHz; one of the output signals is their sum—27.065 MHz, the frequency of channel 9.

Simplex Circuit. Take a look at the block diagram which is nearly the schematic of a converter; the 7.335 MHz signal is amplified by the RF amplifier and fed into the mixer where the LO signal (19.730 MHz) is added to it. The sum frequency (27.065 MHz) is fed into the antenna input jack of your CB (tuned to channel 9), and from the speaker you now hear the time signals. You have "converted" 7.335 MHz to 27.065 MHz!

Incidentally, the workings of CB receivers were well described in e/e for July-August 1974. If you have that issue, the article on page 45, "Discover Your CB Receiver," gives a good explanation of converters.

Our CB time converter uses three easy-to-build and low-in-cost modules available from the International Crystal Mfg. Co., 10 North Lee, Oklahoma City, Okla., 73102. Each module performs one function and consists of a transistor, a tuned "LC" circuit, and other components mounted on a printed circuit board. The three kits needed here are: SAX-1, the RF amplifier; MXX-1, the RF mixer; and OX, a crystal controlled local oscillator. You will have to buy an "EX" crystal for each frequency to be received unless you have one of the old tunable receivers such as the Lafayette Comstat 19, which can be manually tuned over a range of about 300 kHz. In that case, you would require only one crystal to cover this 300 kHz range.

Pinpoint Hertz. How do you calculate the required crystal frequency? First, determine the frequency you wish to

CB TIME CONVERTER

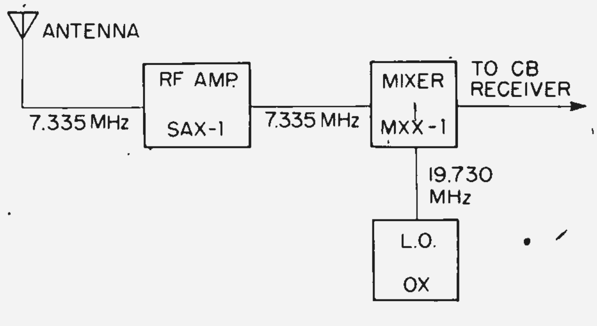
receive; let's say WWV on 10.0 MHz. This is a good first choice since WWV seems to come in well at most times. Next, decide on the channel to use; channel 9 is probably best, since there will be very few strong CB signals to leak through and interfere with the converter signal. The frequency of channel 9 is 27.065 MHz.

The next step depends on whether you are going to convert "up" or "down." Here you are converting up to a *higher frequency*, and so you *subtract* the desired frequency from the channel 9 frequency to get the LO frequency as follows—channel 9 frequency (27.065 MHz) minus the desired signal frequency (10.000 MHz) gives the "LO" frequency, 17.065 MHz.

Now suppose you want to receive a frequency higher than channel 9, say a National Weather Service Station on 162.55 MHz. Incidentally, NWS weather and many other VHF signals are frequency modulated (FM). Your CB rig is not designed to receive FM, but, surprisingly enough, it does a pretty good job (don't try, however, to build a converter for the FM broadcast band; your CB rig can't handle their large frequency shifts).

Here you get the LO frequency by subtracting the channel 9 frequency from the desired frequency, since this is "down" conversion, as follows—desired signal frequency (162.55 MHz) minus the channel 9 frequency (27.065 MHz) gives the "LO" frequency 135.485 MHz.

With three easy to construct and inexpensive kits; which come with an etched and drilled PC board, you can electronically "slide" your CB receiver down to pick-up short wave broadcasters like WWV, CHU, or even the Voice of America.



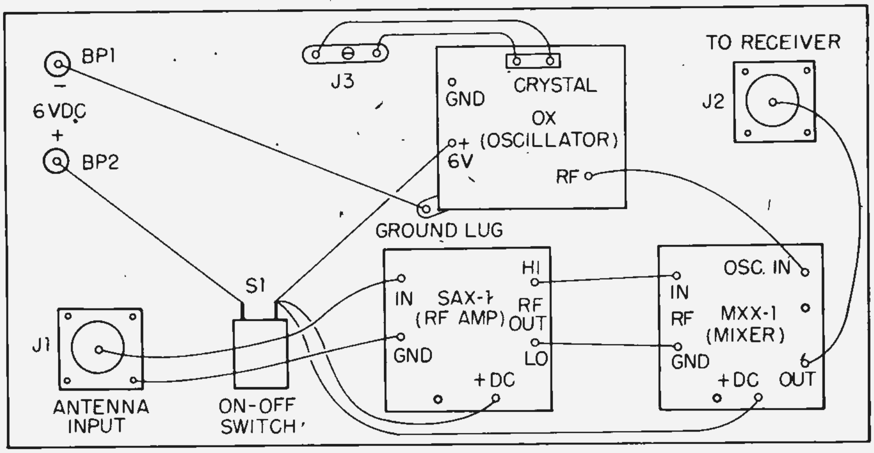
3-Way Cut. So, you want a crystal of frequency 135.485 MHz, right? Wro There is a slight complication in using the OX oscillator at frequencies over 60 MHz. You can't use the basic or fundamental frequency of the crystal. You have to use what are called its harmonics—frequencies which are two or three or more times the fundamental. Here you use the third harmonic—three times the fundamental. Therefore, the crystal frequency should be *one third* the LO frequency. The NWS crystal is, therefore, 135.485 ÷ 3 = 45.1617 MHz. The table gives crystal frequencies for a few other common signals.

In addition to the International Crystal modules and EX crystals, you'll also need a few small parts and a box or cabinet for mounting. The cabinet requirements are not critical; a small metal box or one with a metal cover should serve well. The common bakelite box with aluminum cover is fine. A box about 4 x 8 x 2½-in. is good because it gives you plenty of room for batteries, connectors, etc.

The ICM kits are quite complete; you'll need only wire and solder to build the modules. International Crystal provides detailed instructions for selecting the right components from the ones they supply and for assembling the individual modules. The diagram shows you how to connect the modules together to produce a converter. Before mounting the boards, check your soldering carefully. Look very carefully at the joints where the input and output terminals meet the copper foil. They can easily work loose; it's a good idea to solder each one individually. Use the bolts and spacers supplied to mount the modules on a metal chassis; drill four ⅛-in. holes in a square 1³⁄₁₆-in. on a side for these bolts.

Input-Output. SO-239C coaxial jacks handle the coax cables to the antenna and the transceiver. An spst switch and a snap-type battery clip take care of power connections. A nine-volt transistor radio battery is an adequate power source. However, we prefer to use four AA cells in a holder; the rig works fine on six volts and these cells last longer than the nine volt battery. For long term monitoring you may want to use an external AC power supply; the two

Here's why we stamp this project "goof-proof." Three little sure-fire PC board project kits and a few wires to plug them together pick up shortwave broadcasts and "convert" them to CB channel 9. That's where your CB set takes over. It "picks up" the converted signal; that's why no modification to the CB set is ever required.



PARTS LIST FOR CB TIME CONVERTER

BP1, BP2—5-way binding posts (Radio Shack 274-662 or equiv.)
J1, J2—chassis-mount, SO-239, coaxical jacks
J3—optional crystal socket for "EX" (HC-6/U) type crystals (Amphenol 9748-16-10 or equiv.)
S1—spst toggle switch (ON-OFF)

Misc.—four-cell AA battery holder such as Radio Shack 270-383, cabinet with metal cover about 4-in. x 8-in. x 2-in. such as Radio Shack 270-232, PL-259 coax connectors for input/output signals, wire, solder, etc.

In addition, the following "Experimenter" kits will be required from International Crystal Mfg. Co., Inc., 10 N. Lee, Okla. City, OK 73102: OX oscillator @ $2.95, MXX-1 mixer @ $3.50, SAX-1 RF amplifier @ $3.50, and the proper EX crystal (see text) @ $3.95. Postpaid.

COMMON CRYSTAL FREQUENCIES

Station	CHU	WWV	NWS weather	Marine calling, distress
Freq. (MHz)	7.335	10 5	162.55 162.40	156.8
Crystal (kHz)	19,730.000	17,065.000 22,065.000	45,161.666 45,111.666	43,245.000

binding posts are for this connection.

One last refinement, that is not necessary but certainly is convenient, is an external crystal socket. As shown in the diagram, mount the socket near the OX module and connect two leads (as short as possible) from the OX socket to the terminals of the new socket. This allows you to change frequencies over a narrow range without removing the unit from its case.

A special word here about using your converter on different frequencies: You should follow the ICM instructions carefully in choosing the right coil and capacitor for the kits. For the OX oscillator, the "yellow dot" coil will probably cover the range you want for time listening. However, with the SAX and MXX, the yellow dot has to be matched with the right capacitor: the 100 pF capacitor tunes the range 5.4 to 8.5 MHz—just right for CHU. For WWV you need the 47 pF capacitor that tunes 8.5 to 13 MHz.

When the modules are securely mounted, make the connections between the units as shown in the diagram. Note that the negative battery terminal is connected to chassis ground with a solder lug. Connections to the boards are made with the little connectors supplied. Take it easy and work carefully with them. First cut your wire to the right length, then strip about ¼-in. of insulation from each end. Hold the "open" end of the connector with long nose pliers; squeeze the connector around the wire end. Secure the wire in place by flowing in some solder. Careful! Don't let solder get into the round end that mates with the pin on the PC board.

Setup. For testing and adjusting your converter, an RF signal generator is useful, but not essential. The tuned circuits in the SAX and MXX can be peaked using an on-the-air signal from CHU or WWV. Adjust the slugs in the coils for maximum volume from the speaker.

Of course, your converter needs an antenna to function properly. When radio propagation conditions are good, almost any piece of wire connected to the center (ungrounded) input will serve. We get good results by connecting both wires from a monitor antenna to the center terminal. This is, in effect, a long vertical antenna. Your CB antenna will probably not work well, since most good CB antennas are effectively grounded for any frequencies except the CB channels (good for lightning protection, but not for receiving 10 MHz).

Shortwave Fix-Tuned. There are many shortwave broadcast stations around the world you might try to snag with a fix-tuned receiver like the one here. The radio can be left "on," always tuned exactly to the broadcaster's frequency. When "skip" on the shortwave bands is just right, and the station is broadcasting, you will be ready to copy. While a separate crystal for every possible frequency is a financial impossibility, and not very practical anyway, you can keep a crystal or two around for your most often used frequencies.

Here is a selected list of shortwave broadcast stations which may interest you. Of course, you should confirm reception in your area with a regular tunable shortwave receiver before sinking your good bucks into a crystal.

Voice of America, Greenville, N.C., 15160 kHz, 2345 GMT, relaying programs of the Organization of American States; Greenville, N.C., 15235 kHz, 1900 GMT.

Canadian Broadcasting Corporation, Sackville, N.B., 11720 kHz, 0200 GMT, Northern Service newscast; Sackville, N.B. 15190 kHz, 0100 GMT, Radio Canada International's foreign service in English.

CFRX, Toronto, Ontario, 6070 kHz, can be heard during the evening hours in North America with programs of CFRB, sounding much like a popular music format U.S. commercial BCB station.

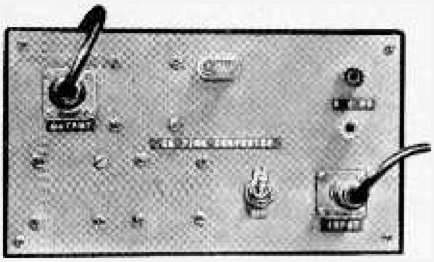
Voice of the Andes, HCJB, Quito, Ecuador, 11745 kHz, English may be heard around 0300 GMT. Or, in the mornings, try 15115 kHz about 1300 GMT.

Radio Peking, Peking, People's Republic of China, 15060 kHz. You can find this station broadcasting in English around 0200 GMT.

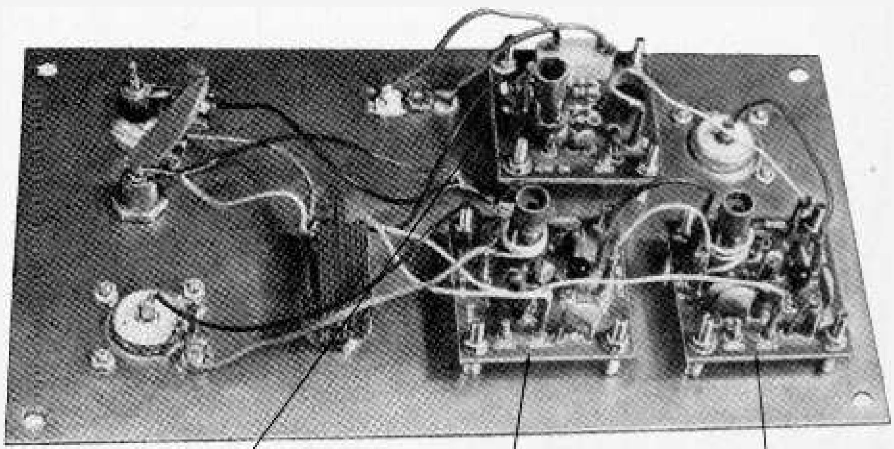
Radio Australia, Melbourne, Australia, 11785 kHz. Plenty of English programs from this down under station; listen in about 1400 GMT.

Radio Tahiti, Papeete, Tahiti, 15170 kHz. With music that runs the gamut from U.S. pops to Polynesian melodies, listen for this station from its sign-on at 0300 GMT.

This little converter now makes your CB into a red hot receiver. With the right LO crystals, you can cover your favorite frequency-stops from 3 MHz to 170 MHz. Good signal hunting! ■



A front panel mounted crystal socket permits moderate shifting of the received frequency without internal retuning. If you use an external 6-volt supply, be sure to remove the dry cell.



Bell & Howell Schools announces two ways to learn new skills in electronics without ever going to class or giving up your job!

Pick the one

Here are two fascinating home-learning adventures that say, "Don't envy the man with skills in electronics... become one!"

If you had to drop everything and go off to school to learn new skills in electronics, there's a chance you might not do it. But Bell & Howell Schools' excellent home training has already proved to tens of thousands that you don't have to drop anything...except the idea that classrooms are the only place you can learn!

You can keep your job, your paycheck and your way of life *while* you're learning. Because these programs allow you to pick the training schedule that best fits in with your other activities. It's *that* convenient.

I. AUDIO/ELECTRONICS

The first learn-at-home program including 4-channel technology. Explore this totally unique sound of the 70's as you experiment with testing equipment and build a sound center featuring Bell & Howell's superb quadraphonic equipment!†

Learn about 4-channel sound—without a doubt the most impressive technical advancement in sound realism in years. A development by which separately-recorded channels literally wrap a room in sound.

And now, for the first time, you can also discover this latest achievement in audio electronics with a fascinating learn-at-home program that explores the whole area of audio technology including 4-channel sound reproduction. A program that could lead you in exciting new directions with professional skills and technical know-how.

You actually build and experiment with Bell & Howell's high-performance 4-channel audio center ...including amplifier and FM, FM-Stereo tuner.

Understanding today's audio technology requires practical experience with high caliber equipment. And with the Bell & Howell amplifier and tuner, you've got the technological tools you need to gain the knowledge and skills that could open up opportunities for you in the audio field. Of course, we cannot offer assurance of income opportunities.

The sophisticated amplifier gives you the circuitry you need to conduct the comprehensive experiments necessary to master audio technology. Like signal tracing low level circuits, troubleshooting high power amplifier stages, and checking the operation of tone control circuits.

You'll investigate the technology behind this amplifier's full logic, 4-channel decoder and learn how full logic decoding produces outstanding front to back separation.

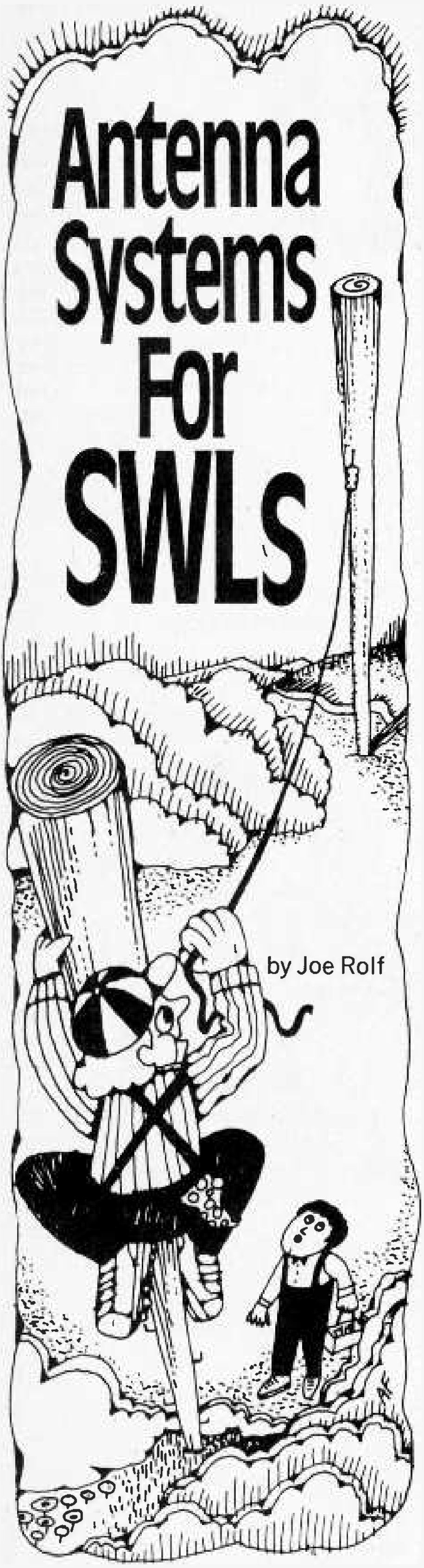
The tuner you build has both superior performance specs and state-of-the-art features such as: all solid state, FET front end for superior sensitivity, crystal IF filters for wide bandwidth, and a superior stereo multiplex circuit for excellent stereo separation.

You cover the full range of electronic fundamentals.

But make no mistake. This learn-at-home program is not just about 4-channel sound. It covers the full range of electronic fundamentals leading to understanding audio technology. So when you finish, you'll have the occupational skills to become a full-service technician, with the ability to work on the full range of audio equipment such as tape recorders, cassette players, FM antennas, and commercial sound systems. Get complete information on this unique program by checking the appropriate box on the card—mail it today!

† Cabinets and speakers available at extra cost.

Antenna Systems For SWLs



by Joe Rolf

These antenna ideas will help you pull in those elusive shortwave stations.

If you're an armchair shortwave (SW) traveler, you've probably already read through the shortwave stations listed in White's Radio Log, located in e/e's sister publication Communications World. Maybe, with mouth-watering anticipation, you've tried to hear Rabaul, Upper Volta, Yemen, Hanoi, or Vientiane. If you haven't been successful, be patient; because that's what it takes—patience—*plus* a good SW antenna. We can't supply the patience, but here are some good antenna ideas which are sure to help.

No matter what shortwave receiver you're using, a good antenna is a must to bring in those distant stations. If it weren't, the manufacturer wouldn't have supplied antenna terminals! The problem is what kind of antenna—a hunk of wire? or maybe something more scientific? We'll help you make the decision by telling you a little about SW antennas and how they work.

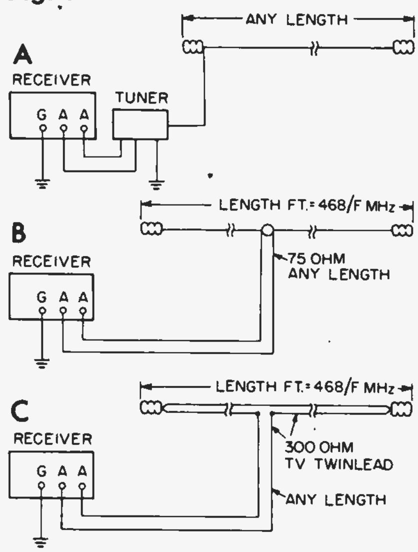
Shortwave antennas can be short and simple or they can be complicated and cover several acres. For shortwave listening most of us are limited to the short and simple ones—those that fit in a backyard and don't cost too much. But even a simple antenna, properly designed and installed, can work wonders.

Fig. 1 shows several commonly used SW antennas with lengths shown for the SW broadcast bands. The antenna in Fig. 1A is known as an unbalanced end-fed longwire. It can be hung horizontally or vertically, or a combination of both. When hung horizontally it has some degree of directionality, while it tends to be omnidirectional when vertical. This antenna will work well on all frequencies if it is made long enough, or it can be cut to operate at only certain frequencies. It works best with an antenna tuner that can be located at the receiver, since the lead-in is part of the antenna's total length. The longwire has a high terminal impedance and always operates best with a tuner that matches the antenna to the receiver. With an antenna tuner, it is an ideal antenna to run around the eaves of the house, or across the attic.

Another Type. Figs. 1B and 1C show the popular centerfed balanced dipole. This antenna can also be hung vertically or horizontally and uses two balanced leads to the receiver that can be any length. This antenna is always cut to a resonant length, though it will also work well at three times the resonant frequency. For instance, an antenna that works in the 90 meter SW band (3.2-3.4 MHz) will also work for the 31 meter band (9.5-9.7 MHz). If space is limited, its ends can be bent down (or even back) as much as 25 percent before reduction in performance becomes serious. Fig. 1B shows a single-wire dipole fed with 75-ohm feedline which can be plastic appliance cord. Fig. 1C shows the folded dipole version built from 300-ohm twinlead. The folded dipole, incidentally, will work well at half the resonant frequency.

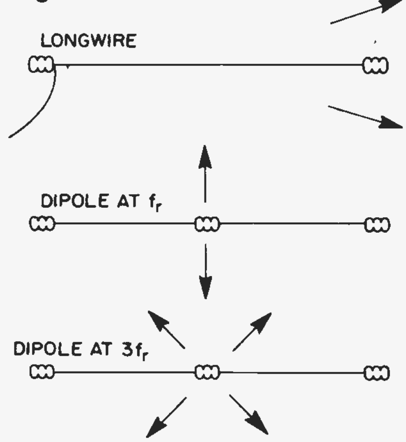
As previously mentioned, a vertical antenna tends to be omnidirectional, while a horizontal antenna tends to have directional characteristics. For general around-the-globe listening the vertical antenna is probably best, though low frequency resonant antennas are difficult to orient in this position because of their length.

Fig. 1



Directionals. If you are interested in DX from a particular part of the globe, however, the directional characteristics of a horizontal antenna can work for you. Fig. 2 shows the direction of maximum pickup for the horizontal longwire and dipole. By looking at a globe and determining the shortest path to the

Fig. 2



area you want to hear, you can position your antenna and use its directional characteristics to advantage.

Fig. 3 shows how directionality can be further increased by bending the ends of the dipole inward. This type of antenna can be easily built by using a center support, such as a TV mast, and bringing the ends in and down toward the ground. For best results, the ends of the antenna must be 10 feet or more above the earth.

A more elaborate antenna that will "look" in any one of four directions can be made by mounting two dipoles in this manner at right angles and connecting the lead-in to different elements to achieve the desired direction. This deluxe array has a disadvantage in that you must have easy access to the top, or center part, in order to change lead-in connections.

Fig. 3

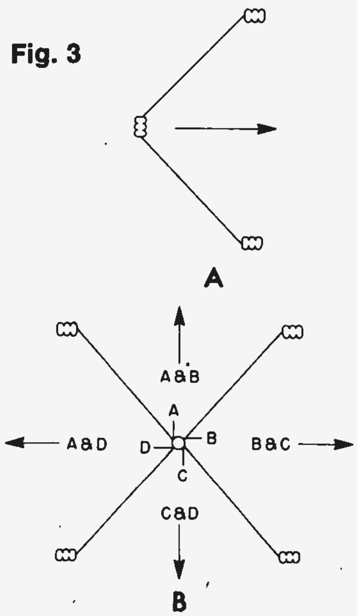
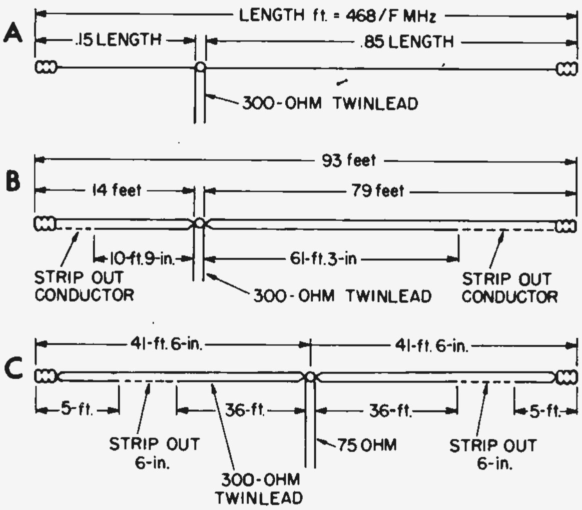


Fig. 4



Three porcelain antenna insulators are used for antenna A. One separates each section of the antenna at the point of feedline connection. The other two insulate the antenna ends from the supporting structure. The antenna at B uses 300-ohm twinlead for the transmission line and the antenna elements. Only the ends at the feedline connections are wound together and soldered. Outside ends are separated, with one partially removed as shown. At C the use of 75-ohm line is called for.

Fortunately, choice DX can be logged on any of the eleven international broadcast bands; but it is difficult (if not impossible) for the serious SW listener to come up with a good antenna for each of eleven bands. Few SWLs have the real estate or inclination to put up a single tuned antenna for each band, so a couple of multiband antennas running in different directions is often the answer. Fig. 4 shows simple multi-band antennas that can be used; and, through compromises, they will give all around performance.

Still Around. The basic antenna shown in Fig. 4A was popular in the 1930s, and is known as the "windom" antenna. It can be fed with 300-ohm TV twinlead, and works well on even harmonics of the fundamental frequency.

Figure 4B shows how, by using 300-ohm twinlead, two antennas can be connected to the same lead-in to give satisfactory performance on the 60, 49, 41, 31, 25, 19, 16, 13, and 11 meter bands. This permits coverage of 9 of the 11 international broadcast bands with a single antenna. By tying the lead-ins together at the receiver and using an antenna tuner, this antenna becomes a longwire, making it probably the most versatile SW antenna available.

Another multiband antenna shown in Fig. 4C consists of two centerfed dipoles made from 300-ohm twinlead connected to the same feedline. This antenna has the advantage of being short (nice for small city lots, or apartment dwellers) and performs well on the 60, 49, 41, 25, 19, 16, 13, and 11 meter bands. Again, it can be connected as a longwire at the receiver and used with an antenna tuner.

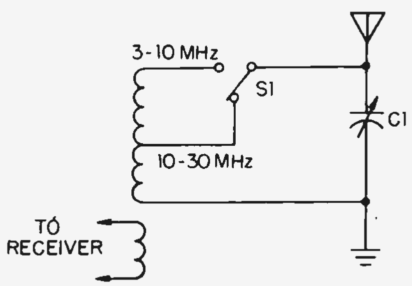
The circuit of a simple SWL antenna

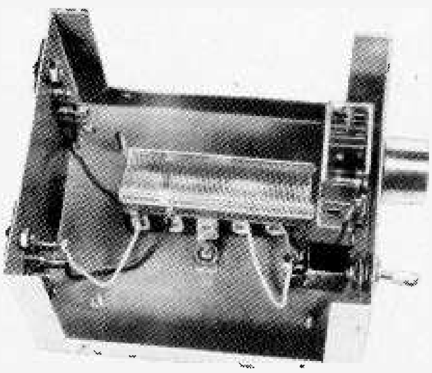
(Continued on page 102)

BUILD A SIMPLE SWL ANTENNA TUNER

Here's a simple antenna tuner any SWL can whip together in an evening and use for a lifetime. Neatness counts when monkeying with low level RF, so mimic the author's model for best results. Keep solder connections clean.

Fig. 5





C1—365-pF miniature variable capacitor

L1—31 turns/in., ⅝-in. diam. coil stock, B&W 3008, Air Dux 532T, etc.
Note: Measure coil and cut ½-in. from one end. Remove one turn in either direction. Measure ½-in. and solder tap to one turn (bend adjacent turns inward for access). Coil ends mount to terminal strip for stability.

S1—Spdt toggle switch

Misc.—2-lug terminal strips for antenna, ground and receiver connections, knobs, wire, solder, 3¼ x 2¼ x 4-in. cabinet, etc.

Both young and old radio buffs usually start out with a crystal set . . .

OATMEAL BOX CRYSTAL

Fig. 1
Sliding contacts made from brass and steel.

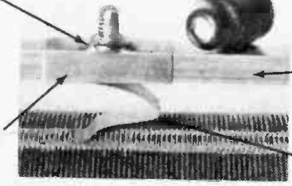
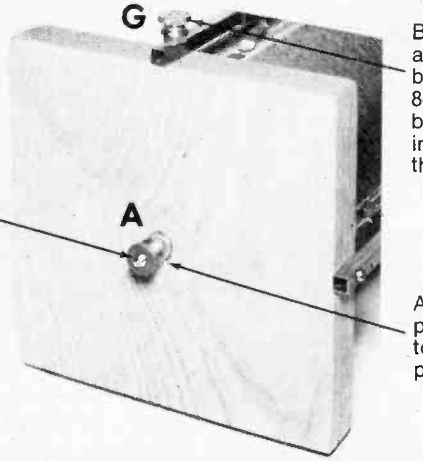


Fig. 2 **Antenna and ground end of the Quaker Oats radio.**



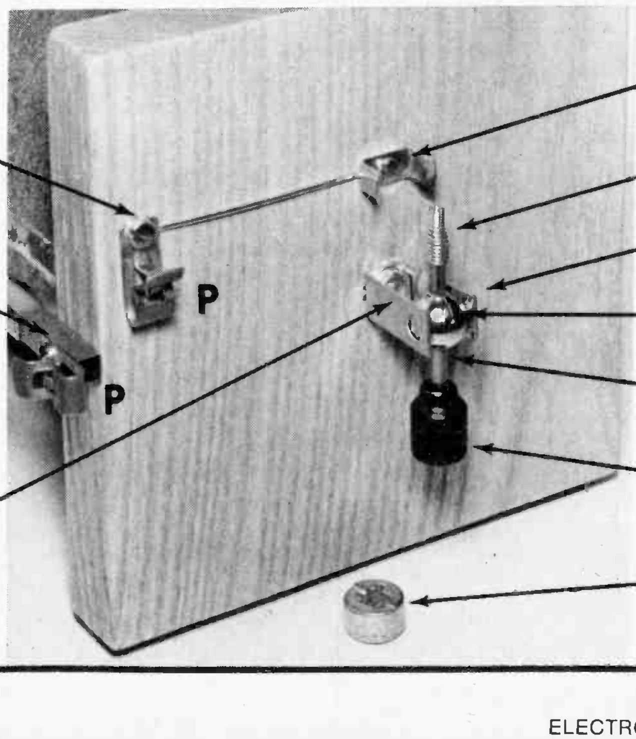
ASK JUST about any radio old-timer, including this writer, and he will probably tell you that his first radio was a home-brew slide tuning coil wound on an oatmeal box, a cat whisker and galena crystal detector, and a pair of earphones. This picture story shows how to make such a radio, and it looks much like the writer's first radio built not long after World War I.

First, make the coil. Remove the two end covers from an 18-ounce, round Quaker Oats box, and cut the tube to a length of about 6½-in. Give the tube a coat of shellac inside and out to moisture-proof it.

The writer used #21 single-cotton-covered enamelled copper magnet wire, and after the coil was wound the cotton was colored green by painting it with India ink to make it look like the old-time green silk-covered wire which is no longer being made. If you prefer, use #20 or #21 enamelled or nylon-coated copper magnet wire, and one pound should easily do it.

Get Going. Punch two small holes through the tube at each end, about ½-in. from the ends, to anchor the ends of your coil. To do a tight, smooth and neat job of winding the coil, tie the end

Fig. 3
Crystal detector end of the Quaker Oats radio.



if your "taste" dates to earlier days, try—

RADIO

by Art Trauffer

of the wire to some object outdoors where there is plenty of room, and unwind a couple hundred feet of wire, and pull the wire tight to stretch out any bends in the wire. Cut off the wire and anchor the end in the two small holes near one end of the tube, and dab a bit of cement to hold it fast. Now wind the coil by turning the tube slowly while you walk towards the tied end of the wire, and when the tube is full of wire cut off the wire and anchor the end in the two holes at the other end of the tube and put on a dab of cement. This trick will give you a neat professional-looking coil.

As shown in the photos, the two wood end blocks for the coil measure 5 x 5 x ¾-in. and are sanded smooth, stained, and varnished. The writer's first project used oak.

Bore a 3/16-in. hole through the exact center of each wood block; these are for the length of 8-32 threaded brass rod that passes through the coil and holds the wood end blocks. One end of the threaded rod holds the U-bracket of the crystal detector (Fig. 3), and the other end of the rod serves as the antenna binding post (Fig. 2).

Note in Fig. 2 that the end of the coil nearest to the antenna binding post passes through a small hole in the wood block and is clamped between the two washers of the antenna binding post; this automatically connects the coil end to the U-bracket of the crystal detector also.

Figs. 2 & 3 give details for mounting the slide rods, the earphone Fahnestock clips, the ground binding post, and the clamp that holds the galena crystal. The simple hook-up is shown in Fig. 4. Fig. 1 gives all details for making the two sliders that will contact the coil.

Contact. Perhaps the hardest job of all is to do a neat job of removing the insulation from the coil when making the two bare wire paths for the sliders. Use fine sandpaper and be careful not to sand off too much of the copper. When you are through brush away any fine copper dust between the turns of the wire. You will get a neater job if you use enamelled wire instead of cotton-covered wire.

For best results with this crystal radio, use a long antenna, a cold water pipe ground, a sensitive galena crystal, and a sensitive high-impedance pair of magnetic earphones. ■

Your basic materials may be the same, but the bucks required to buy them have certainly bounced upward from bygone days! It cost the editor 49¢ for this box which had four different prices on the top ranging from 49 up to 55¢.

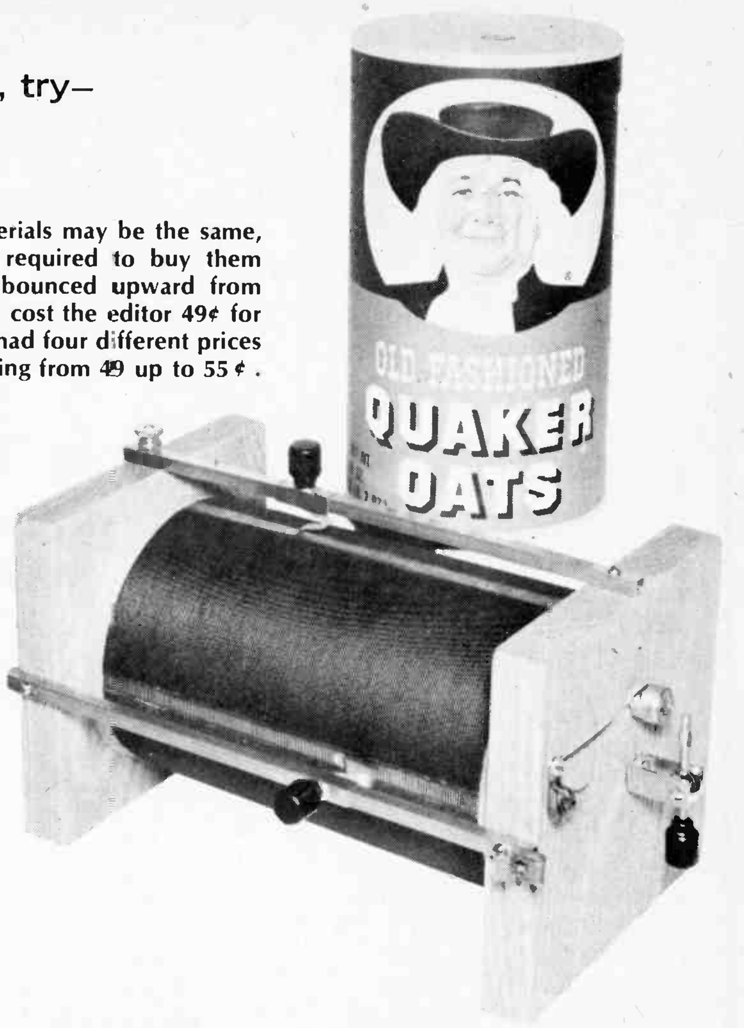
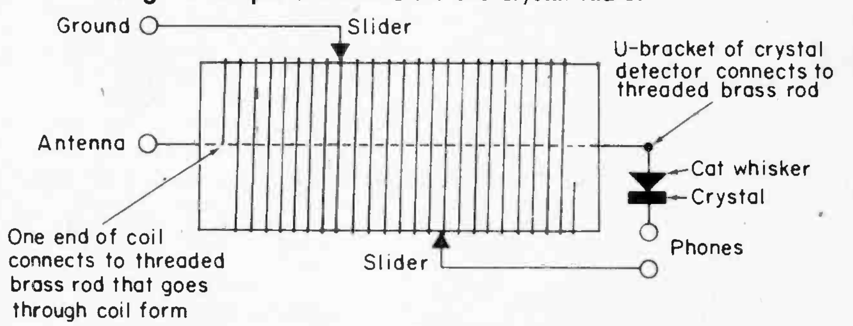


Fig. 4 Simple schematic for the crystal radio.



BILL OF MATERIALS FOR QUAKER OATS BOX CRYSTAL RADIO

1 round Quaker Oats box (18 oz.)
1 lb. #20 copper magnet wire, for winding coil (see text)
2 pieces 5-in. x 5-in. x ¾-in. oak, walnut, or mahogany (for coil end blocks)
1 foot of 8-32 threaded brass rod (to pass through coil form)
1 8-32 brass hex nut (holds crystal detector U-bracket to wood block)
2 12-in. lengths 7/32 OD square brass tubing or solid rod (for slider tracks)
3 ¾-in.-long round-head wood screws (hold brass rods to wood blocks)
1 8-32 x 1½-in. round-head brass machine screw, with hex nut and ornamental thumb nut to fit (for ground binding post)
3 inches of square brass tubing to fit snugly over slider rods (for making the two sliders)
2 6-32 x ¼-in. flat-head brass machine screws (to hold knobs to top of sliders)
3 inches ½-in.-wide brass band (for slider)
4 inches of ¼-in.-wide brass band (for making slider contact blades)
2 medium-size fahnestock clips (for phones binding posts)
1 ½-in. long flat-head wood screw (holds one fahnestock clip to wood block)
1 unmounted crystal detector stand (K/D Stand 9-14, Modern Radio Labs.)
1 mounted galena crystal for above detector stand (9-1 MRL Steel Galena, Modern Radio Labs., P.O. Box 1477, Garden Grove, CA 92642)
1 ½-in. long flat-head wood screw (holds crystal clamp to wood block)

Note: Those who do not have near-by hobby shops or large hardware stores can get most of the above hardware from MRL, P.O. Box 1477, Garden Grove, CA 92642. Send them 25¢ for a copy of their catalog.

RADIO HISTORY

by Art Trauffer

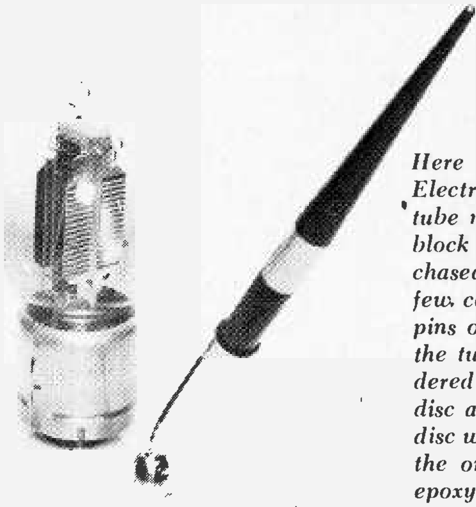
☐ Here are some ideas suggesting how to make novel pen sets that bring back fond memories to old-timers in wireless and radio. The pen sets also fascinate newcomers in radio and electronics, and they make nice gifts.

As shown in the illustrations, an early wireless or radio item such as a vacuum tube, crystal detector stand, or spark gap is mounted on a block of marble, onyx, or wood, and then a funnel and pen is added to complete the desk pen set.

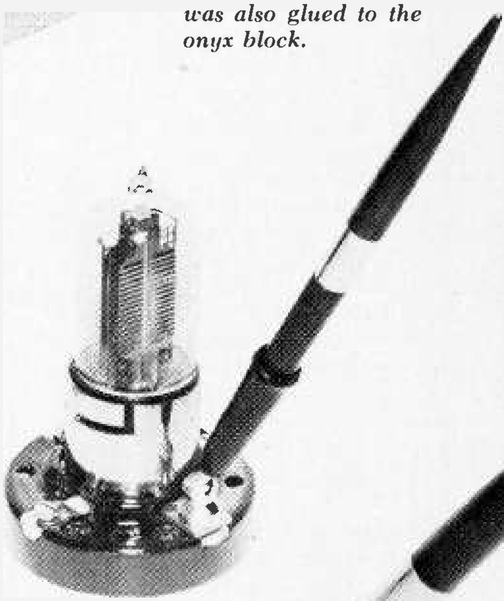
Old-timers in radio might want to use the crystal detector they made or bought for their first crystal set, or the first tube they used when they graduated to tube sets, or the spark gap they made or bought to use with their Ford spark coil transmitter. Newcomers in radio and electronics can purchase the above early items from antique radio collectors, or they can make their own crystal detector stands and spark gaps using the illustrations as guides.

Marble and onyx blocks can sometimes be found at sales, or they can be purchased from large electric lamp supplies firms, or from firms that make sports trophies. Funnels and pens can be purchased from the larger hobbies and crafts dealers. The table gives some purchasing tips.

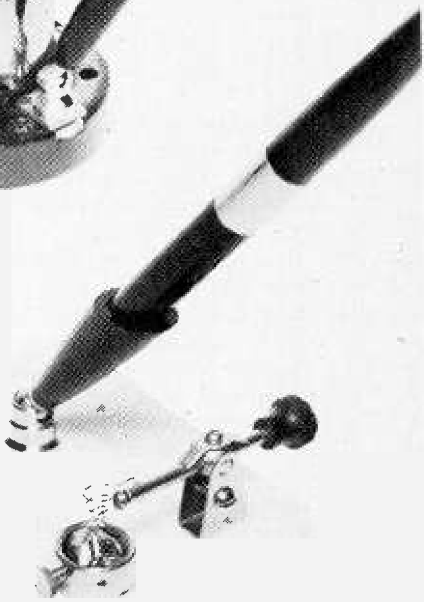
To mount items on marble and onyx blocks you can either drill holes using high-speed drills (at slow speeds), or masonry drills, or you can simply cement the items on the blocks using epoxy glue or the new industrial "wonder glues." ■



Here is a Western Electric 216-A triode tube mounted on a block of onyx purchased at a sale for a few cents. The four pins on the bottom of the tube base were soldered to a small brass disc and then the brass disc was cemented to the onyx block with epoxy glue. The ball joint of the pen funnel was also glued to the onyx block.



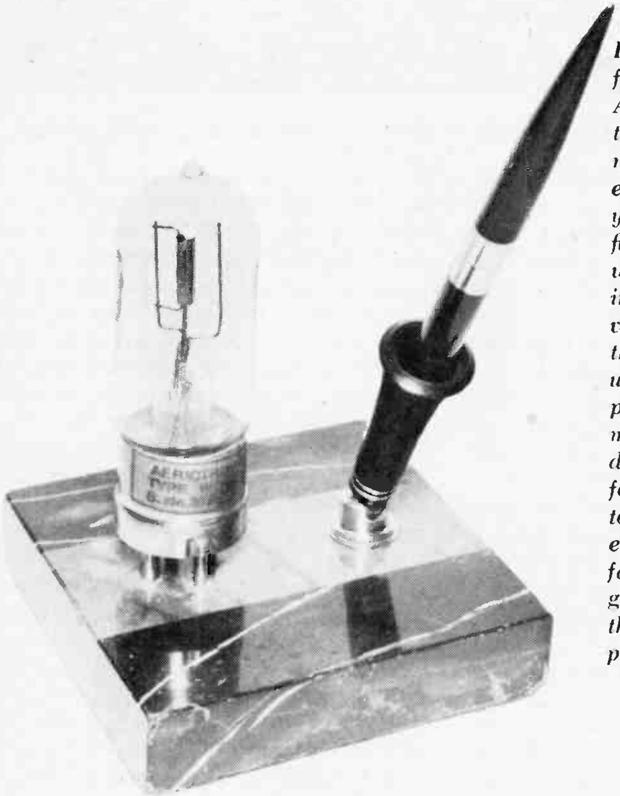
A novel pen set idea is a Western Electric 203-D triode (similar to a VT-1) mounted in an RCA UR-542 porcelain bayonet-type socket. One of the binding post screws was removed from the socket and a 6-32 x ¼ in. flat-head machine screw was passed through the hole to hold the ball joint of the pen funnel. If desired, you can cement the pen funnel to the socket using epoxy, or "miracle glue." Four small felt pads were added to the bottom of the socket.



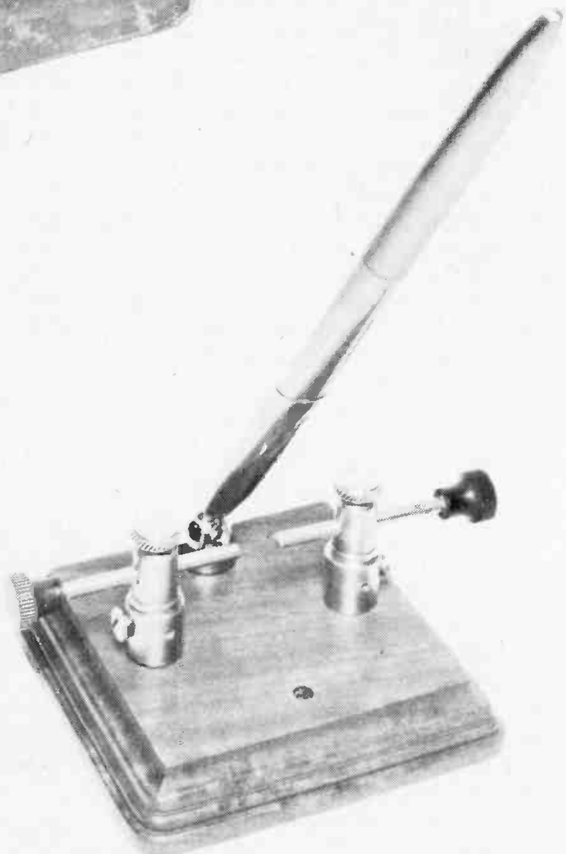
The author used a marble block removed from a discarded basketball trophy purchased for 75¢ at a Salvation Army store. The hole in the block was used for mounting a funnel and pen. The crystal detector parts were glued to the block with epoxy glue.

ON YOUR DESK

Bring back the days of "wireless" glory with these fascinating and useful souvenirs!



Here we have the famous Westinghouse Aeriotron (WD-11) triode tube which made a big hit in the early 1920s because you could heat the filament (1.1 volts) with a 1½-volt drycell instead of using a 6-volt storage battery. In this case, the author used a desk pen set purchased at a rummage sale for 50¢, and drilled four small holes for the tube base pins to fit in, and then used epoxy glue to hold it fast. Green felt was glued to the bottom of the marble to protect polished desk surfaces.



Here is a home-brew stationary spark gap, such as used in the early days of radio—known then as "wireless." Many of you old-timers will recall using a Ford Model-T spark coil to provide the high voltage for the spark! Assembly is easy. Simply pass a machine screw through one of the mounting holes in the base of the spark gap to hold the ball joint of the pen funnel. Glue felt to the bottom of the base to protect polished desk surfaces.

POSSIBLE SOURCES FOR DESK PEN SET MATERIALS

Marble and Onyx Blocks

Salvation Army, Goodwill Stores, auctions, rummage sales

Gilbert & Miller, Inc., 239 New Main St., Yonkers, NY 10701. (This company supplies marble and onyx blocks, as well as pens and pen funnels. Write for catalog.)

Pens and Pen Funnels

Gilbert & Miller, Inc. (see address above) Large hobbies and crafts supplies stores

Green Felt

Notions and yard goods departments of department stores

Early Vacuum Tubes

Antique radio collectors (The following two antique radio newsletters also might be helpful: Antique Radio Topics, published by Antique Radio Press, P.O. Box 42, Rossville, IN 46065—50¢; and The Horn Speaker, published by Cranshaw Publications, P.O. Box 12, Kleberg, TX 75145—also 50¢.)

Watch ads in Collectors News, Antique Trader, etc. for antique radio collectors and dealers wanting to sell early radio vacuum tubes.

Crystal Detector Stands

Modern Radio Labs., 1477-G, Garden Grove, CA 92642

Bill Baker, Route 3, Box 1134, Troutdale, OR 97060 has some Kilbourne & Clark crystal detector stands (circa early 1920s) to sell. Write him for prices.

Crystals

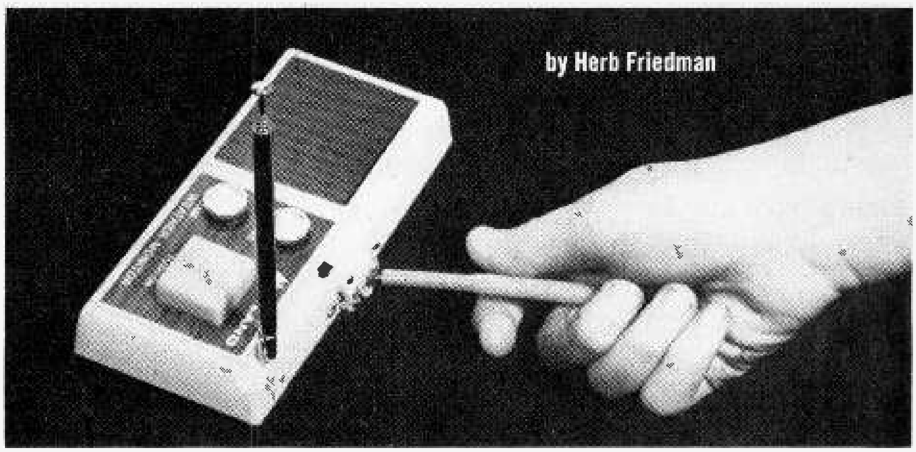
Modern Radio Labs. (see address above) sells various types of crystals. Write for details and prices

Art Trauffer, 120 Fourth Street, Council Bluffs, IA 51501 sells genuine MPM (Million Point Mineral) unmounted galena crystals in original factory boxes (circa early 1920s) at 50¢ each, plus postage.

Spark Gaps

Buy from antique radio collectors and dealers.

ROCK BOTTOM COST HIGH BAND MONITOR



by Herb Friedman

Getting bored by the temp-humidity index? Slide an inexpensive weather monitor up or down for some exciting signal hunting!

BECAUSE they're priced so low, generally from $10 to $20, the "weather monitor" has been a hot gift item for the electronics experimenter, so you probably have one. Tuning the weather station frequencies of 162.40 and/or 162.55 MHz, these small, inexpensive radios are supposed to keep you up to date on the latest weather conditions. But as you've probably discovered yourself, unless you're a boat owner with need for tide and sea conditions, you get a more up-to-date report from your local news station—AM or FM.

Also, reception is probably not all that great. The recommended receiver sensitivity for weather station reception is 0.6 uV for a 50-mile range, and these inexpensive weather receivers can't get anywhere near this kind of sensitivity.

But there's no need to let an unused weather receiver sit on the shelf. Fortunately, very few models use crystal control tuning, and they are easily converted to a police or fire monitor, or even a sound channel receiver for the higher VHF TV stations. But remember, there won't be any super-sensitivity. TV stations might be received some 30 or 40 miles from the transmitter, but you'll have to be within 2 miles or so of the average police or fire transmitter to pick them up. If you live near an airport you might get coverage of the aircraft frequencies above 108 MHz, but with sharply reduced sensitivity.

The weather monitors are generally similar in electronic design, though the packaging might be anything from a cube to a desk-top pen holder. The circuits are bare-minimum superhet receivers with a local oscillator tuned over a limited range by a panel control. Generally, there are two panel controls, one for *volume* and one for *fine tuning*. The fine tuning knob might have calibrations for *both* weather frequencies, or no calibration at all. It doesn't make any difference as long as the local oscillator is tunable.

To change the weather monitor tuning range, all you need do is connect a small external trimmer capacitor across the oscillator tuning capacitor—the fine tuning control. The value of capacitor will determine which frequencies are tuned. Keep in mind that as you tune lower in frequency the sensitivity is sharply reduced, particularly below about 160 MHz. A capacitor with a maximum value of 7 pF will get you down to the police/fire frequencies. A 60 pF maximum trimmer will get you about to the top of the FM band, but tuning will be extremely critical and sensitivity will be very low.

A 60 pF trimmer will also get you some of the TV sound carriers above 162 MHz. How can you receive signals above 162 MHz if the tuning range is lowered? Simple. The harmonics of the local oscillator are used to receive the TV stations. For example, if you lower the monitor's oscillator to, say, 100 MHz, the oscillator's harmonic output is also 200 MHz, and a very weak 300 MHz. (The monitor's front end appears to pass the frequencies above the design-range, 162 MHz, with greater sensitivity than lower frequencies.)

Tear It Down. To experiment you must first get the circuit out of its cabinet. Keep in mind these weather monitors are inexpensive and designed to be assembled quickly by unskilled workers. Don't go looking for tricky or difficult assembly sub-systems. Generally, one or two screws are all that's holding the cabinet together. If necessary, unsolder the speaker wires, battery wires and on-off switch wires, and remove the circuit board from the cabinet. Locate the trimmer capacitor used for the fine tuning and its two solder terminals. Solder a 3-in. length of solid, insulated wire to each terminal.

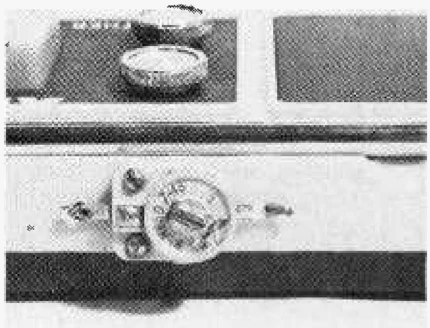
Check how the board fits the cabinet and mark the outside of the cabinet nearest the fine tuning. Drill two small holes at the mark and then install a trimmer capacitor on the cabinet near the holes. Or, you don't have to secure the trimmer if you feel you will experiment with different capacitor values, but it will be difficult to tune the stations with a "floating" trimmer. You can't hand-hold the trimmer because the capacitance from your hand will affect the tuning adjustments.

Slip the wires from the fine tuning control through the holes you've drilled in the cabinet and seat the circuit board. Then reassemble the monitor.

Connect the wires protruding through the cabinet to the trimmer capacitor using the shortest possible leads (cut off the excess).

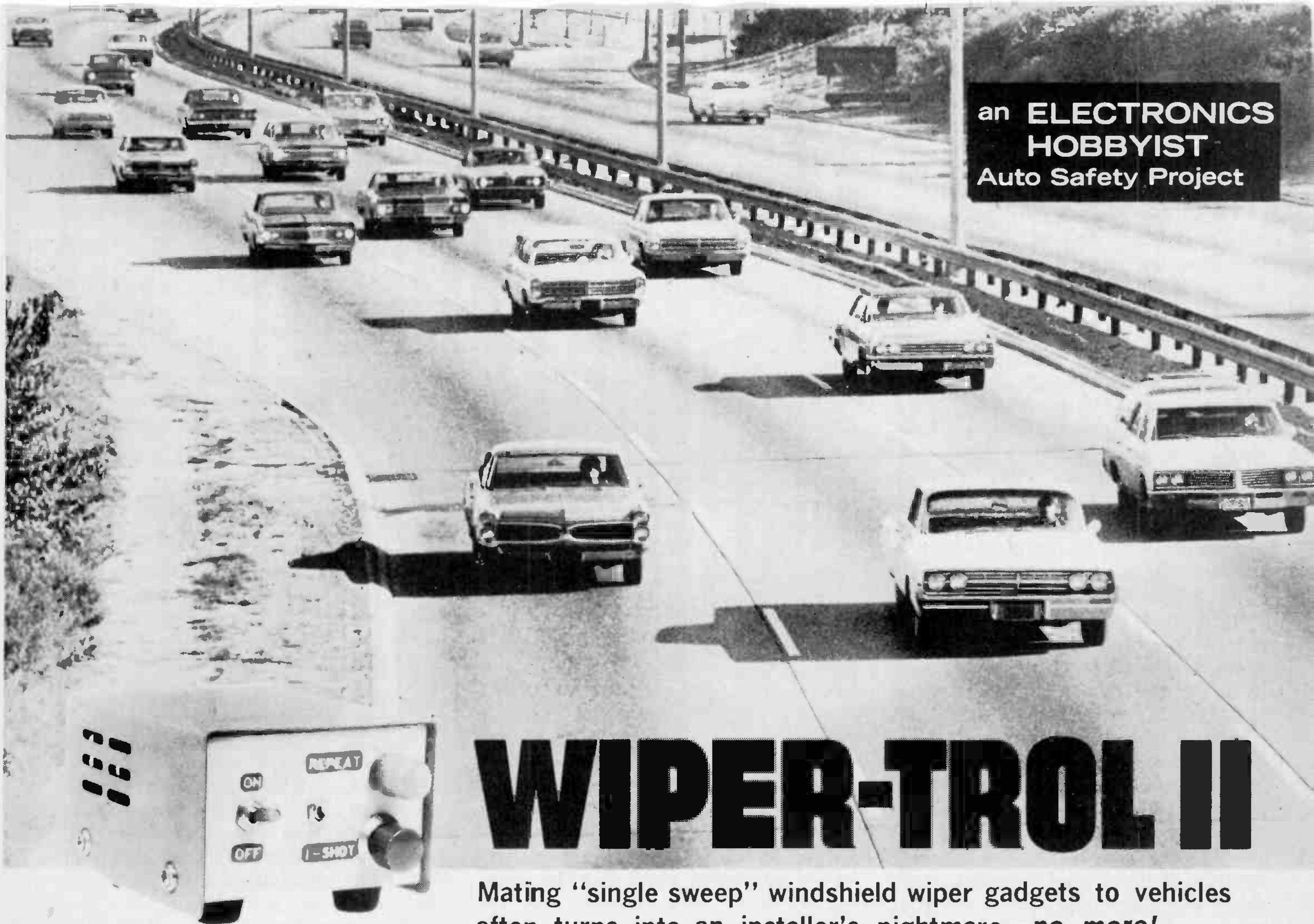
That's the whole bit. Use an insulated alignment-type screwdriver to adjust the trimmer. You'll probably be able to tune a few TV stations immediately. Tuning police/fire calls or anything else will be more difficult because transmissions in these services are short and fast. You can preset the tuning by using a signal generator or a well calibrated grid dip oscillator.

Remember, this is a fun project. Don't hope for more than acceptable reception. But then who knows, you might be able to tune your favorite TV channel and keep track of the program while working in your shop. ■



Install a small trimmer on the cabinet at a point just outside the internal trimmer.

an ELECTRONICS HOBBYIST
Auto Safety Project



WIPER-TROL II

Mating "single sweep" windshield wiper gadgets to vehicles often turns into an installer's nightmare—*no more!*

by Felix Peterson

WHAT'S IN COMMON with all these vehicles (besides Middle East oil)? Wrong! It's not that they're out of gas, it's simply that until now, the very popular wiper delay function which helps keep windshields clean in a drizzle or winter slush has given many auto buffs, hobbyists and commuters a rough time.

So many different windshield wiper systems are used on so many different cars and trucks that no one wiper delay system has been right for everyone. A control system that worked in a '68 "Belchfire 8" might send its SCR or transistor up in a puff of smoke when connected to a new "Mini 4-Banger."

Yet the popularity of these add-on gadgets grows and prospers. Big names and small list wiper delay units in their catalogs and ads. There's no doubt that drivers want to build a project that gives the convenience of a single-flick automatic windshield wiper. That's why we're here, and e/e likes a challenge, so we put an author's head together with ours and came up with the ideal wiper delay project.

Why It's Best. If this system is not for your car, or if your car and you refuse to get together with a workable installation, you will know it *before* you sink valuable bucks and construction time into the project. We show you how to check your car, truck, motorhome, Henry J, or anything that has electrically operated wipers to be sure Wiper-trol II will work—*before you build it.*

Interested? Read on.

Basic Operation. In virtually all cars, turning on the wiper switch momentarily will cause the wipers to sweep once, then return to their park position. The operation of the wiper unit described here is simply equivalent to turning the wiper switch on then off. A 555-type timer controls the opening and closing of relay contacts which are connected in such a way as to simulate turning the dashboard switch on and off. The time interval between wipes can be varied, and the unit does not interfere with normal operation of the wipers.

There are other wiper control units available, but one has to buy them before he can find out if they work on his car. Another problem with existing units is that some do not park the wipers after each sweep. Eventually the wipers can stop in the middle of the windshield. This happens when the rain lets up and there is more drag on the wipers, or when the car is stopped at a traffic light and the wiper motor slows down due to drain on the battery. In contrast, the wiper control presented here causes the blades to return to exactly their park position after each sweep.

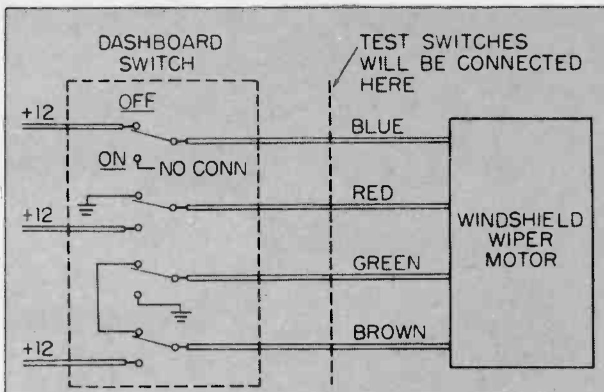
There are two other useful features of this wiper unit. It has a button for one-shot operation of the wipers, and during installation it can be adjusted to give two sweeps for each kick of the motor instead of one.

Before You Build. The object here is to determine whether Wiper-Trol II will work on your car before you build it. Some *dpdt* switches (such as Radio Shack 275-1537) are used because they are more convenient than *spdt*. While car wiper circuits vary a great deal, most run four wires to the motor; therefore, the test described here will assume four wires. If your wiper motor has more wires, just use more switches. This will correspond to another relay in the control box. If your wiper motor and washer pump are housed together, use only the wires to the wiper motor.

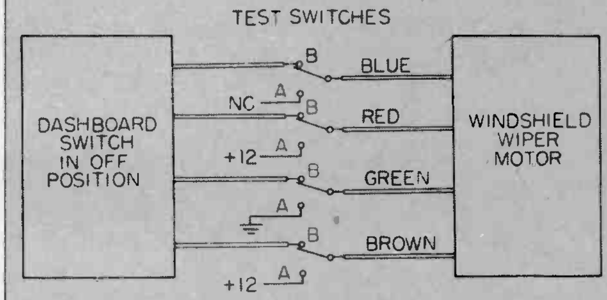
WIPER-TROL II

There are two ways to determine how to connect the *dpdt* test switches into your car wiper circuit. One is to have a schematic for your car which shows the inside workings of the wiper dashboard switch. The other is to determine the inside workings of the dashboard switch through a tracing procedure described later.

Let us first suppose you have a schematic. The figure shows a typical wiring arrangement (in this case, a Chrysler wiper). For low speed operation, the dash switch connects the red and brown wires to the car battery + terminal. Equally important, however, is the fact that the blue is connected to nothing for low speed, and the green is grounded. Your test switches would be connected as shown in the next figure. With the dash switch off, and the test switches at position A, the wipers should sweep. More important, however, with the test switches returned to B, the wipers should go to their park position because the dash switch is turned off. If the test works, the test switches can be replaced with the relay contacts of the control unit with confidence that the unit will work on your car.



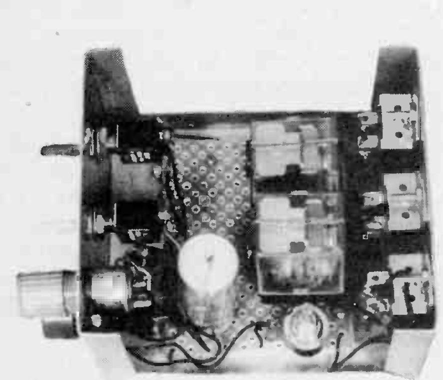
This example of actual windshield wiper wiring is for a 3-speed Chrysler Corporation system. It is shown in the low speed position. While not entirely necessary in all cases, it is nonetheless a good idea to have a copy of your windshield wiper wiring diagram.



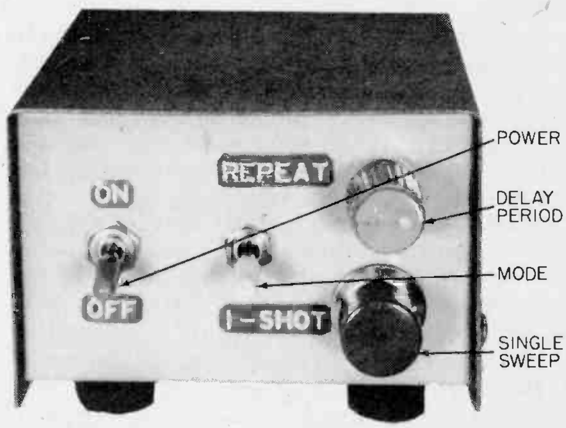
To fully insure your success before you build this wiper delay device, connect inexpensive toggle switches to test the wiper delay technique. You simulate the operation of Wiper-Trol II by throwing both switches at the same time to confirm your hook-up.

Finding Data. Wiring diagrams that show the operation of the dash switch can sometimes be found in the car's manual. Some manuals come with the car, others can be obtained from car dealers or the library. Several books of value are listed at the end of this article. These can be found in most public libraries. The Chilton's Manual has a specific section on wiper circuits. There is detailed information in it for American Motors, Chrysler, Ford, and General Motors wiper circuits and switches. The Volvo manual also shows switch details. The National books do not contain switch details, but have numerous wiring diagrams which can be quite useful.

If a diagram for your dash switch can not be found, a tracing scheme shown in the figure may be used to find out how to connect the test switches. The + battery lead is disconnected (for positive ground cars, disconnect the negative lead) and the ignition switch and wiper dash switch are both turned on. The wires to the motor are disconnected at the motor. Generally, there is a connector at the motor that can just be unplugged. Now sketch a table like that shown, with the first column containing the color of each of the wires, and the second column blank. The object now is to find what each wire coming from the switch side (denoted "S") is connected to, and write the data in the second column of the table. One ohmmeter lead is connected to an "S" wire, the other is connected to the + battery lead, then to the chassis, then to each of the other "S" wires. In this way, for example, one finds that the brown "S" wire is connected to the + battery lead, and the green "S" wire is connected to nothing. To conduct this test, one should have an ohmmeter that can distinguish between a direct connection, and a connection through a resistance of about five ohms. Some dash switches have resistors between



Relay coils are wired in parallel to operate in unison since more contact pairs are required than are conveniently available in an easy-to-find relay. One coil draws 50 mA.



Perhaps the most interesting and clever feature of the Wiper-Trol II is the single sweep (1-shot) mode. Should you accidentally fail to turn the power off, the wiper will single-sweep 10 minutes after the last push of the button to improve your mind.

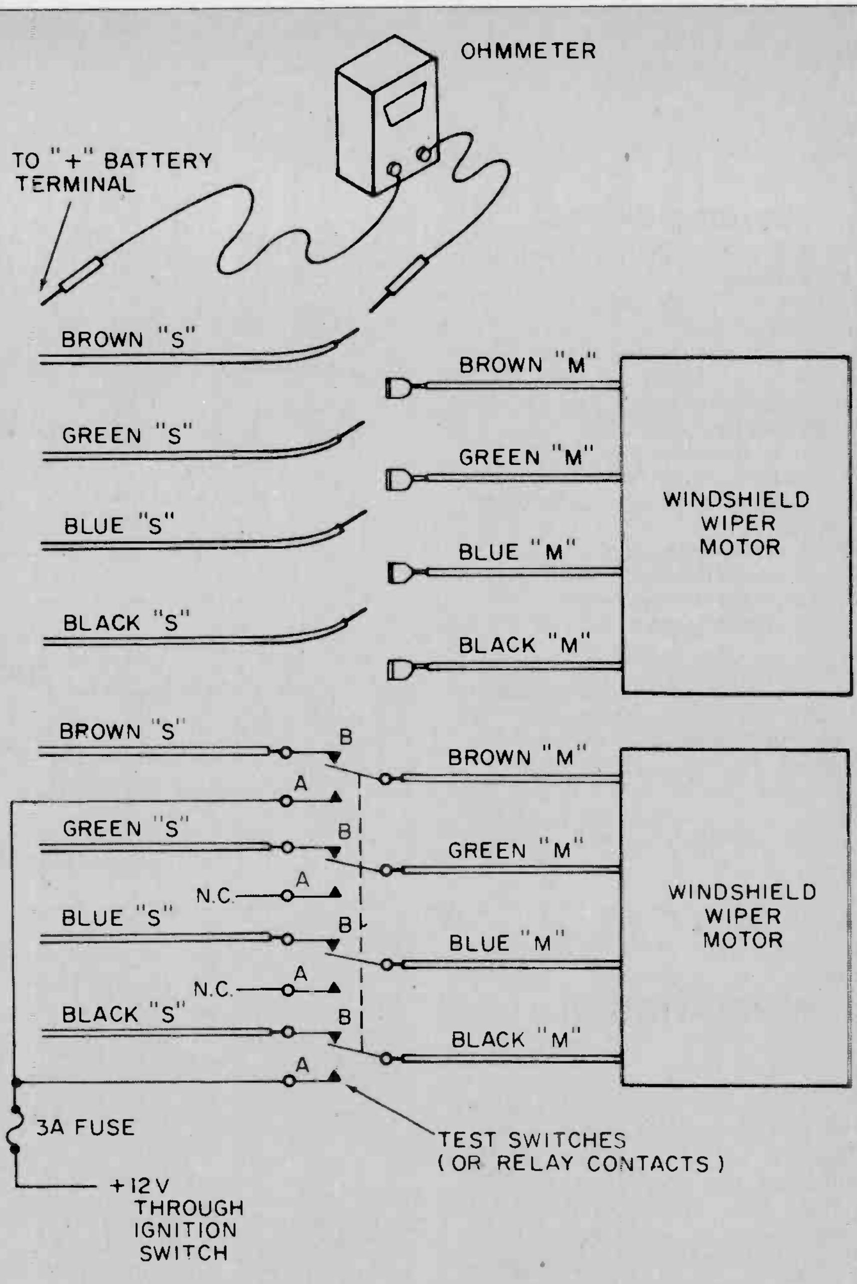
their terminals, and can make it appear at first glance that one "S" wire is connected to two different points, when there may actually be a resistor between the "S" wire and one of the points.

After the table is filled-in, the test switches can be tried, also as illustrated in the figure. Once the switches have been connected, the car battery is reconnected and the ignition switch is placed in the on position, but the car engine should not be running. If placing the switches in the A position sweeps the wipers, and placing them in the B position causes the wipers to park, the control unit will work when the test switches are replaced with the relay contacts.

Other Hints. For those cars with relays built into the wiper circuitry, as on some GM cars, the wiper control unit can still work well, but the test procedure described above is best performed with a car wiring diagram in hand so that you are sure to trace connections *through the dash switch* and not through the car relay. Again, a GM or Chilton Manual can be very useful here. Also, remember that an improper trace may cause some sparks to fly when the test switches are closed—so be prepared to open them quickly. A 3 amp fuse in the power lead to the relay contacts should prevent damage. The test switches should be operated simultaneously, and all leads to them should be double-checked before the experiment is tried. If the test switches do not operate the wipers, check the switches themselves, check your wiring and tracing, and, finally, try getting a description of the dashboard switch from the library, a bookstore, or car service center. This may be the challenging do-it-yourself part.

As can be seen from the schematic, it requires only one IC and a handful of other components. The final assembly fits on a 3 x 3-in. perf board, and inside a small (3 x 2 x 4-in.) cabinet. Power to the IC should come through the ignition switch and S1, which is on the front of the control box. Switch S2 allows the unit to operate in a repeat mode, or a one-shot only mode. In the one-shot mode, the wipers can be kicked at will with a touch of pushbutton S3. With S2 in the one-shot position, R1 causes the wipers to sweep once every ten minutes as a reminder that power is on. In the repeat mode, the wipers are kicked by relays K1 and K2 at intervals determined by R3 which is mounted on the front panel of the control box. The repeat mode allows one-shot operation as well.

Set-Up. Resistor R5 is important be-



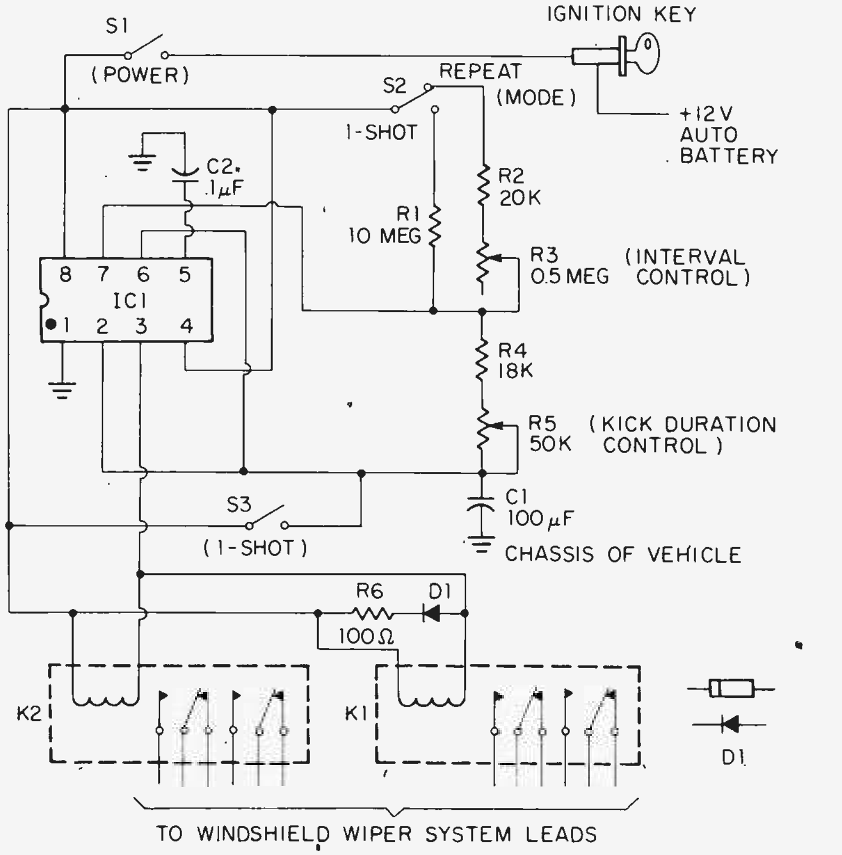
	WINDSHIELD WIPER SWITCH ON (LOW SPEED)
BROWN "S" CONNECTED TO →	+ BATTERY LEAD
GREEN "S" CONNECTED TO →	NOTHING
BLUE "S" CONNECTED TO →	NOTHING
BLACK "S" CONNECTED TO →	+ BATTERY LEAD

Example of how you determine if Wiper-Trol II is right for your vehicle. Simply disconnect battery lead, turn on ignition and wiper control, use ohmmeter to fill in the table. This example is for 1973-1974 Volvo cars.

PARTS LIST FOR WIPER-TROL II

C1—100-uF, 35-VDC electrolytic capacitor
C2—0.1-uF capacitor
D1—1-amp, 50-PIV silicon diode
IC1—555-type timer IC
K1, K2—dpdt relay, 3-amp contacts, 12-VDC coil
R1—10-meg., ½-watt resistor
R2—20,000-ohm, ½-watt resistor
R3—0.5-meg. linear taper potentiometer
R4—18,000-ohm, ½-watt resistor
R5—50-000-ohm linear taper potentiometer, PC type
R6—100-ohm, ½-watt resistor
S1—spst subminiature toggle switch
S2—spdt subminiature toggle switch
S3—spst pushbutton switch

Misc.—perf board, hardware, case approx. 3 x 2 x 4-in., 3 amp fuse and dpdt switches for testing (see text), 4-pin chassis connector and mate (optional, see text), wire, solder, etc.



WIPER-TROL II

cause it allows you to adjust the duration of kick that is best suited to your car, but it is located inside the control box because the adjustment need be made only once. The figure shows that the kick duration is adjustable from 1.3 to 4.8 seconds, and the interval between "sweeps" is adjustable from 3 seconds to 50 seconds. Adjusting the kick duration to be a bit long (around 4-5 seconds) will cause the wiper to sweep twice before parking, thereby drying the windshield just a little bit better.

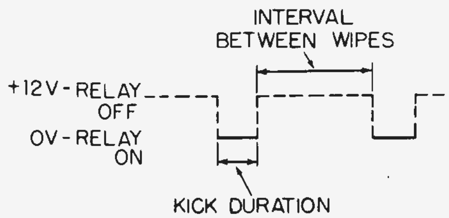
Relays K1 and K2 have *dpdt* contacts, but a *4pdt* relay may be used instead. The contacts must be of the break-before-make type, and should be rated for at least 3 amps, as should the wires connecting them to the wiper motor. Chassis connectors (female) are convenient for handling wires from the

References

Chilton's Auto Repair Manual, 1974, Chilton Book Co., Radnor, PA

Volvo Service and Repair Handbook, Clymer Publications, Los Angeles, CA

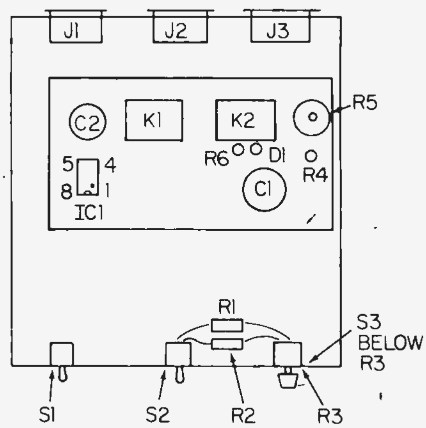
National Service Data, 1974, Mitchell Manuals, Inc., San Diego, CA



For the math-minded, relay-on "kick duration" time equals 0.7 (R4 + R5) C1 and is 1.3 to 4.8 seconds in duration. Interval between "kicks" is equal to 0.7 (R2 + R3 + R4 + R5) C1 and varies with R3 from three seconds to fifty seconds. Waveform is output of 555-type timer Pin 3.

relay contacts. One arrangement is to run all normally closed contacts to connector 1, the center poles to connector 2, and the normally open contacts to connector 3. This places all wiper motor wires on one incoming male connector, and all switch wires on another, thereby making installation straight-forward. This method was used in the author's model.

Another relay may be added in parallel with K1 and K2 if more contacts are needed; up to 150 mA may be drawn by the coils without harming the 555. Power connected to the contacts can come from the ignition switch to

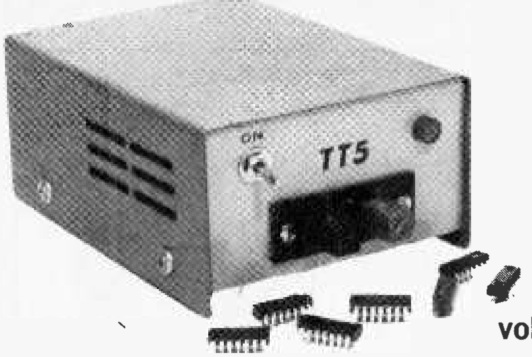


Typical layout of parts on perf board.

be sure wiper motor power is off when the car is unattended (when the ignition switch is off).

Trouble Shooting. If the unit fails to properly operate the wiper motor even though testing with the *dpdt* switches was successful, there can be only a few simple reasons for the cause. Check to see that the 555 operates the relay coils, that the wiring to the wiper motor is correct, and that the relay contacts all open and close properly.

There it is—a do-it-yourself wiper control that lets you drive with both hands on the wheel while it does the clean windshield bit! ■



Hobbyist Power Supply For TTL

TTL-type digital integrated circuits require a steady 5 volts for superior operation. Get ready for TTL projects with this ultra-simple, high performance regulator.

by Herb Friedman

ELECTRONICS is going digital! Not only are space TV photos relayed by digital techniques, but inter-country TV sound across the big pond (Europe) uses bits to represent audio. Right here in the U.S. we find TV receivers and FM tuners are "going digital." Even hobby projects such as you'll find here in e/e are using digital ICs.

The 7400 series of digital ICs is presently the most popular digital device "family," primarily because of its rock-bottom cost and easy handling; and it is more than likely that many hobby or experimenter projects you're going to run across in the next year or so will use the 7400 series of TTL (Transistor Transistor Logic).

The only problem is that TTL almost always requires a tightly regulated 5-volt power supply, and take careful note of those words *tightly regulated.* Often, the 7400-series device will instantly "blow" if 6 volts or a line transient is applied. The margin for error when working with TTL is essentially zero. While a zener diode can be used to provide, say, 5.1 volts, they are not easy for the average experimenter to find, nor do they necessarily provide protection against line voltage transients or short circuit protection.

What's needed is a full voltage regulator having both current and short circuit protection. Should the supply run hot due to excess current drain, or should a wiring error or breakdown in the external circuit short-out the power supply, the supply will automatically turn off, thus protecting both the power supply components and the connected circuit.

While you can always use a handful of components to build a 5-volt regulated supply for TTL—assuming you could possibly find the necessary components in your area—it's much easier to use a LM-309K, a single IC that contains *all* the components of a power supply regulator in a standard TO-3 case. Best of all, the LM-309K can be purchased locally for about $2.50; and that's probably less than the cost of discrete components if you decided to build from scratch.

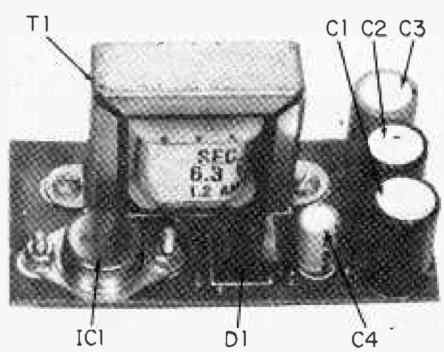
Inside Look. The LM-309K 5-Volt Regulator is available from many surplus dealers and Radio Shack. Mounted on a PC (printed circuit) or perfboard, it can safely deliver up to 1 ampere. Mounted on a heat sink you can squeeze out 3 amperes. The LM-309K gives the average experimenter everything he's looking for in a TTL power supply: tight regulation, transient protection, thermal shutdown, and short circuit turn-off.

A typical TTL 5-volt supply using the LM-309K that's suitable for the experimenter is shown. It's a rather easy circuit to build and provides 5 volts at up to 1 ampere with the IC mounted on a PC board. If you want to avoid the fuss and bother of making your own PC board, you can use a pre-drilled factory-made board which we'll describe later.

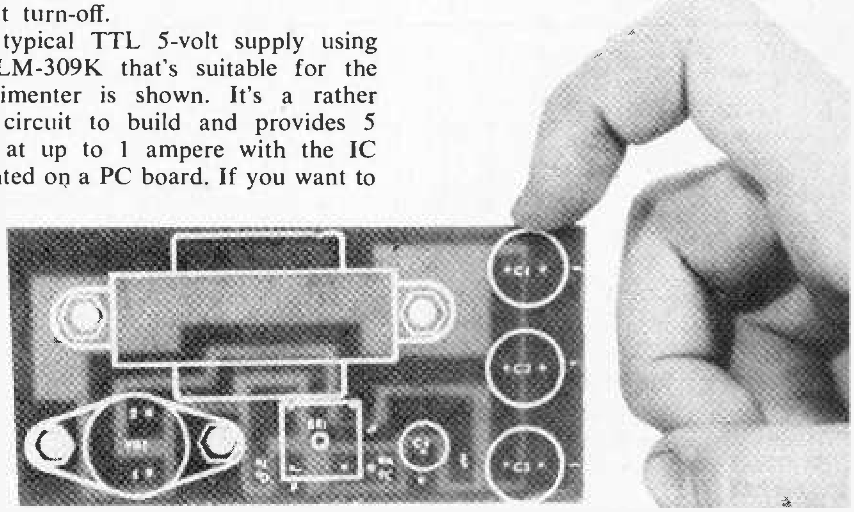
Transformer T1 is an ordinary 6.3-volt filament transformer rated at least 1 ampere. Capacitors C1, C2, and C3 can be replaced with a single 3000-*u*F unit rated at least 15 volts, but you'll find it much easier to locate three 1000-*u*F capacitors. Diode bridge D1 should be rated 5 to 6 amperes to handle the peak current load of the heavy filtering (C1, C2, C3). Do not try to get by with a 1-ampere bridge rectifier.

Capacitor C4 provides a low power supply impedance to the connected circuit; do not eliminate C4. Also, pilot lamp I1 should not be eliminated or its position in the circuit changed because it is used to discharge C4 when the power supply is turned off. Without I1 C4 might retain a charge for several minutes after the 117 VAC input power has been removed and can cause headaches and grief. When? Suppose you connect up your project thinking there's no voltage from a supply that's turned off!

To insure long life, and since the



The completed supply ready for installation in a cabinet or project. Pilot lamp I1, which also serves to discharge the output capacitor, is not part of the PC board assembly.



Easiest way to build the power supply is to use this Radio Shack PC board. All holes are pre-drilled and the component positions are "screened" on the top side. Backlighting shows the heavy copper foil showing through; it means customization without fear of damage to the foil strips.

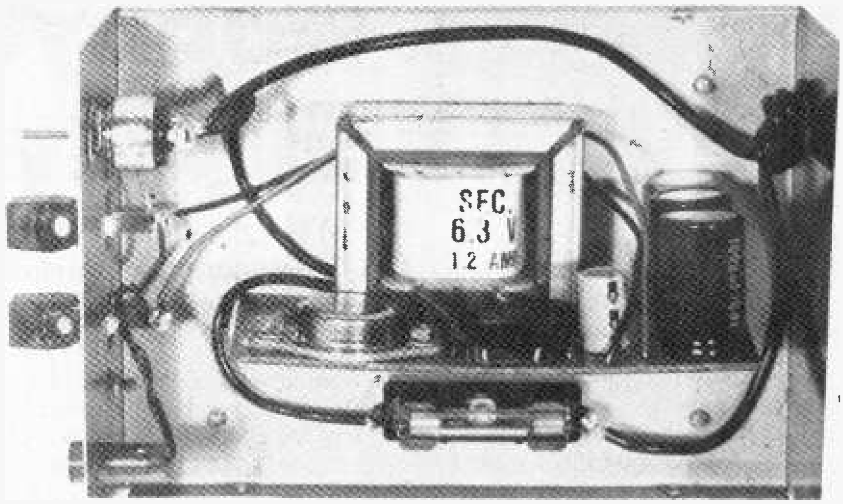
pilot lamp doesn't have to be bright enough to read by, I1 is a 12 volt/25 mA lamp—one of those miniature pilot assemblies that comes with attached leads. Connected to 5 volts, it's bright enough to see even in sunlight.

The supply shown in the photographs is assembled on a factory pre-drilled PC board available from Radio Shack for $1.49. The top side has the component locations screened in white paint. While the transformer mounting holes are spaced for the Radio Shack 273-050 6.3-volt filament transformer, you can, however, use any rated transformer although you may have to drill new holes. A rear-lighted photograph shows the extra-wide copper foil that permits easy customizing of the PC board.

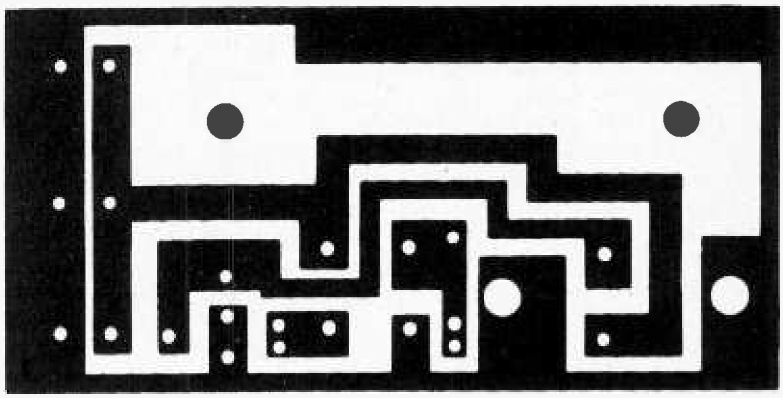
More Data. The instructions supplied with the Radio Shack PC board indicate a different pilot lamp connection than shown in our schematic. For this supply do not follow the Radio Shack connections; install the pilot lamp exactly as indicated in our schematic.

The entire supply—except for power switch S1, pilot lamp I1, and fuse F1—is on the PC board which you can install in any type of cabinet. The complete supply shown uses a 4 x 2⅜ x 6-in. metal cabinet, with the PC board end mounted by L brackets fashioned from scrap aluminum. The fuse holder is mounted on the base of the cabinet. Output is from two spring-loaded pushbutton terminals, but you can substitute 5-way binding posts or any other output connections you prefer.

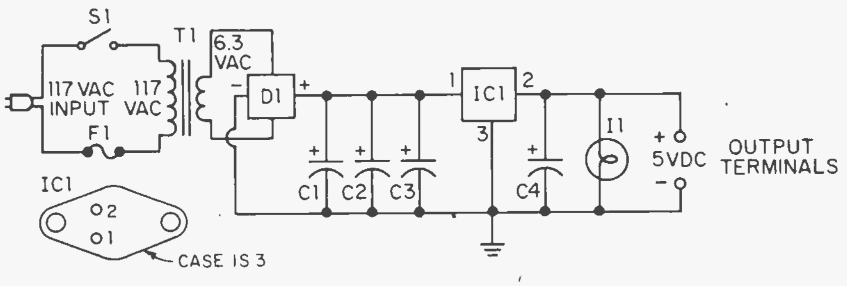
Fuse F1 can be anything from ⅛ to ¼ ampere. Use a standard fuse such as 3AG—not a slow-blow type.



Just one example of a suitable cabinet installation, though any layout will work. The fuseholder is mounted on the cabinet base, while pilot lamp I1 is connected directly across the output binding posts. An old plastic cap was used to give the base lamp a professional appearance.



This is the copper side of your circuit board drawn to its correct size. You can purchase it preetched and drilled, or place carbon paper on a copper clad board, trace the outline onto the board, and use etching solution to make your own board.



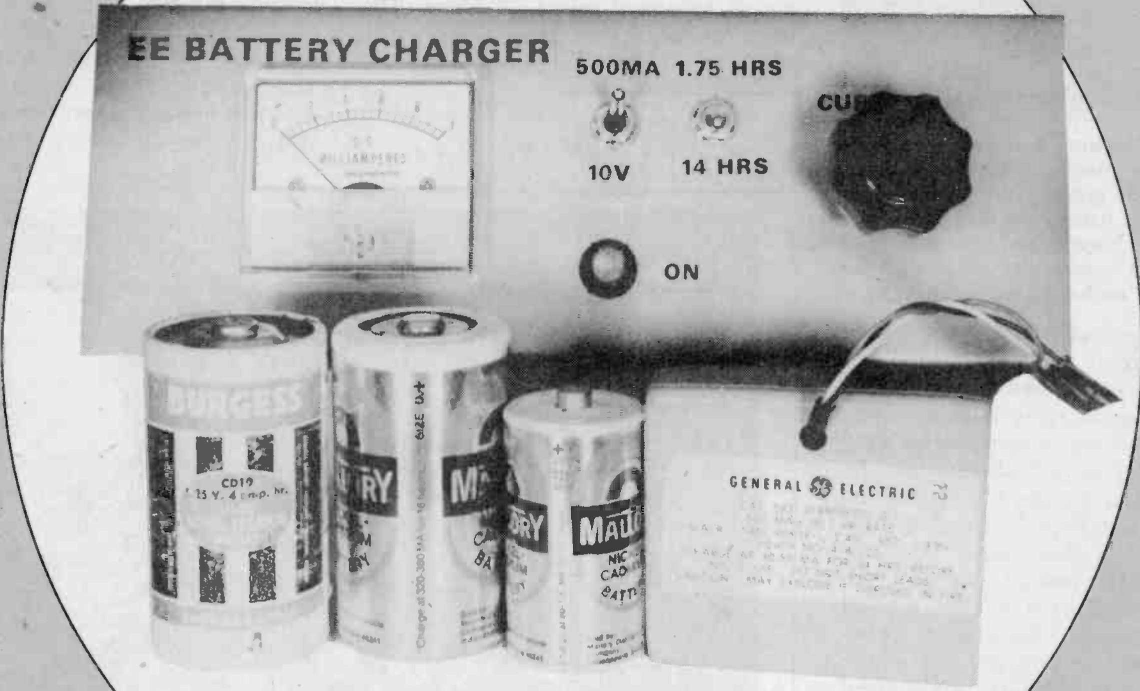
PARTS LIST FOR TTL POWER SUPPLY

C1, C2, C3—1000-uF, 15-VDC or higher electrolytic capacitor, see text
C4—100-uF, 15-VDC or higher electrolytic capacitor
D1—50-volt, 6-amp diode bridge rectifier
F1—¼-amp fuse, fast-acting
I1—12-volt, 25-mA pilot lamp, see text
IC1—LM-309K IC voltage regulator (National Semiconductor Corp.)
S1—spst switch
T1—6.3-VAC, 1-amp or better transformer
Misc.—cabinet, fuse holder, pushbutton or other type terminals, circuit board (optional), wire, solder, hardware, etc.

Too Hot. If the last things you solder are the IC terminals, let everything cool down before you check out the supply. If IC1 is excessively hot—from soldering heat—the automatic thermal protection shuts down the output and you won't get any output voltage. A meter connected across the output terminals will indicate zero. After you are certain IC is cool, measure the output; it should be 5 volts. Next, connect your voltmeter across either C1, C2, or C3, then short circuit the output terminals. If you have assembled everything correctly the meter will indicate approximately 10 volts even though the output is shorted. After the short is removed you should read 5 volts at the output terminals.

The only thing to keep in mind when using this TTL 5-volt supply is that the output current is automatically limited to 1 ampere. ■

SUPERCHARGER



Build this wide range NiCad battery charger with built-in automatic cut-off timer!

by C. R. Lewart

PROLIFERATION of portable electronic gadgets such as calculators, tape recorders, walkie-talkies, radios, etc., gave a big boost to sales of rechargeable batteries. This article should bring your knowledge on the rechargeable battery up-to-date and tell you about a truly universal charging circuit with an electronic timer which you can build.

Rechargeable sealed batteries, besides many other advantages, make the operation of portable equipment quite inexpensive. Do you still remember the high cost of B and filament batteries for portable tube radios? But even with transistorized equipment, the cost of "cheap" throw-away batteries may be quite high. For example, a portable calculator or a radio using four AA throw-away cells needs battery replacement about once a week if it is used for 2 to 3 hours each day. This comes to about \$50 per year. A set of four rechargeable AA-size Nickel-Cadmium (NiCad) batteries costs around \$8 and with proper care should last 3 to 5 years or more. The cost of electricity used for recharging comes to only about 10 cents per year. Quite a difference in cost!

What Proper Care? We mentioned that a rechargeable NiCad battery will last for many years if proper care is exercised. Our charger described in this article will give your rechargeable batteries such proper care. There are three rules to observe when handling rechargeable batteries. They are all expressed in terms of battery capacity in milliampere hours (mAh). This value is usually given by the manufacturer on the battery label. If no battery capacity is given, some common values are shown in this table. However, watch for the figures given by the manufacturer. For example, you may find a sub C cell in a D cell package.

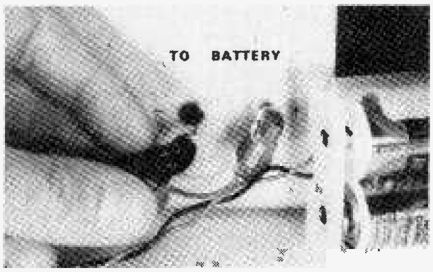
Battery Size	Capacity (mAh)	10-Hour Rate (mA)	5-Hour Rate (mA)
AA	450	45	90
sub C	1000	100	200
C	1500	150	300
D	3500	350	700

Rule 1. Do not discharge continuously at more than the hourly rate (450 mA for AA cells). Whether this rule is satisfied depends on the kind of equipment you are using. This rule will seldom be violated. Just don't try to run your electric power mower on a bunch of AA cells!

Rule 2. Do not continue discharging when the battery voltage is 0 volt (cell reversal). If you have several batteries in series, one will always have slightly smaller capacity than the others. When that battery is completely discharged, the other batteries will still pump current through it. The only way to avoid this condition is to turn off your appliance immediately when the total series battery voltage drops significantly (by more than 1 volt). You will notice it when, for example, your radio starts distorting. Turn it off immediately.

Rule 3. Do not charge at more than the 10-hour rate

SUPERCHARGER



Phone tip jacks shown here can be replaced with five way binding posts or, if you're handy enough, eliminated altogether and replaced with battery holders built right into the supercharger case. Remember, too, that you must remove the AC power cord from the AC outlet to "reset" this timer.

(45 mA for AA cells) and do not continue charging at that rate beyond full capacity for more than a few hours. Slightly higher charging rates of up to the 5-hour rate are permissible as long as the battery is still discharged. To satisfy this rule, you need to control the charging current and the charging time as is provided by this charger. Some so-called universal battery chargers put either a too-high or a too-low current into your batteries. As a result either the battery will be damaged and its life shortened or it will not get fully charged in a reasonable amount of time.

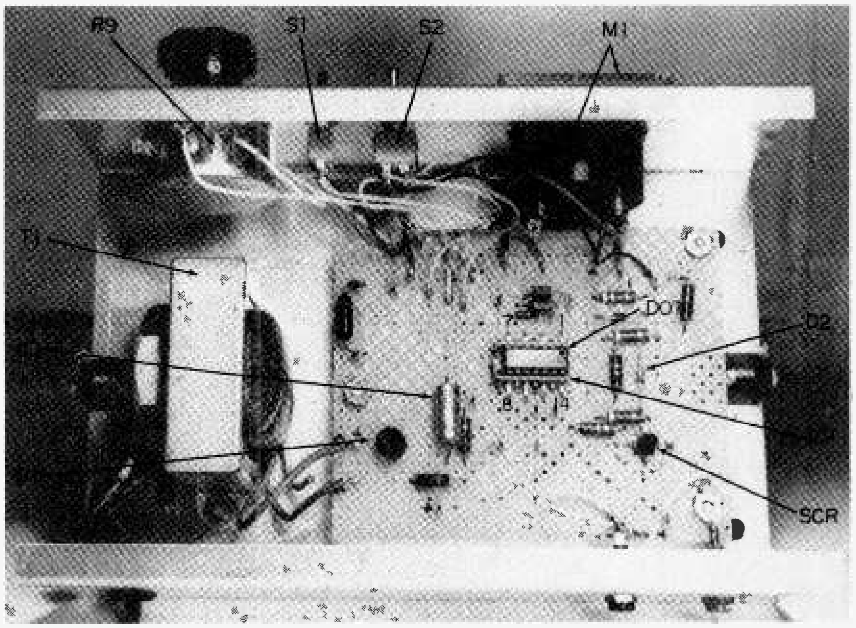
These are general and safe rules. Specially-constructed batteries (for example, the so-called quick-charge batteries) may let you break one or more of these without causing permanent damage. However, unless the battery manufacturer assures you to the contrary you better stick with our three rules; otherwise permanent damage may result. Either the battery will fail (go dead) immediately or its life-span and capacity will be shortened.

Battery Charger. This charger is capable of charging one to six cells from AA to D size. It lets you control the charging current and the charging time. You turn the charger on, set the current to the *10-hour rate* for a full charge or 5-hour rate for a quick boost, and forget it. After 14 hours (or 1¾ hours for a quick boost) the charger will turn itself off. In other words, we pump in *140 percent of battery capacity* to charge it fully (40 percent is the typical loss in the charging process). For a quick boost of 1¾ hours when the battery is completely or partially discharged, we can go up to the 5-hour rate to obtain about one-quarter full battery capacity. For special quick-charge batteries follow manufacturer's recommendations.

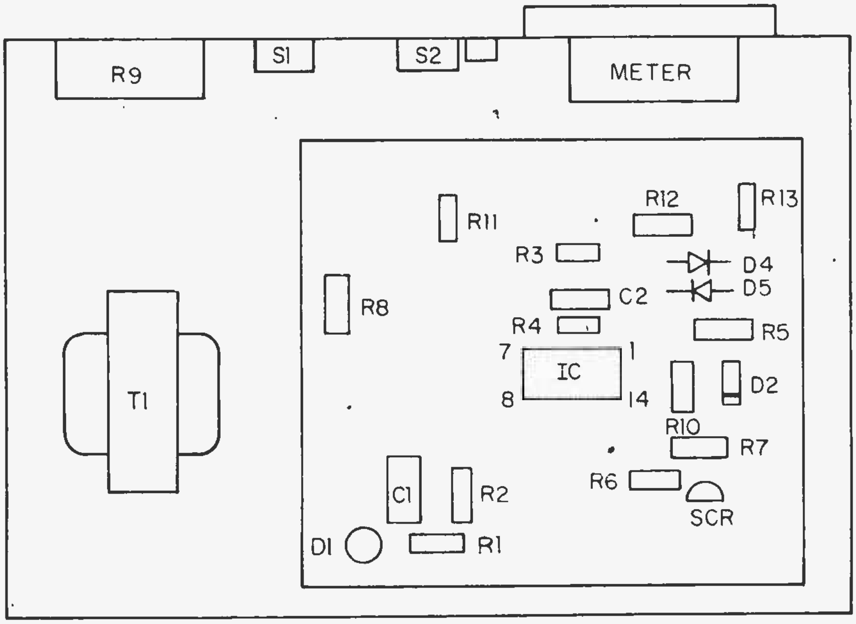
The charger makes use of a newly-developed integrated circuit which combines a built-in oscillator (similar to the 555-type) and a frequency divider of up to 65,536 (2^{16}). This way we can choose a basic oscillator frequency of 0.77 Hz which can be obtained with reasonable resistance and capacitance values and divide it by 2^{16} to obtain timing values of up to 14 hours. The basic frequency, f, is determined by C2, R3, and R4. The frequency

$$f = \frac{1}{2 \times R3 \times C2}$$

where R4 = 2 × R3. The IC is connected in such a way that the timer resets itself when the circuit is first turned on. When its timing interval is up, it will turn the SCR off permanently until the circuit is first removed from, then connected to the power line again. The rest of the circuit is straightforward. The output of the IC (pin 8) controls the gate of the SCR and lights up the LED. The charging current is controlled by the variable resistor R9. The current range with the values shown is between approximately 40 and 500 mA for up to 6 cells. Switch S1



With our photographer and artist both on the job, you should have little difficulty locating parts on your supercharger perf board. While it is possible to build this unit in a much smaller area if you wish, beginners will find the extra room a benefit.



selects the IC divider output of either 2^{16} or 2^{13}.

The lowest divider ratio the IC is capable of, 256, is particularly useful during the charger calibration. To select this counting/dividing mode, disconnect pins 12 and 13 from S1 and temporarily connect pin 12 to pin 14 and pin 13 to pin 5. When you have finished the test, reconnect pins 12 and 13 to S1 after removing your temporary connection. In this mode the timer should turn itself off after 3 minutes 17 seconds plus or minus 10 seconds. The meter M1 is used as a volt meter (0 to 10 volts) across the batteries or as a charging current milliamp meter of 0 to 500 mA. Its function is selectable with S2. The diodes D1 and D2 protect the meter from overload.

Put It Together. You can mount all components on a perfboard as shown in the photographs. The wiring is not critical. The MOS integrated circuit is internally protected against static charges, however we still recommend using a 14 pin socket. Do not insert the IC until you are (1) finished with the wiring, (2) have checked all connections, (3) and made sure the power is off.

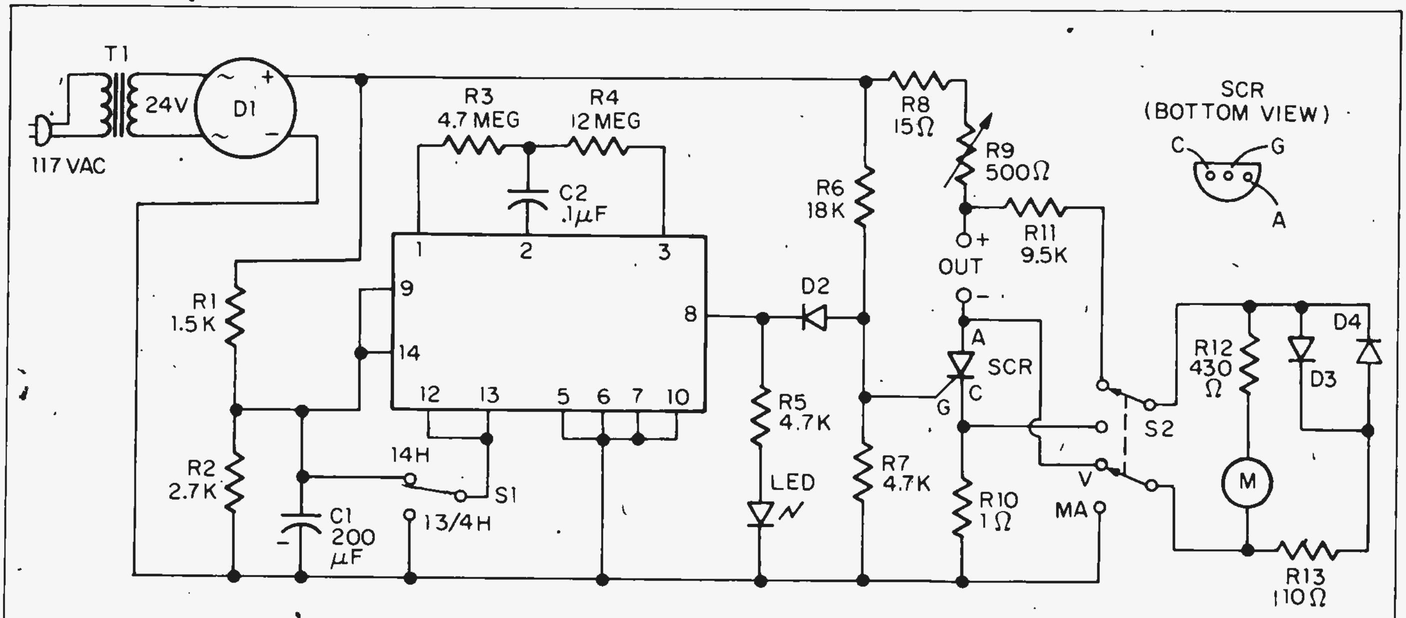
If you plan to charge the batteries outside your equipment, then you must provide battery holders for various size batteries which you want to connect to the charger. Under certain conditions, you may be able to connect the charger directly to your appliance without removing the batteries, usually via the "adapter" jack. You may have to look at the schematic of your radio or walkie-talkie to find out if the "adapter" jack is connected to batteries when a plug is inserted. If so, you can charge the NiCads in the unit.

Once construction is complete, apply power and check to see whether or not the LED pilot lamp is on. If so, it should remain on for either one and three quarters of an hour or fourteen hours, whichever time you have selected with the *time select* switch. To check the correct operation of the timing circuit in less time, you can make the following temporary connections to enable the divide by 256 function. Connect pin 12 and 13 of the IC temporarily to pins 14 and 5 respectively to select the 256 divider ratio. Try different values of capacitor C2 till you get a timing interval of approximately 3 minutes and 17 seconds. Of course, this is not a critical parameter, but it should be accurate to at least 3 minutes and 17 seconds plus and minus 30 seconds.

More Savings. Besides rechargeable batteries, regular throw-away zinc-carbon batteries can also be recharged under certain conditions. Those conditions follow.

- Battery should not be completely discharged (battery voltage should stay above 1 volt).
- Battery should not be leaking.
- Battery should be used soon after being recharged.

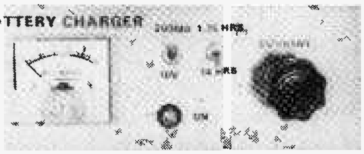
Other popular "throw-away" batteries are alkaline and mercury batteries. Mer-



PARTS LIST FOR SUPERCHARGER

C1—200-uF electrolytic capacitor, 20-VDC or better
C2—0.1-uF capacitor, 12-VDC or better
D1—1-amp, 50-VDC bridge rectifier
D2—general purpose germanium diode such as 1N34A
D3, D4—general purpose silicon diode such as 1N914
IC1—oscillator-timer integrated circuit, Motorola MC14541CP
Note — The oscillator-timer IC, a Motorola MC14541CP, is available for $3.50 postpaid from Circuit Specialists, Box 3047, Scottsdale, AZ 85257.
LED—light emitting diode, red, 20 mA
M1—0 to 1-mA panel meter
R1—1500-ohm, ½-watt resistor
R2—2700-ohm, ½-watt resistor
R3—4.7-megohm, ½-watt resistor
R4—12-megohm, ½-watt resistor
R5, R7—4700-ohm, ½-watt resistor
R6—18,000-ohm, ½-watt resistor
R8—15-ohm, 3-watt or better resistor
Note—You can use two 7½-ohm resistors in series.
R9—500-ohm wire-wound potentiometer
R10—1-ohm, ½-watt resistor
R11—9500-ohm, ½-watt resistor, 5%
R12—430-ohm, ½-watt resistor, 5%
R13—10-ohm, ½-watt resistor
S1—spdt switch
S2—dpdt switch
SCR—0.8 to 1-amp, 100-volt silicon controlled rectifier, G.E. C103
T1—power transformer, 117-V primary to 24-V secondary @ 1 amp
Misc.—perf board, hardware, push-in clips, case approx. 6 x 4 x 3-in., 14-pin IC socket, output terminals, wire, solder, etc.

SUPERCHARGER



Notice there's no on-off switch. That is a function handled by the power cord. Plug it in for on—pull it out for off! Why? It's cheaper to build, for one. For another, all counter reset signals are automatically generated each time the AC power is applied. This no power switch arrangement makes it easier to operate without accidentally resetting the counter timer integrated circuit.

cury batteries are used where high energy concentration in low volume is required. A camera or a hearing aid is a prime example of such an application. The mercury cell has three to five times the capacity of a carbon-zinc cell of the same size but it costs five to ten times as much.

Non-rechargeable alkaline batteries have about twice the capacity of a comparable carbon-zinc cell at approximately three times the price. Mercury and alkaline cells have similar nearly constant discharge voltage and low internal resistance characteristics as the NiCad cells. However, they are not leakproof and should be removed from equipment if not in use. We strongly discourage you from trying to recharge mercury or non-rechargeable alkaline batteries. Gases generated by the recharging process in the sealed cell may cause an explosion and spread the caustic electrolyte.

You may also run across rechargeable alkaline batteries. They are not as popular as NiCad batteries, but are slightly cheaper and have similar characteristics to NiCad batteries. They are not, however, as long-lived. Many other excellent types of batteries are used in military and commercial applications. They did not yet find their way to the consumer market because of high cost.

From this short description, you may deduce that the NiCad battery is the most cost-effective battery in many applications where the appliance is in *frequent* use.

On the Inside. A NiCad battery consists of layers of sintered cadmium and sintered nickel separated by fiber soaked in potassium hydroxide electrolyte.

Sintering consists of baking a powdered metal to the consistency of a solid. A sintered material is highly porous. Its active area is several hundred times larger than that of a solid plate of the

All commercially available nickel-cadmium batteries for consumer use will (or, certainly should) have some indication of what its charge rate and/or ampere hour rating is. The Burgess CD10 cell (far left) does not specifically mention charging rate, but its ampere hour rating is shown on the label. You can, therefore, use the rule of tumb which says charge for 14 to 16 hours at one tenth the battery rating or, in this case, 400 mA. This compares favorably with a 4 Ah Mallory cell.

same dimension. The basic chemical reaction in a NiCad battery is as follows:

Charged

Cathode Electrolyte Anode

$$Cd(OH)_2 + 2KOH + 2NiO$$

Discharged

Cathode Electrolyte Anode

$$Cd + 2KOH + 2NiOOH$$

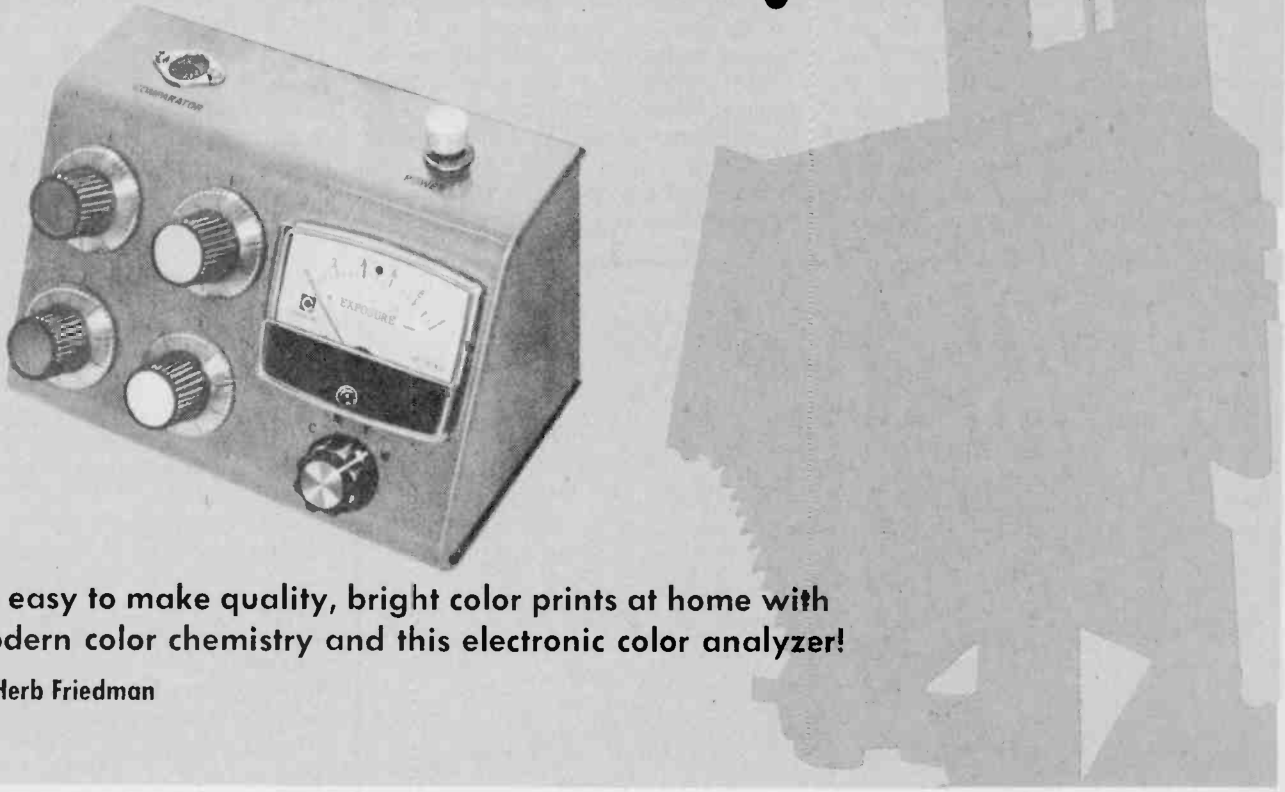
This reaction does not generate any gases. However, during the latter part of the charging cycle, during overcharging and during high discharge, hydrogen, oxygen and electrolyte fumes are being generated. These gases will normally reach an equilibrium condition reacting with each other and with the porous electrodes. Sealed cells also have a safety venting mechanism (activated above 100 PSI) assuring that the cell will not rupture under extreme conditions. Repeated venting however, causes loss of the electrolyte and subsequent battery deterioration. For this reason controlled charging is beneficial to NiCad batteries.

Other Advantages. A major advantage of NiCad cells, in particular when used for portable radios and walkie-talkies, is a nearly constant voltage during the discharging cycle. Regular zinc-carbon batteries lose their voltage at a fairly constant rate and thus affect the performance of the equipment they are powering; however, rechargeable batteries keep their voltage nearly constant until they nearly completely discharge. For example, the voltage of a carbon zinc battery drops by approximately 0.3 volts per cell when it is 50 percent discharged. The voltage of a NiCad battery drops by only 0.1 volt during the same period. Another important feature of NiCad batteries is the low internal resistance on the order of about 30 milliohm (AA cells)—about ten times less than for a comparable zinc carbon battery. This feature is particularly important for class B type audio circuits which require more power during peaks of speech or music. Batteries with a low internal resistance can supply the sudden surges of power required for good, low distortion sound. Another important feature of NiCad batteries, as compared to zinc carbon, is that they can be stored in a charged or discharged state and are virtually leakproof.

For additional information about batteries in general and/or NiCad batteries in particular, refer to the following material. "More Staying Power for Small Batteries", *Machine Design* magazine, December 13, 1973; *Nickel-Cadmium Battery Application Engineering Handbook*, General Electric publication number GET-3148; *Nickel-Cadmium Battery Application Engineering Handbook Supplement*, General Electric publication number GET-3148-S1; *RCA Battery Manual*, RCA publication BDG-111B; *Eveready Application and Engineering Data Book*.

From flashlight to photoflood, from toys to 2-way, NiCads are in widespread use. Everyone is ready to save a buck these days; from a money-saving standpoint, NiCad batteries have some definite advantages. Maybe, if you are a heavy battery user, NiCad rechargeable batteries can help you. Why not check it out? ■

A Darkroom Color Analyzer

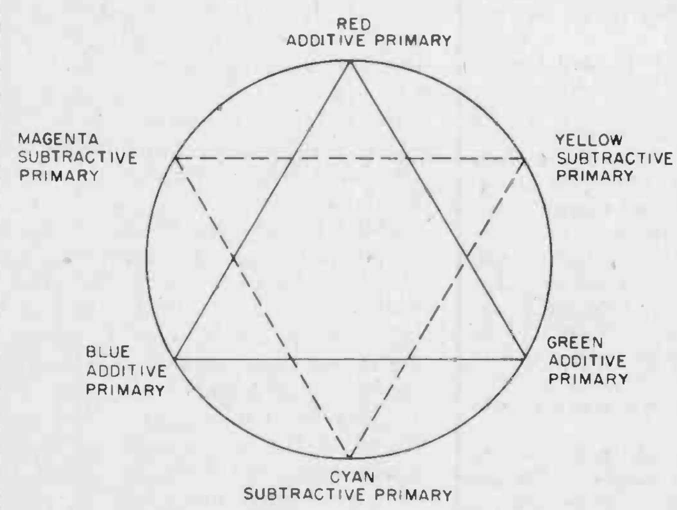


It's easy to make quality, bright color prints at home with modern color chemistry and this electronic color analyzer!

by Herb Friedman

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.

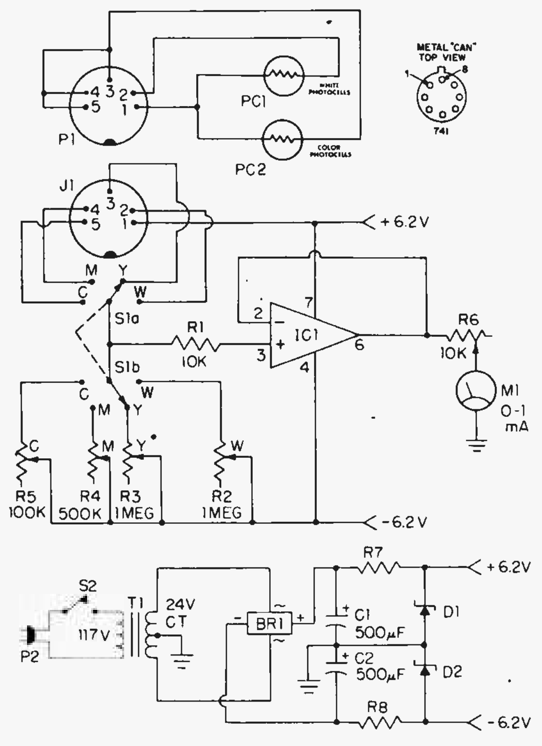
You can either buy or make the printed circuit board (see parts list). Either way, the first step is to prepare the printed circuit board. If you do it yourself, make it any way you like, using free-hand or template resist. Nothing is critical, but be certain there are no copper shorts between the terminals 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



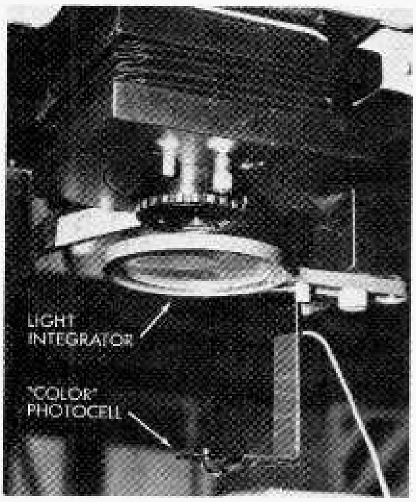
PARTS LIST FOR COLOR ANALYZER

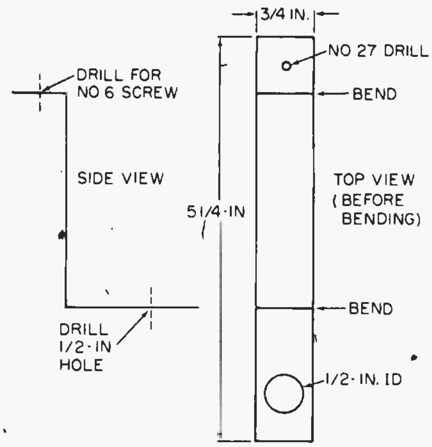
BR1—50-PIV, 0.5-amp or higher silicon bridge rectifier
C1, C2—500-uF, 10-VDC or better electrolytic capacitor
D1, D2—6.2-volt, 1-watt zener diode
IC1—type 741C operational amplifier, see text
J1—5-pin socket, DIN-type (optional, see text)
M1—0 to 1-mA DC meter, see text
P1—5-pin plug, DIN-type (optional, 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 (including postage and handling). Canadian shipments add $2 extra. New York State residents must add sales tax. 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 for each photocell. Postage and handling are included. No Canadian or foreign orders. 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).

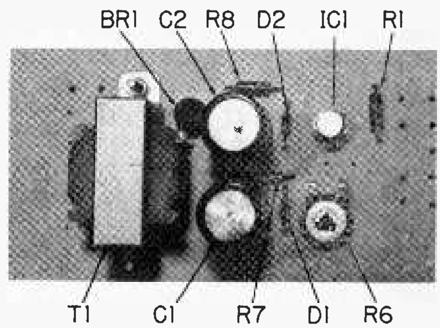
Potentiometers R2 through R5 can be linear or audio taper, though audio taper gives a slightly smoother adjustment; use whatever you have in stock.

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.

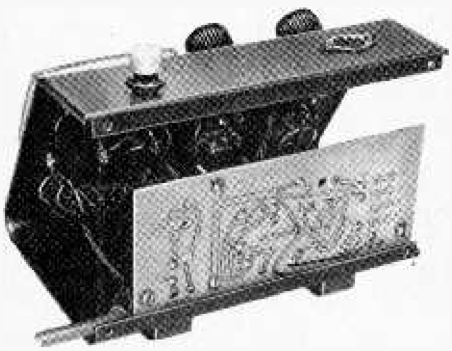
Meter M1 should be 0-1 mA with a zero-center scale. But these are expensive, so you can substitute any standard 1-mA meter you want. You will simply calibrate the instrument for zero-center.

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.

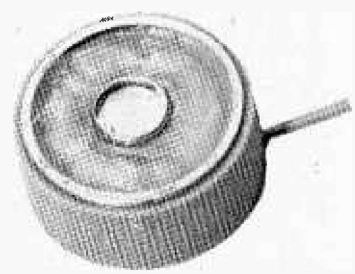
The Comparator. The photocells used for the comparator and exposure sensor, P1 and P2, must be Clairex type CL5M5L. Make no substitutions. From a piece of scrap aluminum ¾ to 1 inch wide, fashion a Z-bracket to the dimensions shown. Drill a ½-inch hole close to the end of the longer Z-leg. Fasten the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

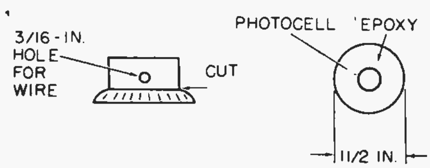


This is the parts location when our PC board is used. To get a free template of the PC board, send a Self-Addressed Stamped Envelope to: Davis Publications, Dept. T, 229 Park Ave. South, New York, NY 10003.



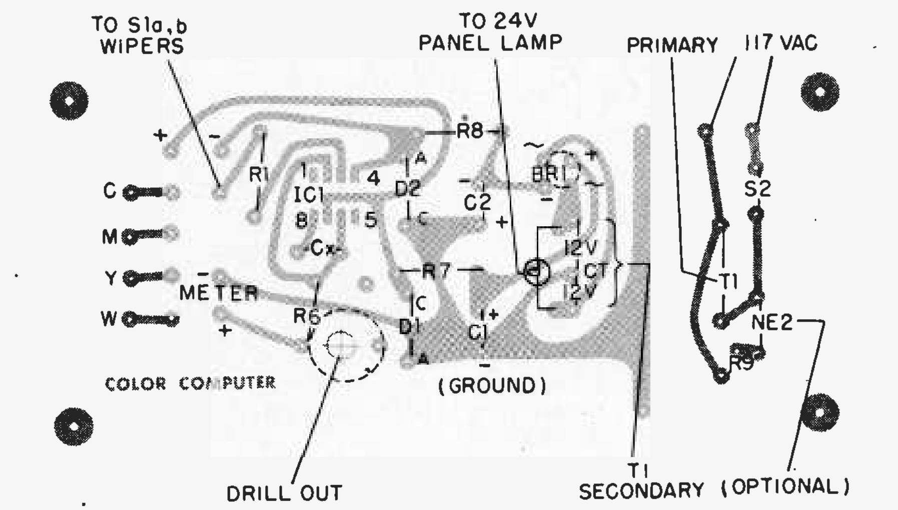
Rear view of author's color analyzer shows vertical mounting of the circuit board.





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



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.

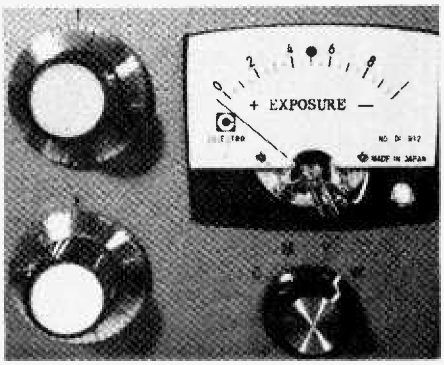
in the hole and attach the connecting wires; these can be extra-thin zip cord such as used for short-length speaker connections. (This whole bit reads a lot more complicated than it is. Use the photographs as a guide.)

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



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.

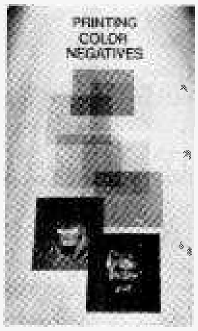
dark or very low light). This is normal and there will be no damage to the circuit or the meter. (Note: If you use a zero-center meter the pointer will barely pin on both sides.)

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.

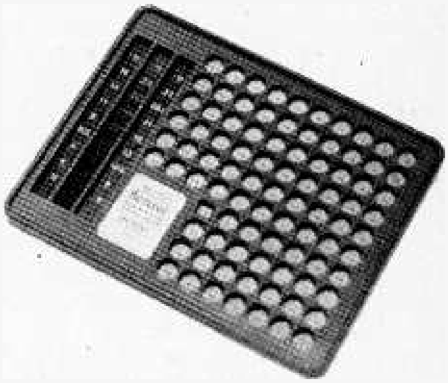
An electronic color analyzer basically consists of a photocell (vacuum tube photomultiplier or photoresistor) positioned under the lens, blue, green, and red filters mechanically positioned over the photocell (or positioned over the cell by hand) and a meter that indicates the amount of light falling 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.

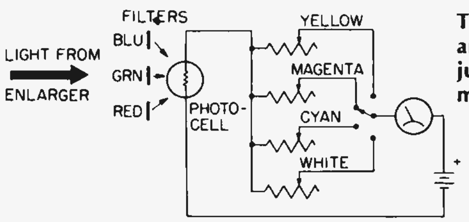
(The color analyzer in this project uses a separate photocell for the exposure. If you look at the easel you'll see a shadow cast by the Z-bracket holding the color comparator cell. Position the exposure cell on the easel so it is just off the edge of the shadow. If you prefer, you can place several 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

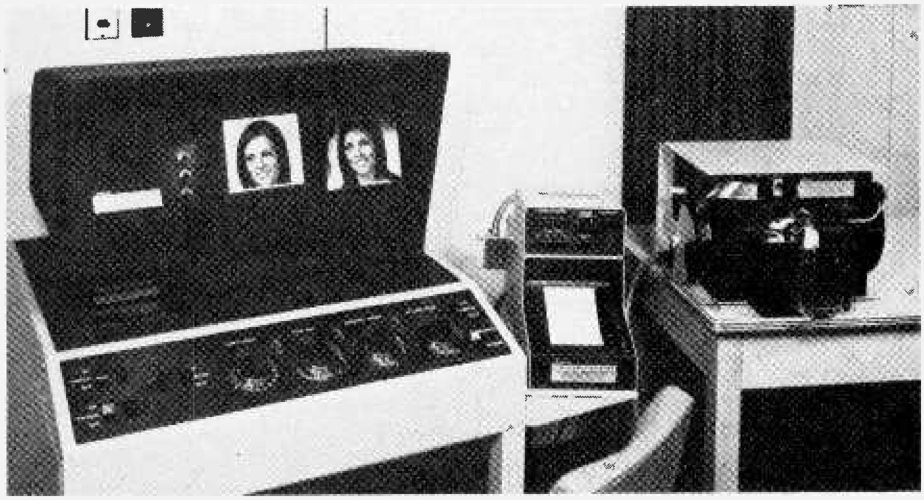
Kodak color printing filters. Typical filter designation CP20Y means color filter with a .20 density; the color is yellow.

required. If you still can't null the meter, it means magenta should *not* be in the filter pack.

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.*



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.

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.

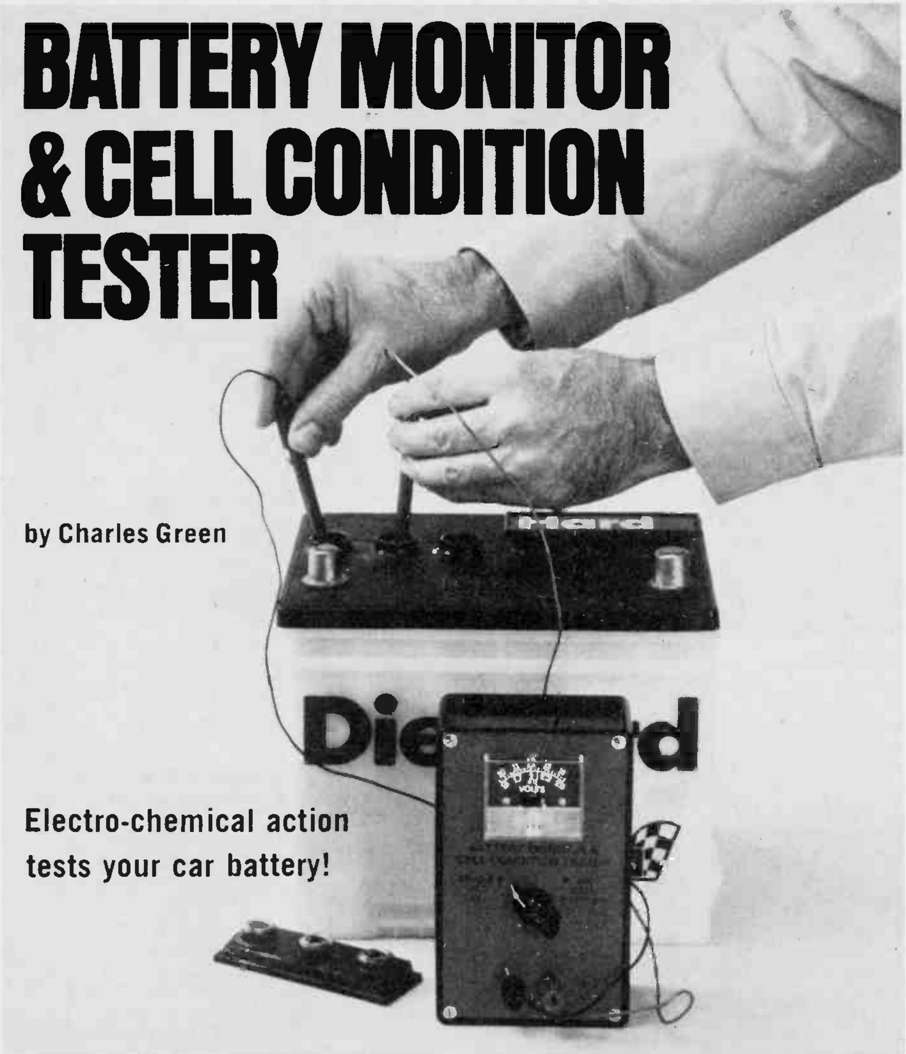
Commercial labs come close to a hobbyist's results only when they are equipped with a video analyzer such as the Kodak Video Color Negative Analyzer Model 1-K; and Kodak only claims a 75%+ first try acceptance rate for their analyzer. The video analyzer is a 5-in. x 5-in. TV display. The operator views 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.

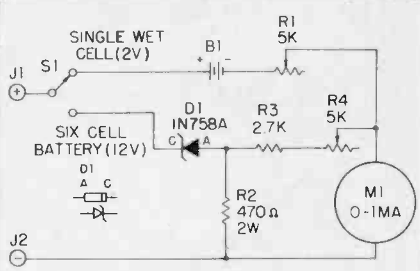
The video analyzer is a fast and easy way to get good color prints on the first try, but since video analyzers cost in the thousands, the color analyzer is the best thing going for the hobbyist. ■

BATTERY MONITOR & CELL CONDITION TESTER

by Charles Green

Electro-chemical action tests your car battery!





PARTS LIST FOR BATTERY MONITOR & CELL CONDITION TESTER

- **B1**—1.4-volt mercury cell, Eveready E640
- **D1**—10-volt, ½-watt zener diode (1N758A or HEP Z0220 or equiv.)
- **J1, J2**—binding posts; red, black
- **M1**—1-mA DC meter
- **R1, R4**—5,000-ohm miniature potentiometer
- **R2**—470-ohm, 2-watt resistor
- **R3**—2,700-ohm, ½-watt resistor
- **S1**—spdt rotary or toggle switch
- **Misc.**—plastic chassis box and panel 6 x 3½ x 1⅞-in. (approx.), perf board, push-in clips, plastic mechanical pencils and solder for test probes (see text), wire, etc.

ARE YOU ONE OF THE many who are servicing his own car? It pays to make sure that the battery is in good shape to prevent that slow, grinding start when you are in a big hurry. Just adding water at intervals isn't always enough to ensure that the battery will be in top condition when you need it.

With our expanded-scale battery tester you can make periodic tests of your battery to insure that the battery is in good shape. The tester is built in a compact plastic cabinet and includes easy-to-make special probes for the cell electrolytic tests as well as overall battery voltage tests. The construction of the tester is simplified for ease in building.

Tester Circuit. When S1 is set to the "single wet cell" position and voltage is at J1 and J2 (from the test leads), M1 will indicate only when the test voltage at J1 and J2 is higher in value than 1.4-volt battery B1. For example, if the test voltage is 1 volt (positive polarity at J1 and negative polarity connected to J2), the meter will not indicate since the B1 voltage is 1.4 volts. When the test voltage is 1.5 volts, there is a 0.1 volt difference over that of B1, and M1 will indicate a current flow (voltage) in the circuit. The 1.4-volt meter scale marking is equivalent to meter zero.

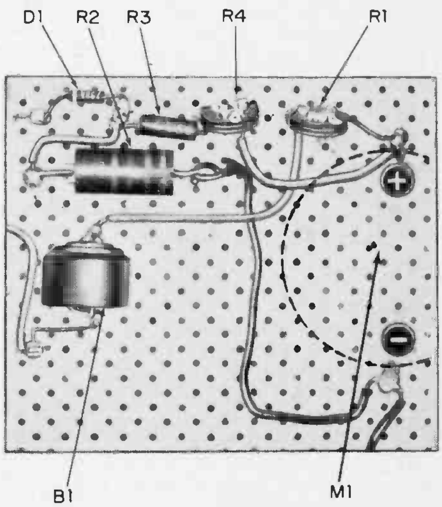
When S1 is set to the "six cell battery" position, zener diode D1 operates similarly to battery B1 in the other position. Since D1 is a 10-volt zener diode, a test voltage higher than 10 volts is required to allow M1 to indicate voltage.

Potentiometer R1 is the calibration pot for the *single wet cell* meter circuit, and R4 is the calibration adjustment for the *six cell battery circuit.* Series resistor R2 provides a minimum current flow through the zener so that it will operate properly.

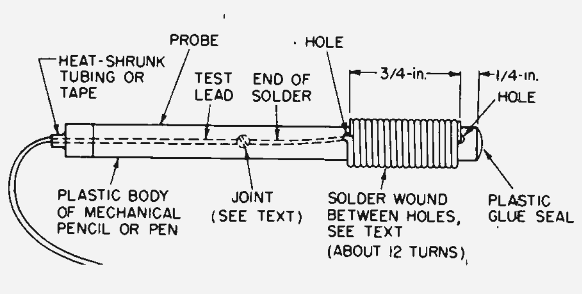
Construction. The Tester is built in a 6 x 3½ x ⅞-in. plastic box with a plastic panel. The box dimensions are not critical, and any convenient size can be used. To minimize possible electrical short circuit hazards, do not use a metal box. Most of the components, are installed with push-in clips on a 3 x 2½-in. perf board with remaining parts mounted on the box panel.

The best way to start construction is to cut out the M1 mounting hole in the panel and install the meter in approximately the same position shown in the panel photo. Then locate and mount S1, J1 and J2. Cut a section of perf board to size, and drill two holes to fit the M1 terminal screws to mount the board. Install the perf board to the meter terminals with two solder lugs supplied with the meter.

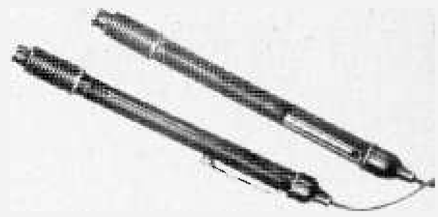
Mount the board components with push-in clips at the approximate locations shown in the board photo. Use short leads for best mechanical rigidity, and wire as shown in the schematic. Make sure that D1 and B1 are connected with the proper polarities as



Perf board showing components including location of meter as dashed line. Mercury cell battery will last its shelf life, which is generally two years for a fresh battery. Eliminate D1, R2, R3, R4, and S1 for a dunk-test only meter. 2-V is center scale.



Use the plastic body of a mechanical pencil or modify a set of old VOM leads. Either way, wrap 10 to 18 turns of "wire" solder around the end to serve as the electrolyte contact surface. Shrink tubing makes a neat job. Connect the wire lead and the solder together before trying to put the lead into the hole.



shown in the schematic. Carefully solder B1 to the push-in clips with a minimum of heat, or the mercury cell may be destroyed. If desired, you can use commercial mounting clips for the battery that do not require soldering.

Wire the remainder of the tester circuits and the panel components. Carefully check the wiring and make sure that M1 is connected with the proper polarity.

Test Probe. The tester requires special probes for the electrolyte test. As shown in the drawing, the probes are made from solder wrapped around the end of a plastic tube (we used a plastic body of a mechanical pencil and #18 60/40 rosin core solder).

Begin construction by selecting a pair of mechanical pencils with black and red plastic bodies for your test leads. Carefully cut off the metal pointed end of each pencil and remove the entire mechanical assembly from inside the pencil. Clean out the inside of the pencils so they are completely hollow and have no inside obstructions.

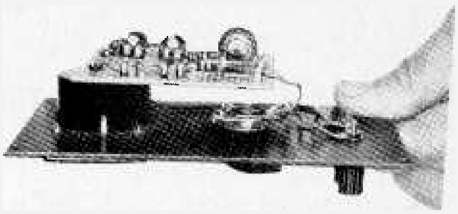
Drill two holes spaced ¾-in. apart approximately ¼-in. from the end of each pencil body, and wrap wire solder between the holes as shown. Insert the ends of the wire solder into the holes to hold the turns in place. The end of the wire solder in the hole toward the other end of the pencil body (the former eraser end) should be long enough to reach through the body end to be carefully soldered onto the test lead. Then carefully push the solder back into the plastic body with a portion of the test lead. Do not try to stretch the wire solder or use too much tension or the solder will break. Carefully insert short plastic sections into the body end to wedge the test lead in place and prevent it from being pulled out, then tape or use heat shrink plastic tubing on the lead end of both test probes. We used hot plastic from an electric glue gun to seal up the open end of the test prod and at the places where the solder is fed into the holes. Do not put any hot plastic over the solder turns.

Calibration. If you have a 1-mA meter for M1 of the same size scale as in our model, and the same type of zener diode specified, you can copy the photo of the meter scale and cement it over the meter scale of your meter. Set S1 to the *single wet cell* (2 volt) range and connect the tester to an exact source of 2 volts DC. Adjust R1 for an M1 indication of 2 volts (at center scale). Then set S1 to the *six cell battery* (12 volt) range. Adjust R4 for a 12-volt center scale indication with exactly 12-volts input to the tester. Make sure that you have connected the right polarity input for these calibration adjustments (J1 connected to positive (+) voltage and J2 connected to negative (−) voltage terminals).

For a more accurate meter calibration (and if you are using a different size 1 mA meter or a different type of 10-volt zener diode) you will need a calibrated variable voltage DC power supply or a DC supply with a potentiometer and a monitor voltmeter. Calibrate both ranges of the tester by adjusting R1 and R4 for midscale indications as in the previous (cemented meter scale) procedure, and then marking the meter scales in accordance with the calibrated DC power supply or the monitor voltmeter. Our model was calibrated from 1.4 to 2.6 volts on the 2-volt range of S1, and from 10 to 14 volts on the 12-volt range.

Operation. Automobile storage batteries consist of a number of 2-volt cells connected in series—three cells for a 6-volt battery and six cells for a 12-volt battery. As shown in the drawing, the tester probes are inserted into the electrolytic filler holes of a pair of *adjacent* (series-connected) cells so that the tester will indicate the voltage between the electrolytes in each cell. This voltage is approximately 2 volts, depending on the condition of the battery cells. The test will show the condition of *the positive plate* in one cell and *the negative plate* in the paired cell. By making tests of each pair of cells along the battery, the overall condition of the battery can be determined. Make sure that you observe proper test probe polarities.

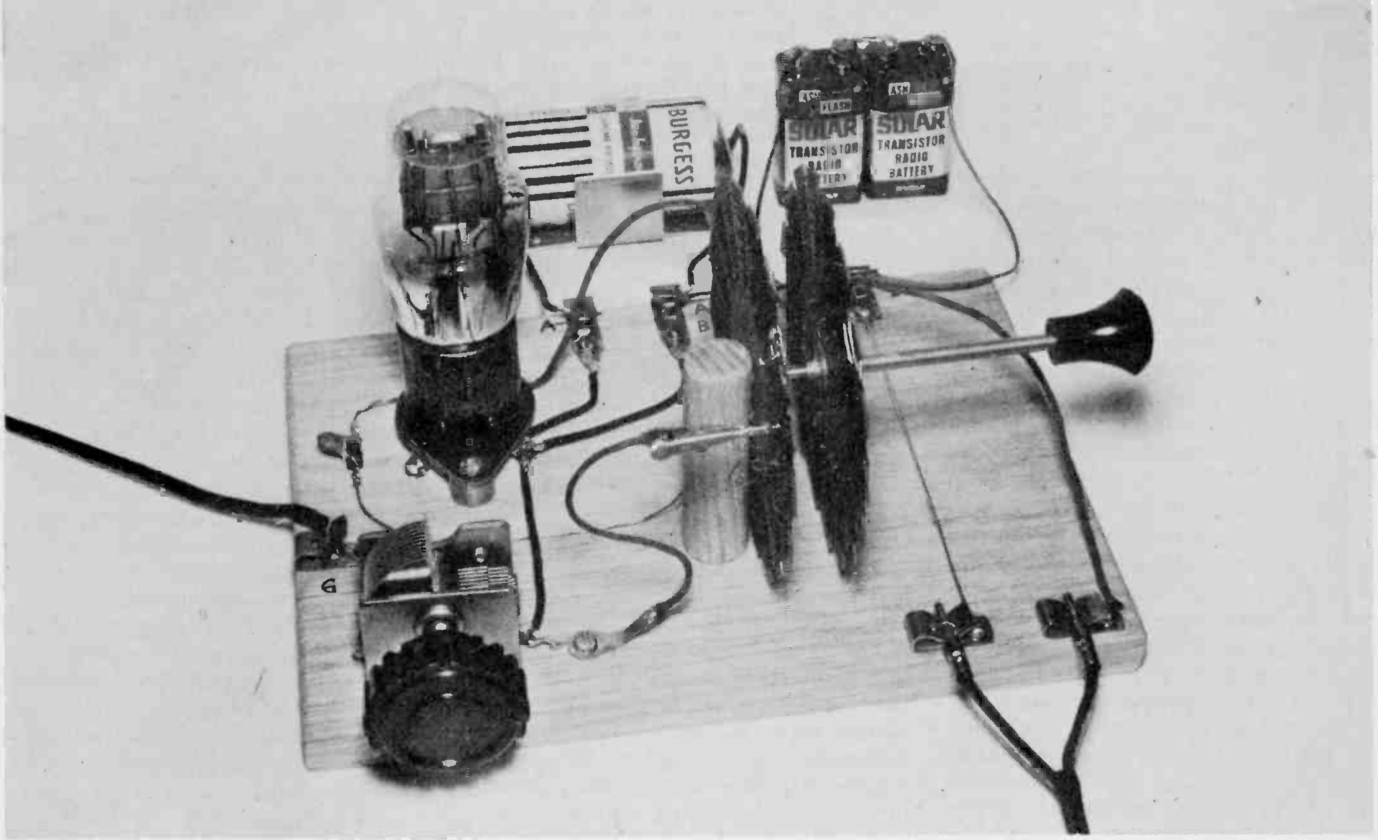
If you are not sure which cell is the correct mate of another cell (since the arrangement of cells under the plastic top of the battery cannot be seen), momentarily place the probe into the electrolyte of a cell and quickly withdraw the probe if the meter (M1) swings sharply upscale, indicating overvoltage. The ¼-in. plastic section at the end of the probes should minimize the possibility of shorting out the cell between the plates, but use care in placing the probes into the battery holes; hold them in your hands—do not just drop them into the electrolyte while taking readings. Place the probes just far enough into the electrolyte to obtain an M1 indication. The probe electrodes may have slight tendency to polarize (act like little miniature storage batteries due to electrochemical action on the solder) and affect the meter indication. To prevent this, slightly agitate the probes in the electrolyte while testing.



Inside the meter. Mount perf board to meter using screws in meter terminals. Solder leads to battery B1 terminals directly or use a battery clip.

Test your storage battery at periodic intervals and note the cell readings. This will give you a performance record to check when you suspect that the battery may be defective. When a battery starts to go bad, it will show up as widely different voltages between cells (usually one cell will start to go bad before the others—not all the cells at once). For best results, make your periodic tests when the battery is in approximately the same electrical state of charge; the battery should be fully charged and have stabilized for some time before making tests. The probes should be washed and dried after each use to prevent corrosion from affecting the readings. The 12-volt scale of the tester can be used with a normal set of test probes to periodically check full battery voltage across the battery terminals. ■

Build an antique
ANTENNALESS 1-TUBE REGEN RECEIVER



This model-maker's delight actually works!

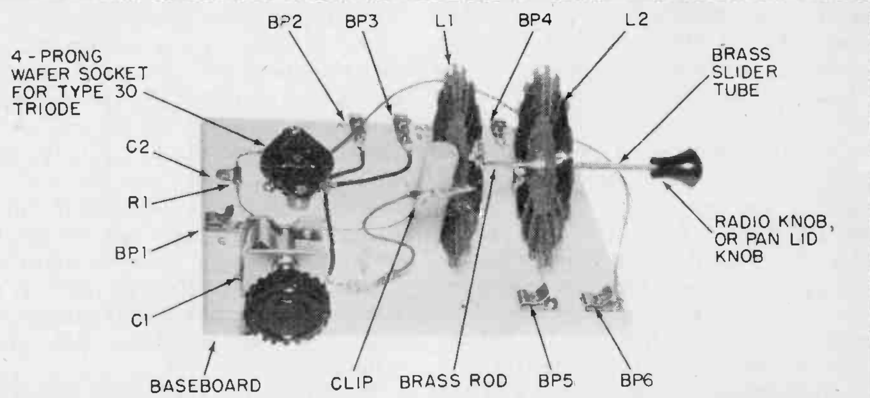
by Art Trauffer

A NUMBER of people would like to build a one-tube regenerative receiver, similar to the popular one-tubers of the early 1920s, but they hesitate, thinking that a long outdoor antenna is needed. So here's a novel receiver, resurrected from an item in Hugo Gernsback's RADIO NEWS magazine of the early 1920s, which requires no antenna and works well with only a connection to your water pipe! As a bonus, you will get less man-made and natural static!

This breadboarded regen receiver is beautiful in its simplicity, and you can probably find most of the parts in your "junk box." Coils L1 and L2 are the highly efficient "spiderweb" type of coils that were popular in the old days, and for capacitor C1 you could use the RF section of a gang capacitor salvaged from a junked AC-DC table radio. You can use any low-filament-voltage, low-filament-drain triode tube for V1. The writer used a type 30 in this project, since it has a filament drain of only .06 amps, making it easy on the "A" battery. For a "B" battery, you need only two or three 9-volt transistor batteries connected in series.

Spiderweb Coils. The drawing of the coil form is an *actual size* pattern for making the two spiderweb coil forms. The writer used gray sheet fiber used for electrical insulation, but if you cannot obtain this use stiff cardboard and two coats of shellac.

Stationary coil L1 consists of 55 turns of #26 gauge enameled copper magnet wire, having three taps near the outside of the coil. In winding the spiderweb coils you start on the inside of the forms and wind to the outside. Punch two small holes in the form and anchor the end of the wire in these holes, allowing six inches of wire for connections later. Wind about 25 turns on the form; then twist a small loop in the wire for a tap;



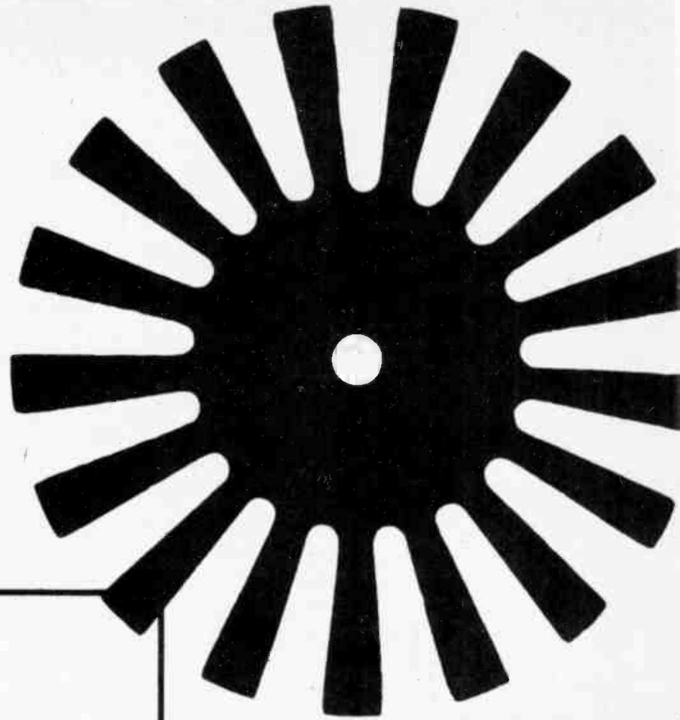
All wired and ready to pull in those DX casts. Wiring is point-to-point, see schematic.

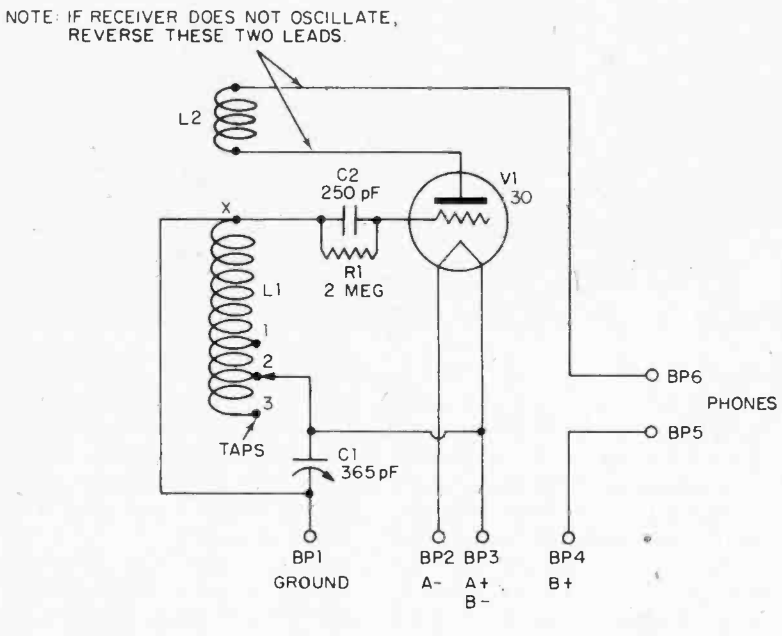
then wind 15 more turns and make another tap. The 55th turn (outside end of winding) will be tap number 3. Put a little Dupont Duco cement on the twist of each tap to make the taps rigid so you can scrape off the enamel on the taps for clip connections later on.

Spiderweb coil L2 is the feed-back coil, or "tickler coil" as it was sometimes called in the old days. L2 has about 50 turns of #26 wire, and no taps. Note that both coils should be wound and mounted so the turns of wire are in the same direction.

Putting It Together. Referring to photo of the regen radio, the hardwood

Spiderweb coil form shown at right is same-size pattern. Use it to make another. You'll need two.





PARTS LIST FOR ANTENNALESS 1-TUBE REGEN RECEIVER

C1—365-pF. variable capacitor
C2—250 or 220-pF. (.00025 uF) ceramic disc capacitor
R1—2-megohm, ½-watt resistor.
V1—any low filament voltage, low filament drain, triode vacuum tube (Author used type 30)
1—baseboard-mounting socket for vacuum tube (V1)
BP1-BP6—medium-size Fahnestock clips
L1—home-made spiderweb coil, with three taps (see text)
L2—home-made spiderweb feed-back ("tickler") coil (see text)
1—#26 gauge enameled magnet wire for L1 and L2
1—4-in. by 8-in. piece gray sheet fiber, for making coil forms (see text)
1—wood baseboard, 7½-in. by 5½-in. by ½-in. hardwood
1—round or square ½-in. wood dowel, 2½-in. long (holds spiderweb coil assembly)
2—round or square telescoping brass tubing, for spiderweb coil slider (see text).
Misc.—hardware: Knob for C1. Mounting screws for C1. Mounting screws for Fahnestock clips. Soldering lugs. Mounting screws and stand-off collars for tube socket. Hookup wire. Flexible wire for "tickler" coil (L2) pigtail leads. Small alligator clip. Pair high-impedance magnetic earphones. "A" battery for V1. "B" battery for V1. Two or three 9-volt transistor batteries connected in series. (see Antennaless text).

For type 30 tubes, try the following sources: Mr. George Haymans, WA4NED, Box 468, Gainesville, Georgia 30501.
Modern Radio Labs., P.O. Box 1477, or 10322 Ballard Drive, Garden Grove, California 92642.
Or any of the other surplus tube mail-order firms that advertise in radio and electronics magazines.
Other low filament voltage, low drain, triode tubes: 1H4-G, 1G4-GT, VT-24/864, 1B5/25S, 1H5-GT, 1LE3, 1LH4.

baseboard (oak, walnut, maple, etc.) is 7½ in. by 5½ in. by ½ in. The supporting upright for the coil assembly is a 2½ in. length of ½ in., or ⅝ in. round or square wood dowel, screwfastened at the bottom using a 1 in. flathead wood screw and glue.

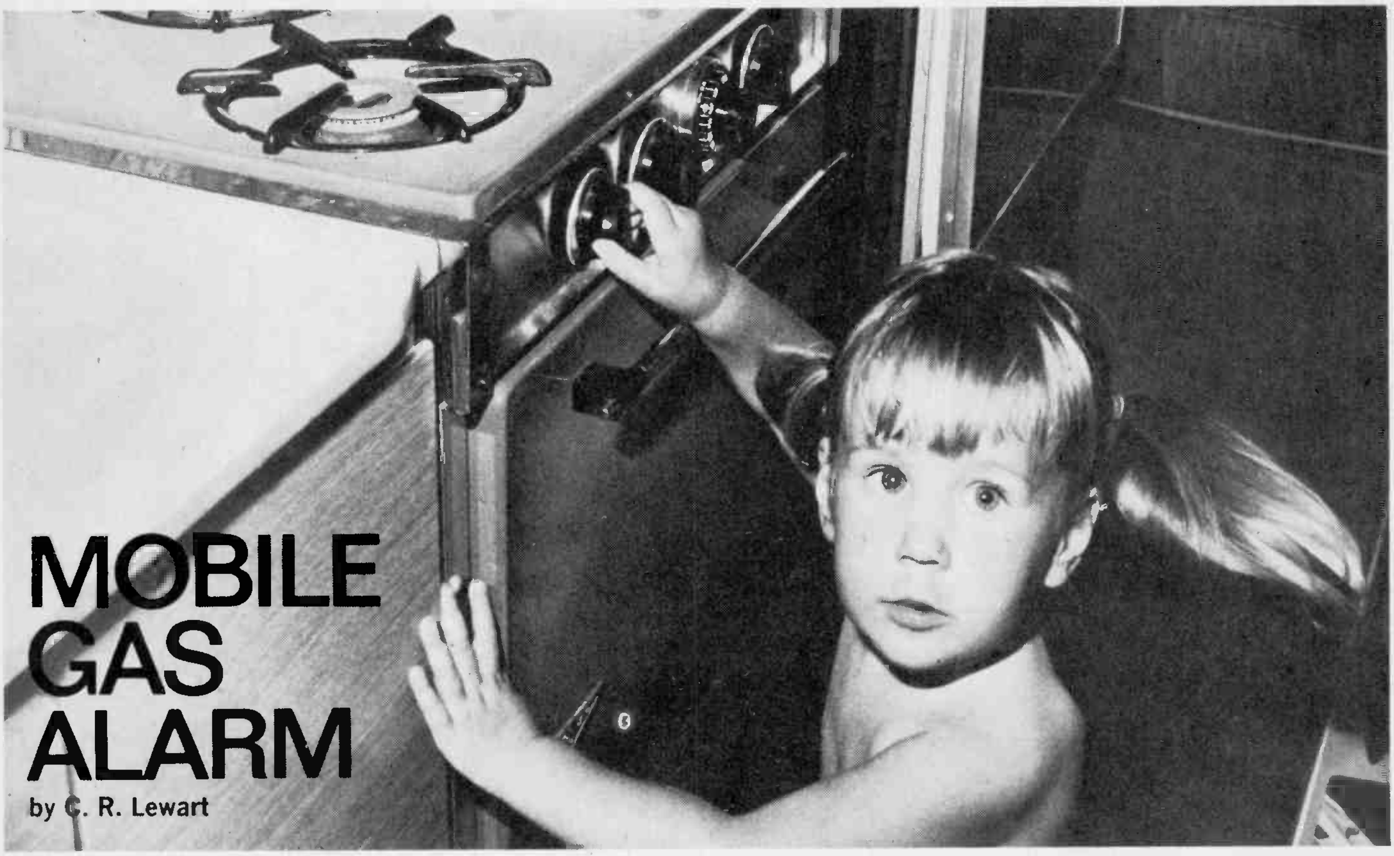
To make the adjustable assembly for the coils, use small diameter brass tubing (two telescoping lengths) obtainable at hobby and crafts supply stores. The author used ⅛ in. diameter tubing for the stationary support "rod," and mating tubing for the sliding "rod," but you may want to use larger, more rigid pieces. The stationary member is about 3½ in. long, and the sliding member is about 3 in. long.

Drill holes of the required size through the center of coil L1 form, and through the wood upright dowel near the top. Pass the stationary brass rod through the hole in the coil form and into the hole in the dowel. Glue or Duco cement is used to hold coil L1 securely to the wood upright.

Drill a hole of required size through center of coil L2 form, and cement the coil form securely to one end of sliding brass tube. A knob goes on the other end of this brass tube.

The tube socket (type depending on tube used) is supported by two standoff metal collars, as shown.

The schematic diagram shows the simple hookup. Connections should be soldered wherever possible. Use a sensitive pair of high-impedance magnetic earphones when listening. A size D flashlight cell will last for a while with a type 30 tube, but a No. 6 ignition battery will last longer. No switch is used—simply disconnect the "A" battery! For the "B" battery, connect two or three 9 volt transistor batteries, in series. ■



MOBILE GAS ALARM

by C. R. Lewart

Now our mobile gas alarm means safety on the road: it stands silently by–sniffing with an electronic nose for dangerous combustible gases. When just a small concentration accumulates around its solid-state nostrils . . . *WHAMMO!* The area is shattered. Not by a tragic explosion, but by a loud screaming alarm that keeps on sounding until *you* turn it off!

Best of all, this alarm can be conveniently powered by electrical systems found in cars, campers, trucks, travel trailers, motorhomes, houseboats, speedboats, electric-start outboard boats, airplanes, all-terrain vehicles, even your electric-start lawn mower–virtually everywhere 12-volt DC power is available.

Author's model for portable use. A remote location for both the semiconductor "nose" and Sonalert alarm is an option to consider.

Although we don't always like to think of it, there is a danger associated with deoxidizing (combustible) gas such as propane-fired camper stoves, gasoline fumes in the bilge of a boat, and exhaust fumes released by everything from diesel trucks to lawn mowers. There's even the possibility of flame-out and gas leakage with a plumber's soldering torch.

All these situations and many more can mean danger if gas is allowed to accumulate in confined areas. Though the special semi-conductor gas sensor used in this project has been the basis for kits and construction articles in magazines in the past, none, to our knowledge, made such efficient use of the power required to operate its sensor OK. No problem when you're powered by your local electric company! It's when your power system is based on a storage battery that even ½-watt becomes important.

With a series dropping resistor lowering 12 volts to the required 1.2, you can waste 9 times the power actually used by the gas detector element. This is pure power waste you can't afford when operating from battery power—even high power auto batteries. Multiply that power loss by the number of hours the unit is in operation (say, overnight)

PARTS LIST FOR MOBILE GAS ALARM

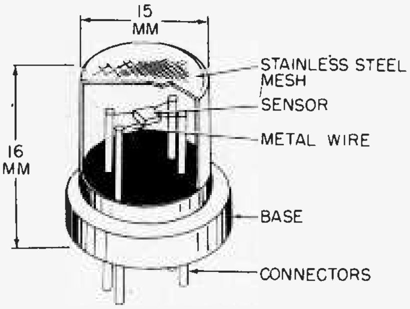
C1—220-uF electrolytic capacitor, 35 to 50 VDC
C2—0.1-uF capacitor, 25 VDC or better
C3—0.01-uF capacitor, 25 VDC or better
D1—9-volt ½-watt zener diode
D2—4-volt, ½-watt zener diode
IC1—555-type timer integrated circuit
Q1—HEP-700 or Radio Shack 276-2026 transistor
R1—100-ohm, ½-watt resistor
R2—110,000-ohm, ½-watt resistor
R3—10,000-ohm, ½-watt resistor
R4—270-ohm, ½-watt resistor
R5—4700-ohm, ½-watt resistor
R6—220-ohm, ½-watt resistor
RV—10,000-ohm potentiometer, linear taper
R8—3300-ohm, ½-watt resistor
S1—switch, spst, any style pushbutton or toggle you select
SCR1—silicon controlled rectifier, Radio Shack 276-1079, or General Electric C106.
Z1—semiconductor gas detector model 105 (Available from Southwest Technical Products Co., 219 West Rhapsody, San Antonio, TX 78216 for $6.25 postpaid)
Z2—sonalert model SC628 or equiv.

Misc.—wire, solder, perf board, push-in clips, cabinet approx. 3-in. high by 4-in. wide by 6-in. deep IC socket, knob, 7-pin miniature tube socket for Z1, polarized socket for 12-volt input power (Calectro F3-170 shown), automotive-type cigar lighter accessory plug and cord for 12-volt input power, etc.

on a camping trip, and you come up with a hefty amount of wasted watt-hours.

But with this project e/e efficiently snips the AC power cord and moves the solid-state gas sensor anywhere 12-volt DC power is available.

You can have this modern gas sensor for use away from power lines that draws hardly more than one tenth of an amp at 12 volts—an average power of

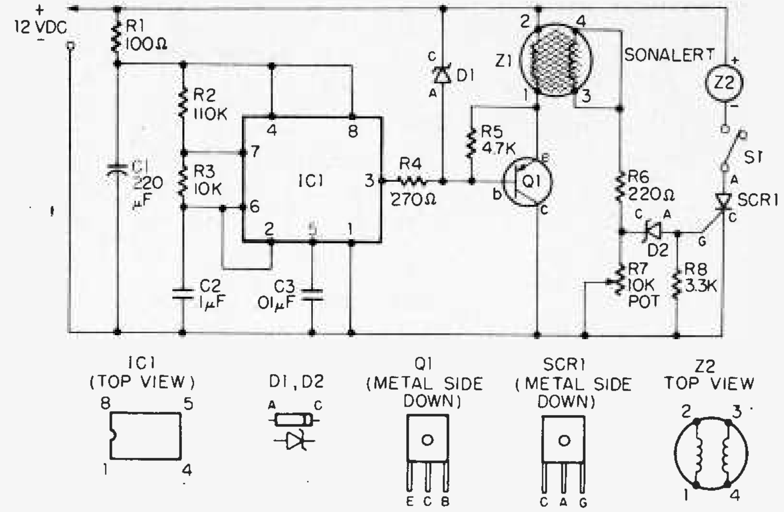


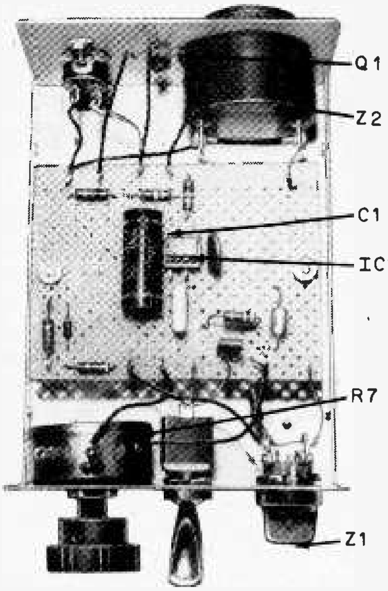
This interior view of the gas sensor element shows that the unit is electrically symmetrical. Either element can serve as the input or the output of this rugged detector.

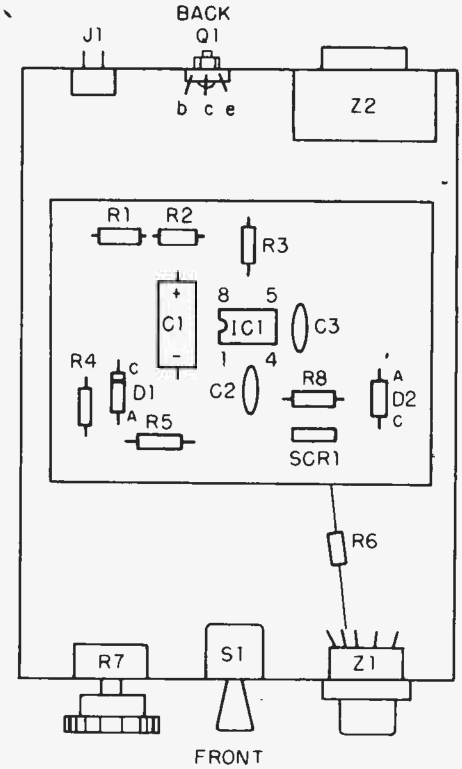
1.2 watts. We've used the handy 555-type timer to **power-pulse** the detector at the 12-volt level, so the *average* power is similar to that provided by 1.2 volts DC.

How Does It Work? Three basic parts of the circuit are a power-saving filament voltage supply for the sensor, the gas sensor device itself, and the alarm tripping circuit. Let us look at them one at a time.

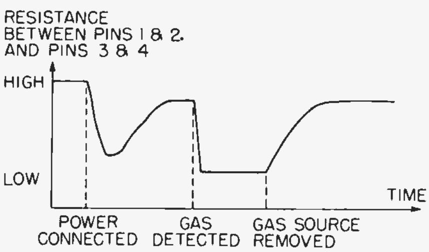
• The power supply for the gas sensor consists of pulse-generating integrated circuit IC1 and a PNP power transistor Q1. The integrated circuit sends periodic pulses which turn the power transistor on and off and thus gate the battery power. This approach saves approximately 80 percent of the battery power as compared to the conventional voltage dropping resistor or power transistor with heat sink methods. Zener diode D1 assures a constant







Follow this layout exactly making point-to-point wiring connections underneath the perf board and to push-in clips. Take extra care that correct polarity is applied.



Time vs resistor graph shows why you must warm up the heater element for a few minutes before making a sensitivity adjustment final.

filament supply for the sensor independent of changes in the battery voltage.

• The gas sensor element (see interior view) is composed of bulk semiconductor material (mainly tin oxide) heated by a thin filament coil. The semiconductor material lowers its resistance when exposed to a variety of deoxidizing gases. The sensor reacts to hydrogen, carbon monoxide, propane, and organic solvent vapors in the alcohol, ketone, and benzol families. For example, the sensor can easily detect concentrations of only 100 ppm of carbon monoxide. The sensor restores itself to high resistance a few minutes after the gas source has been removed, and it has a life span of several years.

• The alarm tripping circuit turns the buzzer on when the sensor resistance decreases so that the voltage at the gate of the SCR exceeds a value preset by R7, the sensitivity adjustment potentiometer. Once the SCR is triggered, the buzzer starts to operate. Then, switch S1 must be used to reset the SCR to stop the buzzer. Zener diode D2 prevents the circuit from sounding

(*Continued on page 103*)

BGNRS FET IC BCB AM RCVR*

***beginners field effect integrated circuit broadcast band amplitude modulation receiver**

THE BEST WAY for the newcomer to radio to learn about receivers is to build one! The easiest type of receiver to build that will be reasonably selective and sensitive is the type that grandad built back in the golden days of radio—the regenerative receiver. But this one has been brought up to date. Instead of old-fashioned tubes, this receiver uses a field effect transistor (FET) regenerative detector and an integrated circuit (IC) for the audio amplifier.

Our model tunes the broadcast band from 550 kHz to 1600 kHz; it provides very reliable reception for the beginner. The receiver is built in a handy metal cabinet, runs on two dry cells, and is designed for simplified construction with perf board mounting of components. The receiver can be used with earphones for digging out the broadcast band DX, and it will operate a speaker when tuned to strong local stations.

Circuitry. Signals from the antenna at J1 are coupled via the antenna trimmer capacitor C1 to the tuned circuit L1-C2 and then detected and amplified by the gate-leak detector Q1. Some of the RF energy is fed back from Q1 to L1-C2 via the tickler coil L2, then detected and re-amplified again by Q1. The amount of RF energy feedback is adjusted by the REGEN control, R1, in shunt with the tickler coil L2. When there is too much feedback, the gate-leak detector Q1 circuit will oscillate, an undesirable condition.

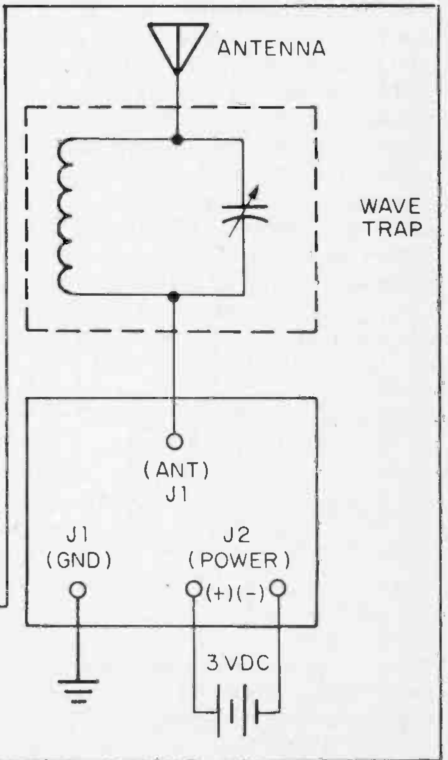
Detected signals from Q1 are coupled through C7 to the integrated circuit and amplified. The amplification is controlled by R7, and the audio output is coupled to J3 for an external speaker (8 to 45 ohms), or earphones. A 3-volt battery or DC power supply is connected to J2 to supply the necessary electrical power for the receiver circuits.

Construction. The FET-IC receiver is built in a 5¼-in. deep by 3-in. high by 5⅞-in. long metal cabinet. Most of the components are installed on a 4¼-in. by 4½-in. perf board section. The remaining parts are mounted on the front and back panels of the cabinet. The parts placement is not critical, but for best performance follow our component layout and wiring placement.

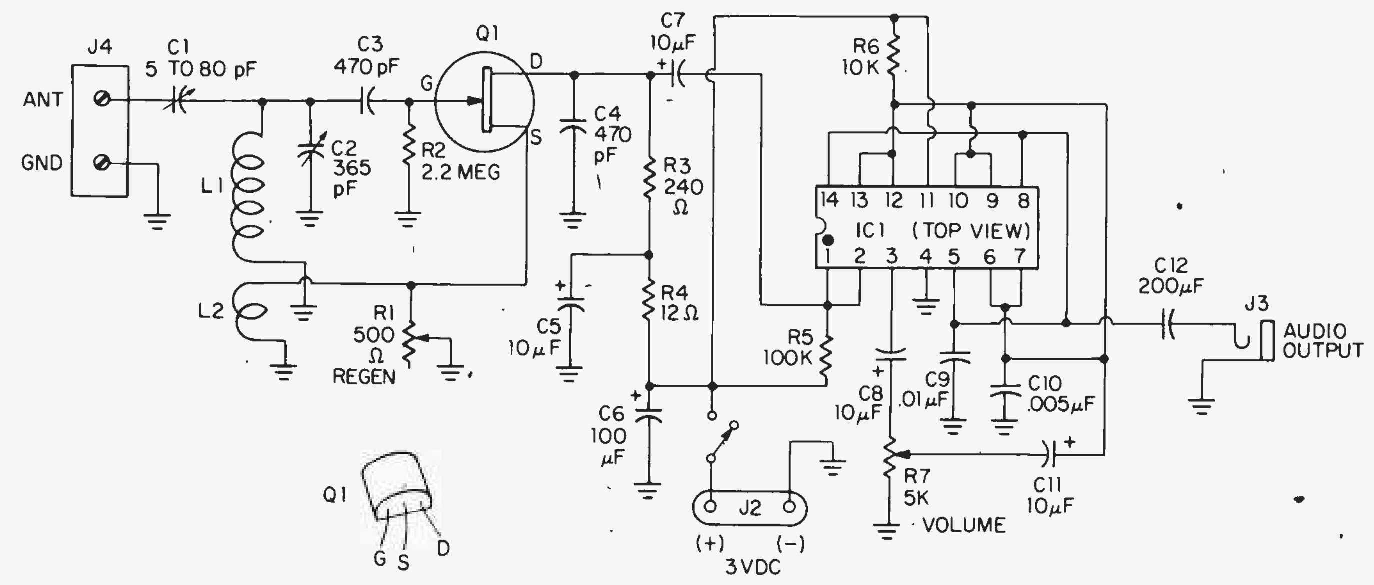
The RF coil L1 is wound on a 2-in. long section of 1¼-in. (outside diameter) plastic tube. A type of plastic tube used for protecting golf clubs—obtainable in sporting goods stores—is used for our coil form. But a cardboard mailing tube 1¼-in. in diameter can also be used.

Begin construction by tightly winding #28 enameled copper wire in a single layer over 1½-in. of the coil form. It's not necessary to count the turns, as the coil may have to be modified to fit your particular antenna. Connect the wire ends through holes at each end of the coil form and connect the wires to two solder lugs mounted at one end of the coil form (see photos). Set the coil aside.

Install the front and rear panel com-



Simple diagram of wavetrap as it is connected to the receiver. Simple parallel tuned circuit provides an extra measure of selectivity.



PARTS LIST FOR BEGINNER'S FET-IC BCB RECEIVER

C1—5 to 80-pF trimmer capacitor (see text)
C2—365-pF variable capacitor
C3, C4—470-pF ceramic or mica capacitor
C5, C7, C8, C11—10-uF, 3-VDC or better electrolytic capacitor
C6—100-uF, 3-VDC or better electrolytic capacitor
C9—0.01-uF capacitor
C10—0.005-uF capacitor
C12—220-uF, 3-VDC electrolytic capacitor
IC1—quad 2-input gate, RTL-type (Motorola HEP570 or equiv.)
J1, J2—screw-type terminal strip
J3—phone jack
L1—RF coil: #28 enamel wire wound 1½-in. on 1¼-in. dia. coil form (see text)
L2—tickler coil: 2 turns hookup wire wound on L1 (see text)
Q1—FET (Motorola HEP802 or equiv.)
R1—500-ohm linear-taper potentiometer with spst switch
R2—2.2-megohm, ½-watt resistor
R3—240-ohm, ½-watt resistor, 5%
R4—12-ohm, ½-watt resistor, 5%
R5—100,000-ohm, ½-watt resistor
R6—10,000-ohm, ½-watt resistor
R7—5,000-ohm audio-taper potentiometer

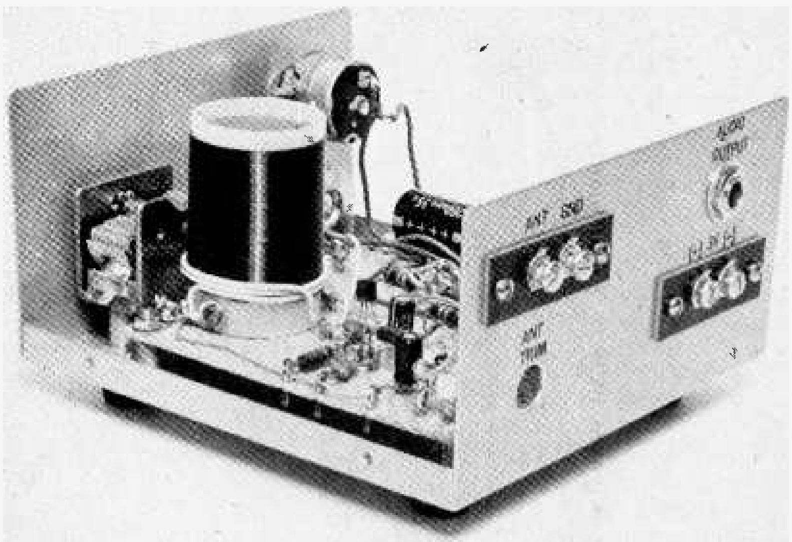
Misc.—metal cabinet 5½ x 3 x 5⅞-in., perf board and push-in clips, 1¼-in. dia. coil form (see text), metal spacers, hookup wire, knobs, 3-volt battery or 3-VDC power supply, high-impedance earphones or speaker (see text), wire, solder, etc.

ponents as shown in the photos. Capacitor C2 is mounted on two ½-in. metal spacers on the box bottom and as close as possible to the front panel. Mount the 4¼-in. by 4½-in. perf board on the box bottom with a ⅜-in. spacer at each corner.

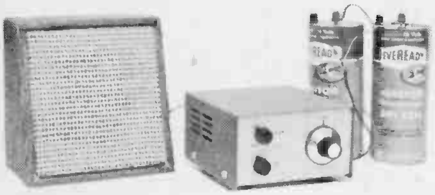
To Continue. Temporarily position the trimmer capacitor, C1, at the rear corner of the perf board (located as shown in the photos) and mark and drill a ⅜-in. access hole in the rear panel for the C1 adjustment screw. Mount the RF coil L1 on the perf board near C2 by soldering one of the coil lugs to a ground lug installed on the nearby corner mounting screw, and solder the other coil lug to a push-in clip on the perf board. Wind two turns of hookup wire around the base of L1 (in the same direction as the L1 winding) and connect the start of the winding to the ground lug, and the finish of the winding to a push-in clip on the perf board. This winding is the tickler coil L2, and may have to be adjusted for best operation.

Lay out and wire the perf board components as shown in the photos and schematic drawing. In our model, the leads of IC1 are flattened out and soldered to push-in clips for connections to the circuit. Of course, an IC socket can be used if mounted on the board by soldering its contacts to push-in clips.

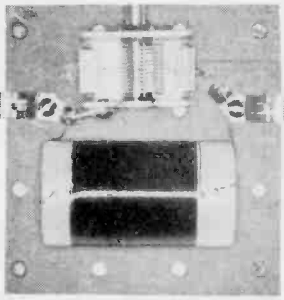
Connect the front and rear panel components to the perf board circuits as shown in the schematic. Make sure that the connecting leads to C1, L1, L2, R1, C3 and the "gate" lead of Q1 are as short and direct as possible. Keep these leads up in the air and away from all the wiring of IC1. Complete the



Use perf board and push in clip construction for your receiver. It's simple and avoids the pitfalls of loose components and shorting wires. Solder lugs are bolted to opposite sides of the coil form and then soldered to two push in clips.



Alternate method of listening to your radio. Although audio power output is low, strong local stations produce a reasonable sound.



Use a short piece of wire to connect one terminal of the wave trap to the radio. Clip your longwire antenna to the other wave-trap terminal and tune out interference.

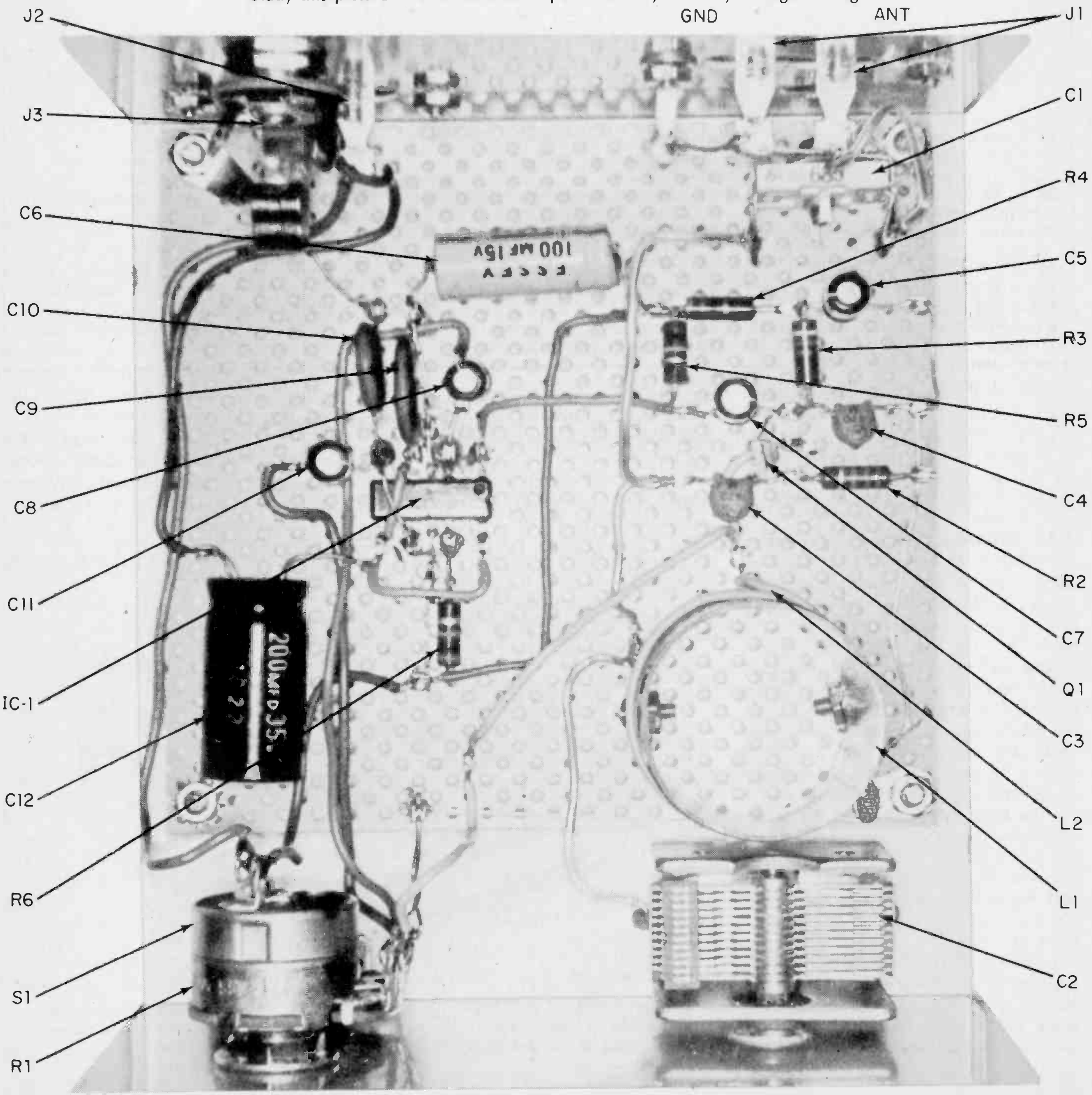
wiring of the receiver. Make sure that all wiring is fastened so that it will not move about.

Operation. For best reception, an outside long wire antenna and a good ground (fastened to a cold water pipe) are required. The antenna should be as long as possible and mounted high up in the air. The mail order houses have antenna kits available which come complete with the necessary insulators and lead-in wiring.

Connect the antenna lead to the ANT terminal of J1 and connect the ground lead to the J1 GND terminal. Connect

(*Continued on page 102*)

Study this picture with its callouts of parts carefully before you begin wiring.



This Plain Jane occasional table conceals...

SOUND FORCE

a 3-way speaker system with downward facing woofer!

by Herman F. Johnson

REMEMBER that old saying once in common use, "Children should be seen but not heard!" A loudspeaker should be the direct opposite, it should be heard but not seen. A speaker system need not look like one of the "common box" variety, either. This one *is* a box system, but it was designed to fit into a popular piece of furniture—the small occasional table known as a "parsons table." By employing one of these tables to house a speaker system, the enclosure can be made of unfinished material; wood joints and jointing screws are hidden from view; and for convenience in assembly, the screws are driven from the outside, into the enclosure.

This is a high performance 3-way system that employs speaker components available at Radio Shack. The enclosure is designed to provide outstanding bass performance from a small system. The bass output is enhanced by locating an 8-inch high compliance woofer facing downward toward the floor. A 5-inch midrange driver and a super tweeter face forward to provide the all important midrange and high frequencies. The woofer is rolled off at 500 Hz. The tweeter picks up the highs from 3300 Hz and up. Of course, the midrange unit operates from 500 Hz to 3300 Hz. This frequency division is supplied by a 3-way crossover network that contains sound level controls for the treble and highs. The power handling capacity is rated at 60 watts.

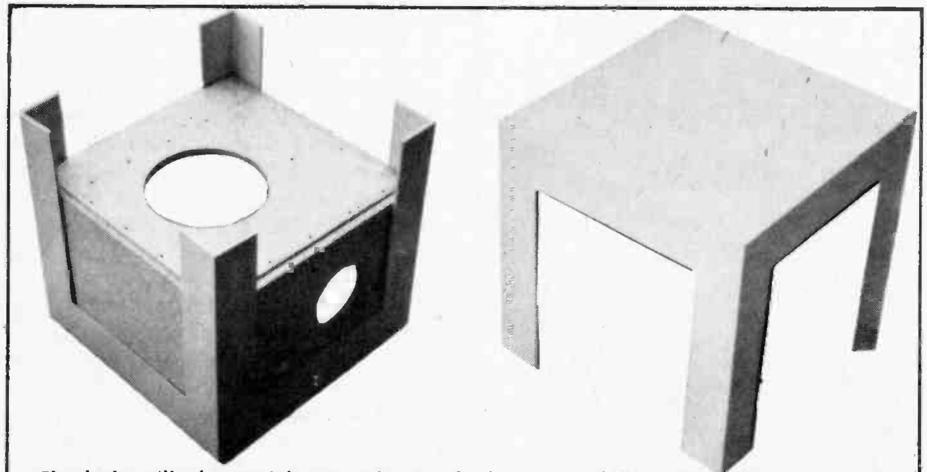
Construction. Before you purchase the speakers, locate a 16-in. cube-shaped occasional table. They are made of high gloss plastic in black, yellow, red and gray colors. Take a good look at the construction of the table before you decide upon the color. The table legs must be right angle shaped, not square, and it should be of one-piece construction rather than the kind with removable legs. These tables are usually found in stores that feature unfinished furniture.

When you have obtained the table that suits your decor, check the inside dimensions between adjacent legs at the under side of the top. This dimension should be 15½-inches in both directions. The dimension 15⅜-in. at the top of the drawing labeled front Elevation allows for 1/16 of an inch at all sides of the top panel for grille cloth covering of the front and both sides of the enclosure. If the dimensions are less than 15½-in. between legs, the square dimensions of the top panel should be reduced accordingly. The dimensions of the top determine the overall dimensions of the other panels.

View "A-A" in the drawing (top removed) indicates the location of all the panels, supporting cleats and glue blocks. Details "A" and "B" locate the cleats. Round dots indicate the location of brads that secure each cleat and glue block to a panel. Details "C" and "D" provide the locations of screw holes (round dots) in the top and bottom panels.

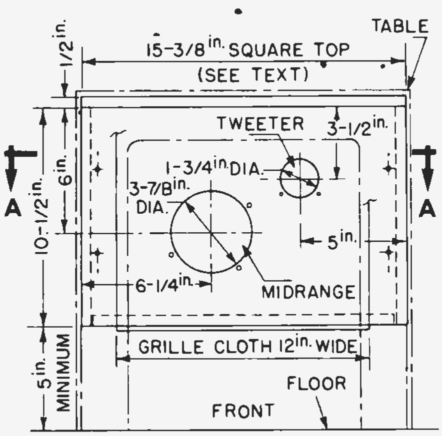
Construction Sequence. You will need a half sheet (48 x 48-in.) of plain particle board, ½-inch thick. Half a sheet is more than enough to build one enclosure, but it is not enough for a stereo pair. When the panels have been cut to size as indicated in the drawings, lay out the center locations for the speakers as shown in the front elevation view and in view "A-A." Carefully cut the midrange and woofer openings with a sabre saw. The 1¾-in. diameter opening for the tweeter is best cut by a hole saw chucked into an electric drill.

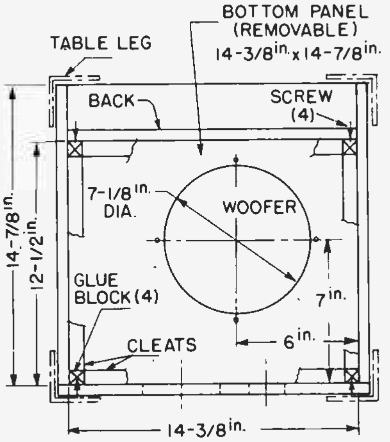
Ten feet of ¾-in. square pine is required for cleats and glue blocks. See



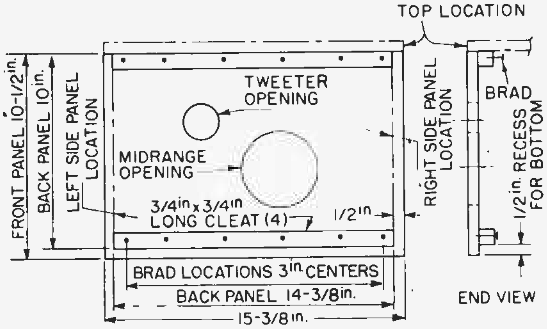
Check the Bill of Materials appearing on the last page of this article. Of course, you must have one set of materials for each speaker you wish to build. You should always use "zip" cord for speaker connections on moderate and high power installations; never that thin stuff sometimes sold on spools as "speaker hook-up wire." Use it for connecting intercoms, if you must, but stick to the #18 for hi-fi.

SOUND FORCE



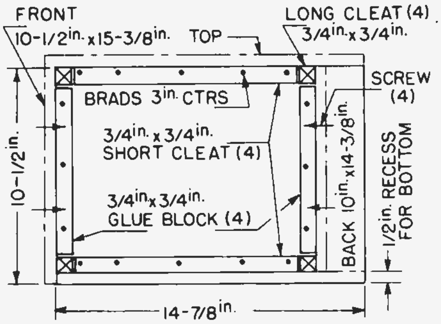


VIEW "A-A"
(INSIDE)

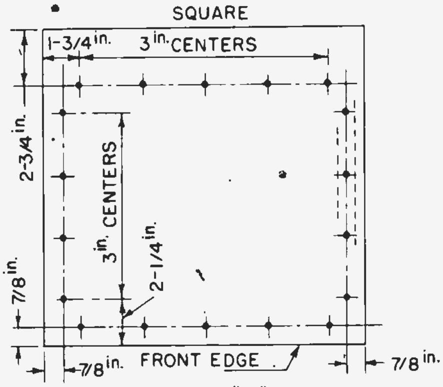


DETAIL **A**
FRONT PANEL, INSIDE FACE
(BACK PANEL SIMILAR, WITHOUT SPEAKER OPENINGS)

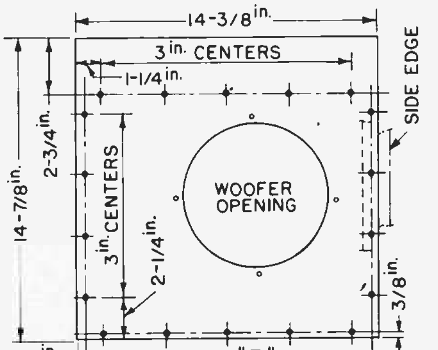
A look at the front and rear (top and bottom, left) of the forward-facing speaker panel. Inside view A-A (above) is a drawing of what you would see if you could look down from the top into the speaker enclosure. The bottom panel which supports the downward-facing woofer is held to the four cleats with screws which are positioned as shown in detail "D" at right.



DETAIL "**B**"
LEFT SIDE PANEL, INSIDE FACE
(RIGHT SIDE PANEL SIMILAR)



DETAIL "C"
(TOP PANEL)



DETAIL "D"
(BOTTOM PANEL)

To complete your "box within a box" you will require panels for the left and right sides as detailed on B above; you will also require the top piece shown in detail C. This can be planed or filed as necessary to fit the inside chracteristics of your table. Remember, the back panel is similar to the front panel (detail A) but without the speaker openings.

the Bill of Material for the lengths. The glue blocks are the vertical corner reinforcements, all others are labeled cleats. Pencil-outline the location of each cleat and glue block on one side of each front, back and side panel. Start on the back panel where two long cleats are aligned along the panel edges as indicated in Detail "A". These lines serve as guides when glue is applied. One inch brads secure each cleat and glue block to the panels. Countersink the brads about 1/8-in. below the surface. The use of cleats assists in the assembly and insures construction of an air tight enclosure (air tightness is a basic requirement to obtain good bass performance).

Next, lay out the screw hole centerlines on the top and bottom panels as shown in Details "C" and "D". Center punch each screw location and drill 1/16-in. holes as indicated. Then, assemble the front, sides, and back panel in the position shown in view "A-A" and align the top panel. You are now ready to mark screw locations into the top side of the cleats with the 1/16-in. drill. At this point you should examine the screw locations to see if any screw is likely to hit a brad when it is driven. If a screw location appears to be too close to a brad, it is best to drill another hole 1/4 or 1/2-in. away from the brad. When you are satisfied that all screws will clear, reassemble the same panels, down side up, and repeat this process for the bottom panel. When you are satisfied that all screw holes are in the clear, re-drill all of the holes 9/64-in. diameter and countersink for No. 6 screws. It is to be noted that four (4) screw holes are required in the front and back panels for screwing into the glue blocks. All of the panel edges should be given a coating of resin sealer to prevent flake off.

You are now ready for the final assembly—except for the preparation of screw holes to mount the speakers. This data follows under speaker component installation, below. Coat all mating surfaces with white glue between the panel and the cleats; then, screw the top down firmly. Do the same for jointing the front and back panels to the glue blocks you have installed on the sides.

Speaker Component Installation. All of the speakers are mounted to the inside face of the panels. However, the diameters indicated in the drawings will allow the two cone drivers to be "backed in" to their respective openings on the inside faces of the panels, so each driver will be centered in the opening. In this position, center punch all four (4) mounting holes from the frame of each unit. Remove the speakers and drive 1/2-in. No. 8 sheet metal screws into the panels about ¼-inch deep. Then, remove the screws and scrape off the displaced wood around each screw hole. This procedure will prevent damage to the cone of a speaker should a screwdriver slip when driving a screw. The woofer and the tweeter should be mounted with screws. The hole locations you have marked for the mid range unit should be drilled 11/64-in. or 3/16-in. in diameter for 8-32 machine screws.

The back of the midrange cone must be isolated in the enclosure from the woofer. This is readily accomplished by bolting a plastic cover over the back side of the midrange driver. A dessert bowl was used by the author. Any bowl that is quite stiff and has a flanged edge all around will do the job nicely. There is no need for a gasket. The edge of the bowl can be clamped to the smooth back surface of the speakers frame by the mounting bolts.

The recessed space behind the back panel is convenient for mounting the crossover network. Draw a horizontal pencil line on the back panel at 4¼-in. from the bottom edge and center mark the location for two ½-in. No. 6 pan head sheet metal screws 4⅞-in. apart. Drive these screws in about half way. Slotted openings are provided on the back of the network for hanging it on two screws. The network is a self contained unit. Hence, three sets of connecting wires must be brought through holes in the back panel for connections between each speaker and a 12-screw terminal strip on the network. Drill holes through the back panel at 1½-in. from the bottom edge for a snug fit to the hookup wires. Follow the instructions attached to the network for connection to the speakers with jumper wires between designated terminals to engage the installed tweeter and midrange level controls that are located on the front of the network.

Cut the speaker hookup wire (zip cord is fine) in about 24-in. lengths. Solder one of these to the woofer terminal lugs, one to the midrange lugs (through a snug fit hole in the side of the plastic cover), and the third to the pull-type binding posts located on the tweeter. Red dot terminals on the speakers should be connected to their respective plus (+) terminals on the network (2, 8, and 10). Unmarked terminal lugs should be connected to the negative (common) terminals on the network (1 and 6). Since two wires must be connected to terminal 6 in a 3-way system, it is a good idea to use spade connectors. The input terminals are located adjacent to terminals No. 1 and 2. The input terminal adjacent to terminal No. 2 is the plus (+) terminal.

Sound Damping. A minimum amount of damping material is recommended to be installed inside the enclosure to absorb reflections from the inside surfaces, back to the woofer. Cut two pieces of one-inch thick fiberglas to fit over the cleats and glue blocks at the back and on one side. And, cut a third piece to fit over the cleats at the top. Staple or thumb tack the damping material to the cleats.

Your enclosure is now complete except for the final installation of the bottom panel containing the woofer. Install four (4) lengths of ⅜-in. by ¼-in. self-stick foam weather strip tape on the face of the bottom cleats along the inside edge of each cleat to insure air tightness under the bottom panel. Then, screw it down in place.

Grille cloth provides an attractive method of covering the exposed unfinished front and side panels. It is sold by most electronic parts stores by the foot from rolls 32 or 36-in. in width. Three 12-in. wide strips about 14-in. long will cover the front and both sides when centered so that the edges are between the panels and the table legs as indicated in the front elevation view. Pick out a soft, cloth-like grille material that will take a smooth right angle bend. Coat the edges with rubber cement, about ½-in. wide, with a paint brush to prevent fraying. Staple or tack an end edge of the material to the bottom edge of the front panel (a paper stapler will do the job if held firmly), then draw it up over the edge of the top panel and staple it to the top. Repeat this process for covering both side panels. It is also a good idea to cover the woofer should a pet crawl under and damage the cone. Staple an 8½-in. square piece of grille cloth to the bottom panel.

Before inserting the enclosure into the table, examine the inside skirt edges of the table below the top. If these edges are a sharp right angle, round them over with a file to avoid abrasion of the grille.

With the table in an upside down position, lower the enclosure down between the legs. Then drill two holes %₄-in. diameter through the table legs and into both side panels in a low position about 11-in. below the top of the table and at about 1¼-in. from the outside right angle corner of each leg. Drive ¾-in. No. 6 round head, plated, wood screws in until the table leg is drawn snug to the enclosure. These four screws are all that is required to support the enclosure in the table.

Operation. As stated earlier, the bass response is robust. If the lows are too strong for your ears, cut back on your bass control at your receiver. It is of considerable advantage to have variable output for both the midrange driver and the tweeter. The midrange control should be advanced more than half way and the tweeter control to about one-quarter turn for most rooms. ■

BILL OF MATERIAL FOR SOUND FORCE

Quantity	Name	Size	Material
1	top panel	15 3/5-in. sq.	½-in. particle board
1	bottom panel	14⅜-in. x 14⅞-in.	
2	side panel	14⅜-in. x 14⅞-in.	½-in. particle board
1	front panel	10½-in. x 15⅜-in.	½-in. particle board
1	back panel	10-in. x 14⅜-in.	½-in. particle board
4	long cleats	¾-in. sq. x 14⅜-in.	pine
4	short cleats	¾-in. sq. x 11-in.	pine
4	glue blocks	¾-in. sq. x 8-in.	pine
44	flat head wood screws	1-in. No. 6	—
4	machine screws	1¼-in.	—
7	sheet metal screws	½-No. 8	—
60	wire brads	1-in.	—
1	occasional table	16-in. x 16-in. x 16-in.	plastic
1	woofer	8-in. (Radio Shack 40-1341)	—
1	mid-range	5-in. (Radio Shack 40-1292)	—
1	tweeter	1¾-in. (Radio Shack 14-1274)	—
1	network	3-way (Radio Shack 40-1339)	—

Misc.—Grille cloth, rubber cement, glue, speaker cord, connectors, 4-sq. ft. of 1-in. fiberglass, etc. (Author used Sycro "Parsons Table" from Sycro division, Dart Industries, Inc., Syracuse, NY 13201)

Stop Wasting Energy!

BUILD TIME TALLY

With electric power at top price, you will want to conserve it more than ever!

by Thomas R. Fox

SOMETHING's been hanging in there too long drawing current all the time, and it's costing you a bundle! What is it? Who knows? But *you* can find out with this simple electromechanical counter driven by a single integrated circuit and connected to the "on" switch of an electrical device, or appliance, or any electric-start engine.

By combining an up-to-the-minute integrated circuit with the old reliable electromechanical counter, you can make an ultra-simple and inexpensive elapsed time meter. The 555-type timer used here is a very handy IC because it is amazingly stable and accurate; its timing isn't significantly affected even if the supply voltage varies widely.

The circuit, (see Fig. 1), centering around the 555 timer, emits half-a-second negative pulses once every 60 seconds. This short, power-stingy pulse triggers the electromechanical counter whose memory requires no power whatever. The 555 output is sufficient to drive the counter directly, which simplifies things quite a bit.

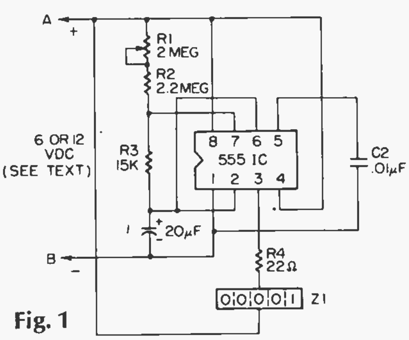


Fig. 1

PARTS LIST FOR TIME TALLY

C1—20-VDC or better, 20-uF Tantalum capacitor.
Note: Common electrolytic capacitors may be used with some loss of timing accuracy.
C2—0.01-uF capacitor, any type, 12 VDC or better
IC1—555-type timer
R1—2-Megohm potentiometer, linear taper
R2—2.2-Megohm, ½-watt resistor
R3—15,000-ohm, ½-watt resistor
R4—22-ohm, ½-watt resistor
Z1—Electromechanical counter, 6-VDC, 5-digit, surplus type
Note: Author used ITT type CE50BN5014U. These units are available for $4.95 each plus postage for 10 oz. from BA, 3199 Mercer, Kansas City, Mo 64111.

Put It Together. Since the entire project minus the power supply has fewer than ten parts, construction is a snap. If the meter is to be used in outdoor equipment, one of the first things to be done is to find a protected spot in the equipment to mount the circuit.

If the meter is to be used indoors to count the minutes a TV is on per month, for instance, a case should be used to mount the counter. An IC socket can be used for the 555 or connections can be soldered directly to its leads if proper precautions against overheating are taken. *Use a 20-ohm, ½-watt resistor in series with one lead of counter Z1 if the meter is to be built into outdoor equipment that uses a 12-volt battery.* With 6-volt systems or with one of the AC power supplies, eliminate the series resistor.

Connect a 6 or 12-volt battery used on the machine being tested or, if it is to be built for indoor use, use four "D" cells in series or a 6-volt lantern battery to calibrate the meter.

With R1 set near its mid-point, the counter should advance one step every 55-60 seconds. Adjust R1 so that the counter clicks exactly every 60 seconds (decreasing the resistance of R1 decreases the time).

For Outdoor Engine Use. Since it is the most common, your machine probably has a negative ground electrical system (negative battery terminal connected to chassis). However, make sure by either examining the electrical wiring diagram or by using a voltmeter.

In negative ground systems, connect a wire to a terminal on the key switch (not to a terminal that is connected directly to the battery) to point "A" on the schematic. Connect a wire from point "B" to the negative terminal of the battery or to any convenient ground. If the timer runs even with the switch off, you've connected point "A" directly to the battery, bypassing the switch. Try another terminal on the key switch (a voltmeter comes in handy when tracing circuity). Before making the final installation, make sure the Time Tally works only when the key switch is *on*.

With positive ground systems, connect point "B" to a terminal on the key switch and point "A" to a ground. The counter itself can be mounted in any location where the numbers can be read. It is not necessary to mount it in the front panel.

Since the Time Tally records minutes, not hours, the "hours" usually referred to in the owner's manual should first be converted to minutes by multiplying the hours by 60. For instance, a 25 hour maintenance schedule should be changed to a 25X60 = 1500 minute schedule. It is most convenient to make the change right in the manual. It is also helpful to record the last minute you serviced the engine.

For Indoor Appliance Use. Use the Time Tally to find out which appliances are gobbling up those expensive kilowatt-hours. The following formula finds the exact costs of those "suspected" appliances:

$$D \doteq \frac{W(0.05)\ m}{60{,}000}$$

where

W is wattage of appliance
m is minutes in use
D is dollars per month

The above equation is based on an

(Continued on page 103)

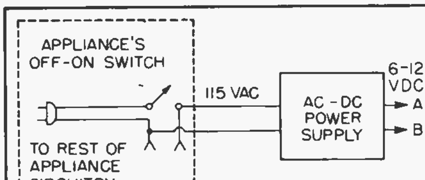


Fig. 2

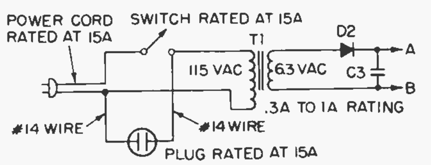
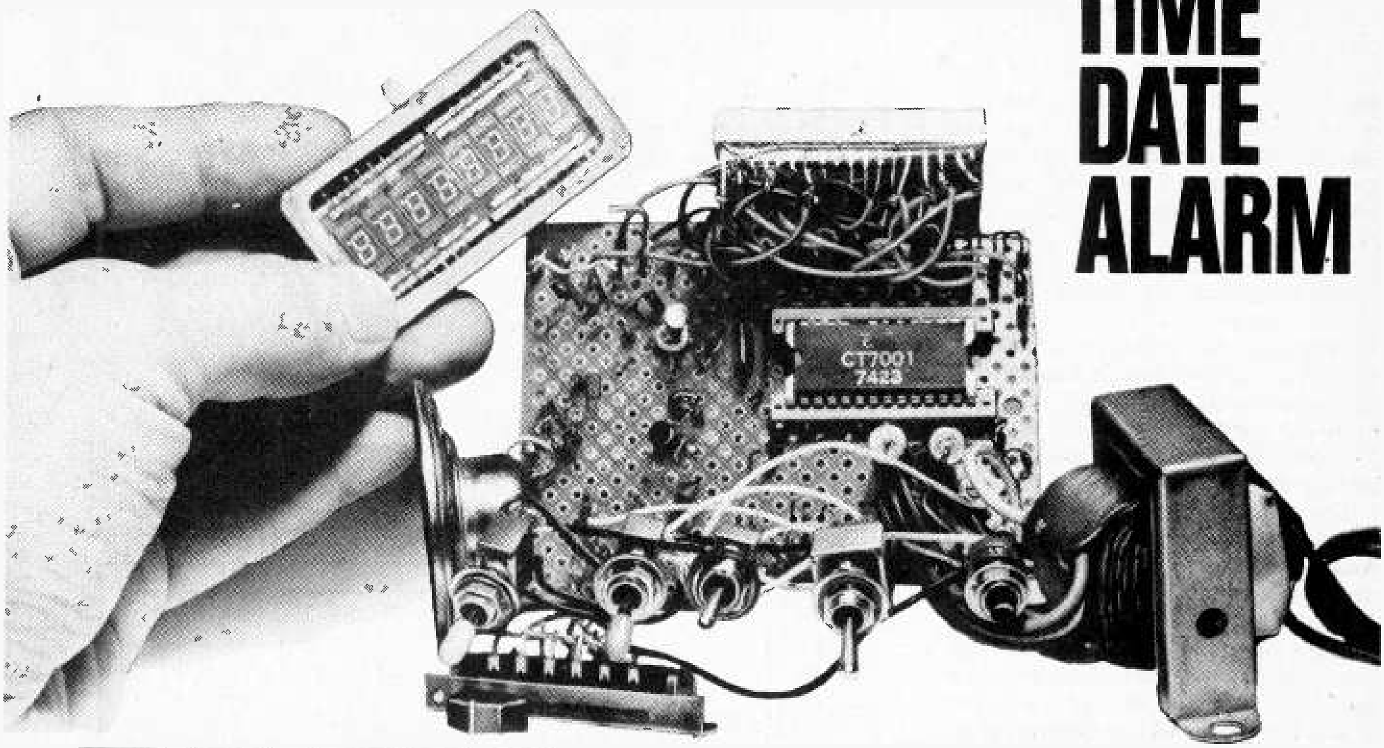


Fig. 3

Putting Time Tally to work. Use Fig. 2 set-up with permanent installations; Fig. 3 shows AC-DC supply. D2 is rated at 1 A, capacitor C3 is 10-uF at 15-VDC or better.

INFLATION-BUSTING DIGITAL CLOCK PROJECT...TIME DATE ALARM



MAXICLOCK

The basic parts—IC, display, transformer, and IC socket—actually cost one half as much as you can pay for similar items used in our last clock!

by C. R. Lewart

TIME FREEZE! What's time freeze? To tell you the truth, nothing that great . . . we think it's everything *else* about this digital clock that's so great!

First of all, it's even simpler to build than our first clock project—a very popular one published over a year ago. Secondly, you'll find that even fewer parts do more jobs.

But today the best feature is one that is uppermost in everybody's mind—the major parts cost. In fact, the overall clock cost is just about *half* the price of our previous clock project. *It's the least expensive electronic digital clock we could find*—kit, project, or assembled—that has just about every feature you can think of in a line-powered digital clock.

It is a 6-digit clock. It is a calendar. It is a 24-hour alarm clock. It has a 10-minute snooze alarm. It has provision for internal battery power operation. It can be operated in either the 12- or 24-hour mode. It knows the days of the month (you update just once every four years at leap year). It is simple to build *without* a printed circuit board because there are no driver transistors for the display. It uses a standard low-cost "calculator" type display, and the display is internally wired—only 13 connections operate all 42 segments of the six-digit display. And all the display connections are made to an IC connector for ease of assembly.

It all adds up to one thing: You should be able to build this clock for a price considerably lower than digital clocks with fewer features. And, oh yes, about time freeze: It's the simple "seconds hold" feature you get with this clock. With it you set the time ahead a minute or two, wait for your time standard (WWV, local radio, Ma Bell, etc.) to count down to zero, flick the function switch, and watch your clock start counting from "00" seconds every time. A small feature, perhaps, but something everyone appreciates.

Other features of the clock are as follows: You can select between time, date, alarm "set" time, or time/date display (a time display for 8 seconds followed by a date display for 2 seconds). A 50 or 60 Hz switch and the time freeze feature let you set time with ease (in the 50 Hz position, the clock will run 20 percent faster on a 60 Hz line). You also have a "snooze" button to recycle the alarm by ten minutes. *There is only one switch for setting hours, minutes, days, and months!* Additional features are an "alarm is set" red LED indicator, leading zero blanking, and a green LED to indicate p.m. The clock also provides an optional 24-hour display, stand-by battery power, and display brightness control.

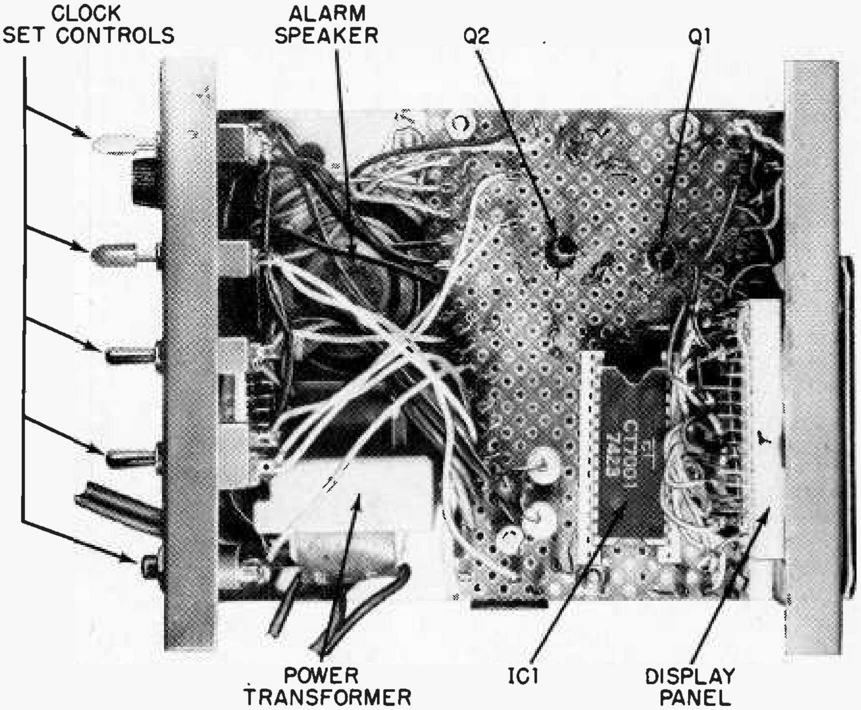
How Does It Work? The brain of the clock is the Cal-Tex CT7001 integrated circuit consisting of thousands of transistors; it counts down the line frequency to seconds, minutes, days, and months. Internal memories record the number of days in each month and the alarm settings. To avoid large numbers of wire leads, the display digits are multiplexed, which means that "gating" signals (digit turn-on signals) are applied in sequence to the "control" grid of each digit. But it happens so fast you "see" a continuous 6-digit display. The display segments of all digits are connected in parallel right inside the display case. It comes pre-wired that way in its compact enclosure.

The first transistor, Q1, turns the leading zero *off* when the "SF" segment (see schematic) appears—this is the only segment not required to form digits 1 and 2. The second transistor, Q2, is a programmed unijunction transistor which drives the speaker to sound the alarm. You can change the sound of the alarm by making C1 smaller or larger as you desire.

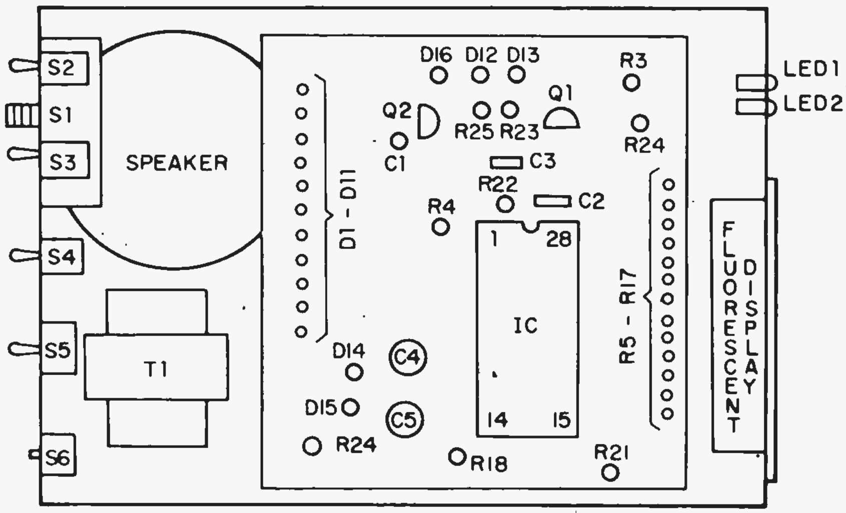
Construction. To build the clock we used point-to-point wiring on a 3 x 4-in. perf board. The clock fits into a 3 x 4 x 5-in. cabinet, but you may want to build it in a slightly larger cabinet with different styling. If your soldering skills are limited, we would recommend a 4 x 5 x 6-in. cabinet. All external connectors are brought out to push-in terminals at the edge of the perf board.

Be careful handling the integrated circuit. A socket for the IC is a must. Install the IC in the socket only when you are finished with all the wiring to prevent a static charge from damaging it.

The display is quite sturdy, though dropping it on its edge on the concrete basement floor (as we did during construction) will definitely wipe it out! Cut a hole in the front of the cabinet for the display and attach it with a bracket, glue, or masking tape. All display connections are brought out on pins similar to a 14-pin dual in-line IC. The pins have to be bent slightly to fit into the IC socket. To improve visibility, we recommend putting a sheet of smoked or green-blue plastic or glass in front of the display.



Birds-eye view of major parts location in a compact and very tight design. Consider building your clock in a more original setting for wall (or even built-in) display with hidden power cord.



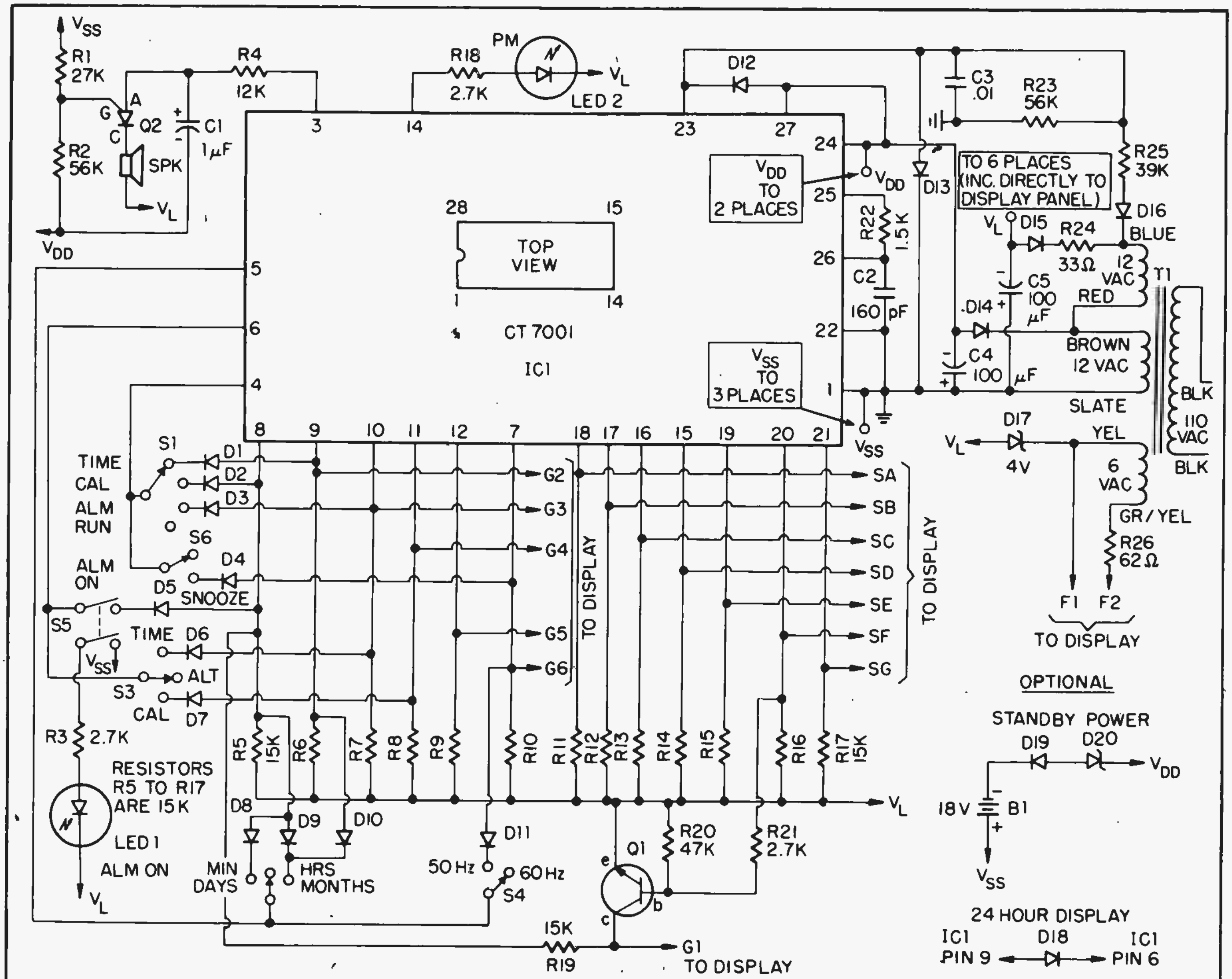
Optional Features. You may want to drop some of the features provided in the basic clock to simplify its construction. You may also want to add a few extra features if you feel strongly about them. Mix and match; it's up to you.

• Leading or blanking zero in the 24-hour mode. If you prefer a leading 0 (05 15 45 instead of 5 15 45) leave out Q1 and R19 to R21.

• Display brightness. If you would like to control the intensity of the display, replace R24 with a 500-ohm potentiometer connected as a rheostat.

• Twenty-four-hour display. You can choose the 24-hour mode instead of the 12-hour mode simply by connecting D18 as shown on the schematic. The clock must be reset when switched from 12- to 24-hour display.

• Stand-by battery power. A couple of 9-volt batteries as shown on the schematic will provide stand-by power. When the AC is *on* they do not supply any current to the circuit. When the AC is *off* the drain on the batteries is only about 3 mA. Though the display will be off, an internal oscillator will keep the counters running so that the correct time and date will be displayed when the power returns. For this option, replace R22 with a 5000-ohm potentiometer connected as a rheostat. Adjust it by unplugging the clock for one minute at a time (with a stand-by battery installed). Then, check whether it is fast



B1—Pair of 9-volt transistor radio batteries.
Note: required only when standby battery power option is included.
C1—1-uF capacitor, any type, 50 VDC or better
C2—150 or 160-pF disc capacitor, 50 VDC or better
Note: You can parallel-connect a 100-pF and 47-pF to obtain an approximate value.
C3—0.01-uF disc or tubular capacitor, 50 VDC or better
C4, C5—100-uF electrolytic capacitor
D1 to **D11, D16, D18**—General purpose silicon diodes such as 1N914
D12, D13—General purpose germanium diodes such as 1N34
D14, D15, D19—1-amp, 200-volt silicon diodes, 1N4003
D17—4-volt, ½-watt zener diode
D20—6-volt, ½-watt zener diode
IC1—Time/date/alarm clock-on-a-chip (Cal-Tex CT7001, do not substitute.)
LED1—Red light emitting diode, alarm-on indicator
LED2—Green light emitting diode, p.m. indicator
Q1—Npn silicon transistor, HEP S0007
Q2—Programmable unijunction transistor, HEP S9001
R1—27,000-ohm, ½-watt resistor
R2, R23—56,000-ohm, ½-watt resistor
R3, R18, R21—2700-ohm, ½-watt resistor
R4—12,000-ohm, ½-watt resistor
R5 to **R17, R19**—15,000-ohm, ½-watt resistor
R20—47,000-ohm, ½-watt resistor
R22—1500-ohm, ½-watt resistor, see text
R24—33-ohm, ½-watt resistor, see text
R25—39,000-ohm, ½-watt resistor
R26—62-ohm, ½-watt resistor
S1—4-position, single-pole rotary or slide switch
S2—Spdt center-off toggle switch
S3—Spdt center-off toggle switch
S4—Spst toggle switch
S5—Dpst toggle switch
S6—Normally open pushbutton switch
T1—Power transformer, P8361
Z1—7-segment, 8-digit fluorescent display with internally strapped segments for multiplex display system, ISE DP89A used by author
Misc.—Small 3.2- or 8-ohm speaker used only if alarm option is included (Radio Shack 40-262 or equiv.); cabinet (author used 3 x 4 x 4½-in. unit but suggests larger size for novice builders such as Radio Shack 270-253 which is 5¼ x 3 x 5⅞-in.); wire, solder, hardware, 14-pin DIP IC sockets for display (2 required), etc.

A partial kit of parts consisting of a Cal-Tex CT7001 (IC1), the ISE DP89A display panel (Z1), and a 28-pin socket for IC1 is available from Photolume Corp., 118 E. 28th Street, New York, NY 10016 for $26.95 postpaid. Power transformer T1 can be added to the basic kit for an additional $3 *at the time of your original order only* (total for 4 items noted in this offer is $29.95 postpaid). Postal money order will speed delivery. Otherwise allow 6 to 8 weeks for delivery. (New York residents must add sales tax.)

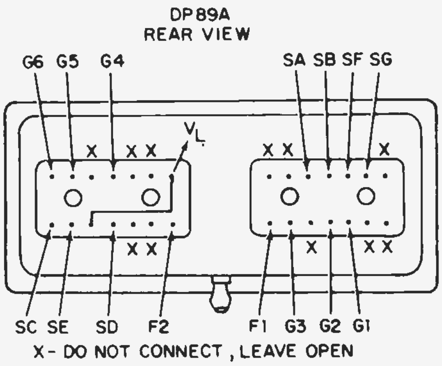
MAXICLOCK

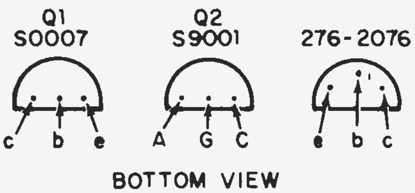
or slow when the AC power is again applied and adjust R22 in the direction which will reduce error.

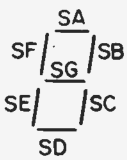
Operation. Set the time, date, and alarm by turning S1 to the proper position (either *time, date, or alarm*). Then flip and hold S2 in the *hour/months* or *minute/day* position—whichever you wish to set. You will notice that the function you have elected to set will increment at one digit per second for as long as S2 is in the off-center position. You will also notice that setting one function will not affect any other function. This feature allows you to set February 29 in a leap year without upsetting any other function. You will also note that moving S1 to *time* stops the clock. When S2 is then actuated, seconds will reset to 00. These two imaginative features make for precise and easy time setting. After making all your settings, return S1 to its normal *run* setting.

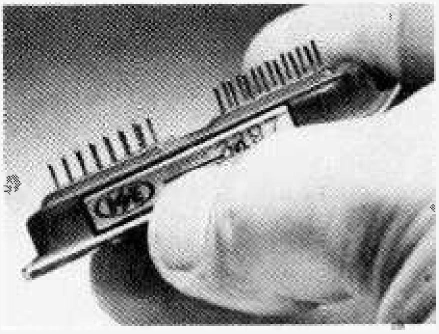
The display mode, *time*-only, *date*-only or *alternate* (time and date), is selected with S3.

The *alarm on* switch S5 also turns on a red LED to make you aware that the alarm is set. The warning light may save you from being awakened at 7 a.m. on a weekend.

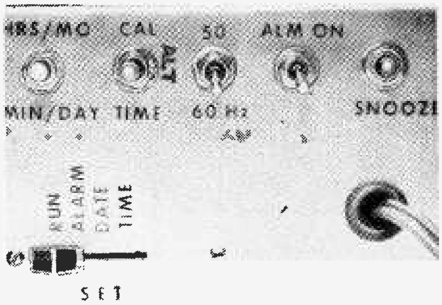




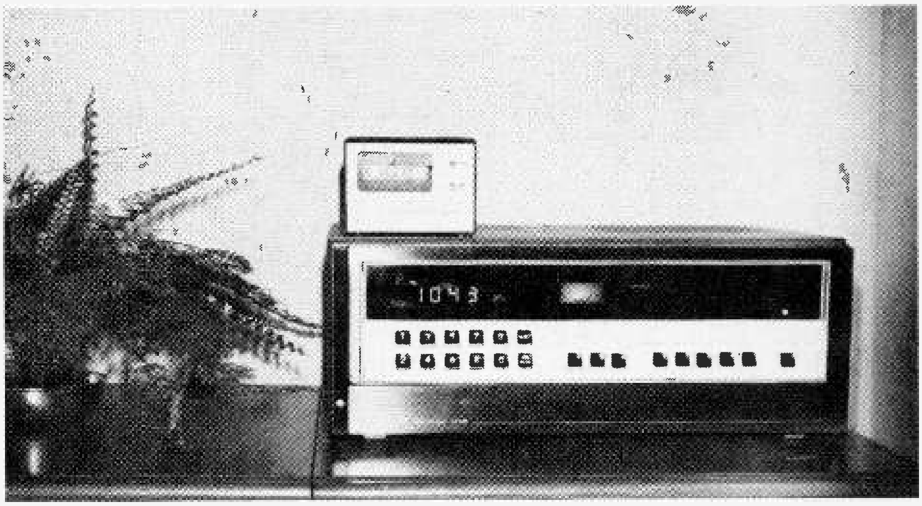




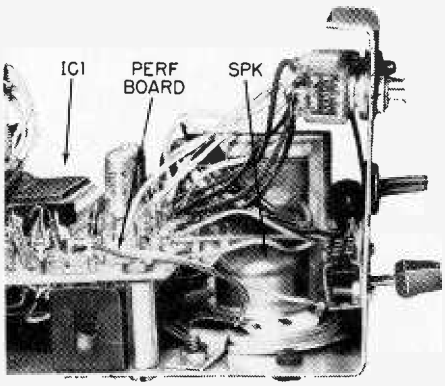
Just a pair of 14-pin dual-in-line IC sockets are needed to connect this compact display with the circuit board. Display is actually an 8-digit device originally for calculator use. Here we blank the third and fifth digits to separate hours, minutes, and seconds.



"Set" switch S1 (see the schematic) tells the clock which of its three functions you want to adjust with the left hand switch (S2). Just hold S2 in the up position to set hours or months; hold it down to adjust minutes or day of the month.



This hi-fi setting is strictly digital with your home-brew digital clock and Heath's AJ-1510 "digital" FM tuner. Hi-fi fans can even add Infinity Systems' Class D Switching Power Amp.



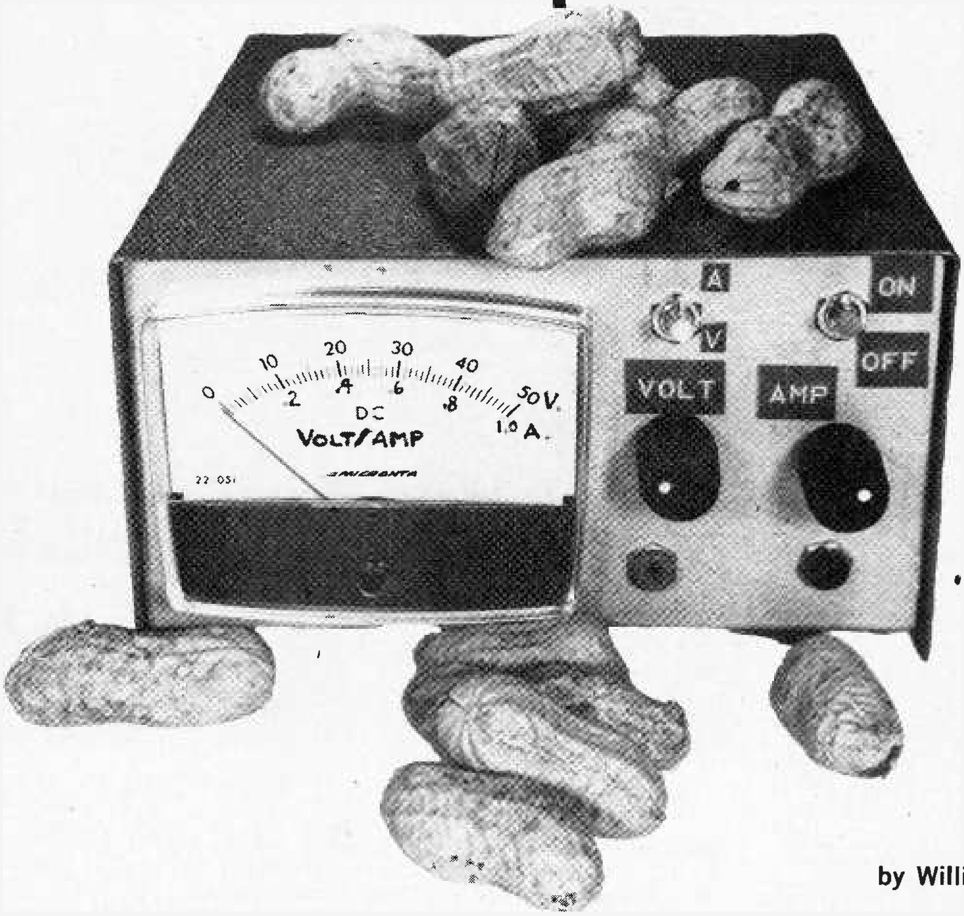
Perf board mounting is simple enough if you use spacers, screws, and nuts as shown. You can mount the display panel (Z1) with anything from double-sided tape to epoxy glue. If you select the alarm option, you must use a small speaker; it can face downward (as shown) or forward for more sound. The kit of basic parts includes the 28-pin IC socket—see parts list for details.

The alarm can be set up to 23 hours, 59 minutes in advance (let the alarm ring for a minute, or better still, just turn it off for a minute before flipping S5 back *on* for tomorrow morning's greeting). Switch S6 is the snooze button and will give you another ten minutes sleep in the morning if you can manage to give it a nudge.

When you set *time* or *alarm*, the p.m. light will indicate whether your setting corresponds to a.m. (light off) or p.m. (light on).

The Wrap-Up. So that's it! A clock project that gives you more for less *is* e/e's style. Our supplier of hard-to-find items has promised to hold the line on prices (see the parts list), so we expect these optional features and useful functions to bring our readers the best clock their inflation-fighting dollars can buy. ■

a professional power supply for hobbyists ...compared to the job it does the cost is peanuts!



by William Montgomery

Sure, I'm a dyed-in-the-wool experimenter/hobbyist, and I've had the fever for some time. And if you're like me, there's a good chance your budget is just as tight.

That fiscal fact plus an appreciation for a good, efficient design is the "need" that helped provide the "shove" that got the ball rolling to crank out this handy power supply for my own use. Looking over the line-up of commercial units and talking to people in the field gives a pretty good picture of just what features are important and which are popular. You'll find them all here with an experimenter/hobbyist's parts budget to boot! Not a bad deal, actually.

You get the benefits of a commercial lab supply for as little as twenty-five dollars—all new parts, complete with case—by building it yourself. A full-blown version complete with switchable front-panel voltmeter/ammeter will peak out at about thirty-five dollars; but if you can scrounge up a 25-volt, 2 or 3-amp power transformer, don't need the meter, and you have a case, all new parts go for about $17. Any way you build it, performance is never sacrificed.

Background: Having the right level of DC power available to test a transistor circuit, a motor, or the like is all too often a problem. It is the old story of not having the right tool at the right time. Batteries don't offer variable voltage or much power. Purchasing an inexpensive, unregulated supply may be satisfactory in some cases, but when transistors in the test circuit begin switching on and off, you may find the supply voltage going up and down. Ideally, one would like to have a selectable voltage level that will not change as the load changes, a fair amount of available power, and an adjustable current limit in order to protect both the supply and the item being tested.

Although ICs are available that deliver regulated voltage selectable over a range of around 0 to 20

POWER SUPPLY

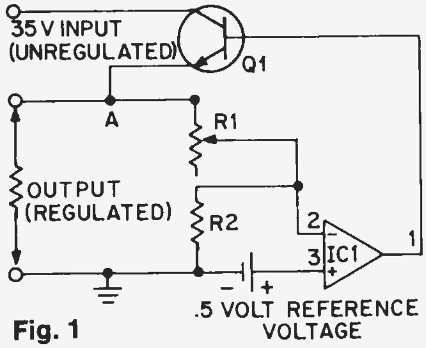


Fig. 1

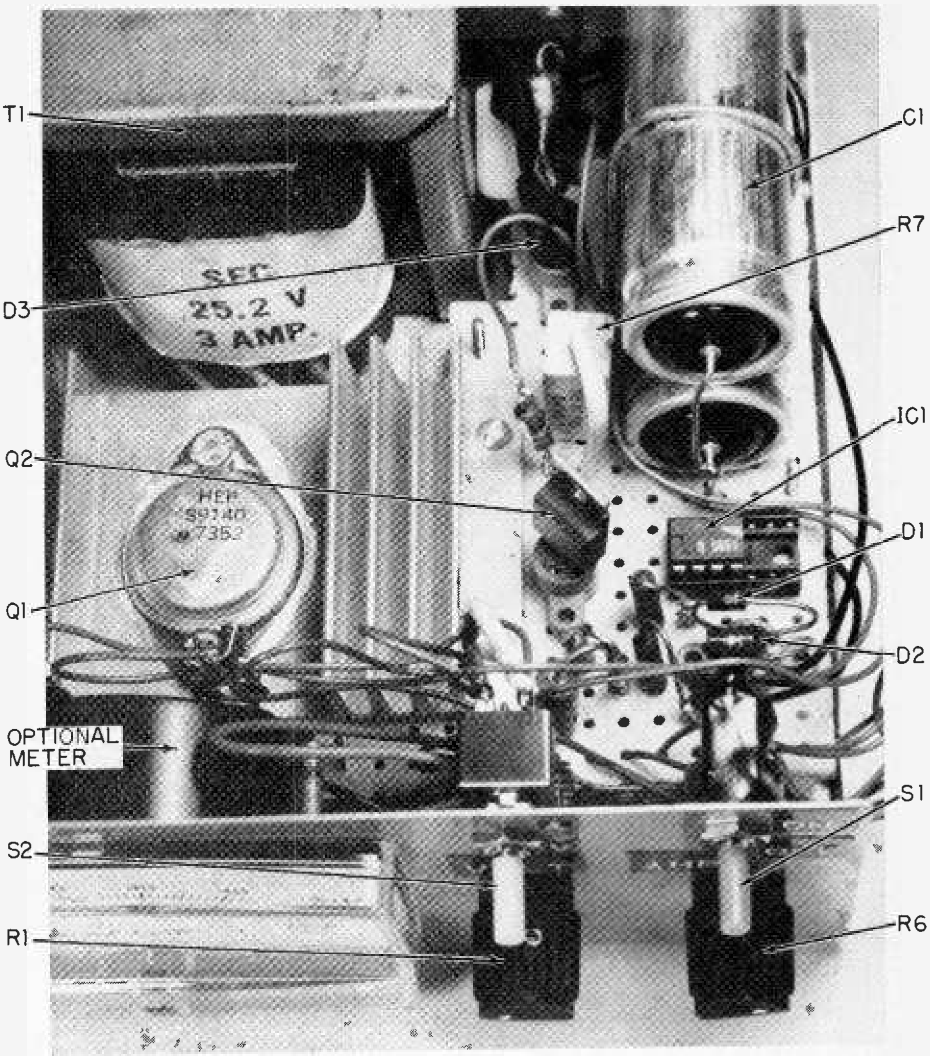
Author's simplified schematic to show the principle of operation. Reference voltage is not necessarily a battery. It could be, but it's not very practical. In this supply it consists of pre-regulator zener D2 and the one-amp silicon power diode called D1.

volts, the power delivered by these ICs is only a few watts. Finally, to purchase a supply that has the desired features would cost a fair amount mainly because one would have to buy a professional-type supply. The answer to all this, however, is really very simple. The power supply described here can be built in only a few hours at low cost, and the features are outstanding.

While the basic principle of operation of this regulated supply is well known—mainly an operational amplifier controlling a power transistor—we have designed this particular unit using components that offer the most for the money and simple circuit "tricks" that provide the best return for your efforts. The result is a supply that uses a handful of electronic parts costing about $20 with the following features:

- Twenty watts of available output power (above 20 watts, for safety, the voltage begins to decrease automatically).
- Adjustable current limiting (maximum current fed to the load can be pre-set to any value between 0.1 amp and 1.0 amp).
- One-half percent regulation (at 10 volts output, for example, the voltage will drop only 0.05 volt between no load and full load).
- Adjustable output voltage of 0.6 volt to 30 volts.
- Short circuit protection (the output of the supply can be accidentally short circuited without harming the supply or even blowing a fuse; try it!).

How It Works. This regulated power supply has a "heart" and a "brain." The brain is a 741 operational amplifier IC which detects error signals. The heart is a power transistor which regulates power to the load. Fig. 1 is a simplified schematic showing how it works. The unregulated voltage comes from a transformer and full wave rectifier. Placing a load across this voltage directly would cause it to drop sharply—which is what we want to avoid.

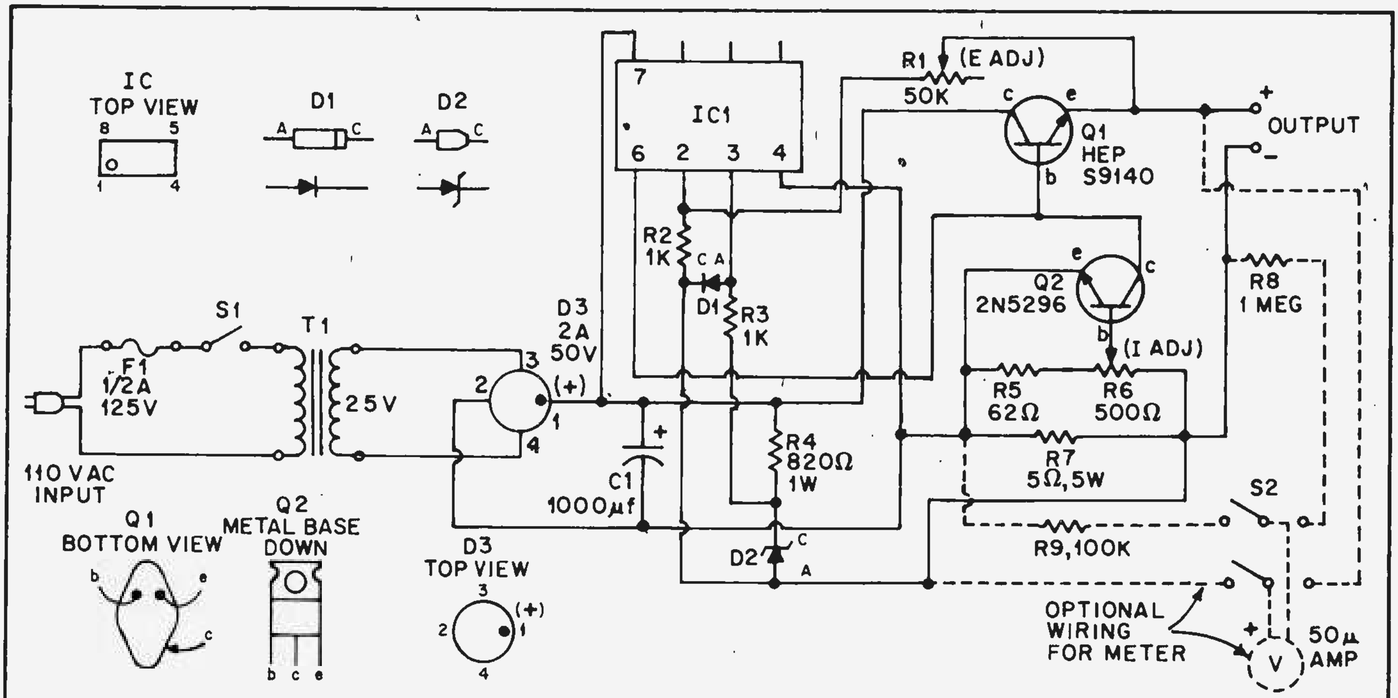


Close-up of construction area showing author's use of transistor sockets for D3, D1 and D2, and Q2. Main point-to-point wiring is done under perf board where hodge-podge wiring techniques can't be seen.

Resistors R1 and R2 determine a voltage gain for the 741 op amp by (1 + R1/R2). The output of the op amp, and therefore the regulated output VOUT is given by $V_{OUT} = 0.6 \times (1 + R1/R2)$, where 0.6 is the reference voltage built into the circuit. This equation holds only when the voltage drop across R2 equals the 0.6 reference voltage, so it is the job of the op amp to force this to happen. The process is basically simple. VOUT is selected by adjusting R1 with, for example, no load on the output. As a load is applied, it momentarily causes VOUT to drop since point A in Fig. 1 is "pulled" closer to ground than before. The voltage across R2 is then less than the reference voltage, so the op amp sees an imbalance, or error voltage, at its input which is amplified and sent to Q1 to turn it on (make it conduct) more. Q1 then "pumps" more current into the load, thereby maintaining the output voltage at its desired level.

In addition to regulating voltage, this unit limits current. In the complete schematic we see that the desired current limit is selected by adjusting R6. When current through R7 causes the voltage at the base of Q2 to be about 0.7 volt, Q2 begins conducting from collector to emitter thereby grounding the output of the op amp and lowering the output voltage, which in turn has the desired effect of limiting the current to the pre-selected level.

The 741 op amp is an ideal device to



You may find the 5-watt, 5-ohm resistor R7 difficult to locate. If so, use a 5-ohm, 10-watt resistor (Lafayette 33-46046) or two 10-ohm, 5- or 10-watt units in parallel (such as Radio Shack 271-132). A dual 741 op amp (such as Radio Shack 276-138) can be expected to meet the author's 10 mV offset spec; for correct pin functions, you change pin 7 to 8 and pin 6 to 1.

PARTS LIST FOR PROFESSIONAL POWER SUPPLY

C1—1000-uF, 50-VDC electrolytic capacitor
D1—1-amp, 50-VDC silicon diode
D2—12-volt, 1-watt zener diode
D3—2-amp, 50-volt diode bridge
IC1—741-type op amp
M1—50-uA panel meter; optional, see text
Q1—npn darlington power transistor (Motorola HEP S9140 or equiv.)
Note: Must be used with a 22 sq. in. heat-sink such as Radio Shack 276-1358. HEP S9102 may be used for Q1 if a 30 sq. in. heatsink is used. The HEP S9140 is available for $4.35 postpaid from Circuit Specialists, P.O. Box 3047, Scottsdale, AZ 85257.
Q2—2N5296 npn power transistor
R1—50,000-ohm linear-taper potentiometer
R2, R3—1000-ohm, ½-watt resistor
R4—820-ohm, ½-watt resistor
R5—62-ohm, ½-watt resistor
R6—500-ohm linear-taper potentiometer
R7—5-ohm, 5-watt resistor
R8—1-megohm, ½-watt resistor (required only if meter M1 is used)
R9—100,000-ohm, ½-watt resistor (required only if meter M1 is used)
S1—spst switch
S2—dpdt switch (required only if meter M1 is used)
T1—power transformer: 120 VAC primary, 24 VAC at 2 amps secondary
Misc.—perf board, hardware, aluminum case approx. 3 x 5 x 6-in., ½-amp fast-acting fuse, fuse holder, kit of mounting hardware for Q1 (HEP A0450 or Radio Shack 276-1370), silicon heat sink compound, wire, solder, etc.

use here because it is inexpensive and has built-in short circuit protection for its output which allows Q2 to ground the output to limit current. When selecting among the various 741 op amps on the market, choose one that, according to its specification sheet, has an offset voltage of less than 10 millivolts; otherwise the lowest output voltage from the power supply will be proportionately greater than the 0.6 volt specified here.

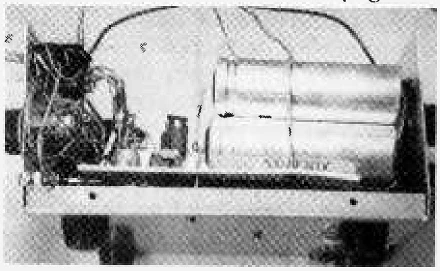
Power transistor Q1 is a darlington type, which means it has a current gain of about 1000. Inside, it is basically one transistor driving another. This results in the high current gain. This high gain is needed to prevent the op amp output from being overloaded, which would reduce regulation quality.

Our Overdesign. Transistor Q1 is rated at 90 watts, but remember that such ratings are at room temperature (25°C). If you set the output voltage to 0.6 volt and draw 1 amp through a load, Q1 will "drop" about 35 volts across it; at 1 amp, that's 35 watts. Without an ice cube on it, Q1 on the heat-sink we have suggested will heat to about 80°C. At this temperature it is capable of dissipating 50 watts, which is well enough above the actual 35 watt requirement for safe operation.

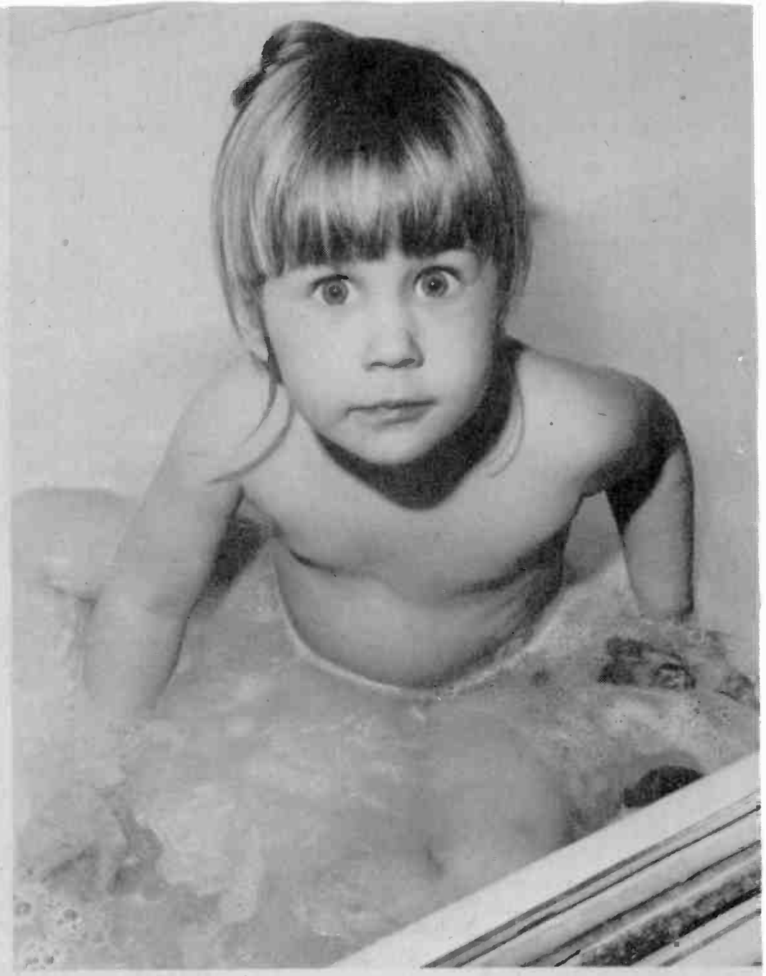
To obtain the low reference voltage for pin 3 of the 741, a regular diode (D1) is used since voltage in the forward direction causes a sharp knee (the voltage at which conduction begins) at about 0.6 volt. It is serving, therefore, as a low voltage zener diode at a fraction of the cost. To greatly improve regulation, D1 is fed by a 12-volt zener, D2, so we have a reference within a reference and a very inexpensive way to obtain a stable low voltage.

Nuts, Bolts 'n Solder. Construction is straightforward. All components will fit on a 4 x 5-in. perf board and within a 3 x 5 x 6-in. cabinet. The transformer may have a center tap (yellow on the Radio Shack version) which can be cut and taped since it is not needed. All 120 VAC leads that go to S1, the fuse holder, and T1, must be covered with insulating tape to avoid the shock hazard associated with these points. In

(Continued on page 101)



Notice tape wrapped around the on-off switch. Safety first is best. The author used 500-uF capacitors in parallel for C1.



DARKROOM PRINTING METER.

Print-paper saver gives you fine B&W prints sooner!

by Herb Friedman

TRY TO grind out wallet-size prints or enlargements from a full 36-exposure roll in only one evening and you'll know just how frustrating life can be. Every change in magnification and negative density means a different exposure. And if you use test strips or exposure guides to hit the correct exposure you're making at least two prints for every one you need.

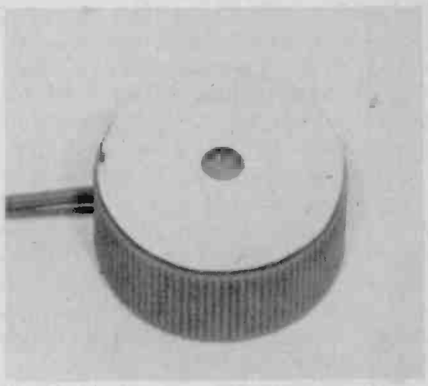
The way to take all this drudgery out of your darkroom work is to use an electronic printing meter, a device that takes only seconds to indicate the correct exposure, regardless of whether the enlarger is at the top or bottom of the rack, or whether the exposure and negative development is over or under.

A quick example will illustrate how easy it is to make prints with a printing meter. Let's assume you have just chocked the negative in the enlarger and have cropped the picture exactly the way you want it. Now you take the probe from a printing meter—which you have previously calibrated for a 10 or 20-second exposure—place it on the easel at the point of maximum light transmission through the negative (the black reference in the print—deepest shadow) and adjust the lens diaphragm until the printing meter's pointer indicates some reference value you have previously selected.

That's the whole bit. Expose the paper for your normal 10 or 20-second exposure and the first print will be a good print. Maybe even a great print. If you're grinding out wallet-size jobs for the whole family, each print from each frame will have the same excellent quality.

A Hint. The key to successful use of a printing meter lies in the fact that, except for some particularly artistic work, any print will look decent to excellent if there is some deep black, even if it's just a spot of black; for the black to highlight or border-white contrast gives the visual appearance of a full contrast range, even if the greys are merged. For those who do portraiture, a printing meter can be user-calibrated for "flesh tones."

The printing meter shown in the photographs has been especially designed for construction and use by the typical e/e photographer/electronics hobbyist. It features a calibration—called "speed"—adjustment to accommodate slow to fast enlarging papers (such as Polycontrast and Kodabromide) and readily available parts, many of which will be found in the typical experimenter's junk box. The layout is non-critical—any cabinet can be substituted; there are no critical shielded



The sensor is really a large tuning knob with photoresistor PR1 embedded in epoxy, plastic or RTV rubber adhesive.

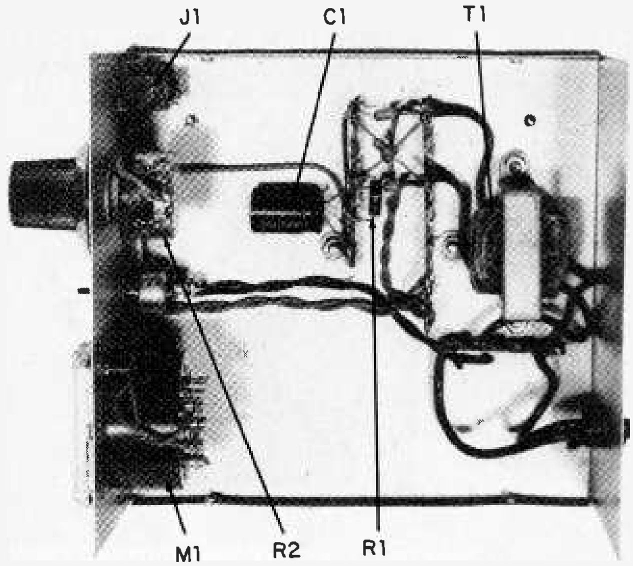
circuits (not even shielded wire is used); and except for the photoresistor sensor, just about any component quality will do. There is absolutely no sense in building the project with the best components money can buy because the best components won't affect the final performance one iota.

Construction. The unit shown is assembled in a 5¼ x 3 x 5⅞-in. metal utility cabinet. Connecting jack J1 is optional as the photoresistor sensor, PR1, can be hard-wired into the circuit. If you use a jack, note that it must be the three-terminal type such as is used for stereo connections; the ground connection is not used since neither PR1 lead is grounded. Do not use an ordinary phone or phono jack as they will ground one of the PR1 leads. Plug P1 must similarly be a matching three-terminal stereo type. Either miniature or full-size jacks and plugs can be used.

Power switch S1 can be anything you care to use—lever, slide, or toggle. Use the least expensive slide switch if you're trying to keep the cost down.

The meter, M1, is a Lafayette Radio 99-26262 illuminated 0-1 mA S-meter. This meter was selected because it has built in pilot lamps with 6 and 12-volt connections. When 12-volt-connected to T1, which is 6 volts, the pilot lamps are dim enough not to affect the sensor and bright enough so that you can see the pointer in the darkroom. Meter M1 mounts in a 1½-in. hole, which can be cut with a standard chassis punch (if you have the punch).

Sort Them. The meter scales are jammed with numerals that can be confusing in the darkroom so the best bet is to paint out the unwanted "calibrations" using Liquid Paper or Liquid KO-REC-TYPE, products used to correct typewriter errors (available in stationery stores). First, snap the plastic cover off the meter. It might feel secure but it's not. Grasp the top of the cover and force the cover outward and down, taking care that when it snaps free the pointer isn't damaged. Next, remove the scale by taking out the two small screws and sliding the scale out from under the pointer. Do not attempt to paint the scale while it is mounted in the meter as a single drop of the fast-setting correction fluid can ruin the meter if it gets into the pivot bearing. When reinstalling the scale, hold the screws with a tweezer or long-nose pliers until you "catch" the first few threads. When the scale is secure, snap the meter's cover into position. (On the unit shown all scales and markings other than 0-to-1 have been painted out, as the 0-to-1 scale is the most convenient to see under dim lighting.)

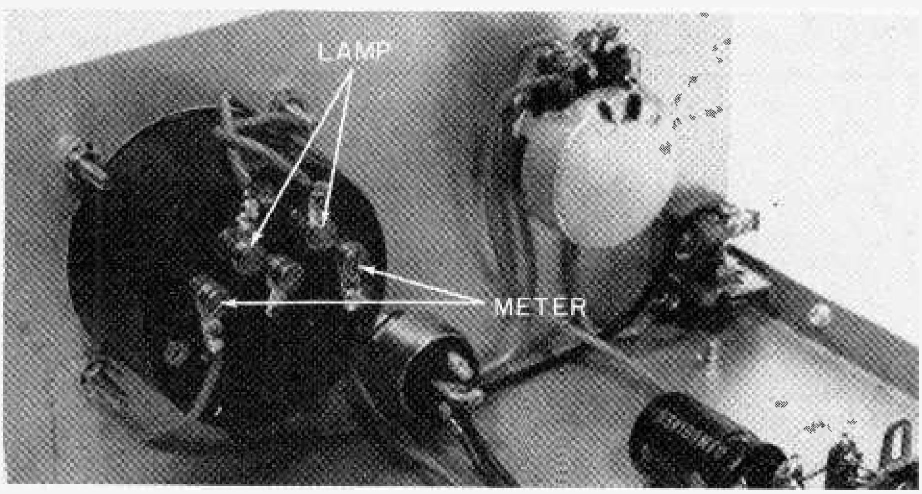


Nothing is critical so don't crowd the layout. Two parallel terminal strips provide the tie points for the rectifier diodes and power supply

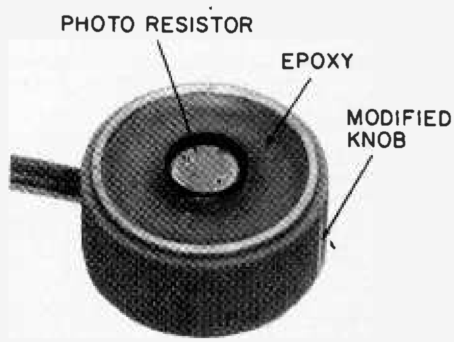
Note that meter M1, power switch S1, and jack J1 have been positioned on the front panel so as to provide the maximum room for the speed control's calibrated knob. Use the largest possible knob as the greater the calibrations the easier it is to reset the control to a desired paper speed.

Power transformer T1 can be any 6.3-volt filament transformer rated 50 mA or higher. (A 6-volt transformer scrounged from a portable cassette recorder will work just fine.)

Power Filter. If the line voltage in your home is known to be reasonably constant, assemble the unit as shown in the schematic. If your local utility likes to bounce the line voltage, or if appliances cause your line voltage to vary (indicated by dimming lights), install zener diode D5 across points A and B. The zener will provide a regulated 6 volts, with the slightly lower circuit



The specified meter has five terminals. The two on the bottom row are for the meter movement. The top row terminals are for the 12-volt lamp connection. The remaining terminal is for a 6-volt lamp connection and is not used.



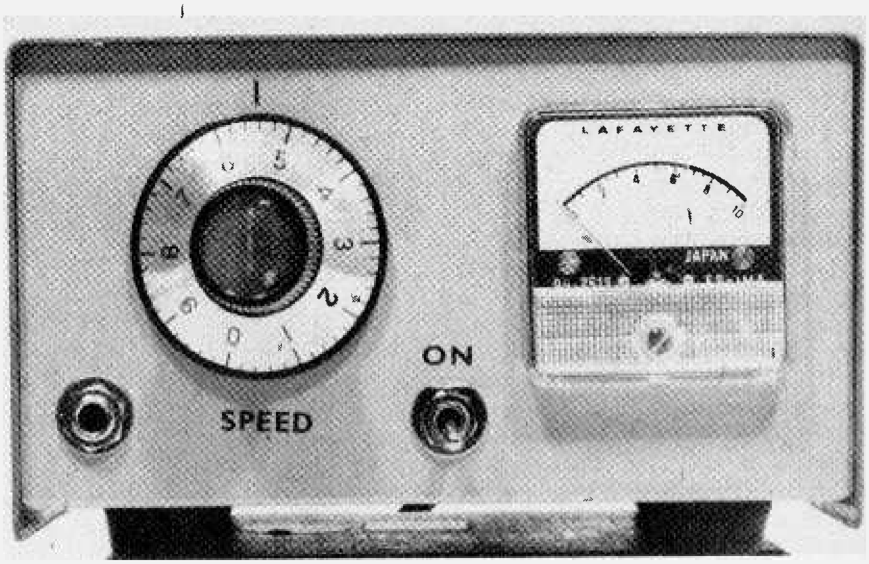
After the sensor is completed, punch a hole in a matching cardboard disc and cement the disc over the sensor. The hole provides a smaller sensitive area required for prints 4 x 5 or smaller. Better results with larger prints are also obtained with the mask.

voltage (6 VDC rather than 9 VDC) providing slightly reduced sensitivity. Normally, you will not need D5, so there's no need to get it unless you're certain you need it.

In order to get speed control R2 to increase sensitivity in the expected clockwise direction, its ground terminal is opposite to the usual volume control ground. Facing R1's shaft with its terminals sticking up, the ground terminal is the one on the left.

Meter M1 has five terminals. The one designated "+" and the one adjacent to it are the meter terminals. The three terminals above the meter terminals are the pilot lamps. The extreme end pilot lamp terminals are the 12-volt connections. The center terminal is not used for the 12-volt connection.

The Eye. The only assembly that requires some care is the sensor. The sensor itself is a photoresistor; however, the photoresistor doesn't have enough heft to maintain its position on the easel, so it must be mounted in a support that can maintain its position without falling over. The sensor assembly shown consists of PR1 epoxy-cemented into a relatively large knob. The knob must be plastic—not metal, though it can have a metal decorative rim—and it's best if there is a recess on the top even if the recess is produced by a rim. Remove the set screw and drill out the set screw hole with a bit approximately 3/16-in. (not critical). Then, using a ⅜-in. bit, drill through the shaft hole clear through the top of the knob. If the shaft hole has a brass (or other metal) bushing make certain the drill bit removes all the metal.



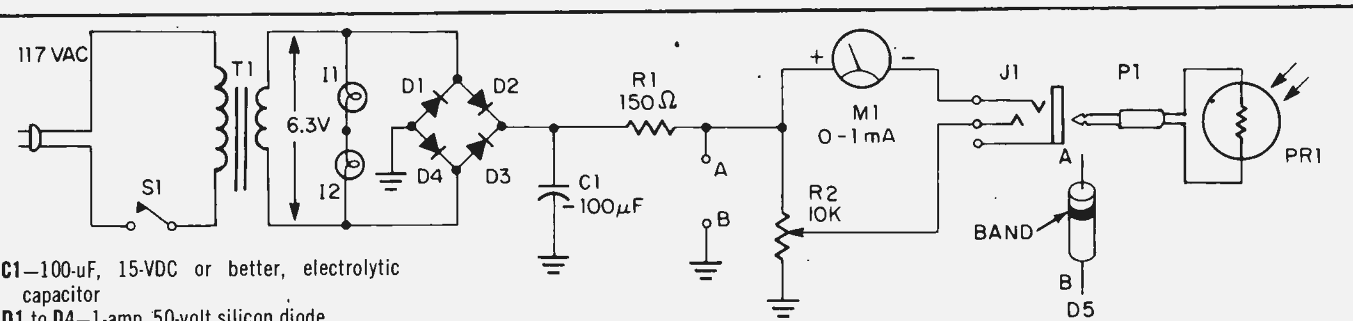
Use the largest calibrated knob you can install without interference by other panel components. The greater the calibration area on the knob the easier it is to preset the paper speed with accuracy.

Pass the PR1 leads through the hole in the knob from the top. Tape it in position. Feed a section of linecord or speaker wire through the setscrew hole and solder the wires to PR1 as close as possible to the knob. Trim away the excess PR1 leads; they should not protrude below the knob. Remove the tape holding PR1, get PR1 as close to the center of the knob as possible, and then pour in a quantity of fast-setting epoxy or liquid plastic from a knob repair kit or plastic modeling kit, and let it set a few minutes until the plastic hardens. Keep the level of the epoxy or plastic below the top of PR1—use less rather than more. If you can't get epoxy or plastic you can use G.E.'s silicon RTV rubber (adhesive, caulk, window sealer, etc.); but the RTV rubber must cure for at least 24 hours. Similarly, pack the bottom of the knob with epoxy, plastic or rubber.

Mask Down. Now, the surface area of the photoresistor is too large for small prints—4 x 5 or smaller—and even some 8 x 10s. So cut a disc the diameter of the knob from shirt cardboard or a manila file folder (but not oak-tag) and using a standard hand punch (such as used in schools) punch a hole in the center of the disc. Apply rubber cement to the rim of the knob and the inside rim of the disc. When the cement is dry drop the disc on the knob so the hole exposes a small part of the photoresistor's surface. It's not all that critical; the hole doesn't have to be precisely over the center of the photoresistor. However, the unit is calibrated for a punch-size hole and might not work properly if the disc is not used, or if the hole is a hand made "pinhole." Use the punch.

Using the Meter. The first step

(*Continued on page 102*)



C1—100-uF, 15-VDC or better, electrolytic capacitor
D1 to **D4**—1-amp, 50-volt silicon diode
D5—6-volt, 1-watt zener diode (optional, see text) (Radio Shack 276-561 or equiv.)
I1, I2—meter lamps, part of M1 (see text)
J1—3-circuit jack and plug set (optional, see text)
M1—0-1 mA movement, illuminated S-meter (see text)
PR1—photoresistor (National 4941 or equiv.)
R1—150-ohm, ½-watt resistor
R2—10,000-ohm audio taper potentiometer
S1—spst switch
T1—transformer: 117 volt primary, 6.3 volt at 50 mA or better secondary
Misc.—large knob for mounting photoresistor, case 5¼ x 3 x 5⅞-in., 5-lug terminal strips for mounting components, wire, etc.

The National 4941 photoresistor is available from the Electronic Hobby Shop, Box 192, Brooklyn, NY 11235 for $3.75 postpaid. New York state residents add sales tax; Canadian orders add $2 for extra postage. No foreign orders, please.

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In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C. Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

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You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

FROM OUR MAIL BAG

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

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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A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

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CIRCLE 12 ON READER SERVICE COUPON

BUILD A PROFESSIONAL DWELL/TACH

Stretch more miles from your gas supply, plus tune-up tips!

by C. R. Lewart

WITH GASOLINE prices going up, and with the growing concern about air pollution caused by automobile exhaust, a well-tuned car becomes a must. One of the essential tools for a tune-up is a dwell/tachometer that helps you adjust your engine to its optimum specs. What we describe here is a dwell/tach based on a newly-developed integrated circuit. It's easy and inexpensive to build, but with the IC it will also be more precise and easier to handle than most currently available commercial units. You may either put the unit in a portable case, as we have done, for use as a diagnostic tool, or you may mount it permanently on the dashboard.

The main advantages of the circuit are readings basically independent of the battery voltage, temperature, and the shape of the voltage at the points.

How Does It Work? First let's consider the shape of the voltage at the distributor points. When the points open there is a sharp spike of 100 to 300 volts followed by damped oscillation settling at the battery voltage as shown in the illustration. When the contacts close, ground is applied to the bottom of the ignition coil, and voltage across the points drops to zero as current flows in the ignition coil primary.

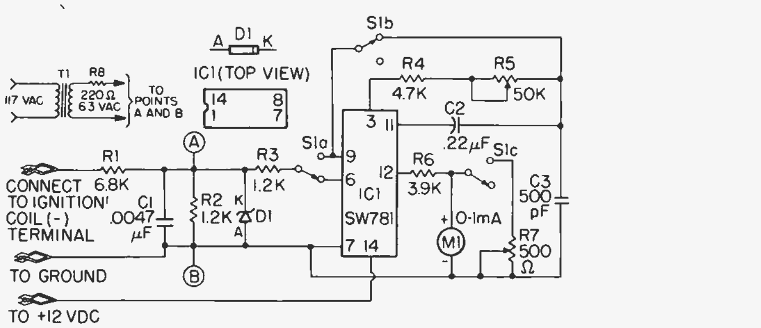
In the integrated circuit there is a temperature-compensated monostable pulse generator section, an amplifier-limiter section, and a voltage regulator section.

For the tachometer mode, the input circuit (R1, R2, R3, D1 and C1) assures that only the initial high-voltage spike caused by the opening points triggers the pulse generator. The generator produces a single rectangular pulse whose amplitude is determined by the IC parameters, and whose pulse width is determined by R4, R5, and C2. The pulses are amplified and fed into a one-milliampere meter which reads the average current. The higher the RPM, the more pulses, and the higher the meter reading.

In the dwell meter mode we bypass the pulse-generator section of the IC and apply the signal directly to the amplifier-limiter section. The meter reading then corresponds directly to the percentage of time the points are closed.

Calibration. The easiest way to initially adjust your unit is to connect it to a 12-volt battery and use a small 6.3-volt filament transformer to supply 60 pulses per second from the power line. *A 60-Hz line frequency corresponds to the following meter reading in rpm.* Set meter to the proper reading with calibration control R5. A 4-cyclinder engine scale would read *1800 rpm* with the 60-Hz input, a 6-cylinder engine would read *1200 rpm,* and an 8-cylinder engine, *900 rpm.*

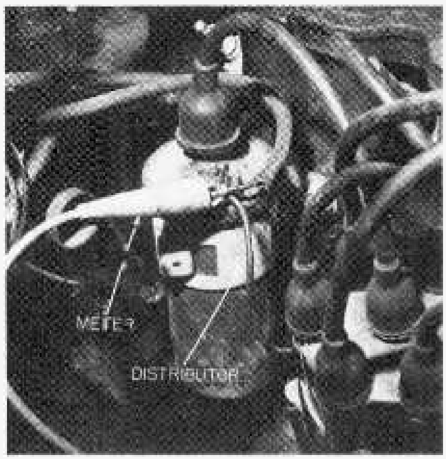
If, for example, you decide on a 2000-rpm full scale for a 6-cylinder engine (equivalent to 3000 rpm for a "4-banger" and 1500 for a V-8), set calibration control R5 for a 0.6 mA reading. The calibration reference for a 6-cylinder engine in rpm (1200) divided by the full scale in rpm (2000) times the full scale meter reading (1 mA) equals the calibration point meter reading in current (0.6 mA). Once calibrated, the rpm value is determined by multiplying the meter reading and the full scale. In this example the full scale is 2000 rpm, so a meter reading of, say,



PARTS LIST FOR DWELL/TACH

- **C1**—0.005-uF capacitor
- **C2**—0.22-uF capacitor
- **C3**—470-pF capacitor
- **D1**—Zener diode, 9-volt, ½-watt
- **ICT**—SW781 (available directly from the manufacturer, Stewart Warner Corp., 730 E. Evelyn Ave., Sunnyvale CA 94086, for $5.25 postpaid)
- **M1**—0-1 mA meter
- **R1**—6200-ohm, 1-watt resistor (you can use two 12,000-ohm, ½-watt resistors in parallel)
- **R2, R3**—1200-ohm, ½-watt resistor
- **R4**—4700-ohm, ½-watt resistor
- **R5**—50,000-ohm potentiometer
- **R6**—3900-ohm, ½-watt resistor
- **R7**—500-ohm potentiometer
- **R8**—220-ohm, ½-watt resistor
- **S1**—4PDT switch, 3 sections used
- **T1**—Transformer, 117 VAC to 6.3 VAC

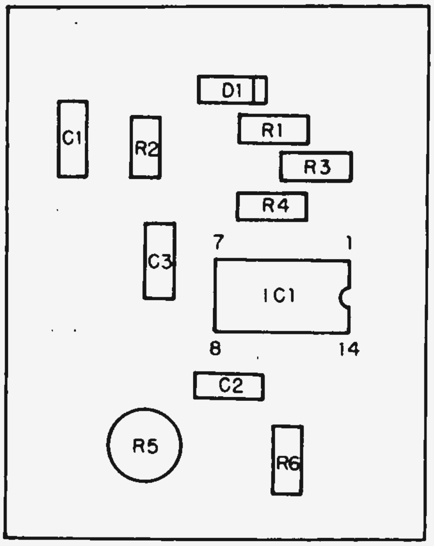
Misc.—Cabinet, perf board, clip leads, wire, solder, etc.



Clip "meter" wire from dwell/tach to ignition coil minus terminal. Look for "distributor" wire. It runs from the (—) terminal to the base of your distributor.

0.4 mA would mean an engine rpm of 800. Once R5 is set it should not require recalibration unless accidentally moved. If you prefer several ranges on a tachometer, or if you would like to use the same scale for 6- and 8-cylinder engines, switch-select a second pot of the same value as R5. Use one switch setting to calibrate for 6-cylinder engines, then throw the switch and use the second pot to calibrate for 8-cylinder engines.

It might be a good idea to tape a small mA-to-rpm conversion chart to the back of your meter. Compute rpm values for major meter divisions to give



Use perfboard construction and lay out circuit components as shown. R7, S1, and M1 are located on front panel.

yourself a quick conversion capability, particularly if you choose a full scale of other than 1000 rpm. If you select a 1000-rpm full scale for V-8 engines, the meter will read directly in rpm. Just ignore the decimal point. For example, .55 would be 550 rpm.

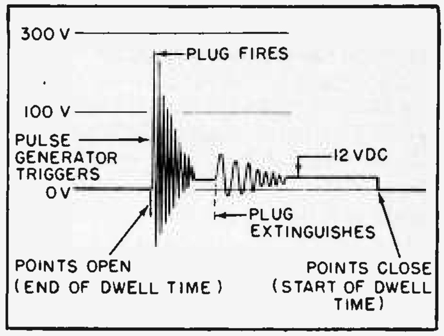
With the values of components shown, you can adjust R5 for a full scale reading for a 6-cylinder engine between approximately 1200 and 6000 rpm.

A dwell meter adjustment is done with R7. When the input (points) lead is disconnected, the meter should read full scale. Due to excellent voltage regulation in the IC, this potentiometer should not need adjustment after your initial setting. Full scale automatically corresponds to a 45-degree angle for an 8-cylinder engine, 60 degrees for a 6-cylinder, and 90 degrees for a 4.

Operation. Connect plus and minus power input leads to your 12-volt car battery. Switch S1 to the dwell function and adjust if necessary for a full scale meter reading, then connect the third lead to the points (thin wire going from coil minus to the distributor housing). Now you are ready to take measurements.

Auto Ignition Info. Let's define some of the points about ignition points. A term used very widely is distributor contact dwell. Degrees of distributor dwell are the degrees of rotation during which the breaker, or contact points, remain closed. This is commonly referred to as dwell angle or cam angle. Correct distributor contact dwell is essential for good ignition performance and point life. Distributor contact dwell in effect is the amount of time that the points remain closed. During this interval of time, magnetic energy builds up in the ignition coil, which, when the points open, generates the high voltage pulse that *arcs* across the spark plug electrode. Generally a longer dwell period (larger dwell angle) is more advantageous for high speed operations.

Replacing ignition points is a simple matter of unscrewing the point retaining plate and screwing down the new one. This is just the beginning of a good tune-up. To check dwell reading you should have a dwell meter. Like most, ours is combined with a tachometer. With the engine running and the dwell meter/tachometer connected you should observe the dwell meter reading. If the dwell reading is within specifications for the engine then you can assume you have the correct gap, and that point contacts are in satisfactory condition. If the



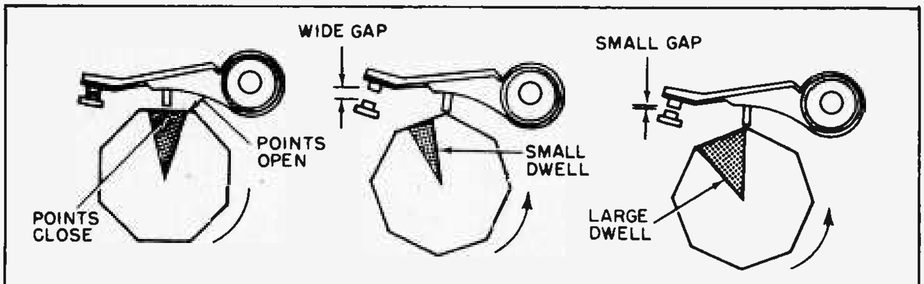
A pulse generator in your dwell/tach is designed to trigger just once each time the points open and a plug fires. Erratic behavior in some non-electronic tachometers is due to this complex wave.

dwell reading is not within specifications, the point gap may be incorrect, the cam worn, the rubbing block worn or the moveable contact arm may be distorted.

Mini Lube Job. Distributor lubrication is something which is usually overdone. If the distributor has an oiler on the outside of the distributor base, add three or four drops of SAE10W motor oil to the oiler. If there is a felt wick under the rotor at the top of the distributor cam, use three to six drops of SAE10W oil. All grease should be wiped from the distributor cam and rubbing block. It's very important that the ignition points be free of grease or oil.

Many ignition systems use dual breaker points. These dual breaker point systems are designed for long life and good high speed performance. They are handled in the same way as single ignition points with the following exceptions: One set of contacts should be blocked open with a clean insulator. A matchbook section makes a good clean insulator for this. Adjust the opposite set of points to specifications using a dwell meter. Loosen the stationary contact block screw just enough so that the stationary contact can be moved with a light touch, otherwise it will be difficult to set the contacts accurately. When the one set of contacts has been adjusted for the correct clearance, tighten the stationary contact lock screw. Block the adjusted set of contacts with an insulator and adjust the other set of contacts in the same manner as the first set. Remove the insulator and recheck the tightness of the stationary contact lock screw. If the contacts have been properly adjusted the dwell should be as specified for both contact sets. Again you must make sure that the gap and the dwell specifications are met for both sets of points.

Don't Overlook The Carb. A list of malfunctions caused by a sick carburetor reads like a "Who's Who of Auto



As a gasoline engine runs, a normally closed switch called the "points" is constantly being pushed open by a cam. Whenever the points open, a high voltage is generated by the ignition coil to "fire" a spark plug. Dwell shows how many degrees the cam turns before it opens the points.

Ailments." It includes hard starting, flooding, delayed acceleration, poor gas mileage, stalling, rough running, fouled spark plugs, and the gas leaks at the carburetor.

Not all of these problems, however, result only from an ailing carburetor. For this reason you should make sure spark plugs, ignition parts, compression, and timing are all in good condition before beginning carburetor service. In short, make sure your engine is correctly tuned, because your carb depends on the proper operation of the rest of the engine.

All types of carbs—no matter how many barrels—have only one throttle adjusting screw. Two- and four-barrel units, however, have two idle adjustment screws—one for each idle system.

Warm the engine to operating temperature and have the choke valve completely open when adjusting. Start the engine and let it idle. If it stalls, turn the throttle screw in until the engine is running steady without any foot pressure on the accelerator.

The idle mixture should be adjusted to give a smooth idle. Missing is a sign of too lean an idle mixture, while rolling or loping indicates too rich a mixture. Turning the screw in leans the mixture. It may be necessary to readjust the idle speed and mixture after the air cleaner is installed.

(Note: late model smog-controlled cars usually have a plastic limiter that restricts the movement of the mixture screw. An acceptable mixture of adjustment should be possible within its limits.)

Turn the idle adjusting screw in slowly until the engine is about to stall. At this point, turn it out about a half-turn. If the engine seems to race, turn the throttle adjusting screw out slowly until the speed comes down.

Service Your Plugs. Be extremely careful how you apply the socket wrench over the spark plug insulators. While they can resist the sledge-hammer blows under extreme temperatures and load that take place inside the cylinder each time they fire, they can be cracked by carelessly banging them with a wrench either taking them out or putting them in.

After removing your spark plugs, you have three things you can do: put them right back in the engine, have them cleaned and regapped and reinstalled, or replace them with new spark plugs.

In the first case, you may merely want to examine the general condition of the plugs or check to see if the heat range is correct for the particular engine. Choice number two would be normal if spark plugs have only been used for around 5,000 miles and show normal wear. Clean and regap after 5,000 miles of use. Choice three would normally apply to spark plugs that have 10,000 miles of use or more on them.

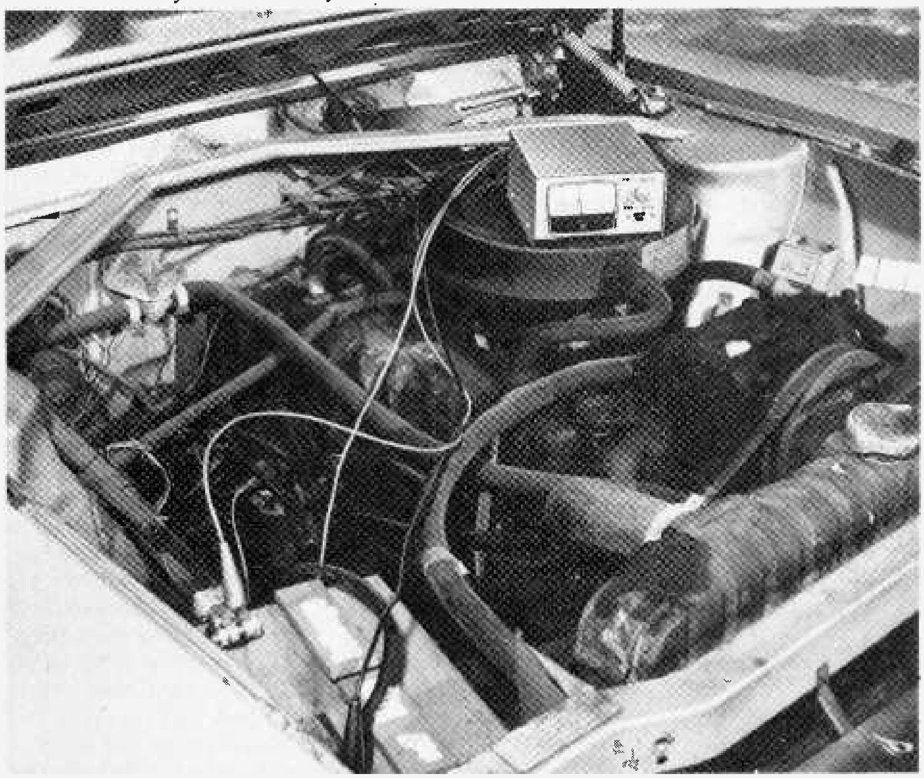
Assuming that no particular complications exist, soak the spark plugs in a good parts cleaner for a few minutes to remove any oily deposits that exist.

To remove carbon deposits, use a small knife or any other small tool which will fit up inside the plug along the insulator. Be careful not to chip the ceramic and avoid the use of a wire wheel, which will completely ruin the plug.

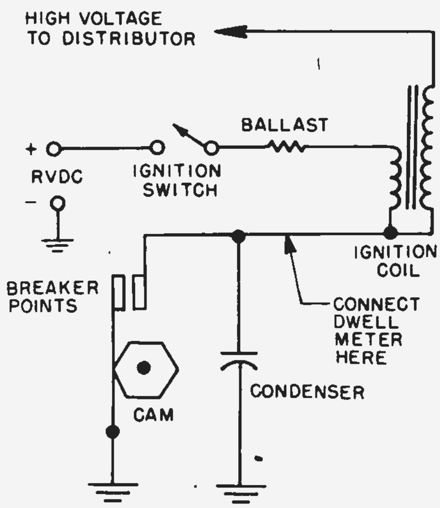
Hard carbon formations are often impossible to remove. As you examine the plugs, you may notice such a condition, or possibly a burned condition of the electrodes. In such a case, it's advisable to install a new set of spark plugs as you'll need them soon anyway.

If the condition of the spark plugs is satisfactory after cleaning, open the gap. File the electrode sparking surface with an ignition point file before opening up the gap. You will get better firing from clean, flat surfaces, so this is an important part of spark plug servicing. Finally, adjust the gap to the manufacturer's specifications (Check the owners manual).

Making sure you have the right spark plugs installed and that they are in good condition is vital to good ignition system performance. But it's only part of the story. Other parts of the system must be working properly if the plugs are to do their job. Wiring, distributor components, and coil condition all affect the production of a healthy spark. ■



Tune-up helped this overdrive equipped '68 Rambler increase mileage from 21 to over 25 mpg at today's 50-mph speeds. They laughed when I ordered overdrive back in 1968. Now one tank gives us a 375-mile driving range!



This is a typical non-electronic ignition system used for nearly all auto and truck engines since Henry Ford dropped buzzer ignition for his Model A. Additional part of ignition switch usually shorts out the ballast for more spark during starting.

Build this long range microphone and...

Bug Mother Nature

by F. J. Bauer

With a parabolic mike offering sonic and electronic amplification you're in tune with Helix Aspera to Yellow-bellied Sapsuckers!

ENGLISHMAN George Riley lives in Kent, works in London, and goes home to an unusual hobby.

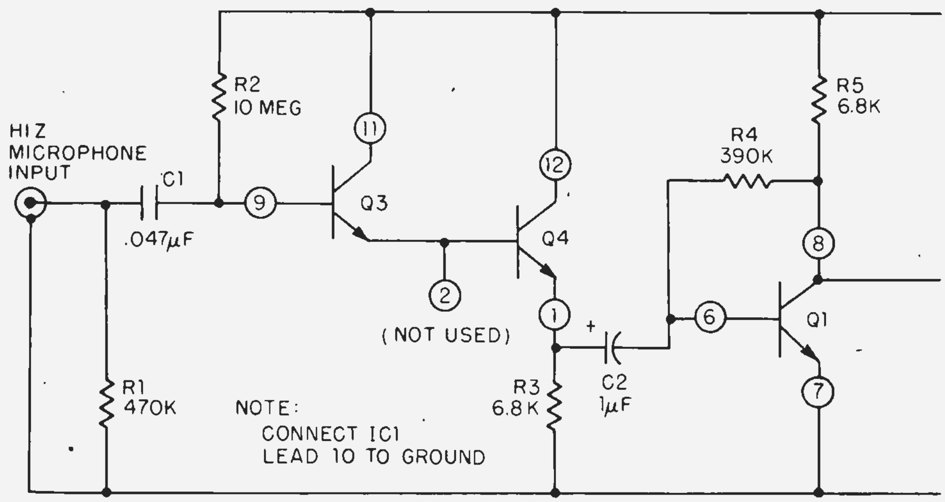
"It all started about a couple of years ago when I borrowed a friend's parabolic directional microphone dish. This type of equipment is hyper-sensitive and can be pinpointed to record a sound without external noise interference. I was using it to record the sound of crickets when I suddenly heard a strange 'slurping crunching' sound. This turned out to be a large snail making the most of some hard grass. From then on I was hooked," says George.

Experts such as zoologist Donald J. Borror have used the parabolic microphone technique to produce 33⅓ rpm records that sonically illustrate ornithology books and booklets.*

After stumbling over a couple of radar antenna dishes a few years ago, I finally decided to put one of them to work. Since I was no microwave expert, I decided to try an acoustic application. After all, I reasoned, a parabolic dish is a parabolic dish whether it is used for reflecting and focusing microwaves or sound waves. The result is the parabolic microphone described in this article.

If you want to go all out for added gain, look over the surplus dealers' list for an 18-inch or larger aluminum model. As nearly as I can tell with the test equipment available, the 18-inch reflector adds about 10-dB gain to the microphone.

Construction. It's simple enough as reference to the photos will reveal. The mount for the dish is made of wood



PARTS LIST FOR A PARABOLIC MICROPHONE

B1, B2—2U6-type 9-volt battery
C1—0.047-uF disc or tubular capacitor
C2, C3, C5, C6—1-uF electrolytic (observe polarity) or tubular capacitor, 35 volts or better
C4—0.01-uF ceramic disc capacitor
IC1—3018 integrated circuit (RCA CA3018), available from Circuit Specialists Co., Box 3047 Scottsdale, AZ 85257; $2.00 postpaid
R1—470,000-ohm, ¼-watt resistor
R2—10-megohm, ½-watt resistor
R3, R5, R8—6800-ohm, ¼-watt resistor

and masonite. The dish is held in place by three threaded rods which also serve as the microphone support. Almost any kind of rod material will do, as long as it is or can be threaded. I happened to have some odd pieces of 9-gauge aluminum clothesline which threaded easily with a 10-32 die. Make the rod length about 7½ inches to allow sufficient leeway for adjusting the microphone for optimum focus. A small bracket or block may be added where the dish touches the wooden base to add rigidity, and a hole in the center of the base will make it convenient to mount the whole assembly on a camera tripod.

Any low-priced ceramic or crystal microphone cartridge will work well with this reflector. The one shown in the photograph happens to be out of a pre-WW II hearing aid!

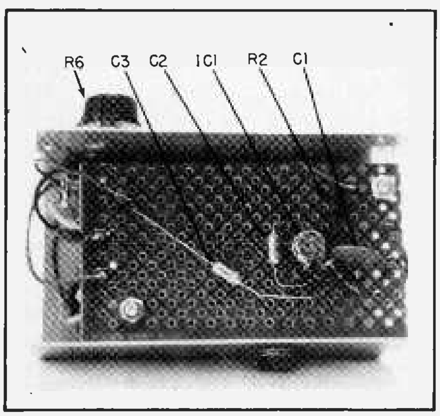
Mount the microphone cartridge on the rods with rubber bands. The exact method of attaching the rubber bands to the microphone cartridge is left to the ingenuity of the builder, since this will largely depend upon the physical configuration of the microphone.

Next route a 16-inch piece of shielded microphone cable from the microphone along one of the rods, through the dish (but inside the back plate), and terminate the cable in a phono plug. The cable should have sufficient slack so that it may be easily plugged into the amplifier box. Also, be sure to allow sufficient lead slack at the microphone end of the cable so that the shock mount effect of the rubber bands is not nullified. This will complete the microphone reflector assembly, which should be set aside until the amplifier is built.

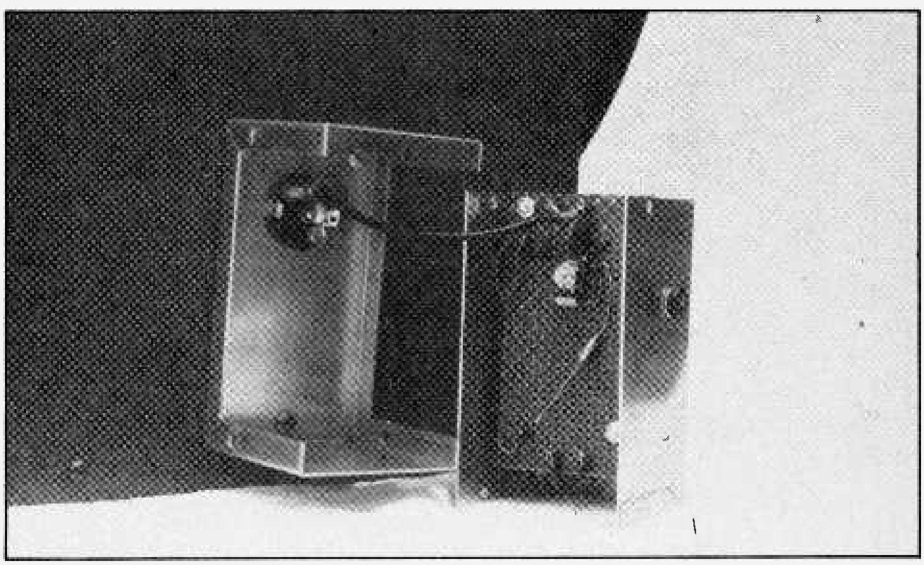
Electronics. The amplifier is a three stage affair using an RCA CA3018 integrated circuit. Transistors Q3 and Q4 are used as a Darlington pair in an emitter-follower circuit in the first stage. This provides the necessary high input impedance required by the crystal microphone. The two following stages utilize Q1 and Q2 respectively as conventional common emitter amplifiers. The average gain per stage is about 38 dB.

Capacitor C4 across audio gain control R6 provides a 3-dB roll-off at 15 kHz, thus limiting amplifier frequency response to the desired audio range. In addition to limiting the frequency response, this capacitor also reduces the tendency of the amplifier to oscillate at higher frequencies, which could result in instability and low output. The 3-dB point at the low frequency end is about 70 Hz, sufficient for this application.

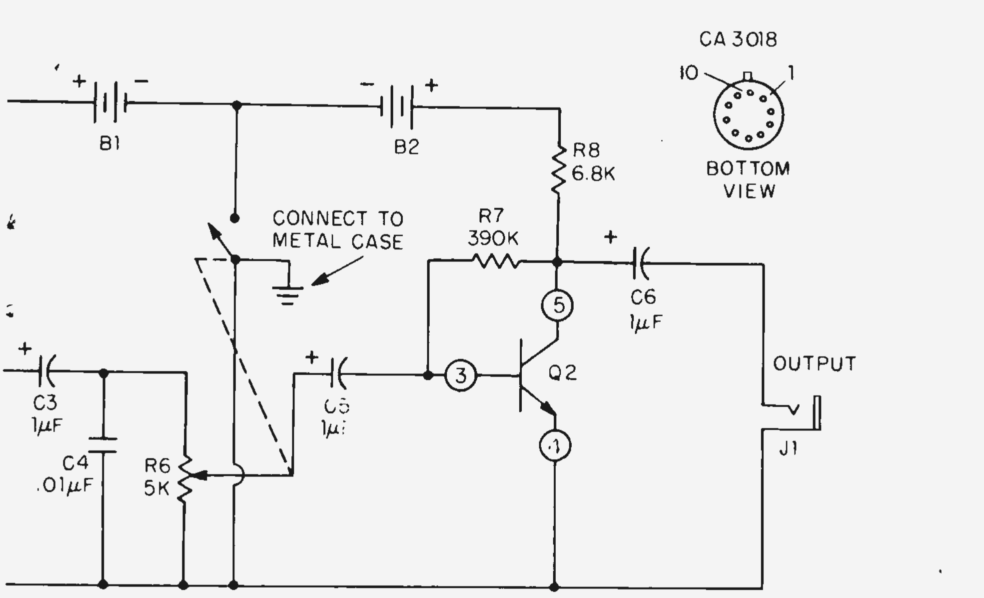
Two 9-volt transistor batteries are used to power the amplifier; not because of high current drain, but, to avoid common coupling between the output stage



Place components above and below the raised perf board. High impedance circuit makes it necessary to shield the amp in a metal box.



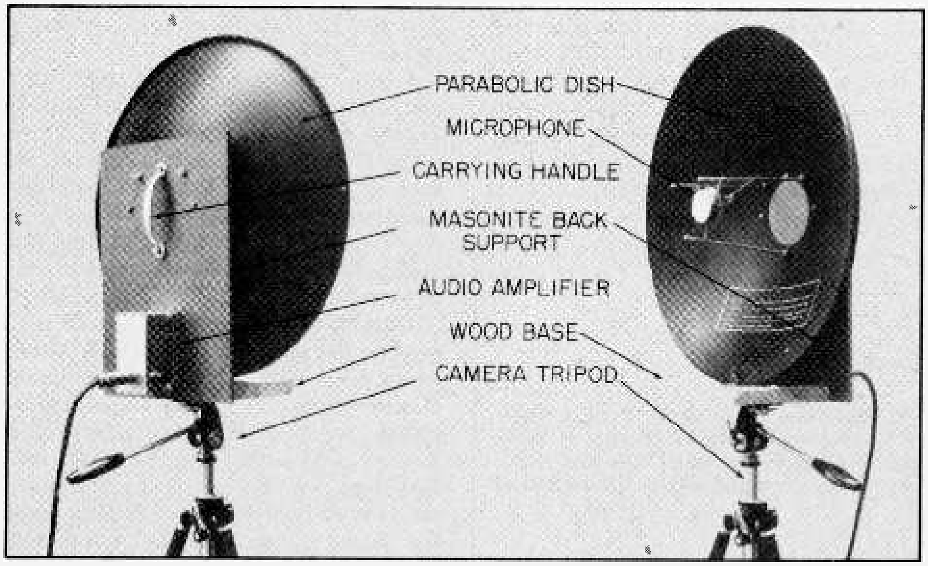
Suspend the microphone you use from rubber bands that extend to the support rods. Or, a clamp wrapped in foam packing material holds Riley's microphone securely.



R4, R7—390,000-ohm, ¼-watt resistor
R6—5,000-ohm audio taper potentiometer with spst switch
Misc.—Aluminum case, 2 x 4-in. perf board, plugs, jacks, hardware, push-in terminals, microphone (high impedance crystal, see text), wire, solder, etc.
Note: The ETCO catalog lists a "government surplus" aluminum parabolic reflector. ETCO Electronics, 464 McGill Street, Montreal 125, Canada.

and earlier stages of the amplifier. An RC decoupling network could, of course, be used instead of two batteries, but it was found that oscillation would occur in spite of the decoupling network after the batteries had been in service for awhile. Two batteries absolutely guarantee against amplifier instability during the useful life of the batteries. The total current drain of the amplifier, by the way, is only 1.5 mA.

No trouble should be experienced with the amplifier if the original layout is followed. All amplifier components are mounted and wired on the perf board as shown. The volume control, capacitor C4, and the earphone jack are mounted on the part of the minibox that serves as a cover and battery holder. All connecting wires are soldered to push-in terminals on the perf board, and the perf board is mounted above the batteries with small bolts and spacers. After assembly, connect the microphone to the amplifier input with a short piece of cable.



The audio amplifier cabinet cover is secured to the Masonite back support permitting snap removal of amplifier chassis for inspection.

Check Out. When testing the amplifier on the bench, either have the microphone connected to the input terminals or substitute a half-megohm resistor for the microphone input. If you have a hum problem it is probably caused by nearby AC wiring. (I had to turn off power to the workbench whenever I tested the amplifier out of its case.) Alternatively, you may find a place in the house that is hum free; make your tests there. With the amplifier completely enclosed in its case, there is absolutely no hum pickup problem.

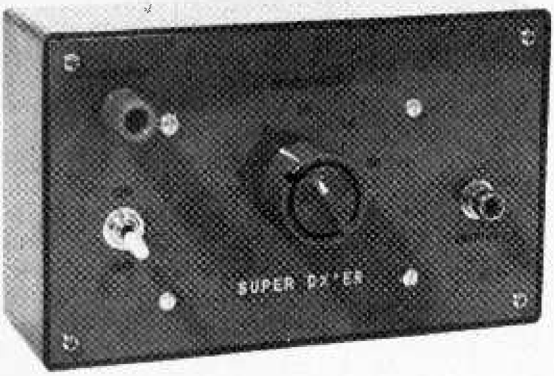
When you are satisfied that the amplifier is stable and working properly, solder the short microphone cable to the input terminals and mount the amplifier in its case. You are now ready to set up the microphone for maximum gain. To do this, you will need a code practice oscillator or other source of audio signal and an AC voltmeter with a ten-volt range connected to the amplifier output.

Set the equipment up in a clear area. Enable the CPA and adjust the audio gain so that the voltmeter reads two volts or less. Next move the microphone cartridge towards and away from the center of the dish to find the microphone position giving the greatest output. Do not let the voltmeter reading go above three volts because overloading the amplifier will make it difficult to find the point of maximum gain. After finding the best position for the microphone, secure the rubber bands on the support rods with dabs of cement.

The parabolic snooper may be used in several ways. As a portable field instrument, just plug in a set of 2000-ohm earphones and be on your way through the woods. The unit will also work as a combination microphone-preamplifier with any amplifier or tape recorder. However, if you are using a speaker for monitoring outside noises, be sure to have sufficient acoustic isolation between the microphone and speaker, such as closed doors and windows. If you don't, all the world will know by your feedback howl that you are listening. When using the unit with an audio power amplifier it is best to run the gain quite high on the amplifier and adjust the system gain as needed with the preamp gain control.

Now you're ready for a new world of close-up sound. ■

*******Common Bird Songs*, the title of a booklet and record by Borror, is available from Dover Publications, 180 Varick Street, New York 10014 for $3.50 postpaid; order number 21829-5. It provides songs of sixty species such as the Robin, Cardinal, Bluejay, Bobolink, and Tufted Titmouse!**



SUPER DXER

Our outboard rig makes QSL waves—adds 20dB minimum gain to any shortwave receiver

CAN YOU REMEMBER the early days of TV—back to the mid- and late-1940s—when the Joneses, who had the only TV in the neighborhood, would strain to clean up a snowy, flickering picture by adjusting a "booster" that sat on the top of their 12-in. phosphor cyclops?

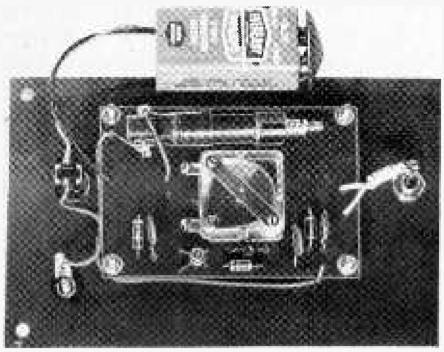
Well, more often than not those outboard boxes, with their 6J6s in push-pull tunable circuits, didn't amount to the proverbial hill-of-beans. Those World War II vintage tubes were not at all well suited to the new-fangled wide-band requirements of TV. But later on as the technology advanced, and more powerful transmitters were built, good, solid pictures became the rule.

Unlike the old TV boosters, today a good booster for short wave receivers—a preselector—can be designed with all the advantages of the latest solid-state devices; and, to boot, it can be simple and very easy to build. It's the easiest way to turn any receiver into an even hotter signal sniffer. You use a booster (a very high gain RF amplifier) between the antenna and the receiver antenna terminals. A good one will also provide sharp image rejection by adding a relatively high-Q circuit to the receiver input. Image signals (which often take the pleasure out of receivers with low frequency single-conversion IF amplifiers by jamming desired signals) vanish as if by magic when passed through a high-Q booster or preselector. In short, a top quality super booster such as the SUPER DXER, will add another dimension of performance to any shortwave receiver.

What It Can Do. The SUPER DXER provides from 20 to 40 dB of signal boost—the exact amount is determined by the particular input characteristics of your receiver. Figuring on 6 dB per S-unit, that's an increase of better than 3 to 6 S-units. In plain terms, the SUPER DXER will bring in stations where all your receiver will pick up running barefoot is its own noise.

The SUPER DXER's input is a diode protected FET (field effect transistor); the protection diodes are built into the FET so that excessively strong input signals, and even static discharges, will not destroy Q1. Since the FET's input impedance is many thousands of megohms, there is virtually no loading of the L1/C1 tuning circuit; its "Q" remains high and provides a very high degree of image-signal attenuation.

The SUPER DXER output circuit is a low impedance emitter follower, and it will match, with a reasonable degree of performance, just about any receiver input impedance. As long as your receiever has two antenna terminals, one "hot" and one ground, you can use the SUPER DXER.



Add an extra 20+ dB gain to your shortwave receiver. Simple kit-of-parts is available. You supply the outer case and knob. Note: Wrap J1 ground wire as shown above.

Optimum performance will be obtained if your receiver is equipped with an antenna trimmer. Just as the antenna trimmer peaks the receiver for use with any type of antenna, it also adds something extra when matching the SUPER DXER.

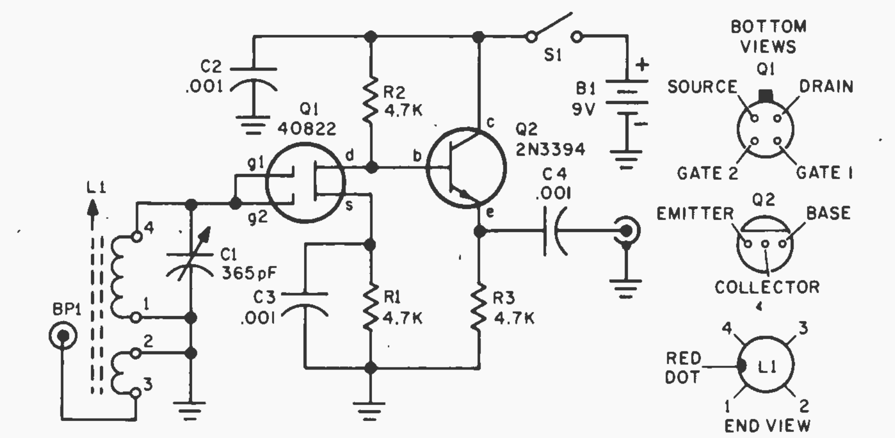
Set Bandpass. The SUPER DXER has a tuning range of slightly more than 3-to-1 between 5 and 21 MHz. That means if the low end is set to 5 MHz, the upper limit will be slightly higher than 15 MHz (3 times 5). If the lower limit is set at 7 MHz, the upper frequency limit will be slightly higher than 21 MHz. Since the slug in tuning coil L1 is adjustable, you can select any operating range between 5 and 21 MHz.

SUPER DXER, though a very high gain device, is absolutely stable if built exactly as shown and described. There will be no spurious oscillations or response. It is possible that changes in the component layout or construction will result in self-oscillation at certain frequencies; hence, make no modifications or substitutions unless you are qualified.

Getting Started. Your first step is to prepare the printed circuit board. Using steel wool and a strong household cleanser such as Ajax or Comet, thoroughly scrub the copper surface of a 2¼-in. x 3¼-in. copper-clad board. Any type will do—epoxy or fiberglass; the type of board is unimportant. Rinse the board under running water and dry thoroughly.

Cover the copper with a piece of carbon paper—carbon side against the copper—and place under the full-scale template we have provided. Secure the PC board in position with masking tape. Using a sharp pointed tool such as an ice pick, indent the copper foil at each component mounting hole by pressing the point of the tool through the template and carbon paper. Next, using a ball point pen and firm pressure, trace the foil outlines on the template.

After all foil outlines have been traced, remove the PC board from under the template and, using a resist pen, fill in all the desired copper foil areas with resist. Make certain you place a dot of resist over the indents at each of the corner mounting holes. Pour about one inch of etchant into a small container and float the PC board—copper foil down—on top of the etchant. Every five minutes or so gently rock the container to agitate the etchant. After 15 or twenty minutes check the PC board to see if all the undesired copper has been removed. When every trace of the undesired copper is gone, rinse the board under running water, and then remove the resist with steel wool or a resist "stripper."



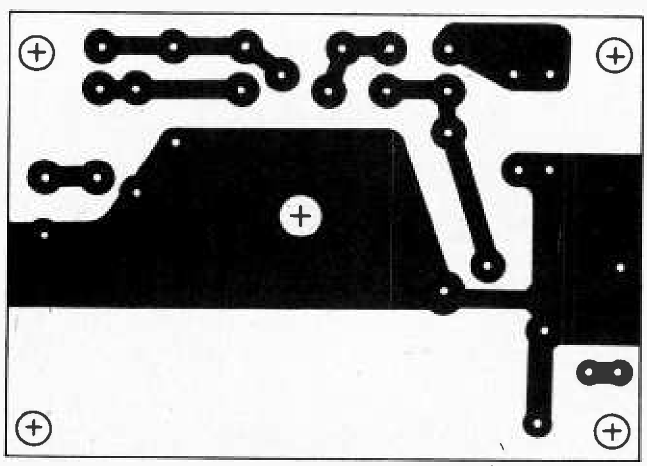
PARTS LIST FOR SUPER DXER

B1—9-volt battery (Eveready 216 or equal) and connector
BP1—insulated binding post
C1—365-pF subminiature tuning capacitor
C2, C3, C4—0.001-uF, 25-VDC or better ceramic disc
J1—RCA-type phono jack
L1—5 to 20-MHz antenna coil, Custom Components SW-520
Q1—MOSFET, RCA 40822
Q2—npn transistor, 2N3394
R1, R2, R3—4700-ohm, ½-watt resistor
S1—spst switch (power on-off)

A kit of all the above components including the printed circuit board is available from the Electronic Hobby Shop, Box 192, Brooklyn, N.Y. 11235. Price of $24.50 includes postage. New York State residents must add sales tax. No foreign orders. Allow 6-8 weeks for delivery. Postal Money Order speeds delivery.

Continue. Drill out all the mounting holes marked by an indent with a #57, 58, or 59 bit—this includes the corner mounting and C1 mounting holes. Then drill the corner mounting holes for a #6 screw, and use a 5/16-in. bit for the C1 mounting hole.

Install tuning capacitor C1 first. Tuning capacitor C1 should be the type provided in the kit of parts. It has a plastic dust cover and a long shaft. Do not use the type supplied with a short shaft to which a tuning dial for the broadcast band can be attached. Remove the mounting nut and ground washer from C1's shaft. Then make certain the shaft's retaining nut is tight. It is usually supplied loose. Discard the ground washer and secure C1 to the PC board with the mounting nut. Then install tuning coil L1. Make note of two things about L1: the terminal end of L1 has a large *red* dot (ignore any other marks); L1 must be positioned so the red dot faces the bottom edge of the PC board—the edge closest to the coil. Also note that the lug connected to the top of the fine-wire primary is adjacent to the bottom of the heavy-wire secondary. When the red dot is facing the edge of the PC board, both these lugs are against the board. Solder the lugs to the matching holes in the PC board. Use the shortest possible length of wire to connect the remaining primary (fine-wire) terminal to the antenna input printed foil. Connect the remaining L1 terminal (heavy wire) to its matching hole with solid, insulated wire—form a right angle bend in the wire so it doesn't touch L1. Now mount the remaining components.



Exact PC board size. Transfer image to copper-clad board using carbon paper. This is the bottom (copper) side of your board. Mount it to the front panel with ¼-in. spacers between board and panel at each mounting screw. Secure the battery to the back of the cabinet with tape.

Orienting Q. Note that Q1 is positioned properly when the small tab on the case faces the nearest edge of the PC board. Also note that the round edge of Q2 faces the nearest edge of the PC board. The flat edge of Q2's case should face C1.

Because the printed copper foil faces the front panel when the assembly is mounted in the case, and is therefore inaccessible for soldering, the connecting wires to front panel components should be installed at this time. Solder 6-in. solid, insulated wires to the antenna, output, and output ground, and +9V foils. Solder the negative (usually black) wire from the battery connector to the ground foil.

The SUPER DXER is mounted in a standard plastic or Bakelite case approximately 6⅜-in. x 3 3/16 -in. x 1⅞-

SUPER DXER

in. The front panel must be aluminum. If the cabinet is not supplied with an aluminum panel, obtain an optional or accessory metal panel. Do not use a plastic panel.

Drill a ⅜-in. hole in the center of the front panel. Position the PC assembly over the hole with C1's shaft fully inserted through the hole, and mark the locations for the four PC board mounting screws. Drill the panel and temporarily secure the PC board to the panel. Then locate the positions for power switch S1, antenna input binding post BP1, and output jack J1. Make certain J1 is as close to the PC board output terminals as is possible—within 1½ inches.

Remove the PC board and drill the holes for the panel components. Power switch S1 can be any inexpensive spst type such as a slide switch. Install the panel components and then the PC board. To prevent the copper foil on the underside of the PC board from shorting to the panel, place a ⅜-in. plastic or metal spacer, or a stack of washers, between the PC board and the panel at each mounting screw. Connect the panel components to the appropriate wires extending from the PC board and the SUPER DXER is ready for alignment.

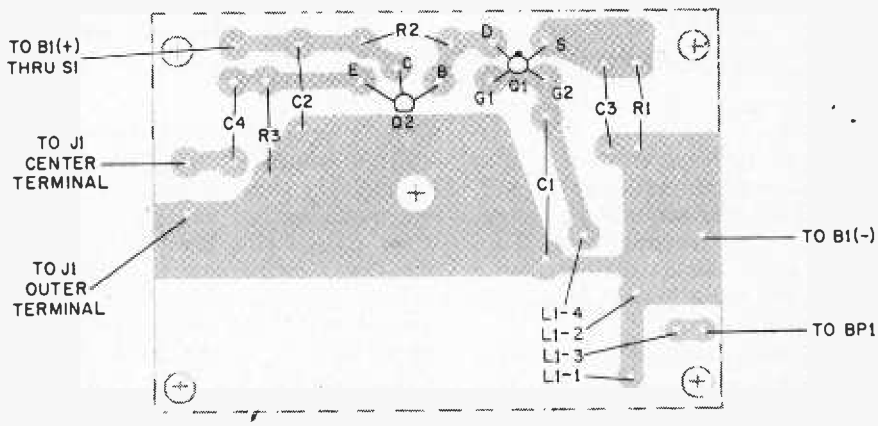
Alignment. Prepare a length of 50 or 52-ohm coaxial cable (such as RG-58) that will reach from the SUPER DXER's output jack to the receiver antenna input terminals. Solder a standard phono plug to one end. Take care that you do not use ordinary shielded cable such as used to interconnect hi-fi equipment; coaxial cable is a must.

Connect the coax between the SUPER DXER and your receiver. Rotate the C1 shaft fully counterclockwise and install a pointer knob so that the pointer extends to the left (9 o'clock position). Connect your antenna to binding post BP1. Then, set L1's slug so that the *bottom* of the screwdriver slot is level with the very *top* of L1. This will provide a frequency range of approximately 5 to 15 MHz. If you back out the slug ¼ inch, the frequency coverage will be from approximately 7 to 21 MHz. You can use any in-between slug adjustment.

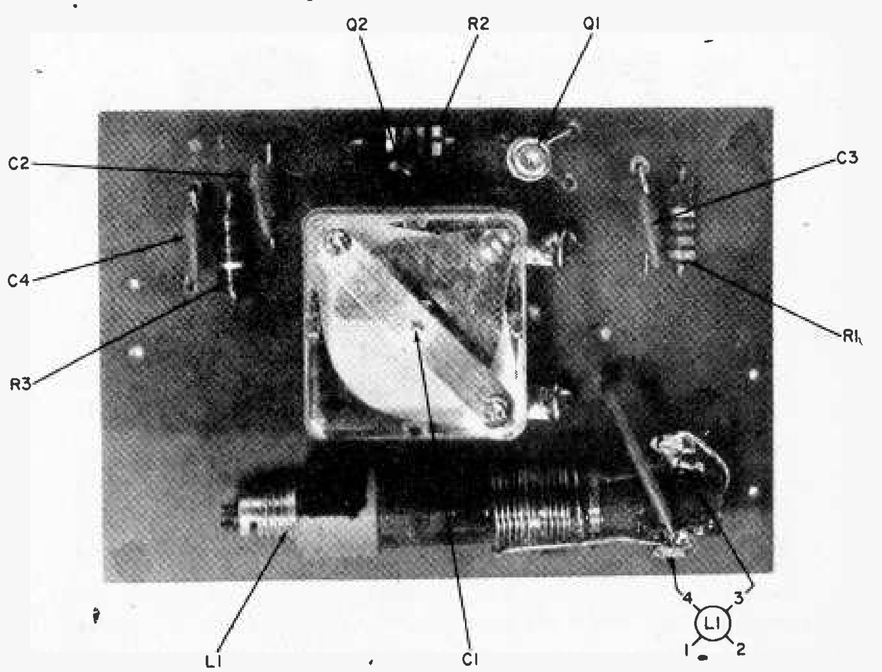
Turn on the receiver and booster, and set the receiver tuning to 5 MHz, or whatever frequency you selected for the "bottom end." Adjust C1 for maximum received signal or noise and mark the panel accordingly. Repeat the procedure at approximately 7, 10, 14, and 15 (or 20) HMz. The panel markings are important because the SUPER DXER's tuning is so sharp it must be preset to near the desired frequency or you'll receive nothing—neither signal nor noise. The panel markings complete the adjustments.

Pull 'em In. To prevent self-oscillation, you must keep the antenna wire as far as possible from the coaxial output cable. To receive a signal, set C1 to the approximate desired frequency and then tune in the signal on the receiver. Finally, peak C1's adjustment for maximum signal strength as indicated on your receiver's S-meter, or listen carefully for an increase in speaker volume. Keep in mind that, if the signal is sufficiently strong to begin with, the receiver AVC will "absorb" the SUPER DXER's boost, and the speaker volume will probably remain the same, though the S-meter reading will increase. SUPER DXER's boost will be most apparent on very weak signals, digging out those signals below the receiver's usual threshold sensitivity, making them perfectly readable.

Don't worry about strong signals overloading your SUPER DXER; it is virtually immune to overload even from excessively strong signals. However, the booster's output can be so high as to overload the input of some budget receivers. If this occurs simply reduce the booster's output by detuning C1 just enough to drop the overall signal strength below the receiver's overload value. Happy DXing! ■



For exact part placement on PC board, see diagram above. View is from component (top) side of your Super DXer board. Layout below shows a completed Super DXer. Pins 3 and 4 of the dual winding coil L1 are shown in an end view for clarity.



A DX CENTRAL PROJECT... SWL's STATION FINDER

☐ ***Tune this stable wide-band oscillator to any SWL station you want to remember; come back the next day and "zero beat" your receiver to the very same spot.***

by Charles Green, W6FFQ

SHORTWAVE BROADCASTS have been a source of interest for many years with their exotic and different forms of programs from all over the world. Many shortwave listeners (SWLs) spend many hours tuning for elusive stations on the international shortwave broadcast bands.

But, once an interesting station is found, there may be a problem in locating it the following day, if the shortwave receiver has poor dial calibration or frequency stability. Also, many receivers used by SWLs have bandspread dials which are only calibrated for the amateur radio bands—not the international shortwave bands.

Our SWL station finder project will make it easier to relocate a desired SW station on a receiver the following day. This project has an rf oscillator which is "zero beat" with the SW station's frequency, will hold the calibration, and deliver a signal close enough to the station frequency to locate the station on the following day.

This SWL station finder covers a 5 to 18 MHz range to include the most popular international shortwave bands. Construction is simplified by using a commercially wound coil and solid-state oscillator circuitry.

Perf board and push-in, clip-type construction is used for easy building. The SWL station finder is built into a compact 6¼-in. long by 3¾-in. high by 2-in. deep plastic utility box, and it requires only two penlite cells for a power supply. No connection is required to your shortwave receiver; the station finder has only to be placed close enough to the receiver for its radiated rf to be picked up.

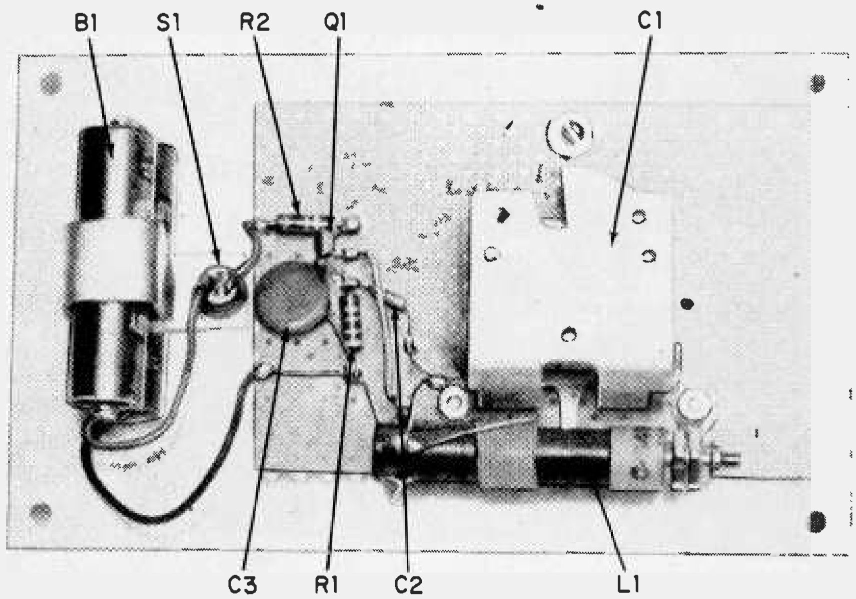
The Circuit. The SWL station finder is essentially an rf oscillator with a hartley (grounded drain) circuit and a FET (field effect transistor) used as the oscillator (Q1). The high input resistance and low heat generation of the FET together with the large value of capacitance in the tuning circuit (L1, C1) provide low drift performance. Also, there is no rf output connection as the circuit radiates the rf signal to the receiver, thus minimizing oscillator loading.

When S1 is depressed, electrical power from B1 flows through the Q1 circuit which oscillates at a frequency in the 5 to 18 MHz range determined by the setting of C1 (which tunes L1). Capacitor C2 and R1 act as the "gate leak" which biases Q1, and C3 is the bypass capacitor which grounds the rf in the Q1 drain circuit. The Q1 source is connected to the tap on L1 that supplies the rf feedback necessary to make the circuit oscillate.

Construction Facts. The SWL station finder is built in a 6¼-in. long by 3¾-in. high by 2-in. deep plastic utility box with a metal panel. Most of the parts are mounted on a 4-in. long by 2⅝-in. wide section of perf board with push in clips, and the board is installed behind the metal panel with three ⅜-in. long metal spacers. The parts placement is critical because of the high frequency operation of the circuit, and for best performance follow our component layout and wiring placement. All of the wiring must be made with short lengths of solid hookup wire for best frequency stability.

Begin construction by mounting the vernier dial on the panel in the approximate position shown in the photos. Cut the perf board section to size and mount C1 through holes cut in the perf board (in the position shown in the photo) using three machine screws in threaded holes in the front of C1. Install a ground lug on the lower mounting screw of C1 placed on top of the perf board.

Temporarily position the shaft of C1



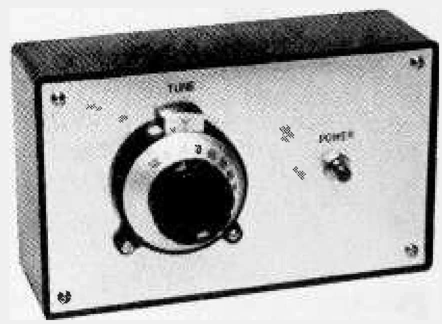
Very simple wiring job gets you a variable frequency reference for SWLing.

onto the vernier dial and locate the mounting holes for the ⅜-in. metal spacers. Remove the vernier dial and then cut the rotor shaft of C1 to the length required to fit when the ⅜-in. spacers are installed. On our model (for greater rigidity and a neater appearance) we used long machine screws for the vernier dial mounting that also fit through the ⅜-in. metal spacers and held the board. But, if this is believed too difficult, you can mount the perf board with ⅜-in. metal spacers at each corner of the board.

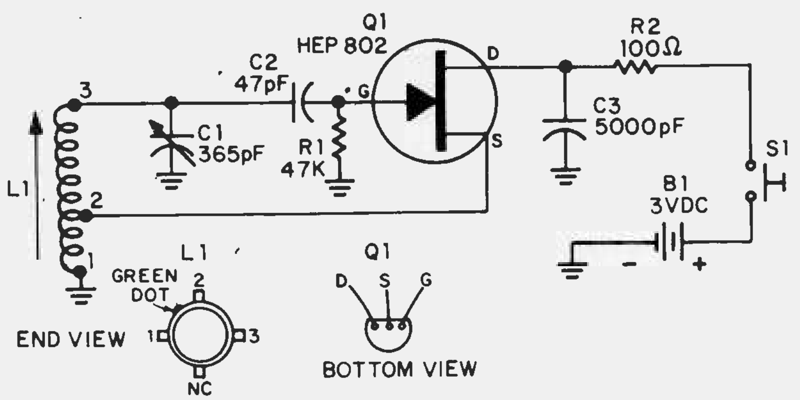
After the perf board is mounted, locate and cut a hole in the metal panel for S1 in the position shown in the photos. Cut a bracket from sheet aluminum to fit around the two penlite cells that are series connected to make up the 3-volt battery B1. Drill a hole in the end of the bracket to fit the mounting screw of S1. Then install S1 and the B1 bracket on the metal panel with the bracket positioned as shown in the photo.

Mount L1 on the perf board parallel to the base of C1. A solder lug fitted on top of the coil with an extra nut and soldered to another solder lug mounted on the adjacent ⅜-inch spacer mounting screw keeps it in place. The other end of L1 is held by soldering pin 1 to a push-in clip on the board. Locate the L1 pin numbers by the position of the green dot on the coil form as shown in the schematic drawing.

Install Q1, R1, R2, C2 and C3 with push in clips on the perf board between S1 and C1 as shown in the photo. Position the components as in our model, and cut the leads short so that the components will remain in place without any movement for best frequency stability. Wire the rest of the circuit as shown in the schematic drawing keeping all leads as short and direct as possible.



Low drain circuit is powered by three AA cells. Holder can be made from scrap piece of aluminum or bought. Vernier dial has 8 to 1 turns ratio for precise adjustment.



PARTS LIST FOR STATION FINDER

B1—3-volt battery (two penlite cells in series, see text)
C1—10-pF to 365-pF variable capacitor
C2—47-pF ceramic or mica capacitor
C3—.005-uF capacitor
L1—5 MHz to 18 MHz tapped oscillator coil (J. W. Miller C-5496-C)
Q1—field effect transistor, HEP 802 (Motorola)
R1—47,000-ohms, ½-watt resistor
R2—100-ohms, ½-watt resistor
S1—spst push-button switch, momentary contact, normally open
Misc.—6¼ x 3¾ x 2-in. plastic utility box with metal cover plate (Radio Shack 270-627), 2-in. precision vernier dial, perforated board and push in clips, ⅜-in. metal spacers, hardware, wire, solder, etc.

The J. W. Miller C-5496-C coil is available from Circuit Specialists, P.O. Box 3046, Scottsdale, AZ 85257, for $3.80 postpaid.

Testing And Calibration. Calibration of the station finder is not necessary, but for convenience in tuning, you can mark the ends of the vernier dial to indicate the high frequency end (18 MHz) with C1 at *minimum* (plates unmeshed) capacity and the low frequency end (5 MHz) with C1 at *maximum* (plates meshed) capacity. Rub-on decals can be used to mark the vernier dial ends and for marking the metal panel.

Preset L1 by adjusting the tuning slug all the way into the coil (for maximum inductance), and adjust C1 for maximum capacity. Place the station finder unit near your shortwave receiver, and tune the receiver to 5 MHz. Press S1 (to *on* position) and adjust the tuning slug of L1 for maximum received signal. Place the station finder metal panel into the plastic box and it's ready for use.

If your shortwave receiver does not have an S meter to indicate the unmodulated carrier of the station finder,

(Continued on page 101)

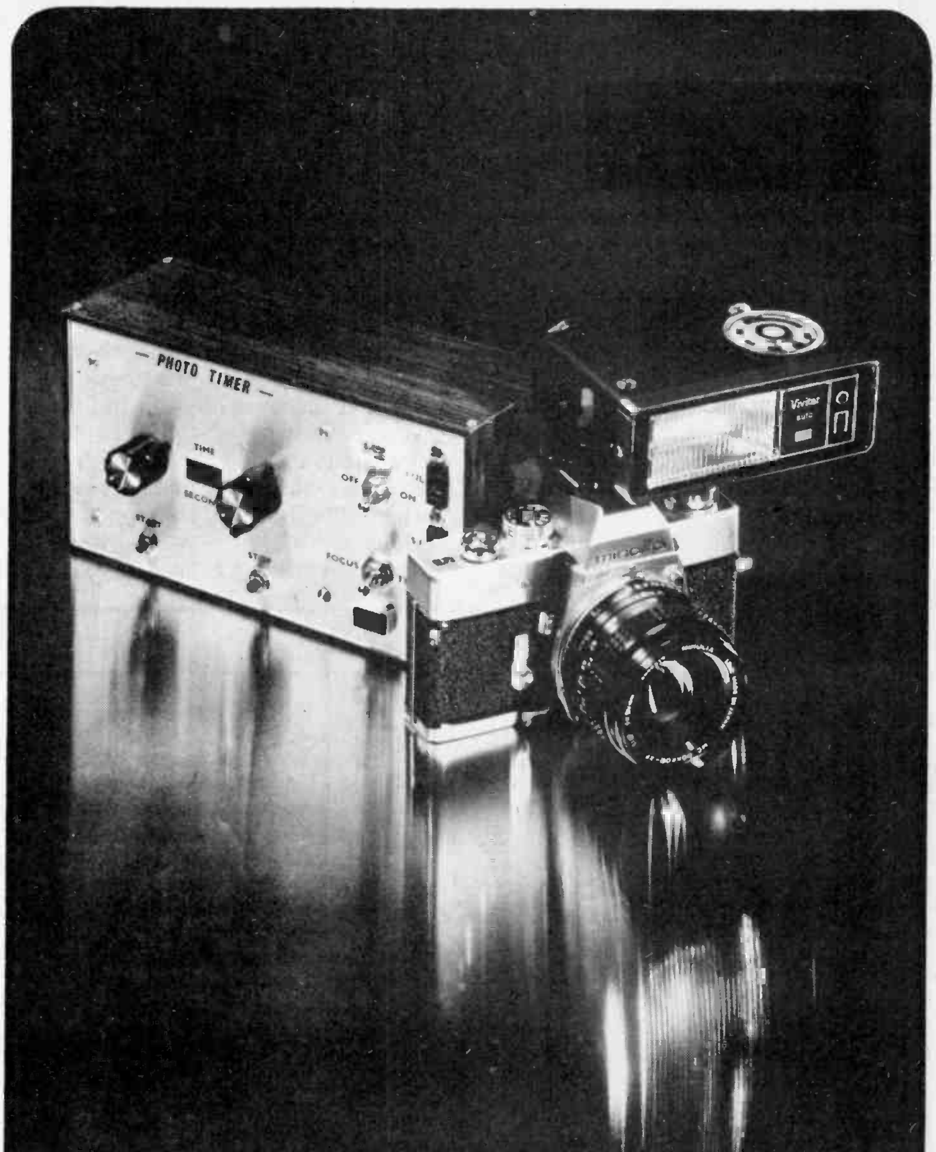


PHOTO TIMER

Designed for your creative difference by a darkroom craftsman. This precision tool does everything but turn off the lights!

by Adolph A. Mangieri

FEATURING illuminated digit-set dials, automatic reset, and safelight control, the PHOTO TIMER eliminates error-prone juggling of room light, safelight, and timer switches and dials. You can set the timer in complete darkness and you can be sure the safelight was off when you used your enlarger printmeter. The large easily-read dial indications make the timer a joy to use. The timer also includes push-to-start and push-to-stop buttons.

Using the 555 precision IC timer, the timer circuit is not affected by line voltage changes. Timing is adjustable from 1 to 119 seconds in one-second steps. Accuracy and repeatability depend only on the accuracy of the timing resistors and quality of the timing capacitor. The PHOTO TIMER is easily constructed at low cost.

Circuit Operation. The schematic diagram shows a 555 precision timer connected as a one-shot timer with automatic reset. The timing interval is determined by timing capacitor C1 and by timing resistors selected by switches S1 and S2. Assuming pin 5 of IC1 is disconnected from calibration pot R9, the time interval T (seconds) equals 1.1 times R (megohms) times C (microfarads). Timer-output at pin 3 controls both normally-off load relay K1 and normally-on load R6. If one load is de-energized, the other is energized and vice-versa.

With C1 initially held discharged by IC1, timing commences when start button S4 is depressed causing a triggering pulse at trigger pin 2. The relay closes instantly and C1 begins to charge through the timing resistor. When the voltage of C1 rises to two-thirds of the DC supply voltage, IC circuits are activated causing the relay to open and C1 to discharge completing the cycle with automatic reset. A timing cycle in progress may be terminated by depressing stop button S3.

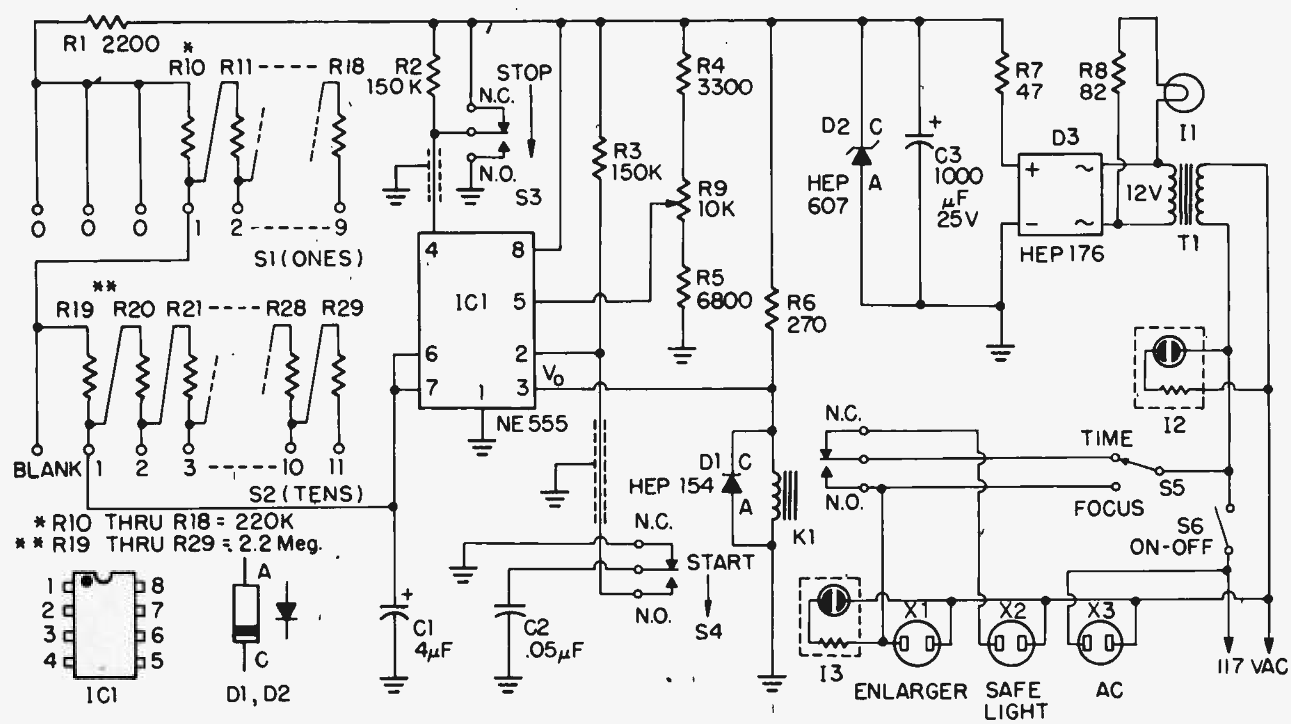
Calibration pot R9 varies the timing control voltage at pin 5 accounting for tolerances of timing capacitor C1. Provided with both normally-on and normally-off loads, the IC circuit draws a fixed load current from the power supply. Resister R7 sets the DC supply voltage to about thirteen volts. Voltage clamp zener diode D2 limits the supply voltage to safe values if the supply voltage should rise. Timing is not affected by changes in supply voltage. Rectifier diode D1 eliminates voltage spikes at K1 which would re-cycle the timer.

Construction. Build the PHOTO TIMER in a 9 x 5 x 3 in. metal cabinet. Begin construction by cutting out two 2½ in. dial discs from 1/16 in. thick red or white transluscent plastic. The discs are easily cut using a holesaw. Chuck the discs in a mandrel and true up the edges. Ream the center hole to clear the shafts of switches S1 and S2. Drill through a pair of small panel knobs and cement a knob to each disc using epoxy cement.

Drill suitably spaced (one disc diameter) slightly undersize holes in the panel and ream for a close fit for the shafts of the switches. Cut the perforated board to size and drill four holes for 6-32 x 2 in. spacer bolts which support the board behind the panel. Drill four matching holes in the panel, bolt the board directly against the panel, and locate and machine holes in the board to accept the switches. Cut out a ⅜ by ¾ in. window in the panel midway between the switch shaft holes. Complete machining of the panel and apply panel labelling and a clear protective coating.

Install switches S1 and S2 on the board, dial discs on the switch shafts, and trial mount the assembly on the panel. The dial discs should rotate with little wobble and no contact with the panel. If needed, enlarge a switch hole on the board to correct any disc tilt by shifting the switch slightly. Remove the circuit board assembly from the panel and affix the discs at the top end of the shafts. This simplifies application of dry transfer numerals at the edges of the discs while using the switches to index the disc for each position. Label the "ones" dial with three zeros and 1 through 9. Label the "tens" dial 1 through 11 leaving a blank space. You can remount the assembly on the panel and check and correct any badly aligned numerals.

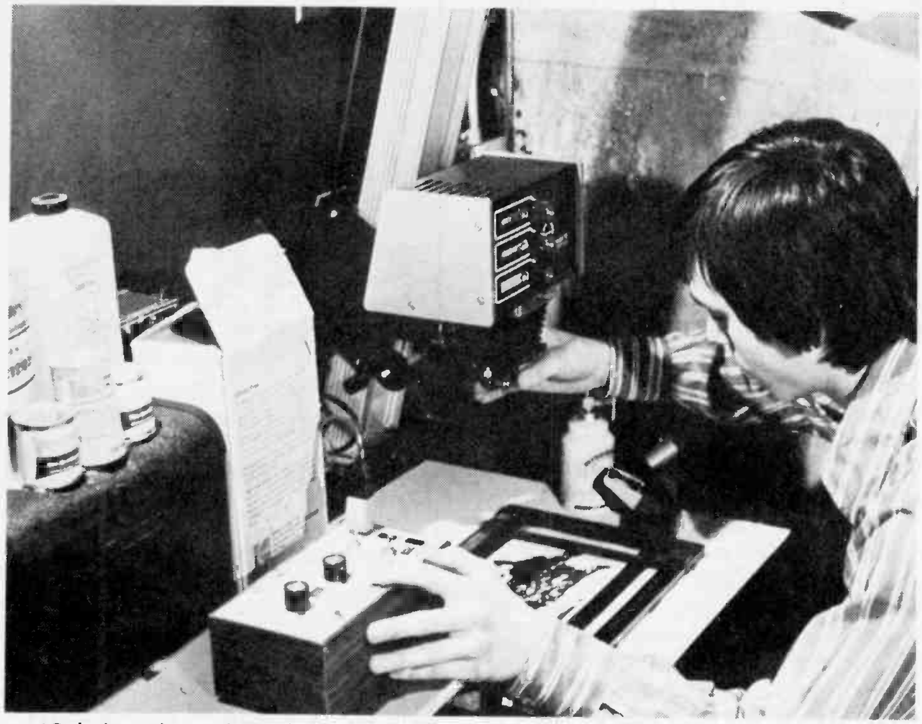
Using 1/16 in. aluminum, make the compartment partition supporting trans-



PARTS LIST FOR PHOTO TIMER

C1—4-uF, mylar capacitor, 50-VDC (Cornell Dublier WMF or similar)
C2—0.05-uF, capacitor, 100-VDC or better
C3—1000-uF, electrolytic capacitor, 35-VDC or better
D1—1-amp, 50-volt silicon rectifier (HEP 154)
D2—15-volt, 1 watt zener diode (HEP 607)
D3—1-amp, 50 volt bridge rectifier
I1—see R8 note or #47 panel lamp
I2, I3—neon panel lamps
IC1—555-type integrated circuit
K1—dpdt relay, 12-volt DC, 3-amp contacts, coil resistance 350 ohms, coil current 50 mA. (Radio Shack 275-206 or equiv.)
R1—2200-ohm, ½-watt resistor
R2, R3—150,000-ohm, ½-watt resistor
R4—3300-ohm, ½-watt resistor
R5—6800-ohm, ½-watt resistor
R6—270-ohm, 1-watt resistor
R7—47-ohm, 1-watt resistor
R8—82-ohm, 3-watt ww resistor. Note—delete if 14 volt lamp such as #53 is substituted for I1.
R9—10,000-ohm trimpot
R10 to **R18**—220,000-ohm, ½-watt resistors, 5% or better
R19 to **R29**—2.2-megohm, ½-watt resistors, 5% or better
S1, S2—single-pole, 12-position switch, shorting type
S3, S4—spdt momentary pushbutton
S5—spdt toggle switch (FOCUS/TIME)
S6—spst toggle switch to match S5 (ON-OFF)
T1—miniature transformer, 117-VAC pri., 12-VAC sec, 300-mA
X1, X2, X3—AC chassis receptacles

Misc.—panel knobs, case 8½ x 4½ x 3-in. (Vector W30-86-46), perf board, push-in terminals; translucent plastic sheet 1/16-in. thick for dial, small knobs, line cord, IC socket, spacer bolts (4), wire, solder, etc.



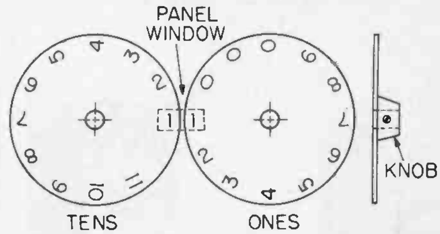
IC-design photo timer features backlighted digit-set dials, pushbutton start and stop buttons, and safelight control. Modern circuitry provides high accuracy and repeatability over the 1 to 119 second timing range. Home darkroom using our photo timer is equipped with Omega B color enlarger.

former T1 and relay K1. The partition is secured by two of the spacer bolts. Cut out a portion of the flange of the partition to avoid interference with the "ones" dial disc. Make a bracket to accept the socket of K1 and affix to the partition. Wire the AC sockets, neon panel lamps (supplied with external voltage dropping resistors), and toggle switches before installing T1 and K1. Wire the normally open poles of the DPDT relay in parallel to double the current rating.

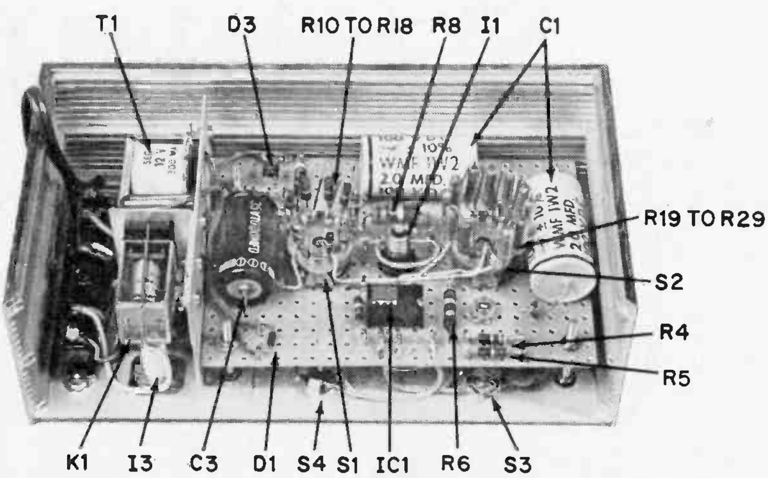
Install a large rubber grommet on the circuit board directly behind the panel window to accept panel lamp I1. Tint the lamp with red transparent lacquer. Complete wiring of the board using a socket for IC1. Carefully observe polarities of D1, D2, and C3. Use shielded wire for connections to pushbuttons S3 and S4. Install resistors R10 through R29 directly on the switches. It's usually a simple operation to defeat the switch detent stops on S1 and S2 allowing continuous rotation of the dials. Set the switches to pick up R10 and R19 and position and secure the dial discs for 11 seconds readout.

Capacitor C1 should be a mylar, polycarbonate, or polystyrene low-leakage, low-loss type. C1 was made up by connecting two 2 uF capacitors in parallel but you can use a single 4 uF capacitor. You can use a 5 uF capacitor by changing R10 through R18 to 180,000 ohms and R19 through R29 to 1.8 megohms.

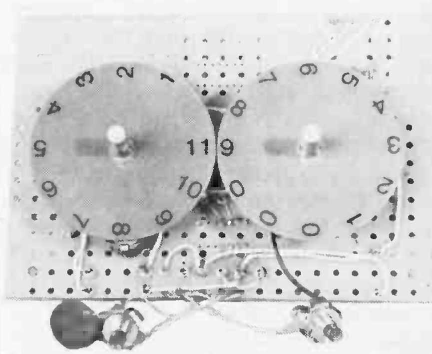
Checkout And Calibration. Using a VOM, verify the presence of approximately thirteen volts DC across C1, about fifty milliamperes current in R7, and about five volts AC across lamp I1. If you have substituted for T1, it may be necessary to resize R7 and R8 accordingly. To calibrate the PHOTO TIMER, plug a sweep second electric clock into socket X1. Turn S6 on and set S5 to time. Set the dials for fifteen seconds. Depress start button S4 and observe elapsed time on the clock. By trial settings, set R9 so that the clock runs for fifteen seconds. Next, set the dials for 119 seconds and observe elapsed time. If you have used high quality capacitors for C1 the interval should check close to 119 seconds with



Digit-set discs can be made at home from a plastic sheet. Press-type numerals can be used for neat job after cutting out the discs if you draw a temporary base line for each double digit and use it to align numbers.

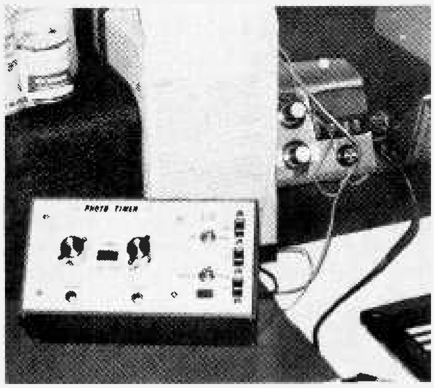


Major parts layout showing author's use of two 2-uF caps in parallel for C1.

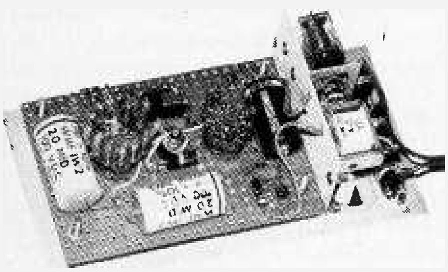


Dial discs are labeled 0 to 9 (units) and 1 to 11 (tens) with discs positioned at top of switch shafts while using the switches to index the discs. Illustration shows 119 seconds. This system allows resetting to the exact time within the resolution and accuracy of the system's electronic timer.

PHOTO TIMER



Our amateur home darkroom includes the e/e Color Analyzer featured in the Sept.-Oct. '74 issue. It's located in the background to the right of the dry chemical (fixer) box.



Line (117 VAC) circuits and relay are placed at left side of the partition. Heavy-weight perforated board supports rotary switches S1 and S2. Timing resistors mount on switches.

some allowance for inaccuracy of timing resistors.

Put It To Work. Plug the enlarger into socket X1 and safelight into socket X2. Plug the enlarger exposure meter into socket X3. Set S5 to Focus when focusing or using the exposure meter. The safelight will now be off as is required for use with any enlarger exposure meter. To expose the print to the set time interval, switch S5 to Time and depress the start button S4. During exposure, the safelight will be off but will return automatically upon completion of the exposure. Panel lamp I3 will be on during the exposure interval. If you have inadvertently overlooked setting of the timer or lens opening and have initiated the exposure, you can terminate the exposure with return of safelights by depressing stop button S3.

By the way, photo fans, check out our B&W photo print analyzer coming soon in a future issue of e/e. It's the complement to our very popular "Darkroom Color Analyzer" project in the September-October 1974 issue of e/e. ■

DICKEY FLASHER

Cut through the party's gloom with flashing studs

by John E. Portune, WB6ZCT

DICKEY FLASHER is a real party stopper that will literally get you switched on—sequentially flashing neon shirt buttons or tuxedo studs. Dickey Flasher is inexpensive, easy to build and a real conversation starter for light social situations. Slip your hand into your pocket, turn on the switch and your shirt front begins flashing like a neon sign.

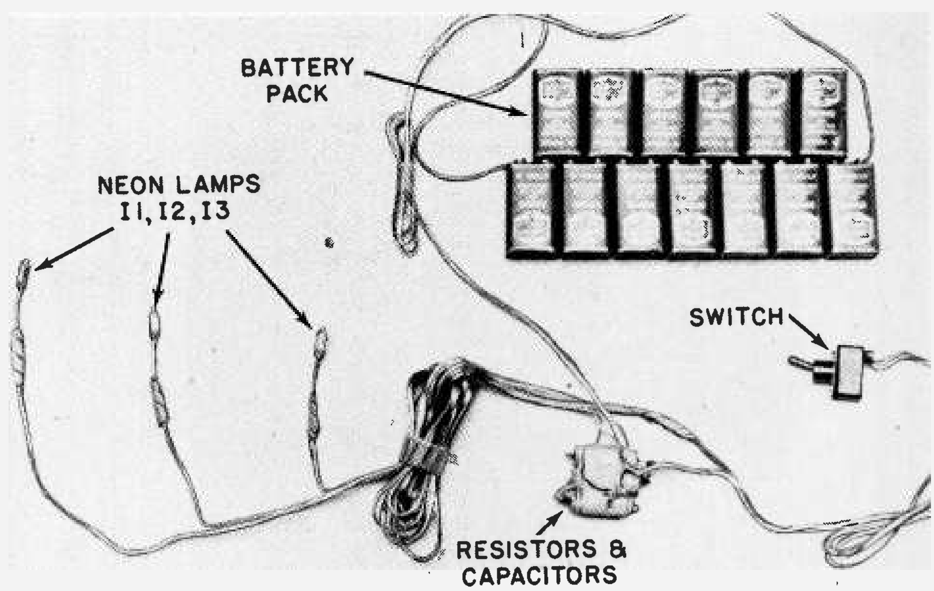
The circuit is a multi-neon-bulb version of the well-known simple neon relaxation oscillator. Less battery, the parts cost about two dollars. More commonly, one sees the circuit built as an amusing display novelty. The current drain is so low (about 200 microamps) that a small B battery will keep Dickey Flasher going continuously for months.

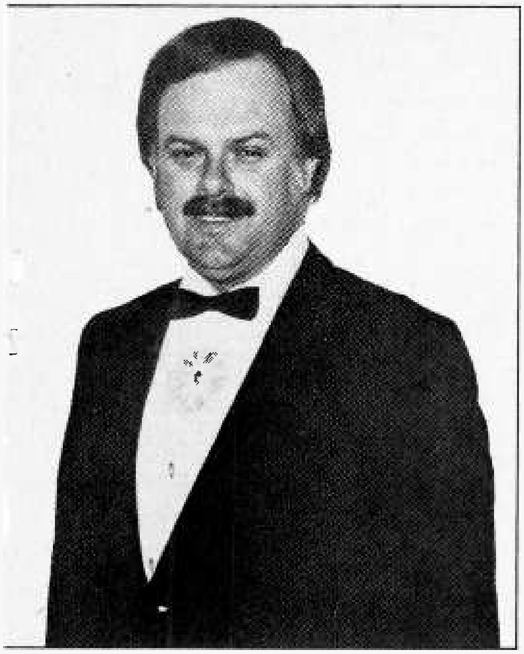
How It Works. Let's begin with the one bulb flasher as shown in the diagram. When switch S1 is closed, current flows through resistor R1 and begins to charge capacitor C1. The value of the resistor and capacitor determines the flash rate—0.5 megohms and 0.5 microfarads will give a flash rate of about 1 second. A lower value of either will make the unit flash faster.

But at the moment current begins to flow, the neon gas is effectively not in the circuit. A non-conducting neon is virtually an open circuit. When, however, the charge on the capacitor reaches the firing voltage of the neon (typically 60-70 volts) the neon fires, producing light, and becomes a short circuit. This quickly discharges capacitor C1 and extinguishes the neon lamp. The process then begins all over again with the charging of C1.

In the schematic drawing of the multi-bulb version of Dickey Flasher, the

Assembling Dickey Flasher is like wiring up a rat's nest. Actually, it is more a wiring harness than a boxed project simply because it is made to fit under clothing without the integral parts, except neon bulbs, exposed. Insulate all electrical connections against body perspiration. And make the cables long enough only to reach where they must go without too much extra length which may annoy the wearer.





action is basically the same. The only difference is that now there are several resistor-bulb legs connected in parallel across the battery, and the capacitors are connected in a ring between the legs. This succeeds in causing the charge-discharge process to transfer from leg to leg sequentially. More than three may be used; the number was chosen to replace the number of studs on a formal evening shirt or dickey for other occasions and situations it is possible to make five or more neon lamps fire in sequence.

Putting It All On. In making Dickey Flasher portable and concealable in one's clothing, the battery presents the biggest problem. NE-2 neon lamps require a minimum of about 80 volts DC to fire. A small 90-volt B battery, or two 45-volt units will work fine. But they are usually too thick and bulky to carry easily in one's pocket. To overcome this, a battery pack of ten or more common small 9-volt transistor radio batteries are snapped together in series using their own terminals back-to-back as connectors. (Incidentally this is not a bad way to replace hard-to-get B batteries in older tube-type portable electronic equipment.)

Taped together, the battery pack retains considerable flexibility and is slim; both are handy features if you have to sit down for a couple of hours during an evening. The cheapest 9-volt batteries you can find are quite satisfactory, the current drain is so low.

Group the capacitors and resistors together, soldering the leads directly and using tape to insulate everything. Connect the neon bulbs, the battery pack and the switch to this RC unit by appropriate length pieces of light, two-conductor speaker wire. In wearing Dickey Flasher, the batteries go in the right rear pocket, the capacitors and resistors in the left rear, the switch in the left front and the neons are pushed through the button holes. Another version of the flasher the author enjoyed had five bulbs built into a hat along with the resistors and capacitors. The battery and switch remained in pockets. Everything should be covered with tape; masking tape is the least expensive. Try to keep wires away from parts of the body where you perspire.

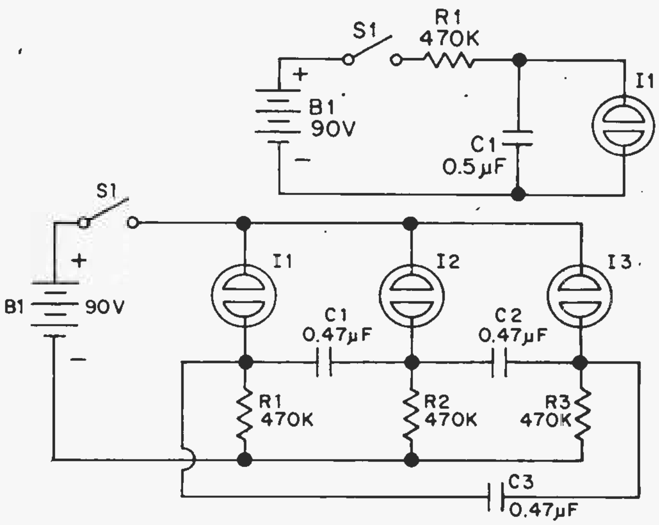
Getting the Most Laughs. Experience has shown that it is best from the point of view of entertainment not to let the bulbs flash all the time. Rather, arrive at the party with Dickey Flasher switched off. Then during conversation, quietly slip your hand into your pocket and turn on the lights without any outward show. You'll find that the reactions will be spectacular. Some will instantly dissolve in laughter, others will go blank not believing their eyes, and a few will try to ignore you. (The last group is the funniest!)

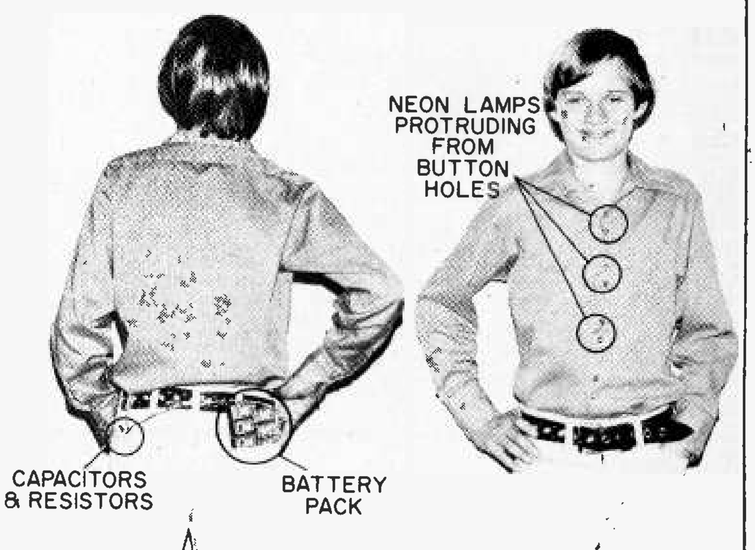
But no matter how and when you use Dickey Flasher you'll find this little group of lights well worth the small investment in sheer entertainment. ■

PARTS LIST FOR DICKEY FLASHER

B1—90-VDC battery made from 10 9-volt transistor batteries
C1, C2, C3—0.47-uF, 200-WVDC capacitor—printed circuit types are flattest
I1, I2, I3—NE-2 neon lamp. NE-2H may be substituted for higher brightness provided B1 uses 13 9-volt batteries because of higher bulb firing voltage.
R1, R2, R3—470,000-ohm, ½ or ¼-watt resistor
S1—On-off toggle, slide, or rocker switch, miniature types preferred (Radio Shack 275-603, 275-401 or 275-611 or equiv.)

Misc.—Wire, solder, masking tape, etc.





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ASK HANK, HE KNOWS!

(Continued from page 18)

ing for the diagram for an Andrea Radio, serial No. 11606. If you can help, write to him at P.O. Box 5220, St. John's, Nfld., Canada A1C 5W1.

Loaded Question

Hank, I've got a question. Since a lot of CBers run power and think they know all about radio, why aren't they radio amateurs? Or do you have to have 3 kW to be a "fine CBer out there"?

—R. D., Kansas City, MO

Hey, pal, seems like you're taking a shot at the CBers. Well, what you say is very near to the truth for too many CBers, but there are many CBers who live by the book. And believe me, if they wanted to be hams, they would be hams. Ham radio is not the ultimate answer to radio 2-way communications. Because the bulk of the hams obey the law doesn't mean that ham radio is the only answer. I would like to point out that the breed of ham I knew is vanishing. They are not appliance buyers and band snobs who refuse to chat with novices. There is much in your house to clean up, so don't worry about the CBer.

Old Tubes

I have some old electron tubes. Where can I get some information about them?

—D. P., Canan, TX

I sent your letter to Jim Fred, the Antique Radio Editor for ELEMENTARY ELECTRONICS magazine. e/e is the sister publication to ELECTRONICS HOBBYIST. If you are interested only in selling the tubes, try a local flea market.

They Grow Up Quick

Hank, in the March/April 1975 issue of ELEMENTARY ELECTRONICS *you answered K. K. of Winnipeg, Canada, who is a 12 year old, that since he is "a smite young," the Science Fair Shortwave Radio Kit would be good enough for him to assemble. I'm 12 years old also and have made a Heathkit 8-track tape stereo system, intercoms, and also a Dynaco tuner and amplifier. I made the Science Fair Kit when I was seven. I think that K. K. should get an electronic kit which is a little more sophisticated.*

—S. G., New York, NY

Hey, S. G., I believe I was right about K. K. and the kit recommended. It's not how old you are, but the experience behind you. Let K. K. build a few easy kits before he gets to the Heaths and Dynas. (Gee, it was nice to hear from you.)

Computer Bug

I am just 13 years old and am interested in electronic computers. I want to study computers and would like to know if ELEMENTARY ELECTRONICS *would be good for the study.*

—V. S., Jersey City, NJ

If you want to become an Olympic Gold-Medal Track Star, you have to learn how to walk first. Now is the time in your life to prepare for a vigorous high school program of mathematics and science. The more courses, the better. Also, get involved in some computer club in high school. If none is available or one cannot be started, get involved in the physics and math clubs. And give yourself some bonuses, read as many books on the subject you can find. As for ELEMENTARY ELECTRONICS, we suggest you keep it on your required reading list.

Twice as Much

Since CD-4 discs for 4-channel hi-fi systems contain twice as much information as stereo discs, is their playing time half that of the stereo disc?

—J.B., Linden, NJ

The CD-4 disc playing time is essentially the same as a stereo disc. The added information, or channel space, is added by increasing the frequency band spread of the disc. CD-4 discs go up to 50,000 hertz, and require special phono playback cartridges to extract the full four channel information recorded.

That's the Ticket

Do you need a special CB license to operate SSB?

—E. B., Sylvania, OH

Nope, just the run-of-the-mill Class D ticket is good enough.

Low Power Linear

I'd like to know if there is an amplifier to boost the power on my CB from 100 milliwatts to 3 or 5 watts?

—R. S. B., Great Falls, MT

Anything you can do that will add on, modify, alter, or whatever, will make your CB transmitter illegal. Stay loose, keep out of the FCC fuzz's hair. Want a full 5 watts? Pick up a legitimate CB rig. If cash is short, look for a used unit or a three-channel job for under $100.

Grounded Out

I must voice strong objection to your statements concerning the ground (green) terminal of electrical outlets in the Jan./Feb. 1975 issue of ELEMENTARY ELECTRONICS. *The National Electrical Code requires without exception that the ground terminal be connected to the power line ground via a conductor at least as large as the "hot" wire to the outlet, in all new installations. Many deaths are the direct result of operating certain equipment (especially power tools and appliances) without the proper ground. Electrical noise reduction, which you gave as the reason* *for grounding an outlet, is strictly a fringe benefit. Your ignorance on the subject was further indicated when you said that the ground terminal should be connected to the outlet box via the outlet mounting lugs. I strongly suggest that you clarify your statements.*

—C. B., Monroe, LA

You are correct. It appears that I erred but I would like to call your attention to your phrase "all new installations." I was talking about an old installation, which is not covered by this code. I would like to point out that if the ground terminal is automatically connected to the box, why the green ground screw? The answer is simple—do not rely on the mounting screws, which may rust. Also, plastic boxes are making the scene—they're good insulators. One thing I believe we both agree on is the reading of the National Electrical Code. It's good reading and may save your life.

What's a BFO

I have an 8-band radio and on it there is a BFO switch. Can you tell me what it's for?

—R. P., Edinburg, PA

Sure can. When the BFO is on, it will cause a whistle to be heard whenever a station's carrier is present. You may have to jiggle the fine tuner knob to get the tone you like to hear. Now this whistle, or tone, is annoying when listening to an AM station, and that's why you can turn it off. However, when a station is broadcasting an unmodulated or Morse code signal, the BFO provides the tone necessary to hear the signal. That way you can copy it down.

Good Trio

I'm looking for a shortwave receiver, one with good sensitivity. I picked out three receivers, one a Heathkit GR-78 which is a six-band covering 190 kHz to 30 MHz. I also saw a Lafayette HA-600, a 5-band amateur and shortwave receiver, covering 150 kHz to 30 MHz. The third one was a Realistic DX-160, 5-band covering 150 kHz to 30 MHz. Which one shall I get? I need some professional help.

—J. G., Greenfield Park, Que.

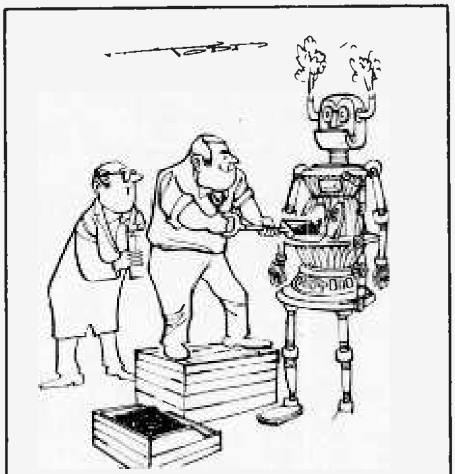
All these products have published specifications which are believable—they are made by reliable outfits. As for which receiver to buy, it is your decision because only you can know exactly what you want. Check the specs carefully. Then check the features and compare the lot against the prices. Lots of luck!

Ham Parts

In your March/April issue of ELEMENTARY ELECTRONICS *there was an article on shortwave antennas by Joe Rolf, and it included a schematic and picture of an antenna tuner. At what company (their address too, if possible) can I get the coil. The ones mentioned were B&W 3008 and Air Dux 532T.*

—W. M., Waterloo, IA

The parts in question are typical ham radio parts available from most parts supplies stores who service hams.



"Crude as it may be, Alex, I think we may have licked the high-cost-of-energy problem."

Wind Power

I set up a fan-generator combination on a small tower and now I get about 30 amps AC at 15 volts. I'm using a car's alternator as the generator. What can I do with this power after seeing it is not reliable because the wind varies in speed?

—E. E., Ellenville, NY

You're talking about 450 watts of power. Pass it through a resistor and use the heat to assist your regular heating system. Maybe the resistive load can be placed on your garage floor which will keep the car warm for fast starts on very cold mornings. The wind is fickel and you can't rely on a fixed frequency output or constant voltage output. But, a resistor doesn't care provided it can take the maximum power or current available. For maximum power transfer, the lead-in line must be #10 copper wire or better.

Inside CB

Can you advise me where I can get information on basic CB operation, rules and regulations. I am also interested in a copy of 1975 CB YEARBOOK. Where can I get one?

—R. H., Davenport, IA

You're out of luck—the 1975 Edition of the CB YEARBOOK is sold out! But don't dispair. ELEMENTARY ELECTRONICS has Kathi Martin giving inside info each issue along with timely and interesting features and technical reports throughout the year. And more! The 1976 issue of CB YEARBOOK is due on the newsstands on November 18, 1975. Look for it!

Tube Switch

I had my color TV picture tube replaced in my home. The repair man "broke the vacuum" and told me to get rid of the dud. In doing so, I noticed that he replaced a 18VBTP22 with a H-18VBKP22. Is he screwing me up?

—B. M., Jeffers, MN

Heck no! The replacement is the new type to be used with your set. I'll bet it's an RCA make and uses the latest "matrix" which means better color than before. Also, the new tube contains improved X-radiation attenuating glass—a safety plus at no extra cost. You know, you have a good man servicing your TV set.

Get the Point?

I have a very large collection of 78 rpm records dating back to 1910 and play them from time to time using "Kacti" needles. Alas, my supply has dwindled to zero and I can't seem to buy any. What should I do?

—Edwin Strauch
327 No. Penn St.
Allentown, PA 18102

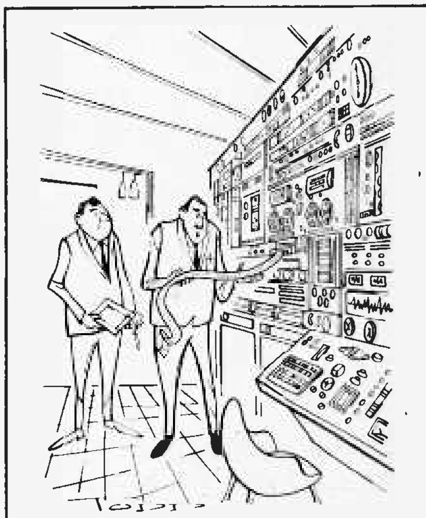
Some of our readers, Edwin, are sure to have a few spares they can let you have or let you know of a suitable substitute. May I suggest you record your discs on cassettes? Playback would be easier and record wear-and-tear reduced considerably.

Getting Out of Town

Please burn this letter after you answer it. Last night I jumped a pair of leads to a burglar alarm system in a supermarket and all hell broke lose. What gives?

—A. P., Chicago, IL

The better systems sense changes as well as cicuit breaks. When you put your clip lead across the circuit to deactivate a portion of the system, you changed the resistance of the loop. This was sensed by the alarm system and it automatically called the cops besides waking up the neighborhood and your getaway driver. Listen, if you are electrically inclined, why not investigate one of the home correspondence schools that advertise in this magazine. Earn some scratch from an honest job like TV servicing and become a good customer of your local supermarket. In the meantime, get out of town. This is one letter I will not burn. ■



"Computed answers withheld pending payment of my lease which as of this date is two days overdue!"

R = Cubed

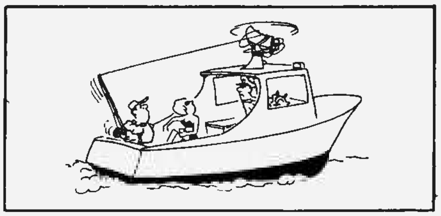
(Continued from page 16)

other end-to-end. The following intermediate values (and all their multiples of 10) are thus available: 12, 15, 18, 19, 42, 45, 48, 49, 72, 75, 78, 79, 92, 95, 98, and 99. Fig. 2 shows how the decades should be laid out on a flat piece of cardboard before assembling the cube so that the proper ends of the decades are adjacent, and the connections mate between the faces. The accompanying tables give a few examples but not all of the combinations possible) of terminal connections for obtaining different intermediate resistance values.

The cube is constructed of "artist-board" since it is inexpensive and easy to work with, but wood, plastic, or any other insulating material can be used. The mini-clips press fit into the artist-board without requiring glue or crimping, and provide convenient right-angle mounting of two resistors and a good electrical connection for the clip-leads. The cube in the photo measures two inches on a side, but could be made either larger or smaller. Measure an equal distance in from each corner and drill a 1/16-in. pilot hole for each mini-clip, push the clip in with a pair of pliers, and orient each one so that it is parallel to the others.

The cube is best laid out in two flat pieces, as shown in Fig. 2, then cut and scored, and the two pieces glued together. Each face of the cube is painted with the appropriate color-code to indicate the decimal multiplier (same as the last color band on each resistor in the decade), and the numbering is all done with press-on numbers. One or more decades can, of course, be omitted, and can always be added later if desired.

Had to Be Different. The Editor's approach to building R-Cube was similar, but we used a wooden block. Brass brads about ¾-inch long were used in place of the flea clips. Before you hammer them in place, practice on a scrap piece of wood. If all the brads were inserted at the same location on the three faces at each corner, they would meet, bend and chip the wood. A bit of offset is required. We licked the problem by hammering the brads in at an angle to avoid in-wood collision of brad points. The brads make good mechanical and electrical connections. In fact, it withstood the 10½ EEE crunch of some klutz. That's ruggedness! Build your R-Cube today, build two, build several—they beat resistor substitution boxes and stack even better. ■



Pro Power Supply

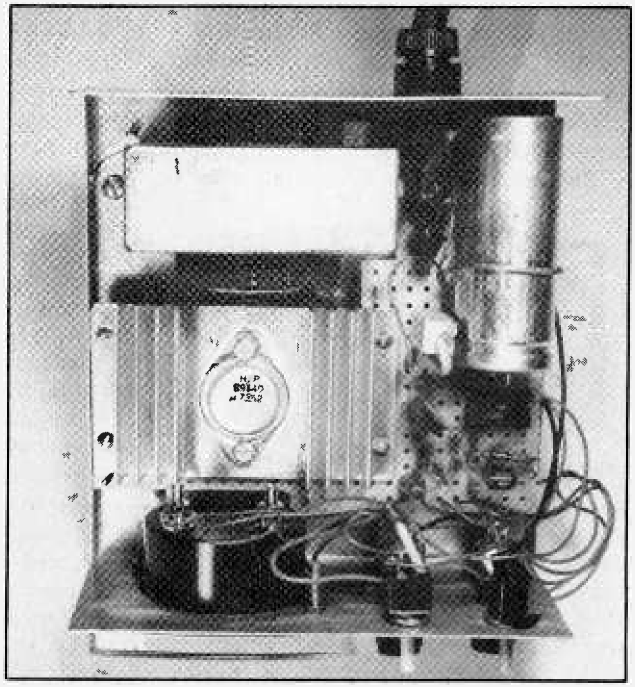
(Continued from page 75)

addition, a 3-prong plug should be used with the ground prong going to the cabinet—as with any properly protected electrical tool. Capacitor C1 may be increased to 2000 *u*F if better regulation is desired. It is best to use a 4-pin socket for D3 and a mini-DIP socket for the IC to avoid heating the devices themselves when soldering.

The heat-sink for Q1 can be mounted directly on the perf board. Mounting hardware and a socket (see parts list) should be used to hold the device firmly to the heat-sink. The mica insulator in the mounting kit can be coated with silicon heat-sink compound to aid in cooling Q1. To further aid in cooling Q1, holes should be drilled in the bottom of the cabinet, and holes should be present along the top or sides of the box. Q2 can be nearly any transistor with a gain of at least 50 and a rating of 40 volts and 25 mA. The Q2 suggested here does not require a heat-sink.

Finally, a voltmeter is *not* needed in the cabinet since once the voltage is set with an external meter it will not change unless the pre-set current limit or power limit (20 watts) is exceeded. If a meter is desired, however, the schematic shows how one can be connected to serve as both an ammeter and a voltmeter.

Major circuit/component areas include heat sink and Q1 which is on perf board pre cut to "wrap around" transformer T1 and the optional meter. Electronic regulator circuitry is wired in the small perf board area just to the left of Q1. Filter cap C1 is held to the board with hefty wire tied to the perf board securely.



Calibration. To calibrate the *voltage* control, R1, connect an external meter, turn R1 to different voltage levels, and mark these voltages on the panel next to R1. To calibrate the *current limit* control, R6, set R1 to 10 volts, apply a 10-watt, 10-ohm load and turn R6 down until the voltage just begins to drop. This is the 1-ampere point; it can be marked on the panel next to R6. To get the 0.1-ampere mark, change the load to 100 ohms at 10 volts (1-watt resistor). Turn R6 until the voltage begins to drop, and you've got the 0.1 amp limit. Current limit points in between are obtained in similar fashion.

This power supply takes about four hours to assemble and should provide years of stable performance. ■

SWL Station Finder

(Continued from page 92)

you can intermittently tap S1 to produce a series of CW "dashes" and then tune for the loudest "clicks" in the receiver. Or, if you have a beat frequency oscillator (BFO) on your receiver, you can adjust the BFO for a convenient audio note (as in CW code reception) and tune for best reception.

Do not place the station finder too close to the receiver, or it may overload the receiver, and result in broad tuning. Place the receiver far enough away for sharp tuning for best results. Tune the station finder from the high frequency end of the vernier dial (minimum capacity) downward and toward the lower frequency end to minimize the possibility of receiving image signals; tune for the strongest signals as heard in the receiver.

When you have found a shortwave station that you wish to listen to again, depress S1 and zero beat the station finder signal with the received station. Do not retune or disturb the station finder unit until the next day (at the correct time of reception). Tune your shortwave receiver until you hear the station finder (but first push and hold S1). You should then be able to find the desired shortwave station close to the frequency. You may have to fine tune the receiver slightly to compensate for warm-up drift of your receiver.

You can also use the station finder to transfer the tuning of a shortwave station from an uncalibrated bandspread dial to another position on the main tuning dial by zero beating the station with the station finder signal. ■

Darkroom Printing Meter

(Continued from page 78)

is to select a decent reference negative and make a good print using a 10, 15, or 20-second exposure. We suggest 20 seconds as it will become your standard exposure, and will be sufficiently long to allow moderate dodging. When you are certain you have a print exactly the way you want it, and without disturbing the enlarger's controls, place the printing meter's sensor under the *brightest* light falling on the easel—it produces black (maximum shadow) on the final print. Now turn on the printing meter and allow about five seconds for warm up. Adjust speed control R2 so the meter pointer indicates any meter reading you want to use as a reference. It doesn't matter what the reading is as long as you always use the same reference for the standard exposure time. For example, 0.2 on the meter scale is a good choice because it is well illuminated by the meter lamps. But you might just as easily select mid-scale as the reference meter reading. It doesn't make any difference; just be consistent.

Once you have adjusted the speed control for the reference meter reading note on a piece of paper or in a notebook the dial reading from the speed control's calibrated knob. This is the reference speed value for the particular printing paper. For example, let's say you made the test print on Polycontrast using the #2 filter, and the speed knob indicates 5.6. Next time you want to print using Polycontrast with a #2 filter you simply set the speed knob to 5.6, put the sensor under the darkest shadow area and adjust the lens diaphragm for a reference meter reading. Everything will be set for your standard exposure time.

Changing Filters. Kodak provides a speed rating for all their papers and you can easily work out the correct (or close) speed control settings without making a "perfect" test print for each type and grade of paper. For example, changing from a #2 to #4 filter usualy means increasing the exposure by a 3.5X factor. If your #2 exposure is 10 seconds, the #4 exposure will be 35 seconds—somewhat long. You can, however, open up the lens diaphragm for a 3.5X light increase (close enough value) and adjust the speed control for the reference meter reading. The new speed control setting is the speed value for the #4 filter. You can do this with variable contrast filters or numbered printing paper.

While the most pleasing print usually has some black, there are times when there can be no black, such as snow scenes, portraits, etc. You can peg the speed control's calibration to a grey corresponding to a skin tone, or any other degree of grey you might desire. The only thing you cannot do is calibrate the meter for highlights, since the meter might not have enough sensitivity for slow papers, and highlights can completely fool the meter.

If desired, you can take a speed control calibration reading for each type of paper (using your standard negative) for both shadow detail and intermediate grey. This way, you can quickly set up for typical snapshots, scenics, or portraits.

Keep In Mind. The sensor has a slight light memory, so we suggest the sensor be turned face down when not being used and the power switch be turned on and off in the dark, though you can keep the darkroom illuminated by a safelight with the power switch on. Meter readings, however, must be taken with all room lights off; only the enlarger should be on and the print meter should be positioned so that its meter lamps do not illuminate the sensor (even slightly). ■

Antenna Systems for SWLs

(Continued from page 31)

tuner that you can easily build is shown in Fig. 5. Details of the tuner built in a small utility box is shown in the photographs. This SWL antenna tuner can be used to improve the performance of any longwire antenna. Select the proper range for C1 with S1 and peak C1 for best S-meter output on your receiver. Fig. 6 is a photo of the completed SWL antenna tuner ready for connection to your antenna system and receiver.

Summing Up. The best antenna for you depends on the type of DX hunting you want to do and the space available. A long-wire with the antenna tuner shown will work well for general listening. If you're interested in a particular part of the work and a particular band, a single frequency dipole pointed in the right direction will give excellent results. If you want one antenna that will do as much as possible, use a multi-band antenna. In any case, those hard to log DX stations will come a lot quicker with any of these antennas, mounted as high as possible. ■

Fig. 6

FET Receiver

(Continued from page 64)

either a 3-volt DC supply or two 1½-volt dry cells in series to J2. Make sure that the positive supply lead is connected to the (+) terminal and the negative lead is connected to the (—) terminal. Plug in a pair of high impedance earphones (1000 ohms or more) to J3.

Set the volume control R7 to maximum amplitude position (fully clockwise), and adjust REGEN control R1 to mid-range. Tune C2 until you hear a station in your earphones; it may be received as a "whistle" or beat note. This is the undesired condition mentioned before and is caused by the oscillation of the gate leak detector circuit of Q1—the result of too much RF feedback. Therefore, adjust R1 until the whistle disappears and the station is heard. Retune C2 for best reception. Practice will be necessary for good results.

The most sensitive and selective point of the R1 adjustment is just below the point of oscillation. After tuning in a station, use R7 for comfortable audio volume; R1 should not be used since it reduces selectivity as well as audio volume.

Adjust the antenna trimmer C1 for best sensitivity over most of the band. This setting may have to be changed for best results at the band ends. If necessary, the value of C1 may have to be changed to a different maximum capacity to better match your particular antenna length. Also, you may have to adjust the position of the L2 tickler coil, or add or subtract turns to cover the entire band. Do not be afraid to experiment with this coil. If you do not hear any signals that "whistle," reverse the circuit connections to L2. Also, try moving the tickler coil further up L1.

Speaker operation for personal listening can be achieved with strong local stations. A 45-ohm speaker (the type that is used in intercom systems) is best for this receiver. Other lower impedances down to 8-ohms will result in lower audio volume.

A Modern Wave Trap. The regenerative type of receiver is sensitive, but since it only uses one tuned circuit (unlike a multi-stage superhet receiver), it is subject to overload by strong local radio stations. To overcome this effect back in the golden days of radio, grandad used a device called a "wave trap." This consisted of a tuned circuit in series with the antenna that attenuated the interfering station's signal and allowed weaker signals to be received.

If there is a strong local station interfering with your reception, construct a duplicate of L1 and connect it in parallel with a variable capacitor of the same value as C2 to serve as a wave trap (see drawing and photo). Tune the wave trap variable capacitor to the same frequency as the interfering station. The easy way to do this is to first tune your receiver for *maximum* received signal of the *interfering* station; then tune the wave trap (connected in series with your antenna lead) for *minimum* received signal. ■

Mobile Gas Alarm

(Continued from page 61)

an alarm if a transient appears on the 12-volt power supply line.

Operation. The gas sensor element has a fair amount of thermal inertia as shown in time versus resistance graph.

Therefore, after connecting the instrument to a 12-volt car or boat battery, wait for four to five minutes with S1 in *off* position and R7 at minimum (counter-clockwise) resistance. After the time has elapsed, turn S1 on and start turning the sensitivity adjustment slowly clockwise. When the alarm sounds, switch S1 off, turn R7 slightly back, then switch S1 on again. To obtain maximum sensitivity you can repeat the sensitivity adjustment after a half an hour.

When the buzzer sounds, the only way to turn it off is with S1 (not with the sensitivity adjustment). Check the circuit by rubbing a drop of gasoline or alcohol on your fingers near the sensor. The alarm should then sound. It then takes the sensor four to five minutes to restore itself to the same sensitivity.

Construction. The project is straightforward. Follow the layout shown. All the components fit on a 3- by 4-in. perf board. A 6- by 3- by 2-in. cabinet will house the entire project. Mounting the gas sensor is easy, fitting into a 7-pin miniature tube socket. Pins 1 & 2 are interchangeable, as are pins 3 & 4. Though we mounted the sensor in the same cabinet as the rest of the circuit, you may want to install it at some remote location in your boat or trailer and connect it via a 3-wire, No. 18 stranded cable to the alarm box. Use the cabinet as a heat sink for transistor Q1; it does not have to be insulated since the collector on the metallic transistor tab is at ground potential. You can pick the 12-volt supply from the cigarette lighter or by making a separate connection to your battery. Use a socket for the integrated circuit to avoid overheating the pins when soldering.

Typical temporary installation in a pick-up camper. Recreational vehicles often have an electrical outlet supplying 12-volt power.

There is a strong possibility that a number of asphyxia-related camping tragedies could have been avoided if this simple gadget had been on the job. Of course, nothing takes the place of *safety first!* A propane-fired cooking stove should *not* be used to warm an enclosed camper or trailer while people sleep. Similarly, children should be taught the dangers of "haphazard" adjustment of kitchen knobs. ■

Time Tally

(Continued from page 68)

average utility cost of $.05 per kilowatt hour.

There are two ways of connecting the Time Tally to the appliance being timed. The simplest way, in theory at least, is to connect a 6 or 12-volt power supply directly to the appliance on-off switch as shown in Fig. 2. However, because the switch is often in a tight corner, this approach is sometimes difficult. Another approach, which makes the Time Tally even more versatile, is shown in Fig. 3. With this set-up, one merely plugs the appliance into the Time Tally plug. The appliance switch is left *on* so that the appliance can only be turned on or off by using the Time Tally switch.

Other Uses. The Time Tally can also be used in an auto to time the length of driving time for a trip. Here the Time Tally should be connected as described in the outdoor-engine use section.

The indoor version of the Time Tally, if used with the power supply shown in Fig. 3, can be used as a digital cooking timer. Just flick the switch the minute an egg goes into boiling water or a TV dinner goes in the oven, and watch for the recommended minute to show up. Here a resettable 6-volt counter would come in especially handy, but you can mentally note the present reading and watch for the desired one. ■

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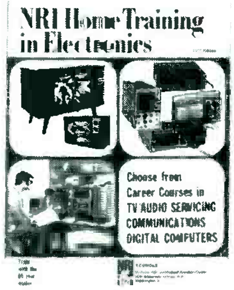

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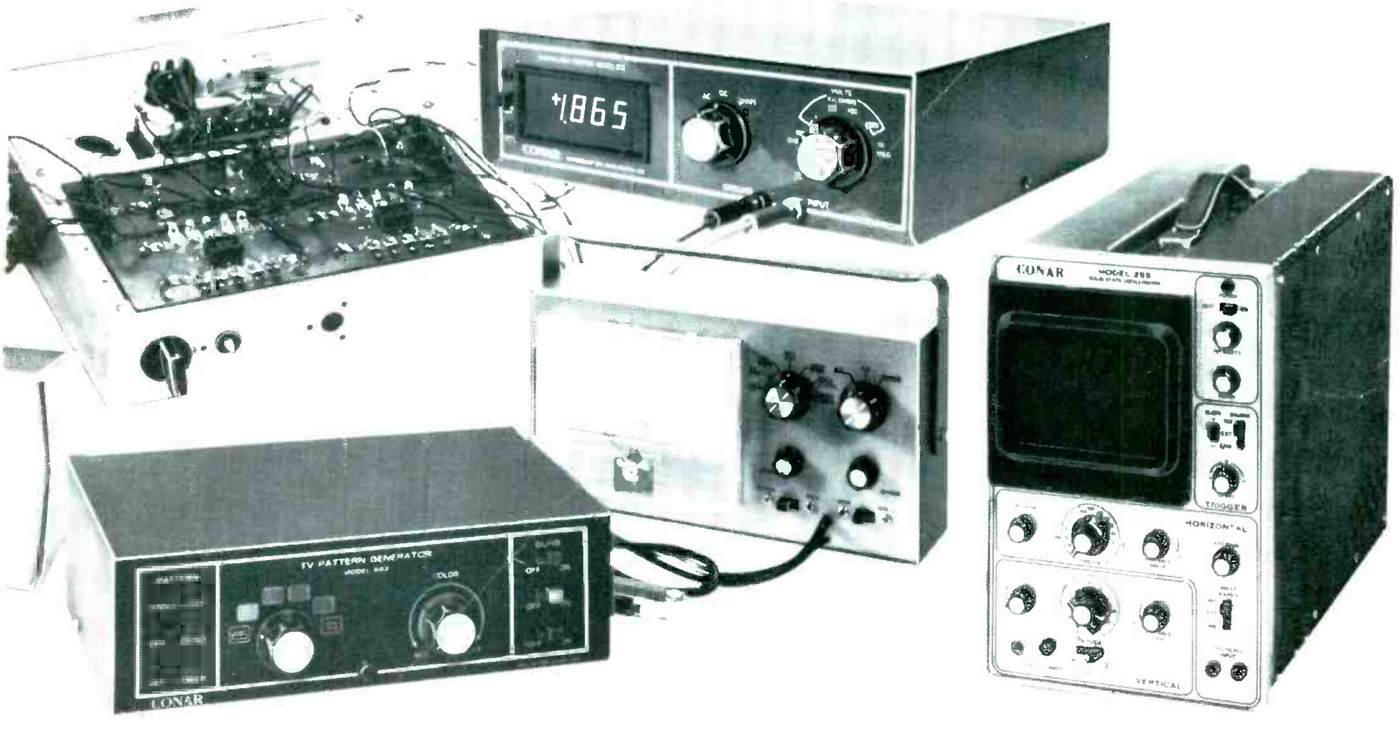

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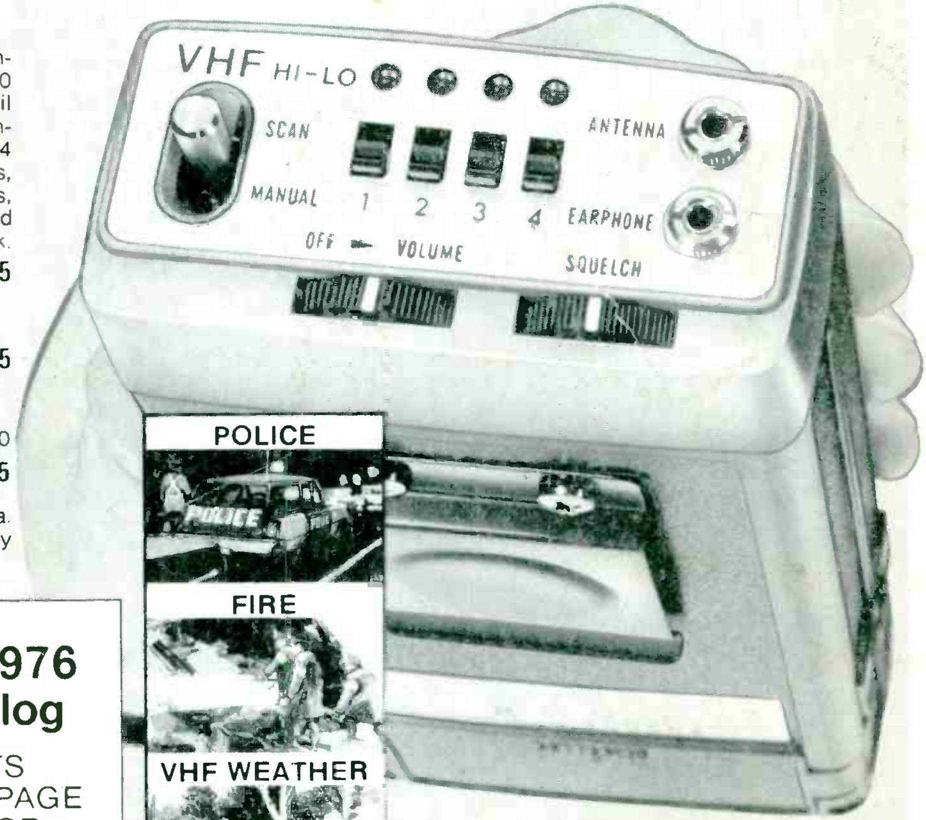

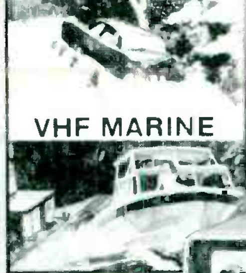

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