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POPULAR ELECTRONICS

OCTOBER 1966

50 CENTS

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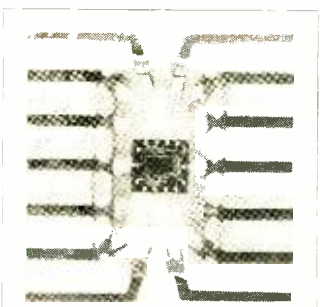
VOLUME 25 — **OCTOBER, 1966** — NUMBER 4

SPECIAL CONSTRUCTION FEATURE

FEATURE ARTICLES

DEPARTMENTS

Electronics hobby has dubious types, too **80**



Can this spider-like IC do YOUR job? **52**

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This month's cover photo by Bruce Pendleton

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LETTERS
FROM OUR READERS

Address correspondence for this department to: Letters Editor, POPULAR ELECTRONICS, One Park Avenue, New York, N. Y. 10016

HAM RADIO EQUIPMENT JAMBOREE

Looking for the amateur radio column in the August, 1966, issue, I found in its place "Amateur Equipment Jamboree: 1966" which informed me how "professional" my amateur station could be in performance and appearance if I used factory-built equipment, or built my station from commercial kits. This sort of article has become typical in the current electronics and amateur radio publications. At one time the radio amateur was a distinguished individual who was envied because of his competence and ingenuity in constructing and operating his own wireless station. But today's amateur simply writes a check, buys a load of factory-built machinery,

strings up an antenna (often factory-built, too), plugs it all in, twists the knobs and pushes the buttons according to the instruction book. He knows, of course, that if anything burns up, the rig can be sent back to the factory for repairs; in fact, a service guarantee usually comes with it. Hamming has become a fun-communicating type of operation with few individuals building their own equipment, or even taking an interest in the technical side of radio. Perhaps it is out of monetary interest that the magazines are pushing this commercialism, but the trend has got to be reversed if we are to keep our hobby colorful and interesting.

DONALD CHESTER, K4KYV
Woodlawn, Tenn.

I would like to point out an error made in the "Amateur Equipment Jamboree" concerning the Heathkit SB-300 receiver. It is listed as a Heathkit SB-301.

DON WILLIAMSON, KPM3960
Florence, Ky.

There's a mistake in the "Radio Amateur Equipment Sampler" on page 73. It says that the Hallicrafters HT-10 is designed to operate on 80-10 meters. It also operates on 6 meters.

JOHN BOHN
Minot, N.D.

Donald, if our children are forced to do everything our parents did, we would still be

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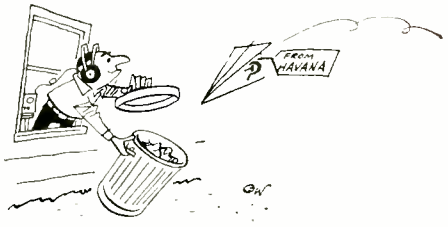
LETTERS

(Continued from page 6)

listening to Atwater Kents. You can build a station from scratch and strain to get on the air, and there's nothing wrong with that, if that is what you want to do, or you can get on the air as expeditiously as possible, and devote time and energy to things new, different, and better. There's no doubt that a home-brew rig demands of the builder a good deal more aptitude and practical know-how, but is he getting the most out of his energies by punching holes in chassis to make a conventional transmitter or receiver instead of, say, building a moon-bounce capability? Besides, there's nothing to prevent the kit builder or owner of a "store-bought" unit from knowing all about his equipment, and the purpose of each resistor and capacitor. Don, the Heathkit SB-301 is a new model. John, you are right about the Hallicrafters HT-40; it does go up to 6 meters. That's pretty fine and fancy reading of the fine print—and we appreciate it, because this sort of thing helps keep editors on their toes.

HAVANA PROPAGANDA

I truly agree with the letter entitled "Damaging QSL" (July, 1966). Every hobby has its bad points, and being on a propaganda list is not very enjoyable. I, too, have been receiving propaganda from *Radio Havana*. How about printing a list of the countries that send



propaganda to listeners when all the listeners want is a verification of report of reception? In this way, we would know which countries not to write to.

MITCHELL HERBACH
Brooklyn, N.Y.

Please tell your readers to stay away from *Radio Havana*, Cuba. I have not SWL'ed now for two years, but the communist propaganda rubbish keeps coming. Help!

BILL BRADFORD
Murray, Utah

Okay, Mitch, we'll publish the info as we get it. Bill, wonder what the Radio Havana *people would do if you wrote to them and asked them, in a nice way, to take your name off their mailing list.*

SWIMMING POOL SPLASH ALARM

I put together the "Swimming Pool Splash Alarm" (July, 1966) and followed the diagram

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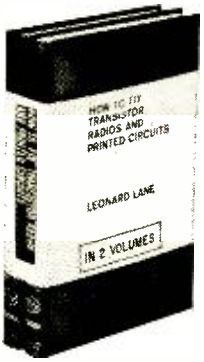

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LETTERS (Continued from page 8)

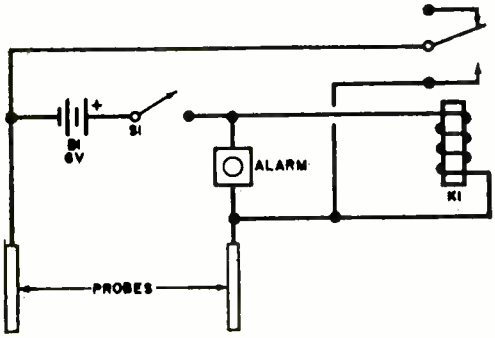
and text very closely. The alarm worked on the first two trials and cut out on the third. Transistors *Q1* and *Q3* were found to be defective and were replaced, but on subsequent tests the same thing happened. Is it possible that the diagram is at fault?

GENE H. ALBRIGHT
New Stanton, Pa.

The "Swimming Pool Splash Alarm" can also be used as a burglar alarm. All you have to do is connect a normally-open microswitch across the probes and place the switch in contact with a door or window.

JIM VARRONE
N. Miami Beach, Fla.

I have found an easier way to make this alarm. By eliminating most of the compo-



nents and the separate battery, but retaining all of the features and the relay in the original circuit, cost, time, and space can be saved.

WILLIAM A. RUSSO
N. Merrick, N.Y.

Gene, the diagarm is correct; diode D1 *is supposed to protect the transistors from reverse current surges. Try adding a resistor in series with the relay winding to reduce the amount of current flow. The larger the ohmic value of the resistor, the less current will flow; but don't use a value large enough to interfere with proper relay action. The Potter and Brumfield RS5D relay is available with different coil ratings. Did you get the one specified? Jim, your suggestion is a good one—actually, there are a great many variations of and applications for this circuit. Bill, your circuit could work if the conductivity of the water allows enough current flow to energize the relay. Don't sell the transistors short; they do increase circuit sensitivity significantly.*

BEWARE OF SILVER SOLDER

We have received a report from the New Mexico Department of Health on a case of cadmium poisoning involving a television station repairman who had been using silver solder with a high cadmium content. Also, two deaths have occurred, one in California,

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LETTERS

(*Continued from page 10*)

and one in Utah. Not all silver solder contains cadmium. However, the following precautions should be followed: warning labels, which should be on all packages, should be carefully read and followed; the working area should be properly ventilated; and workers should tell their physicians what their jobs are and what types of materials they handle. Occupationally-caused illnesses and diseases can be easily overlooked if physicians do not have this vital information.

U.S. Department of
Health, Education, and Welfare
Public Health Service
Washington, D.C. 20201

ELECTRIC DICE GAME—NO DICE

I think it a misnomer to call the device designed by Ken Greenberg (July, 1966) an electronic dice game. The device can perform the function of one twelve-sided die but not of two conventional six-sided dice, for a number of reasons. First, one cannot obtain the number 1 when two dice are tossed in a game. Second, even if you were willing to discard the number 1, the numbers 2 to 12 that the electric gadget offers the player are equiprobable, which is contrary to the probabilities associated with these numbers on a tossed pair of dice. It is well known, for example, that a 7 has a far greater probability ($\frac{1}{6}$) than a 12 ($\frac{1}{36}$). I think this should be brought to the attention of your readers.

SOLOMON ROSENSTARK
Department of Electrical Engineering
New York University
University Heights, N.Y. 10453

Like the Solomon of old, your words of wisdom are well spoken; but authors and editors, being what they are, do take poetic license from time to time. At least the electronic "dice" weren't loaded. We agree that equiprobable situations are atypical of dice.

SO WHY NOT HERTZ?

I made a list of the "Measurement Units" in the article entitled "Test Measurements Profile" in the April 1966 issue (the same issue in which you announced the change from cycles to hertz), together with the names of some of the devices mentioned. I observed that every one of them is named for some early experimenter in electronics: *ampere* (Andre Marie Ampere, French physicist); *farad* (Michael Faraday, English chemist and physicist); *gauss* (Karl Friedrich Gauss, German mathematician); *henry* (Joseph Henry, American physicist); *Maxwell bridge* (James Clerk Maxwell, Scottish physicist); *ohm* (George Simon Ohm, German physicist); *volt* (Count Allesandro Volta, Italian physicist); *watt* (James Watt, Scottish inventor); *Wheatstone bridge* (Sir Charles Wheatstone, English physicist);

(*Continued on page 103*)

PARTS
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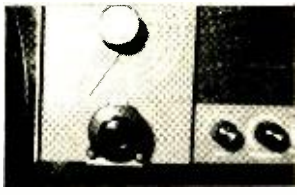
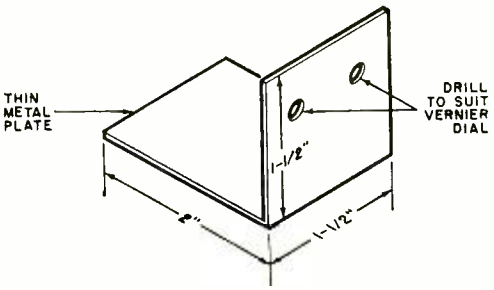
IDEAS
GADGETS
DEVICES

TIPS & TECHNIQUES

VERNIER DIAL PROVIDES MECHANICAL BANDSPREAD

If you own one of those inexpensive communications receivers with stations crowded on the dial, you can improve station separation dramatically with a modest investment of about 89 cents, and a few spare moments of your time. All you do is replace your existing fine tuning or bandspread knob with a vernier dial that you can get at most electronic supply houses. If you cannot mount the dial directly on the panel over the control shaft, first mount the dial on a small support panel fabricated from light-gauge aluminum or sheet metal as shown in the drawing. Then secure the panel, with the installed dial, to the bottom of the chassis or cabinet after





slipping the vernier dial over the bandspread or fine tuning shaft. You'll be pleasantly surprised by the change in tuning ease.

—Bruce Carlin

TRUNK ROLLER MAKES DIAL CORD BRACKET

Hobbyists and experimenters who design or assemble their own receivers are usually faced with the problem of running the dial cord from the tuning dial through holes to the underside of the chassis and back up again. Keeping the dial cord from rubbing against the sides of the holes usually presents a challenge to the builder. A pulley bracket

(*Continued on page 20*)

POPULAR ELECTRONICS
READER SERVICE PAGE

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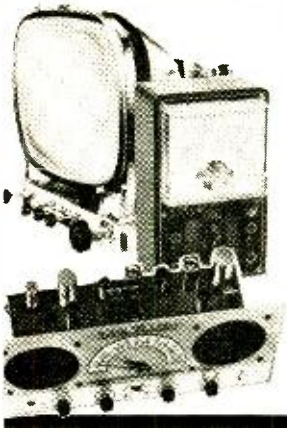

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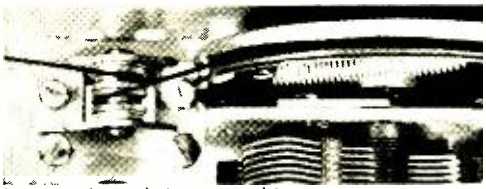
TIPS

(*Continued from page 14*)

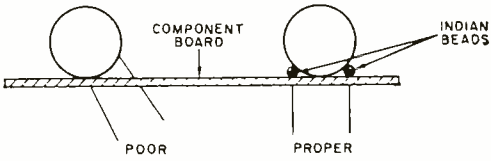
fabricated from a small trunk roller and dial cord pulley can he used to simplify the project. Just remove the roller and use the bear-



ing portion of the assembly to support one or more pulleys as shown. The support housing can be mounted on the chassis with machine screws. —*Ronald L. Ives*

INDIAN BEADS KEEP 'EM STRAIGHT AS AN ARROW

If you've had the occasion to mount a ceramic disc capacitor on a circuit hoard, you might have wound up soldering the capacitor in an ungainly position, giving your project a "biased" appearance. To insure correct posture of the component, and an overall improvement in the project, slip a small-sized Indian bead onto each lead of the capacitor before soldering it. —*Jan Rosenbaum*



FROM PILL BOTTLE CAP TO POSITION INDICATOR

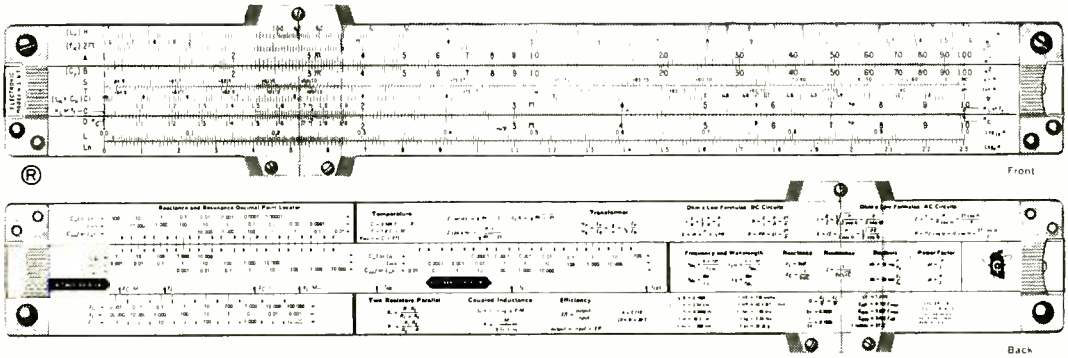
Those seemingly useless pill container caps with a pointer to remind you when it's time to take your next pill can also be used as shaft position indicators on your electronic projects. To make such an indicator, remove the pointer disc from the lid and drill a $\frac{3}{8}$"-diameter hole in the center of the cap. Then slice off the dial portion of the cap, using a sharp knife or razor blade. Slip the dial onto the potentiometer shaft and secure it in place with a nut. Now replace the indicator knob on the dial. —*Art Trauffer*

(*Continued on page 100*)

Be the man who's always first to say: "I've got the answer right here."

START USING THIS REMARKABLE

ELECTRONICS SLIDE RULE



SOME DAY EVERYONE in electronics may have a slide rule like this. Till then, the man who uses one will seem like a wizard as he solves reactance and resonance problems in 12 to 20 seconds —*without pencil and paper.*

This is a professional slide rule in every detail, a full 10" long, made exclusively for Cleveland Institute of Electronics, to our rigid specifications, by Pickett, Inc. It can be used for conventional computation as well as special electronics calculations. All-metal construction assures smooth operation regardless of climate.

Handsome top-grain leather carrying case has heavy-duty plastic liner to protect slide rule; removable belt loop for convenient carrying. "Quick-flip" cover makes it easy to get rule in and out of case.

You also get four full-length AUTO-PROGRAMMED™ Lessons, which teach you how to use the special electronics scales on the slide rule. These lessons have been carefully designed to meet the same high educational standards as the electronics career courses for which our school is famous. Even if you've never used a slide rule before, you'll soon whiz through the toughest problems with this CIE rule.

Deliberately underpriced. Many men in electronics have told us that this unique slide rule, leather case, and 4-lesson course easily add up to a $50 value. But we have deliberately underpriced it at less than $25. Why? Our reason is simple: we are looking for men in electronics who are ambitious to improve their skills...who know that this will require more training. If we can *attract* you with the low price of our slide rule and course—and *impress* you with its quality—you are more likely to consider CIE when you decide you could use more electronics training.

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CIRCLE NO. 13 ON READER SERVICE PAGE

NEW PRODUCTS

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

ELECTRONIC IGNITION SYSTEM

Attention: motorcycle owners. The *Judson* "Cycle-Tron" is a completely integrated electronic ignition system designed specifically for motorcycles. The output of the Cycle-Tron, unlike that of the standard coil ignition system, does not fall off as the speed of the engine increases. Providing positive ignition under all conditions at any speed, the Cycle-Tron enables improved performance, a smoother running engine, and quicker starting. Because there is less wear or erosion on ignition components, fewer tune-ups are required. Installation is simple and can be made on the average motorcycle in less than 30 minutes. The unit carries a 3-year warranty.

Circle No. 75 on Reader Service Page 15

STEREO TAPE RECORDER KIT

Considerable savings can be realized by a builder of the kit version of the professional Magnecord 1020 four-track stereo tape recorder being offered by the *Heath Company*. Total assembly time is about 25 hours; assembly involves two circuit boards and mechanical mounting of the transport components. Included in the Model AD-16 kit are precut, prestripped, and marked connecting wires and shielded cables. Walnut cabinet is optional. With the AD-16, you can play back and record "live" from microphone or from auxiliary sources in four-track stereo or mono at either 7½ or 3¾ in/s. It also has sound-on-sound, sound-with-sound (mixing), and echo capabilities.

Circle No. 76 on Reader Service Page 15

INSTANT-LOADING CARTRIDGE RECORDER

This three-pound, battery-powered cartridge recorder by *Concord Electronics*, Model F-100, plays or records for a full hour on one snap-in cartridge, then shuts off automatically. The C-60 cartridge, interchangeable with those of most better quality cartridge recorders now on the market, snaps into place instantly. Tape speed is 1⅞ in/s; frequency response, 60-10,000 hertz. The F-100's compact size (3" x 5" x 8"), light weight, and rugged construction make it useful for travelers—in automobiles, aircraft, or other moving vehicles. Accessories include a remote control microphone, microphone stand and pouch, two patch cords, and a carrying strap.

Circle No. 77 on Reader Service Page 15

5" WIDE-BAND OSCILLOSCOPE

The Model 315A high-sensitivity 5-MHz 5" oscilloscope announced by *Precise Electronics* is intended for audio and industrial testing as well as for TV servicing (both black-and-white and color). The "Green Line" panel-controls layout makes for increased efficiency and ease of operation on the part of the user. Some of the 315A's features: vertical response to 5 MHz with 10 mV r.m.s./cm. sensitivity; three-step frequency-compensated vertical attenuator with separate stepless control; two-stage push-pull vertical amplifier plus cathode-follower input; panel-mounted astigmatism control; drift-free positioning control; and fully automatic sync.

Circle No. 78 on Reader Service Page 15

COMMUNICATIONS RECEIVER

Hallicrafters' Model S-210 six-band receiver includes the AM and FM broadcast bands plus the 49-, 31-, 25- and 19-meter short-wave bands. "Spread" tuning (the spreading apart of distant stations electronically) permits the listener to zero in on short-wave stations with local-station ease and precision. On the front panel are band selector/a.f.c., tuning, on-off volume, and tone controls. The metal cabinet is covered in walnut-colored vinyl with wood grain inlay trim.

Circle No. 79 on Reader Service Page 15

CARBON MICROPHONE

Available both in kit form and as a completed unit, the Dart M-100 carbon mike put out by

Introducing EICO's New "Cortina Series"!

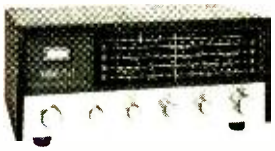
Today's electro-technology makes possible near-perfect **stereo at moderate manufacturing cost:** that's the design concept behind the new EICO "Cortina" all solid-state stereo components. All are 100% professional, conveniently compact (3⅛"H, 12"W, 8"D), in an esthetically striking "low silhouette." Yes, you can pay more for high quality stereo. But now there's no need to. The refinements will be marginal and probably inaudible. Each is **$89.95 kit, $119.95 wired.**

Model 3070 All-Silicon Solid-State 70-Watt Stereo Amplifier: Distortionless, natural sound with unrestricted bass and perfect transient response (no interstage or output transformers); complete input, filter and control facilities; failure-proof **rugged all-silicon** transistor circuitry.

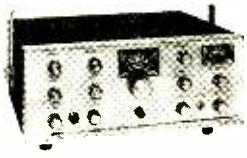
Model 3200 Solid-State FM/MPX Automatic Stereo Tuner: Driftless, noiseless performance; 2.4μV for 30db quieting; RF, IF, MX are pre-wired and pre-tuned on printed circuit boards — you wire only non-critical power supply.

7 New Ways to make Electronics more Fun!

Save up to 50% with EICO Kits and Wired Equipment.



You hear all the action-packed capitals of the world with the **NEW EICO 711 "Space Ranger" 4-Band Short Wave Communications Receiver** plus ham operators, ship-to-shore, aircraft, Coast Guard, and the full AM band, 550KC to 30MC in four bands. Selective, sensitive superhet, modern printed circuit board construction. Easy, fast pinpoint tuning; illuminated slide-rule dials, logging scale; "S" meter, electrical bandspread tuning, variable BFO for CW and SSB reception, automatic noise limiter, 4" speaker, Headphone jack. **Kit $49.95. Wired $69.95.**



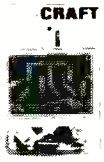
More ham for your dollar than ever — with the one and only SSB/AM/CW 3-Band Transceiver Kit, new **Model 753** — "the best ham transceiver buy for 1966" — Radio TV Experimenter Magazine. 200 watts PEP on 80, 40 and 20 meters. Receiver offset tuning, built-in VOX, high level dynamic ALC, **silicon solid-state VFO.** Unequaled performance, features and appearance. Sensationally priced at **$189.95 kit, $299.95 wired.**

NEW EICO 888 Solid-State Engine Analyzer

Now you can tune-up, trouble-shoot and test your own car or boat.

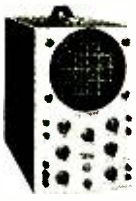
Keep your car or boat engine in tip-top shape with this completely portable, self-contained, self-powered universal engine analyzer. Completely tests your total ignition/electrical system. The first time you use it — just to tune for peak performance — it'll have paid for itself. (No tune-up charges, better gas consumption, longer wear) 7 instruments in one, the EICO 888 does all these for 6V and 12V systems; 4, 6 & 8 cylinder engines.

The EICO 888 comes complete with a comprehensive Tune-up and Trouble-shooting Manual including RPM and Dwell angle for over 40 models of American and Foreign cars. **The Model 888 is an outstanding value at $44.95 kit, $59.95 wired.**



New EICOCRAFT easy-to-build solid state electronic TruKits:® great for beginners and sophisticates alike. As professional as the standard EICO line — only the complexity is reduced to make kit-building faster, easier, lower cost. Features: pre-drilled copper-plated etched printed circuit boards; finest parts; step-by-step instructions; no technical experience needed — just soldering iron and pliers. Choose from: Fire Alarm; Intercom; Burglar Alarm; Light Flasher; "Mystifier"; Siren; Code Oscillator; Metronome; Tremolo; Audio Power Amplifier; AC Power Supply. **From $2.50 per kit.**

There's more PUNCH in the new EICO "Sentinel-Pro" 23-channel Dual Conversion 5-watt CB Transceiver. New advanced Big-Reach **"Range Plus"** circuitry lengthens "talk-power" reach. Automatic noise limiter super-sensitizes for weak signals. "Finger Tip" antenna loading and transmitter tuning controls. 23 crystal-controlled transmit and receive channels — **all crystals supplied.** Rear-illuminated S/RF meter. Transistorized 12VDC and 117VAC dual power supply. **Wired only, $169.95.** Positive-Negative Ground/Mobile Marine Modification kit (optional $5.95).



Model 460 Wideband Direct-Coupled 5" Oscilloscope. DC-4.5mc for color and B&W TV service and lab use. Push-pull DC vertical amp., bal. or unbal. input. Automatic sync limiter and amp. **$99.95 kit, $139.50 wired.**

FREE 1967 CATALOG PE-10

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Send me **FREE** catalog describing the full EICO line of 200 best buys, and name of nearest dealer. I'm interested in:

- ☐ test equipment
- ☐ ham radio
- ☐ stereo/hi-fi
- ☐ Citizens Band radio
- ☐ automotive electronics

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Model 232 Peak-to-Peak VTVM. A must for color or B&W TV and industrial use. 7 non-skip ranges on all 4 functions. With exclusive Uni-Probe.® **$29.95 kit, $49.95 wired.**

CIRCLE NO. 16 ON READER SERVICE PAGE

PRODUCTS (*Continued from page 22*)

Semitronics Corp. is suitable for CB, ship-to-shore communications, intercoms, mobile radio, or for any other amateur or professional use. Each do-it-yourself kit comes complete with a schematic plus diagrams for using the mike. The Dart M-100 has an output impedance of 100 ohms, a sensitivity of —43 db = 3 db, and a frequency response from 300 to 3000 hertz. The exciting voltage is 6 volts at 50 mA.

Circle No. 80 on Reader Service Page 15

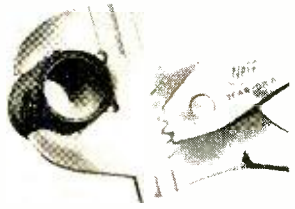
SIGNAL MONITOR

Said to perform with virtually any receiver on the market today, the *Heathkit* SB-610 signal monitor visually displays both transmitted and received signal waveforms. It displays the actual signal envelopes or trapezoid patterns from ham radio transmitters and can be used with any transmitter from 160 to 6 meters. The comprehensive assembly manual includes procedures for displaying signals from 5-watt CB equipment, and also provides the ham or CB'er with characteristic waveforms for signal analysis—including SSB and RTTY.

Circle No. 81 on Reader Service Page 15

ADJUSTABLE WRENCH

A wrench that grips like a pair of pliers has been announced by *Neff Enterprises, Inc.* Called "GEAR-GRIP," it's available with three different jaw configurations; smooth "V" jaws, straight jaws, and "V" jaws with pipe teeth. The "V" jaw models have a capacity from 5/16" to 1" and the straight jaw model from 0" to 15/16". Plier-like ratchet action is obtained—without removing the tool from the work—by simply relaxing your grip and allowing the jaws to slip around the work quickly to get a new grip.



Circle No. 82 on Reader Service Page 15

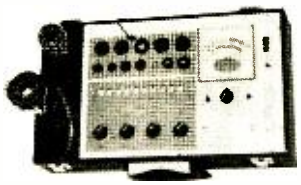
SOLID-STATE CB TRANSCEIVER

Crystal socket accessibility and solid-state switching are featured in the "Slimline 675" 10-channel, 5-watt CB transceiver introduced by the *Amphenol Corporation*. To add transmitter and receiver crystals, you just remove three knobs and two shaft nuts from the front panel controls; the panel is then lifted away, exposing the backs of the crystal sockets and the channel indicator dial. Use of solid-state switching provides protection against accidental "no-load" and "front-end" burnout—there are no contacts to stick, short out, or corrode due to arcing. The receiver is a dual-conversion superhet, equipped with squelch control. Frequency stability is at least ± 0.005% from —20°C to +85°C. Average power output: 3.5 watts. Measuring only 2½" x 6½" x 9", the "Slimline 675" also boasts a built-in public address system.

Circle No. 83 on Reader Service Page 15

TWO-IN-ONE TUBE TESTER

Designed to perform professional-quality tests on receiving tubes *and* the latest type color and black-and-white TV picture tubes, the Model 115 tube tester being marketed by *Precise Electronics* offers many features previously found only in much higher priced instruments. It includes VTVM circuitry for grid circuit emission and gas tests on receiving tubes, and a unique 10-circuit switching design permits testing of all the new tube types that have elements with multiple pin connections. For TV picture tubes, the Model 115 has facilities for beam-current tests (rather than total cathode emission) and rejuvenation without danger of burnout. Weighing only 8 pounds, the "Green Line" tester is packaged in a rugged portable carrying case.



Circle No. 84 on Reader Service Page 15

STEREO TAPE RECORDER

Lafayette Radio Electronics has introduced the Model RK-815 four-track, three-speed, solid-state portable tape recorder which incorporates a heavy-duty, 5-position selector control (rewind, stop, run, pause, and fast forward). Other features include: four-track stereo/mono record/playback, 5-watt audio output, sound-with-sound, sound-on-sound, separate tone and volume controls for each channel, a stereo record/playback vu meter, and a 3-digit tape counter with preset button. Frequency response is ± 3 db, 40-15,000 hertz at 7½ in/s; — 3 db, 40-10,000 hertz at 3¾ in/s. The RK-815 is mounted in a textured solid vinyl case.

Circle No. 85 on Reader Service Page 15

Build this famous knight-kit®
Star Roamer® 5-Band Shortwave Receiver Kit

and have the whole wide world at your fingertips!

Think of it!—even if you know nothing at all about electronics—in a few fun-filled evenings you can assemble the Knight-Kit Star Roamer that lets you listen to the four corners of the world!

You visit the famous cities of Europe, Asia, Africa ... get continuous 24-hour-a-day aviation weathercasts ... zero-in on Coast Guard LORAN signals ... get the exact time from station WWV in Washington, D. C.... listen in on the interesting conversations of Hams, Citizens Banders and Radio Telephoners—AND listen to your favorite programs on the standard AM band, too.

Thousands of folks of all ages have assembled the Star Roamer and have been amazed at how easy it is. All you do is follow crystal-clear, nontechnical instructions and extra-large illustrations that show where every part fits ... and almost before you know it you're listening to exciting broadcasts from all over the world!

The Star Roamer covers 200 to 400 kc and 550 kc to 30 mc in 5 bandswitched ranges, and features a reliable superhet circuit ... plus Automatic Volume Control to prevent fading and blasting, illuminated "S" meter for fine tuning, and many other features found only in shortwave receivers that cost many times more.

Complete with all parts, handsome 5½ x 12¼ x 8" charcoal gray and aluminum case, and easy-to-follow assembly instructions for only..... **$39.95**

Read the unique money-back guarantee ... exclusive in the industry ... then rush coupon for full details and Special Introductory Offer.

KNIGHT-KIT GUARANTEE

Build a Knight-Kit in accordance with our easy-to-follow instructions. When you have completely assembled the kit, you must be satisfied or we will return your money, less transportation charges, under the Allied guarantee of satisfaction.

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P. O. Box 4398, Chicago, Ill. 60680

Please rush full details and Special Introductory Offer on the **Knight-Kit Star Roamer 5-Band Shortwave Receiver.**

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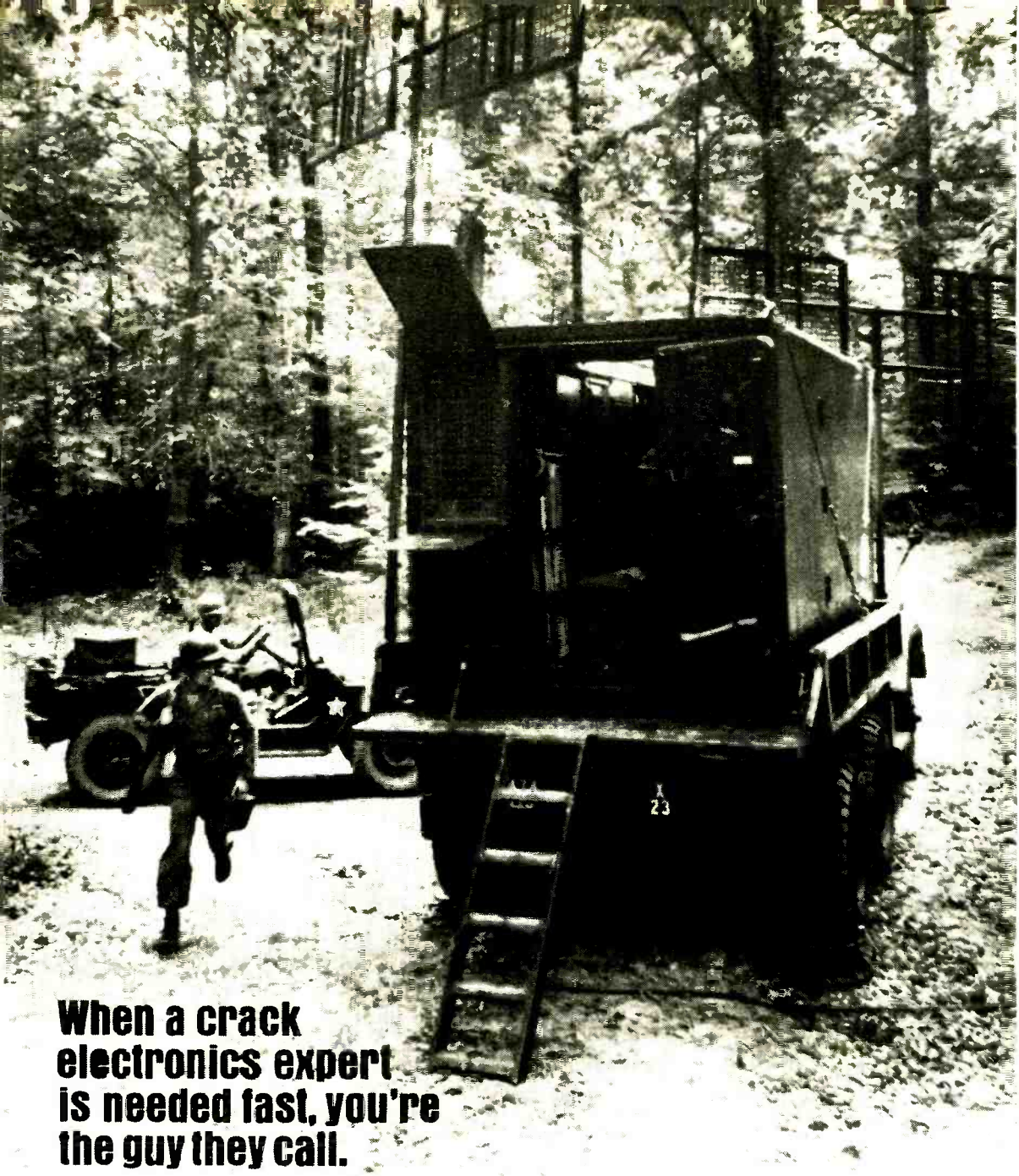

When a crack electronics expert is needed fast, you're the guy they call.

Sometimes you feel like a country doctor with sixteen cases of measles in town.

But working on emergencies is nothing new to you.

You're the expert and emergencies are your job.

You're the one guy in the company that can practically field strip a computer and put it back together again. Circuits are so pressed into your brain you can almost hear a short one. They make the TV's you repaired back in high school look like crystal sets.

If it wasn't for the electronic training you got in the Army, you'd still be a tube tester. But the Army opportunity came along and you took it.

A full-dress, eight-hours-a-day, five-days-a-week school that taught you a skill you'll build a career on.

A solid career that can mean sound security all your life.

There's nothing like being an expert. That's what you can be in today's action **Army**

ELECTRONICS LIBRARY

CREATIVE ELECTRONICS FABRICATION

by Owen G. Patrick

How much pride do you take in projects built from plans in POPULAR ELECTRONICS? When you have a project working to your satisfaction, do you show it off? Or is it operative but ugly? Psychologists tell us that a handsome project always "works" better. Using some simple and some not-so-simple construction techniques, Owen G. Patrick designs and "builds" a signal tracer in this book; and when the unit is finished, it's a beauty. *Creative Electronics Fabrication* tells you how to work with metal chassis, boxes, and cabinets for best results. The information is practical and well presented.

Published by Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York, N.Y. 10017. Hard cover. 258 pages. $6.50.

SERVICING TRANSISTOR TV

by Robert G. Middleton

Transistorized television receivers are being marketed in an ever-increasing volume, and heretofore little practical servicing information on transistor TV circuits has been available. Bob Middleton has organized this service guide so that it will be useful for quick reference to a particular section when a particular set of trouble symptoms is encountered. The book is divided into the various receiver sections and subdivided according to symptoms. Most of the possible causes for each symptom are listed, and those troubles frequently encountered are analyzed.

Published by Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 46206. Soft cover. 223 pages. $3.95.

TRANSISTOR CIRCUIT ANALYSIS AND DESIGN, Second Edition

by Franklin C. Fitchen

Intended as an electronics course for electrical engineering students, this book will also prove useful to the practicing engineer—who will find the analysis and design examples helpful as background for the solution of specific problems. Vast changes in the characteristics of available devices sparked the revision of this text. Also, this edition is larger than its predecessor. Several advanced design techniques are described, and ties between semiconductor physics and device characteristics have been made stronger.

Published by D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J. Hard cover. 412 pages. $8.50.

—30—

NEW LITERATURE

To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15.

Everything in electronics for home, industry, and laboratory is claimed for the contents of *Lafayette Radio*'s 1967 catalog, No. 670. Consisting of 512 pages, it covers stereo hi-fi, CB, and ham gear, test equipment, radios, TV's and accessories, auto accessories, etc. As usual, all major manufacturers are represented, plus Lafayette's own components.

Circle No. 86 on Reader Service Page 15

Regency Electronics has produced a 16-page booklet that explains how the Regency solid-state "Tone Program System" enables firemen to turn out within five seconds after receiving an emergency call. The booklet, which tells how tone alerting works for small, medium, and large emergency units, is offered free to fire chiefs, civil defense directors, fire equipment distributors, and municipal officials.

Circle No. 87 on Reader Service Page 15

"Barry's Green Sheet," a new catalog released by *Barry Electronics Corp.*, covers tubes, semiconductors, transformers, chokes, meters, wire, and test equipment, together with other components and equipment. The catalog is said to be unusual in that it contains many hard-to-find and unique items available at tremendous savings.

Circle No. 88 on Reader Service Page 15

A 12-page, two-color catalog on "G," "M" and other series panel meters—including a 1½" edgewise meter for use where panel space is at a premium—is being offered by the *Triplett Electrical Instrument Company*. The "G" Series meters, which come in a variety of sizes and shapes, feature flexibility and interchangeability and are equipped with the Triplett BAR-RING magnet and one-piece die-cast frame.

Circle No. 89 on Reader Service Page 15

All U.S. Signal Corps technical manuals that are available from *Quaker Electronics* are listed in an 8-page booklet. The manuals are either new or like-new. Also available, and included in the listing, are instruction books and other material pertaining to Signal Corps equipment.

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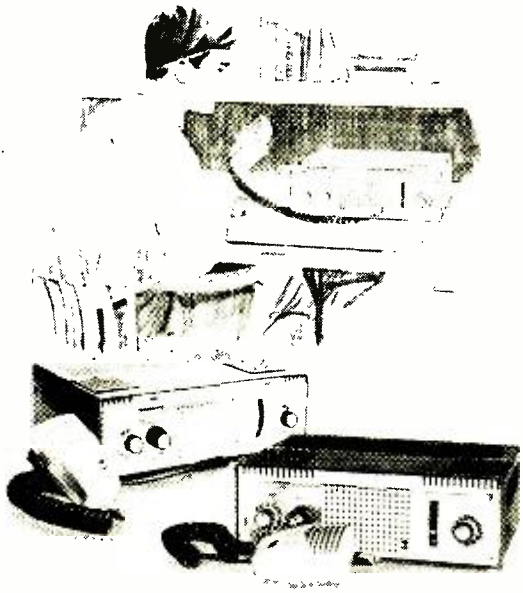

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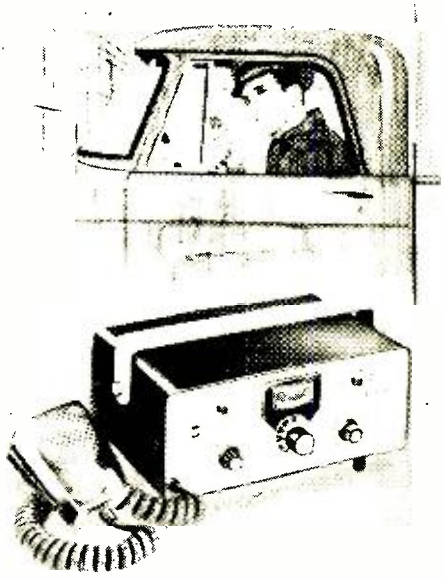

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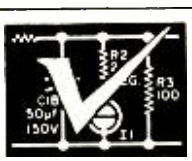

OPERATION ASSIST

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

Pierson KE-93 receiver with "Vipak" unit; tunes BC; has 12 tubes. Schematic and operating manual needed. (Carl Grahn, 14801 Sunset Ave., Oak Forest, Ill. 60452)

Philco Model 37-650 receiver; tunes BC and s.w. on 3 bands; has 8 tubes. Schematic needed. (Dale Carlow, W. Pembroke P.O., Charlotte, Me.)

Stewart-Warner TRF receiver, ser. 14761, circa 1928; tunes BC; has 5 01A's. Schematic and source for tubes needed. (James Royer, R. R. 3, Coldwater, Mich.)

Weston Model 664 capacity meter. Operating manual needed. (Edward J. Lamanski, 78 Palisade Ave., Bogota, N.J. 07603)

RCA Model K-80 receiver; tunes BC and 2 s.w. bands; has 7 tubes. Dial face needed. (W. Paul Chamberlain, 2417 Kenwood Rd., Bakersfield, Calif. 93306)

American Bosch Model 610 receiver; tunes 550 to 16,000 kHz on 3 bands; has 6 tubes. Schematic needed. (Benny Bagasol, 859 Commercial Ave., Apt. 1, S. San Francisco, Calif. 94080)

Motorola TV receiver, ser. 242937, circa 1948; has 23 tubes and 12" picture tube. **Hallicrafters** Model S-20R receiver, circa 1942; tunes s.w. on 4 bands; has 9 tubes. Schematics and parts lists needed. **American** receiver, ser. 25-112265, circa 1938; tunes 550 kHz to 90.5 MHz on 2 bands; has 5 tubes. Schematic, parts list, filter choke, and source for L-49-C tube needed. (Dennie Egan, 210 Highland Oaks Dr., Los Gatos, Calif. 95030)

R.M.E. Model 4350 receiver, circa 1957. Schematic and operating manual needed. (Mike Czuhajewski, RFD 3, Paw Paw, Mich. 49079)

Capehart 17M3 radio/phonograph, ser. 6577S. Schematic needed. (Robert L. Tumpkin, 8036 Brush, Detroit, Mich.)

E. H. Scott SLR-H receiver, ser. 3705; tunes 0.53 to 15.6 MHz on 2 bands; has 11 tubes. (Raymond L. Stone, 2172 Marshall Ave., Napa, Calif. 94558)

Hallicrafters S-106 receiver. Schematic needed. **Garod** crystal calibrator and monitor, surplus, CGQ-60133, circa 1945. Parts list needed. (Kenneth J. Romm, 6520 W. 82 St., Los Angeles, Calif. 90045)

L. W. Electronic Lab. LW-51 transmitter; 6 meters. Schematic, parts list, and tune-up procedure wanted. (William M. McDonald, 19 Sargent St., Lawrence, Mass. 01841)

Silvertone receiver, circa 1944; tunes 550 kHz to 18 MHz on 3 bands; has 8 tubes. Schematic needed. (J. E. Christian, 2623 Shelby, Apt. 136, Dallas, Tex. 75219)

(*Continued on page* 32)

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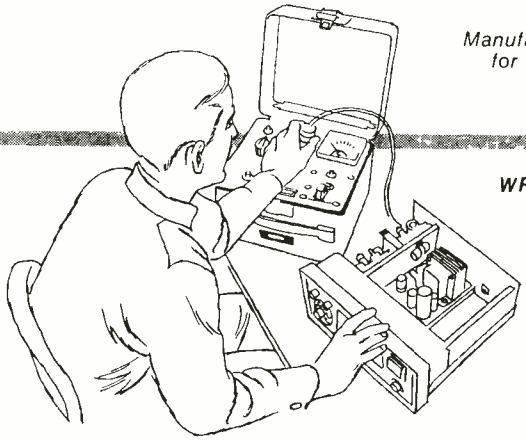

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(*Continued from page* 30)

Atwater-Kent 55C receiver, ser. 4001709. Cabinet and source for parts needed. (Lorne E. Baker, Box 128, Mt. Pearl, Newfoundland, Canada)

Webcor 2030-1A tape recorder, circa 1953; has 5 tubes. Schematic and operating manual needed. (George Downes, Jr., Rt. 1, Magnolia, Ohio 41643)

TS-239/UP oscilloscope, surplus. Schematic needed. (S. P. Christian, 23653 Hazen, Southfield, Mich. 48075)

Garrard R.C. 98/4 record player. Record spindle needed. (Jeffry Blumenfeld, Belmont Dr., Colonial Pk., Monticello, N.Y. 12701)

Rex UC-1 UHF/TV converter, circa 1953. Schematic and tube complement needed. (Russell Cox, Jr., 7495 E. Townline Rd., Rt. 1, Bridgeport, Mich. 48722)

Western Electric D-153964 receiver, ser. 809, lot 3; has 8 tubes. Schematic needed. (C. Fred Mullins, 3258 Rebert Pike, Springfield, Ohio)

VCR97 cathode-ray tube base connections needed. (Jerry Proc, 76 Barnesdale Ave. N., Hamilton, Ontario, Canada)

RBB-2 or **RBC-2** receiver, made by RCA, circa 1941; tunes 4 to 27 MHz on 4 bands. Schematic for receiver and power supply (RBA-1 or RBB-1 or RBC-1) needed. (Dick Atkinson, 1679 W. 15 St., Erie, Pa. 16505)

Triumph Model 335 VOM, Navy Dept. Model OCR-1, 1CTU 60143. Schematic needed. (Frank Keegan, 189-10 46 Ave., Flushing, N.Y. 11358)

CRV-46152 DZ-2 aircraft direction finder, ser. 365, made by RCA, 6/30/39. Loop assembly, loop assembly drive, and drawings needed. (Charles Lane, 5201 Roland Ave., Baltimore, Md. 21210)

Solar CE capacitor analyzer, type 1.60. **Sonar** Model CFC VFO. Operating manuals needed. (Dennis Dufour, 148 Clayton Dr., Norco, La. 70079)

Eicor Model 15 tape recorder. Schematic and source for parts needed. (W. F. Goepel, 265 Carol Rd., Stratford, Conn. 06497)

Eldico SSB-500 linear amplifier, circa 1956; 80 through 10 meters. Operating manual and schematic needed. (John Vanloon, Rt. 3, Lemont, Ill. 60439)

TCS-9 receiver, type COL-46159, made by Collins, ser. 250. Schematic and information on operation of "Osc. Selector" needed. (Ronnie Schmidt, 2611 Stratford Ct., San Antonio, Tex. 78223)

Harmon-Kardon Model A 250 "Epic" stereo amplifier; 25 watts; has 8 tubes, 3 transformers. Schematic and operating manual needed. (Steven Terry, 147 Columbia Heights, Brooklyn, N.Y. 11201)

Atwater Kent Models 9, 10, 12, 19, 20. Schematics needed. (Gerald Grulkey, 2801 Greenwood Dr., Richmond, Calif. 94806)

National NC-57 receiver, circa 1950; tunes 560 kHz to 54 MHz on 5 bands; has 9 tubes. First and second i.f. transformers and detector input transformer needed. **RCA** Model 96T2 receiver; tunes BC and s.w. from 550 kHz to 18 MHz; 7 tubes. Schematic and speaker needed. (Robert M. Miller, 107 N. Long Dr., Rockingham, N.C. 28379)

Sears "Meteor" Model 6146 TV set, circa 1957; has 12 tubes and 21ATP4A picture tube. All available information wanted. (Philip Hodge, 5628 S. Harper, Chicago, Ill. 60637)

Montgomery Ward 62-451 receiver, series A2, circa 1936; has 11 tubes; tunes 528 kHz to 22.0 MHz on 4 bands. Schematic, parts list, and operating manual needed. (R. J. Gehring, 501½ Humboldt Ave., Wausau, Wis. 54401)

Supreme Model 567 receiver, ser. 201. Wiring diagram needed. (Robert Sauve, Mont Sacré-Coeur, Granby Shefford, Canada)

Knight C-27 CB transceiver. Construction manual needed. (E. C. Galland, William H. Carr Jr. H. S., 157 St. & 17 Ave., Whitestone, N.Y. 11357)

Polytronics PC-6 ("Polycomm 6") transceiver, ser. 82A120. Schematic and instruction manual needed. (Howard H. Halperin, 9712 S. Merrion Ave., Chicago, Ill. 60617)

Radio City Products 662-663 electronic multitester, circa 1948. Schematic and operating manual needed. (J. Flavin, 8809 W. 81 Terr., Overland Park, Kan.)

(*Continued on page* 38)

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(*Continued from page 32*)

Crosley Model 51 receiver, circa 1924. Schematic and source for tubes needed. (Ray Carifio, 7855 S.W. 17 St., Miami, Fla. 33155)

BC624A receiver, surplus, part of SCR 522 package. Schematic and operating manual needed. **Reiner Electronic Co.** Model OBL-2 oscillograph, surplus, ser. 375. Schematic, operating manual, information on probes, and conversion data needed. (Herman W. Frisch, 14602 S. Avis Ave., Lawndale, Calif. 90260)

Stromberg Carlson Model 440-M receiver, circa 1941; covers 3 bands; has 8 tubes. **Sparks-Withington** (Sparton) Model 36-6-8X, circa 1945; covers 6 bands; has 6 tubes. Schematics and source for parts needed. (Mark L. Miner, 610 Dellwood Ave., St. Simons Is., Ga. 31522)

Crosley Model 58 XA receiver; tunes 550 kHz to 22 MHz on 3 bands. Schematic and alignment data needed. (Harold Shuff, Jr., Box 774, Plevna, Kan. 67568)

RCA Model 1T receiver; tunes from 540 to 1720 kHz; has 4 tubes. Schematic, parts list, and specs for antenna needed. (L. M. Palladino, 318 W. Emerson St., Melrose, Mass.)

E. H. Scott "Philharmonic XXX" receiver, circa 1939; covers 6 bands; has 30 tubes. Schematic of power supply needed and service notes. (John Morrison, 30 Walnut Ave. E., Farmingdale, N. Y.)

E. H. Scott receiver, ser. M-257, circa 1934; tunes AM and s.w. on 4 bands; has 15 tubes. Wiring diagram and coil alignment procedure needed. (Pat Morgan, Box 1-16, Athens College, Athens, Ala.)

Hammarlund Model HQ-140X receiver; tunes from 540 kHz to 31 MHz. Operating manual needed. (Michael Jaworek, 28 Mapes Ave., Nutley, N.J. 07110)

Hallicrafters Model S-20-R receiver, ser. HA-29668; tunes 550 kHz to 22 MHz on 4 bands; has 9 tubes. **Fada Radio Corp.** Model 1007 audio signal generator, ser. 53; has 5 tubes. Schematics and alignment procedures needed. (Wilfredo L. Galimba, Pangasinan School of Arts and Trades, Lingayen, Philippines)

Crosley Model 173 receiver, ser. AGC A526956; has 6 tubes. Schematic needed. (Sam Casella, 2938 S. Juniper St., Philadelphia, Pa. 19118)

Knight-Kit Model T-50 transmitter; tunes from 80 through 10 meters. Schematic and operating manual needed. (John E. Evans, 12414 Rt. 4, Mechanicsburg, Ohio 43044)

Heath Model AR-3 receiver, circa 1956; tunes 550 kHz to 30 MHz on 4 bands; has 5 tubes. Source for parts and construction manual needed. (Ben H. Lane, Jr., 5012B Ave. C., Malmstrom AFB, Mont. 59401)

Triplett Model 1252 VTVM. Schematic, operating manual, and parts list needed. (Robert Macfarlane, Thayer Rd., Higganum, Conn. 06441)

Stewart-Warner Model 9001-G radio-phono combination; tunes BC and s.w. and from 9 through 12 meters; has 7 tubes. Schematic needed. (M. Hoffman, 7G Research Rd., Greenbelt, Md.)

Philips Model S143U receiver, circa 1947; tunes 150 kHz to 22 MHz on 3 bands; has 3 tubes. Schematic and service information needed. (A. Mandelkern, Katamontet, Block 24, Jerusalem, Israel)

Microtone mine detecting set (C), contract #DA-30-075-ENG-3036, surplus, circa 1954; has 8 tubes. Operating manual and transmit-receive head needed. (Neil Horowitz, 144-35 68 Dr., Flushing 67, N.Y.)

Hammarlund "Super-Pro 200" receiver, circa 1943; tunes 100 kHz to 20 MHz. Schematic and operating manual needed. (Aristotle Bouras, 1753 Cottage Grove Ave., San Mateo, Calif. 94401)

Heathkit Model GC-1 receiver, circa 1959; tunes 550 kHz to 32 MHz on 5 bands. Assembly manual needed. (Buford B. Banes, 3524-A Nevada St., Bell, Calif. 90201)

Supreme Model 570 signal generator, ser. 570 316. Schematic or operating manual needed. (Paul Wewe, 2215 New Tampa Hwy. #5, Lakeland, Fla. 33801)

Ampro Model 731 tape recorder, circa 1950; has 4 tubes. Schematic, operating manual, and source for replacement heads needed. (Scott Marovich, 2407 S. Rose St., Kalamazoo, Mich. 49001)

Radio Craft, any 1947 and 1948 copies wanted. (Jack Messenger, Glenwood, Minn.)

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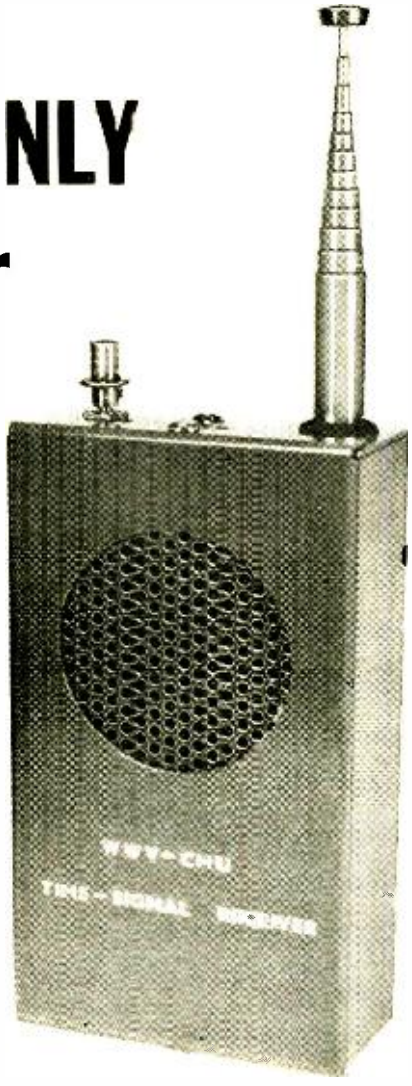

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COVER STORY

BUILD a portable time-signal receiver and you can tune in on standard time broadcasts from your living room, picnic table, boat, car, or even from a private plane. This miniature receiver is a complete superhet circuit with crystal-controlled local oscillator, prepackaged pretuned i.f. module, and *transformerless* audio amplifier. A printed circuit board makes it easy to build and only a screwdriver (no test equipment) is needed for alignment!

Standard time signals can be heard in almost every country in the world. In the United States, radio stations of the National Bureau of Standards (all having the call-sign WWV) continuously transmit time signals on a number of frequencies. Besides accurate time-signal information, the transmissions also provide: standard radio frequencies, standard audio frequencies, standard musical pitch, standard time intervals, radio propagation forecasts, and geophysical alerts. This receiver can be used to monitor WWV on a frequency of 10 MHz or 15 MHz.

You can also use the time-signal receiver to tune in CHU, Ottawa, Canada, on a frequency of 7335 kHz, or on 14.670

MHz. The CHU time-signal broadcasts are very popular because of their voice-time announcements each *minute*. A short tone or "beep" is broadcast each second.

The model of the WWV-CHU receiver shown on the cover (a portable, crystal-controlled, 8-transistor receiver) can be built for a little less than thirty dollars. It has an r.f. amplifier, a mixer, a pre-aligned J. W. Miller i.f. amplifier, and a push-pull Class B audio output. Powered by an ordinary transistor radio battery, the receiver has a low power consumption and battery life is quite good.

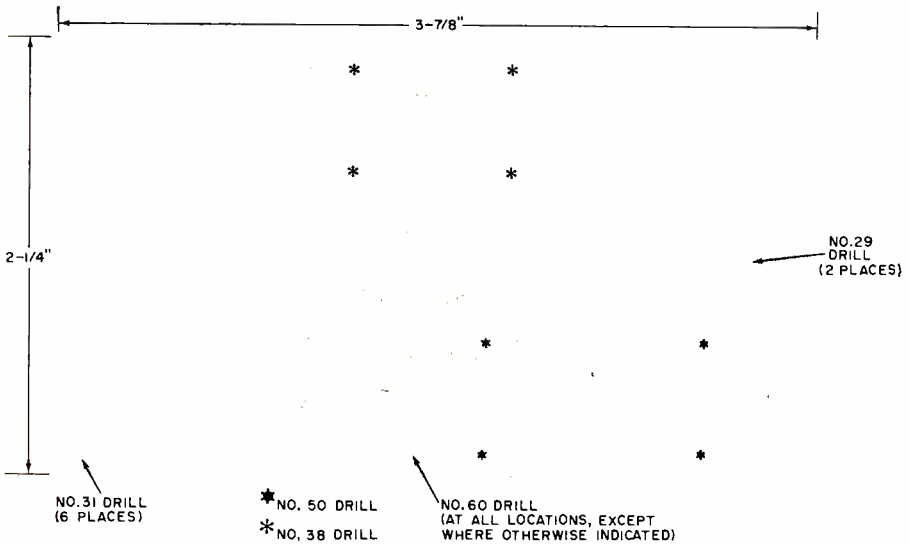
The WWV-CHU receiver is portable and can be used anywhere. A telescoping, built-in whip antenna can be extended to 52 inches for increased signal pickup. The audio stage drives a built-in speaker. In a noisy environment, or for private listening, an earphone can be plugged into the jack provided for that purpose. Since the receiver is crystal-controlled, there is no need to tune for the station.

Sensitivity is excellent, being better than one microvolt for a S/N ratio of 10 dB, which compares favorably with the large multi-tube communications receivers. Although the circuit is fairly complex, the receiver is *easy* to build. There are *no* coils to be wound since prewound, molded r.f. chokes are used. The receiver is even *easier* to align. The only piece of "equipment" needed for alignment is a screwdriver.

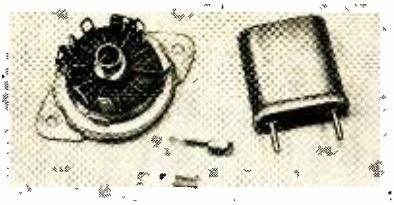
How It Works. The r.f. front end uses several new, low-cost, encapsulated, *npn* silicon transistors. Transistor *Q1* is the r.f. amplifier, and transistor *Q2* is the mixer. Coils *L1* and *L2* are prewound iron-core r.f. chokes and are specified as being either 10 μH or 5.6 μH. If 10-μH chokes are used, then CHU on 7335 kHz or WWV on 10 MHz can be tuned. The 5.6-μH chokes will enable the receiver to be tuned to three time-signal stations: WWV on 10 MHz, CHU on 14.670 MHz, or WWV on 15 MHz. Midget trimmer capacitors *C2* and *C6* tune or resonate the chokes to the respective frequencies. Transistor *Q3* is the local oscillator, which is crystal-controlled and "untuned." Fundamental crystals are used in this circuit.

The miniature i.f. module eliminates the need to build a separate i.f. amplifier. Within the module are two transistors, three i.f. 455-kHz transformers, a crystal diode detector stage, and miscellaneous decoupling capacitors.

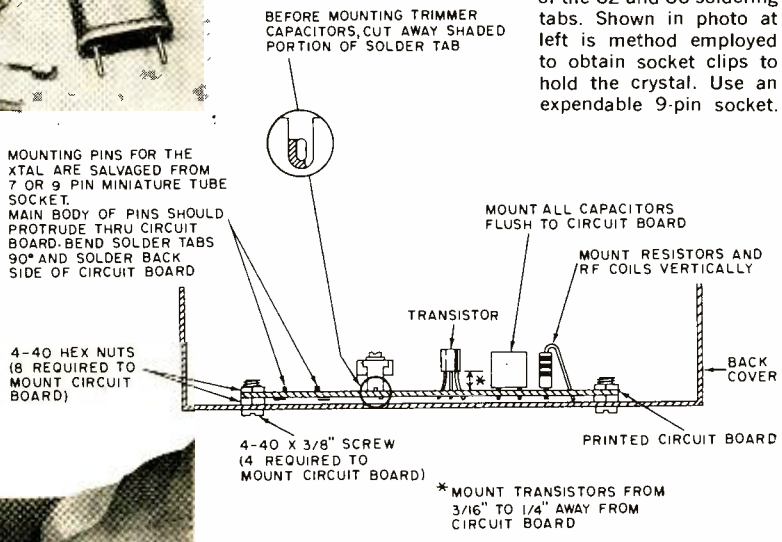
The volume control is potentiometer *R12*. There are *no* transformers in the audio amplifier section so that cost and receiver weight are kept down. The audio preamplifier is *Q4*, a *pnp* germanium transistor. Transistors *Q5* and *Q6* operate push-pull Class B in a complementary-

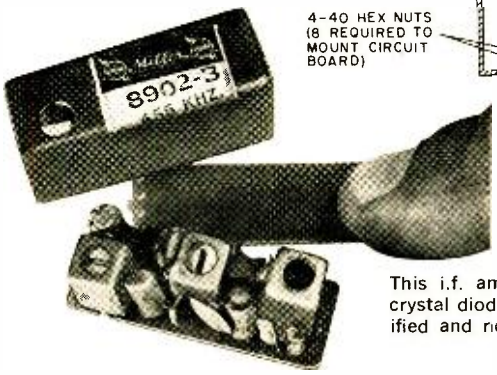


Copper foil side of homemade printed circuit board should have the outline shown in the 1:1 drawing above. Holes to pass wire leads are drilled with a #60 drill. All other holes are drilled to the sizes indicated.

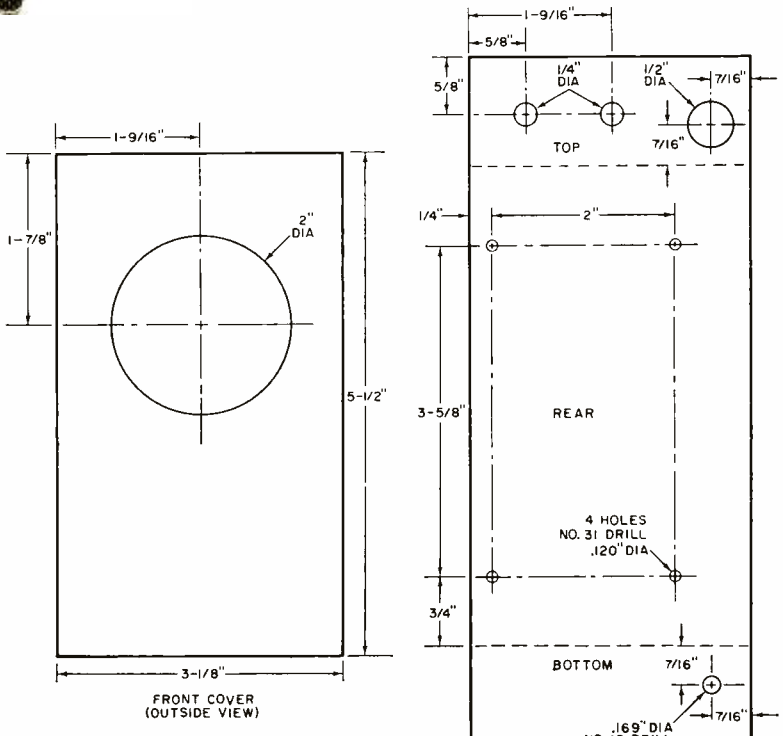


The edge-view drawing of the printed circuit board shows special preparation of the C2 and C6 soldering tabs. Shown in photo at left is method employed to obtain socket clips to hold the crystal. Use an expendable 9-pin socket.



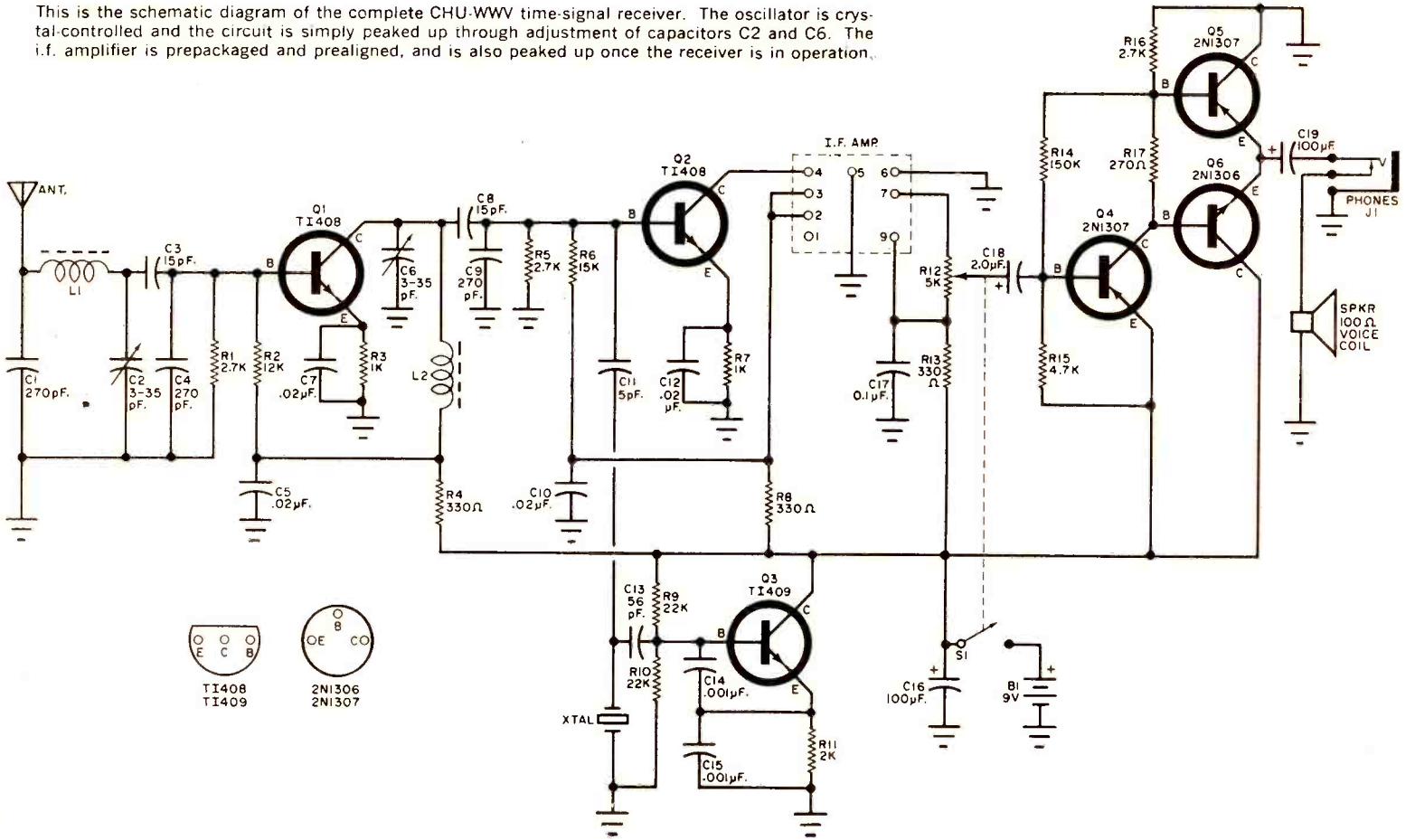


This i.f. amplifier contains two transistors, three i.f. transformers, and crystal diode detector. Be sure to get the J. W. Miller Model 8902-B specified and not the older-style Model 8902 with outboard i.f. transformer.



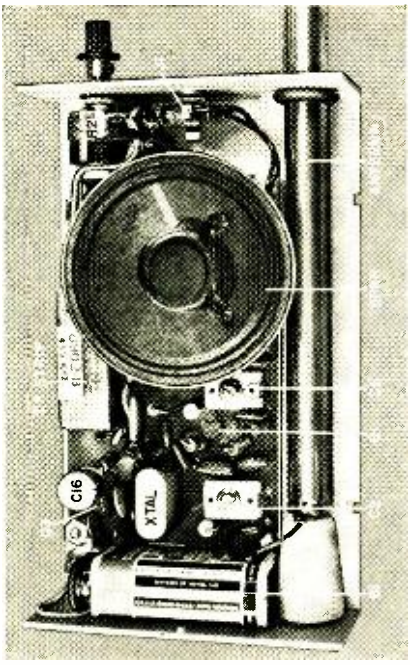
If you purchase an LMB aluminum box No. 139, you can duplicate construction of the receiver shown on the cover using these dimensions.

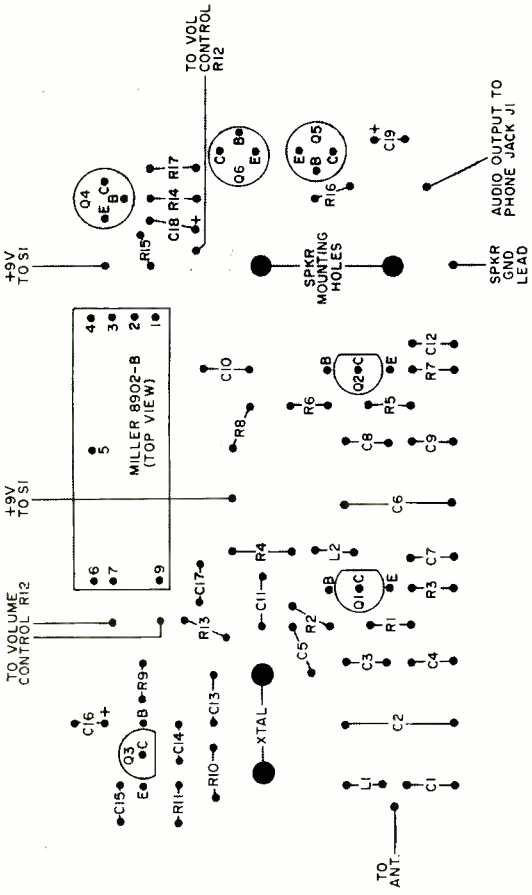
This is the schematic diagram of the complete CHU-WWV time-signal receiver. The oscillator is crystal-controlled and the circuit is simply peaked up through adjustment of capacitors C2 and C6. The i.f. amplifier is prepackaged and prealigned, and is also peaked up once the receiver is in operation.



Use the layout of the top side of the printed circuit board shown below to spot the positions for the components in the wiring diagram above. Holes for the loudspeaker apply only if a Quam 2¼" PM speaker is installed in the space provided.

Compare photo below with board layout at left. Speaker is now fastened to printed circuit board and the chassis cover with speaker cutout slips over U-shaped back cover seen in this photo.





symmetry configuration. A 100-ohm speaker is fed from the audio output stage through closed-circuit phone jack *J1*. When headphones are plugged into the phone jack, the speaker is automatically disabled. Any impedance headphone can be used. The audio output stage delivers over 50 milliwatts of power.

Construction. The entire time-signal receiver circuit is constructed on a printed circuit board measuring only 3⅞″ x 2¼″ in size. A glass epoxy circuit board, etched and drilled, is available from the author (see Parts List).

Component mounting should follow that shown in the photo at left. All resistors are mounted vertically and all capacitors mounted as close to the printed circuit board as possible. Prior to mounting the miniature trimmer capacitors, *C2* and *C6*, cut the soldering tabs as shown on page 43.

Space limitations will not permit the use of a crystal socket on the printed circuit board. Instead, two socket pins salvaged from a 7- or 9-pin tube socket are soldered directly to the board. Once these have been soldered in place, also as shown on page 43, they serve as the "socket" for the crystal.

All of the transistors should be mounted approximately ¼″ away from the circuit board. Carefully observe correct placement of the "flat" side of transistors *Q1*, *Q2* and *Q3*. As usual in soldering transistors, keep the heat applied to the leads to a minimum, but consistent with a good connection.

The connecting leads to the circuit board (from *B1*, *J1*, *R12* and *S1*) should be approximately 2″ long. These will be cut to the proper length once the circuit board has been installed in the chassis box. The speaker mounts directly on the printed circuit board where the holes are provided—it is installed last. Two *4-40* screws secure the speaker to the printed circuit board.

Prepare the metal box by drilling the holes in the back cover and making the 2″ cutout in the front cover (see drawing on p. 43). Cement a 2½″ x 2½″ piece of perforated sheet aluminum in back of the 2″ cutout. Use epoxy cement for this step. If you wish, you can paint the perforated sheet before cementing it in place.

PARTS LIST

B1—9-volt battery
C1, C4, C9—270-pF, 500-volt, dipped silver mica capacitor
C2, C6—3-35 pF, miniature trimmer capacitor (similar to Arco 403)
C3, C8—15-pF, 500-volt, dipped silver mica capacitor
C5, C7, C10, C12—0.02-μF, 75-volt miniature ceramic capacitor (similar to Lafayette 33 R 6906)
C11—5-pF, 500-volt, dipped silver mica capacitor
C13—56-pF, 500-volt, dipped silver mica capacitor
C14, C15—0.001-μF, 75-volt, miniature ceramic capacitor (similar to Lafayette 33 R 6902)
C16, C19—100-μF, 12-volt, miniature printed circuit electrolytic capacitor (similar to Lafayette 99 R 6086)
C17—0.1-μF, 75-volt, miniature ceramic capacitor (similar to Lafayette 33 R 6908)
C18—2.0-μF, 6-volt, miniature printed circuit electrolytic capacitor (similar to Lafayette 99 R 6070)
J1—Miniature closed-circuit phone jack
L1, L2—10.0-μH miniature iron core r.f. choke (similar to J.W. Miller 9310-36) or 5.6-μH miniature iron core r.f. choke (similar to J.W. Miller 9310-30); to tune 7-10 MHz, use the 10.0-μH chokes, and to tune 13-16 MHz, use the 5.6-μH r.f. chokes*
Q1, Q2—Npn low-cost silicon r.f. transistor (similar to Texas Instruments TI408, Semitronics T-33, etc.)
Q3—Npn low-cost silicon r.f. transistor (similar to Texas Instruments TI409, Semitronics T-33, etc.)
Q4, Q5—2N1307 germanium pnp transistor
Q6—2N1306 germanium npn transistor
R1, R5, R16—2700-ohm, ½-watt resistor
R2—12,000-ohm, ½-watt resistor
R3, R7—1000-ohm, ½-watt resistor
R4, R8, R13—330-ohm, ½-watt resistor
R6—15,000-ohm, ½-watt resistor
R9, R10—22,000-ohm, ½-watt resistor
R11—2000-ohm, ½-watt resistor
R12—5000-ohm potentiometer with s.p.s.t. switch, ¾"-diameter (similar to Lafayette 32 R 7363)
R14—150,000-ohm, ½-watt resistor
R15—4700-ohm, ½-watt resistor
R17—270-ohm, ½-watt resistor
S1—S.p.s.t. switch (on R12)
SPKR—2¼"-diameter PM speaker (similar to Quam 22A06Z100 for exact mounting on printed circuit board)
XTAL—Fundamental frequency crystal, 0.01% tolerance, with HC/6U holder (similar to International Crystal Type FA-5); use 7790.0 kHz to receive CHU on 7335 kHz ($3.30); use 9545.0 kHz to receive WWV on 10.0 MHz ($3.30); use 14,215 kHz to receive CHU on 14,670 kHz ($4.40); use 14,545 kHz to receive WWV on 15,000 kHz ($4.40); any crystal available from International Crystal, 18 N. Lee, Oklahoma City, Okla. 73102 plus postage*
I.F. AMP.—Subminiature, 2-transistor i.f. package (must be J.W. Miller 8902-B)*
1—Printed circuit board (available from author with mounting hardware for $2.50, postpaid)*
1—5½" x 3" 1¼" aluminum box (similar to LMB 139)
1—Telescoping antenna; 52" fully extended, 5⅞" retracted; 8-32 stud at bottom (similar to Lafayette 99 R 3008)
1—Steatite cone insulator (similar to E.F. Johnson 135-501)
Misc.—½" rubber grommet, battery clip, plastic knob for R12, wire, solder, etc.

*To assist in building the WWV-CHU receiver, the author has available a kit of parts containing the printed circuit board, i.f. strip, one crystal (your choice of frequency), and a set of matching r.f. chokes for $13.50, postpaid. Write to Caringella, P.O. Box 327, Upland, Calif. 91786. California residents should add 4% sales tax.

Mount the telescoping whip antenna through a ½" rubber grommet in the hole in the top of the back cover. The bottom of the whip is held by a steatite insulator. The solder lug, provided with the antenna, should be installed between the bottom of the antenna and the top of the insulator. Next, install the volume control, *R12*, and the phone jack, *J1*.

The completed circuit board, with speaker installed, is mounted last. If you follow the layout provided in the drawings, the speaker will automatically line up directly behind the 2½" opening when the front cover is installed.

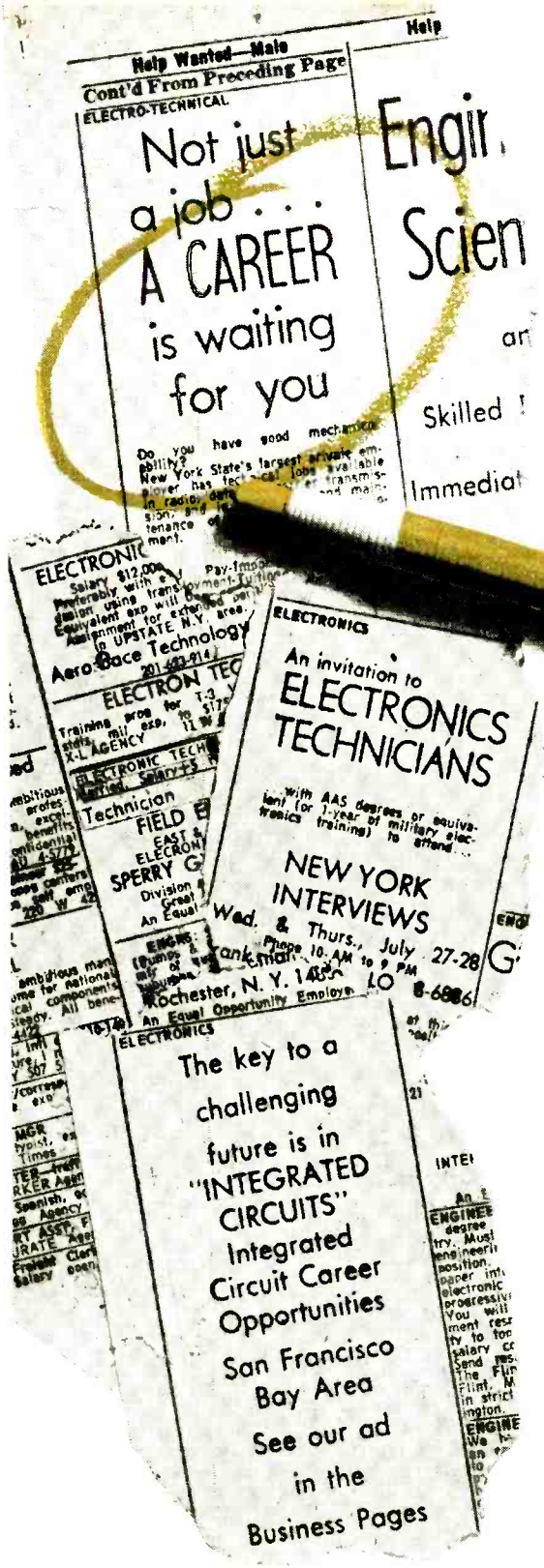
Place a solder lug under the *4-40* nut in the lower left-hand corner of the circuit board. The solder lug will thus serve as the ground point for the negative lead of the battery. Run the battery's positive lead along the underside of the circuit board and solder the end to switch *S1*.

Alignment and Operation. The completed receiver can be aligned with an "on the air" signal from WWV or CHU. Since the receiver's local oscillator is crystal-controlled, there is no need to "hunt" for the station.

Assuming propagation conditions will permit reception of the desired station at the time you select (see box entitled "Time Signal Broadcasts"), simply tune *C2* and *C6* for maximum station volume or background noise. Also, a slight "tweaking" of the input transformer in the i.f. strip might be necessary. A hole in the top of the i.f. module enclosure allows access to the input transformer tuning slug.

In most cases, the built-in antenna is all that is needed. However, it is possible to improve reception with a "long wire" antenna. An external antenna can be clipped to the top of the whip. The

(*Continued on page* 116)



CAREERS IN ELECTRONICS

POPULAR ELECTRONICS ANALYZES THE JOB OPPORTUNITIES FOR ELECTRONICS TECHNICIANS

By KEN GILMORE

FEW PEOPLE study electronics just to satisfy their curiosity. They do it to get jobs, establish a career, and fulfill a desire to improve their position in the community.

In the two previous parts of this series of articles[1,2], the discussion centered around the training of electronics technicians. The advantages and disadvantages of home study and resident schools were highlighted with particular emphasis placed on the time involved, tuition costs, types of study courses, etc.

But how about the payoff? What kind of job can you get once you've nailed your diploma to the wall? What do the companies who hire electronics technicians think of home-study and resident school graduates? What do they look for in a prospective employee? In other words, what's the best way to prepare yourself for a career in electronics?

To find out, POPULAR ELECTRONICS queried more than 150 manufacturers and service organizations—large and small—about their electronics technician hiring policies. Some 30 percent agreed to answer our questions in detail. And

[1] *Resident Schools, September, 1965*
[2] *Correspondence Schools, February, 1966*

from these answers, we have a good picture of how technician jobs are being filled.

Jobs for electronics technicians, we found, generally fall into three categories. Broadly speaking, they are: (1) the radio/TV service technician; (2) the broadcast-communications technician; and (3) the industrial engineering technician.

The Radio/TV Service Technician

A lot of guys make a good living these days repairing radios, television sets, hi-fi equipment, public address systems, and other electronic gear. The possibilities here for employment are wide open. Almost every school—home-study or residence—can give you bushels of case histories of graduates who have gone into radio/TV repair work, started their own shops, and are now running modestly prosperous businesses.

Scores of electronics schools can prepare you for such a career. Home-study schools offering this kind of training generally supply you with test equipment that you build from kits as part of your training, then use in your business when you complete the course. Some schools also supply lots of helpful advice about starting your own business.

Home study has a great advantage in preparing you for a job in radio/TV repair work: you can keep your regular job while learning to be a service technician at night. Of course, you can also attend a local residence school that offers night courses. Obviously, the home-study approach allows more flexibility: you move at your own pace. And interruptions—vacations or illness—won't interfere with your study as they would if you were attending regularly scheduled classes.

As for getting a job in a radio/TV shop, it's equally easy for the resident school and home-study graduate. If you're a good man with a soldering iron, voltmeter, and scope, you won't have any trouble getting started. "We hire both home-study and resident school graduates," stated the employment manager of a very large service organization. "Some men go right to work on a direct-hire basis; others go into a training program that we conduct. We take men with varying amounts of education and start them off at whatever level their training qualifies them for."

Radio and TV servicing and repair technicians, like other craftsmen, are in short supply. "When we opened up service outlets some time ago," says the district service manager of a nationally advertised brand of electronic appliances, "it took us months to find enough men to staff them. It's always a struggle to get enough really good men."

Says the owner of a large repair service in Chicago, "I could use two or three good men right now if I could find them. But it's useless to advertise. All the answers are from *would-be* technicians. I need men with training—men who can walk up to the bench and go to work."

The color TV and CATV explosion has accentuated the demand for radio/TV servicing technicians. Color TV receivers need converging, and the majority of the receivers need good outdoor antennas. Both the home-study and resident schools have tooled up to offer good study courses in color TV.

Broadcast-Communications Technician

The first requirement for getting a job in this field is an FCC license—*First Class Radiotelephone* for AM, FM, or TV broadcast work; *Second Class Radiotelephone* for communications equipment servicing. You can get either license after either home-study or residence

DID YOU MISS THE PREVIOUS STORIES?

Readers who missed the earlier stories by Ken Gilmore on electronics training in resident schools and through home-study courses will be able to read them in the Fall Edition of the ELECTRONIC EXPERIMENTER'S HANDBOOK. This Handbook is now on sale at many newsstands—look for it.

school training. Many schools, in fact. guarantee that you will get a license if you stay with it. If you fail your FCC exam the first time, they'll give you additional instruction—and keep on giving it—until you have the price of admission to a good job: your FCC ticket.

If you choose the home-study route, you can always keep your present job while you study for your ticket. But whichever type of training you elect to undertake, you'll be qualified to apply for a job with a radio or television station or go to work in communications equipment installation and maintenance. "We get so many requests from radio and TV stations," says an executive of one home-study school, "that we can't list them in our monthly newsletter. When a graduate asks what jobs are open, we simply send him a list of those jobs available in his area, or whatever part of the country he wants to work in."

There's plenty of room for communications technicians these days: gas and electric companies, taxi fleets, forestry services, and many other organizations now have cars and trucks outfitted with two-way radio. Some communications technicians are specializing in the repair or maintenance of Citizens Radio Service transceivers—a paying field that didn't even exist eight years ago! And, of course, all airplanes are now radio-equipped and laden with plenty of sophisticated gear.

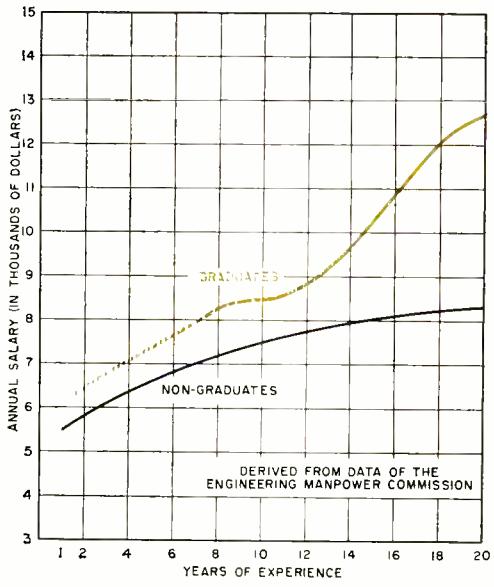
"We need people for computer repair and installation of communications gear," said one employment manager who regularly hires technicians from all over the country. "We don't expect a new man to know our particular equipment, but if that man has a good background in electronics, we'll hire him and train him to handle our gear." And, added this manager, his company routinely hires both home-study and residence school graduates.

Several large companies that hire technicians to work in communications told POPULAR ELECTRONICS that they hire strictly on the basis of electronics know-how and couldn't care less *where* the applicants got their training. One Midwest employment manager indicated that he saw very few applications from home-study graduates! And he couldn't figure out why.

Industrial-Engineering Technician

Practically every phase of industry needs electronics technicians desperately. Every big electronics company seeks technicians to work with design engineers, to build and test prototypes of new equipment, to help figure out production-line techniques, to test, calibrate, and troubleshoot equipment, to work as service engineers and keep customers happy with their equipment.

"We've always got vacancies," said one employment manager. "We can never find enough qualified men." Adds an-



Comparative earnings of non-graduate technicians vs. technical institute graduates have been analyzed by the Engineering Manpower Commission of the Engineers Joint Council, Inc. The above graph was prepared from advance information released by the EMC prior to publication of its detailed study on the careers of nearly 35,000 technicians. Not only are starting salaries higher for the graduates, but earning power increases with on-the-job experience.

other employment manager who hires 100 electronics technicians a year: "We always need more skilled technicians, especially those who know something about digital computers and telemetry." "We have trouble finding people to work on microwave equipment," says a third one.

If you want one of these jobs as an industrial or engineering technician, you'll need more training than for either of the above careers. Furthermore, you'll find that when it comes to landing that job, you'll be on the inside track if you have some electronics job experience or if you got some training at a residence school. This employment attitude is slowly softening and more and more companies are looking at a man's ability rather than his method of training.

One employment manager who hires up to 25 school graduates a year as assembly, test, and calibration technicians put it this way: "I'll hire any graduate if his knowledge and practical ability equals that of other trainees we hire."

On-the-Job Experience

"We take all training with a grain of salt," says the personnel manager of an eastern electronics company, "whether it be a technical institute, college, home-study school, or service school. Our real interest is in a man's experience and in his desire to learn. Frankly," he adds, "our needs are for specialists in three areas: microwave, radar, and digital techniques. Generally we find that graduates of most schools—residence or home-study—don't know enough about any of these subjects for our purposes, usually having had only a course or two in each. So we hire them as trainees and offer them the opportunity to pick up enough knowledge on the job to become an associate engineer. For this reason, we look at each technician candidate individually; if a fellow projects a deep interest in electronics and a strong desire to learn, we feel that we can use him in our R&D atmosphere."

Another employer says he hires home-study graduates as trainees, but admits that some have weaknesses. "They may have theoretical knowledge," he says, "but lab experience is becoming increasingly important. And that, they generally don't have." Consequently, this man adds, the home-study graduate does not generally begin at as high a salary level as the man who had the chance to handle laboratory-type equipment in a residence school.

One West Coast employment manager, doubtful about home-study graduates, gave this reason: "They consistently fail our *very tough* entrance examinations." Another employer, who said he rarely hired recent home-study graduates, added that he does hire them as soon as they have had on-the-job experience. "They lack experience in laboratory techniques," he remarked, "so we seldom hire them right out of school. But if they get some practical experience, then we find them satisfactory."

Our survey turned up several important points that home-study graduates should consider when looking for a job. The most critical is to try to get your first job with a big company. Practically every major organization hiring between 10 and 100 new electronics technicians per year have special "in-plant" training courses designed to take the graduate with a broad electronics background and make him into a specialist. The smaller companies that hire three to five technicians per year rarely have indoctrination courses. If a small company needs a technician, its officials expect to hire a man capable of going right to work the following morning. The moral is obvious: Don't let that biggest of the big companies scare you—it's the best place for a school graduate to start a career.

Need for Highly Trained Technicians

The strange attitude of a few companies toward most home-study graduates, POPULAR ELECTRONICS believes, grows out of three things. First, the emphasis these days is on the very highly trained electronics technician—the man who has

had essentially the same technical education as a graduate electrical engineer! Such a man is also expected to have had practical experience with computers, servo systems, microwave technology, high-powered transmitters, and other complex, expensive equipment. This *is* what some graduates get in such outstanding technical schools as RCA Institutes, DeVry Technical Institute, Central Technical Institute, Milwaukee School of Engineering, Capitol Institute of Technology, and others.

A graduate of the best home-study courses offered by Cleveland Institute of Electronics, Capitol Radio Institute, National Radio Institute, National Technical Schools, and others may have covered essentially the same ground in theory. But, obviously, the home-study school cannot ship each student a transmitter, a computer, or any massive equipment to play with.

Second, 10-15 years ago home-study schools concentrated primarily on basic electronics and radio-TV repair. That situation has changed rapidly in the past decade, and the better home-study schools have gone far beyond this old concept. A few manufacturers, nevertheless, still think of "TV Repair" training when they hear the term, "home study." Fortunately, more and more manufacturers are astonished to find that home-study graduates are well versed in many other things besides radio/TV repair.

Third, some home-study students themselves may have the wrong objectives. A man, for example, can sign up for a course in basic electronics. As soon as it is completed, he applies for a job as an engineering technician with a computer manufacturer. He flunks the employment examination. The student is then dissatisfied with the school, which he believes let him down. And the computer company has a nagging feeling that home study is no good. Neither is true; the fact is simply that a basic electronics course was never designed to train a man to be a computer technician.

It Takes Time and Effort

Graduates of two- or three-year residence courses in top-rated schools attend classes for an average of some six hours a day, then spend two to three hours doing homework, with perhaps another session with the books over the weekend. Such students, in other words, spend virtually their entire time for two or three years studying electronics. Altogether, they may devote some 3000 to 4000 hours to becoming highly trained technical experts. By the time they've finished the better schools, they know calculus, Boolean algebra, and solid-state theory. They are thoroughly familiar

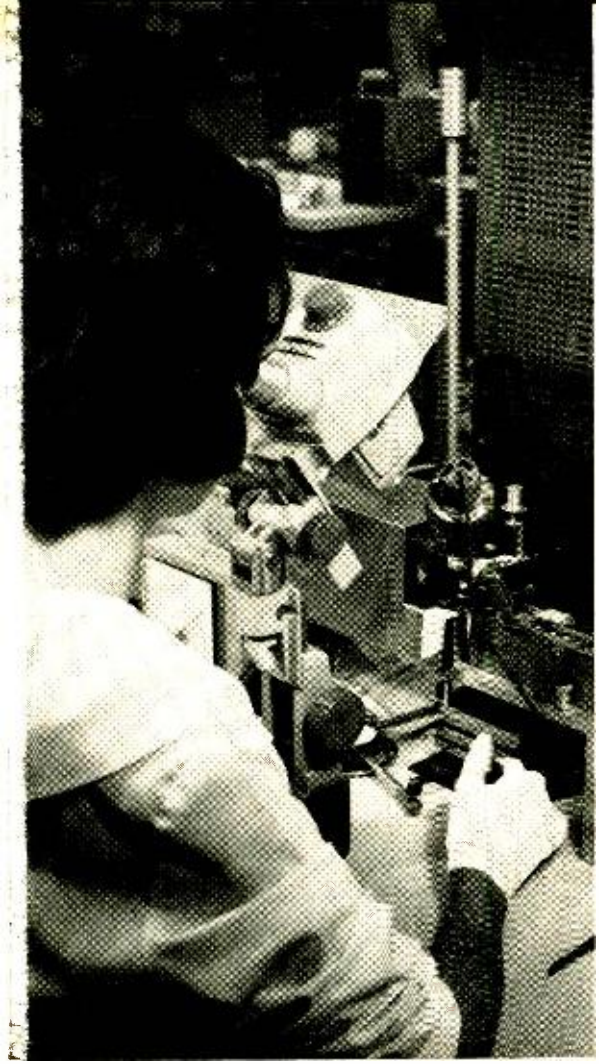
(*Continued on page* 109)

WHAT ARE THE STARTING SALARIES?

Those with the most training get the fattest pay checks. Graduates of three-year courses at top-rated technical institutes or junior colleges, and of the advanced home-study courses, make more money than those with less training. One manufacturer, for example, told us that the general run-of-the-mill graduate technician who qualifies for employment at his plant gets $93-$115 a week as a starting salary. Graduates of the high-level courses generally start at $120-$150 a week. These are graduates with no "on-the-job" experience.

Geographical location has a strong influence on pay checks. Electronics concerns in large cities and in the heavily industrialized regions such as those on the East and West Coasts and in some parts of the Midwest tend to pay more than those in smaller towns and cities. Any talk about specific figures must be general, since variations are wide. Normally, however, technicians working for industrial firms whose payrolls tend toward the low end of the salary scale might get only $80 to $95 a week as beginning pay. Those at the high end of the scale tend to cluster in the $100-$120 range, though some go higher. In communities where pay scales are lowest, of course, living costs also tend to be low.

In general, the same principles apply for radio/TV service technicians. Starting salaries for technicians who have completed a residence or home-study course may range from $75 to $115 a week, depending on the course and where they work. Men who plan to work in communications will normally earn salaries in between those of service technicians and industrial technicians.



INTEGRATED

By DON LANCASTER

Testing integrated circuits is one of the costlier operations of the industry. Powerful semiautomatic optical instruments, such as the one shown at left, are used to inspect components a few thousandths of an inch thick. (Photo courtesy of Motorola)

THE MAGIC wand of microminiaturization has cast a spell on the electronics industry—a spell that will lead in the next few years to unheard-of new electronic devices and applications. Picture-on-the-wall TV, vehicular anticollision radars, home computer centers, portable electronic calculators smaller than a slide rule, precision controls for home appliances, person-to-person televiewers —these are but a few samples of the vast cornucopia of low-cost, high-reliability, and extremely small size electronic miracles that are to be ours in the very near future.

The components produced by this technology are called integrated circuits —or simply IC's. But just what *is* an integrated circuit? And why talk about IC's at all? Aren't they so expensive now that only the military can afford them, and so specialized that only computer specialists can use them? Not at all! Integrated circuits have become so cheap, reliable, and easy to use that most engineers consider it unwise to design new "ordinary" circuits with separate parts in applications where IC's can be used.

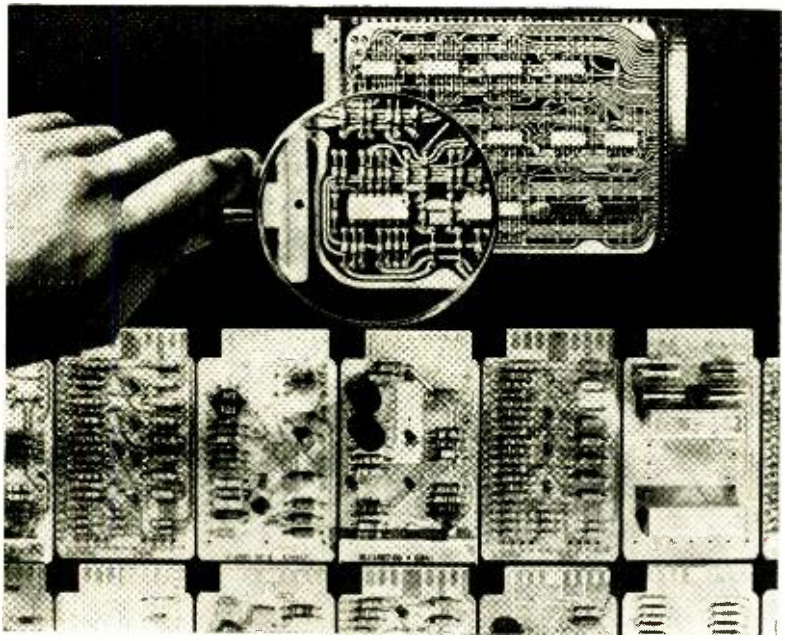
An Old Concept. Remember the 6SN7 radio tube? There must have been millions of them in use at one time or another. This tube is the octal-based dual triode that helped start the computer industry, served as a tone generator in electronic organs, and starred in the horizontal circuits of countless TV sets. The 6SN7's big advantage over its older counterparts was its two-for-the-price-of-one feature. Now two tubes occupied the space of one, and only one socket was needed. You saved two filament wires, four stripping operations, two solder joints, and lots of space. No longer did you talk of a single tube function, since *a system of devices and interconnections in a single compact package was now available.* And this is precisely what an integrated circuit is.

The 6SN7 was followed by the smaller 12AU7 and 12BH7, after which came the semiconductor devices with a new set of problems. The devices (transistors and diodes) got smaller and smaller while

CIRCUITS

THERE IS A BRIGHT FUTURE FOR A NEW TECHNOLOGY IN MOLECULAR ELECTRONICS THAT COULD MAKE POSSIBLE A NEW GENERATION OF PRODUCTS FOR INDUSTRY AND HOME

WHAT ARE THEY?



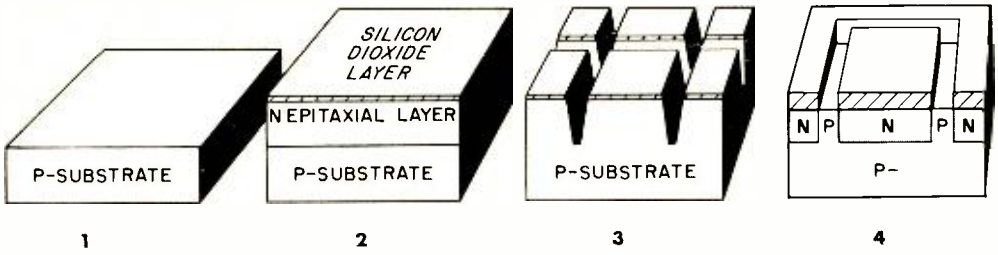
Monolithic integrated circuits, such as the one shown magnified above, are used in Sperry Rand's new UNIVAC 9000 series data processing systems. They perform the same functions as the large conventional printed circuit boards. One chip is the equivalent of 14 conventional printed circuit boards like the ones shown in the lower area of the photo.

external circuit wiring remained essentially as bulky as ever. However, since the transistor and diode generate little or no heat, the normal requirement for air ventilation was no longer critical. This being the case, the only remaining obstacles to miniaturization were the other circuit components.

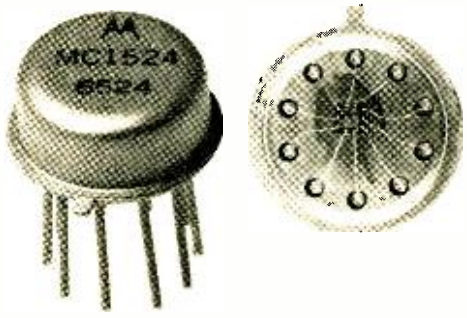
The next step in the stride toward miniaturization was the putting together of two transistors in a single six-legged can to form what seemed like a "2N-6SN7" unit. Not only did this procedure simplify the wiring and basing requirements, but it also brought along other definite advantages. Since the two transistors were made side by side on a single slab of silicon perhaps no bigger than 25 mils square, they maintained the same temperature—which provided perfect tracking in critical, wide-temperature-range circuits. Identical geometry made the pair perfectly balanced, and for the first time it was possible to get a truly complementary *pnp-npn* pair.

Because transistors were able to operate at extremely low power levels, and the power dissipated in load and bias resistors was negligible, substantially

Typically, the manufacturing sequence for a monolithic IC is as follows: (1) Processing starts with a chip of lapped and polished P-type silicon wafer (P-substrate) about 0.010 of an inch thick. (2) An N-type epitaxial layer is grown over the wafer; this is followed by a thin layer of silicon dioxide that is formed by heating in an oxidizing atmosphere. (3) Grooves are etched around the areas to be isolated using normal photo-engraving process. (4) A highly doped P-type impurity is diffused into the grooves down through the epitaxial layer to the substrate. This impurity is covered by a second layer of silicon dioxide formed by heating again. (5) A photo-resist pattern masks those areas that must be etched to form the transistor base area and resistor patterns. (6) A P-type impurity is diffused into the etched areas to (continued on next page)



smaller components could be used. Having gotten this far in the size reduction scheme, the next step could be easily anticipated: how to put resistors, capacitors, and inductors in the same can with the transistors. After all, since there are many identical circuits that are used over and over again with only slight changes, a few standard circuits would allow a wide variety of applications. Therefore, if the designer used lots of transistors and resistors, and built entire systems in small cans, he could eliminate countless interconnections.



The standard package for most integrated circuits is the multi-lead TO-5 case. Shown above is a 10-lead version of the common transistor case. Wires 0.001" in diameter link each contact pad on the circuit with a pin on the base as shown at right.

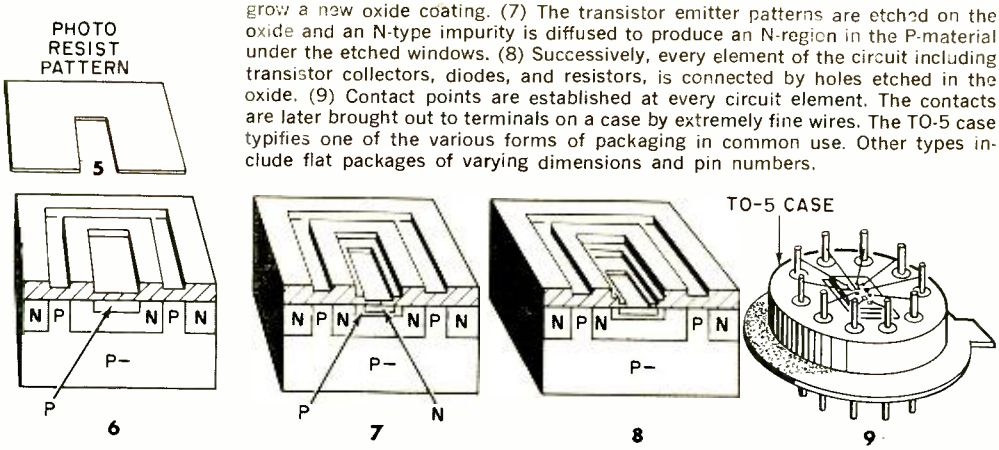
Ways To Make IC's. The resistors were easy to put on a silicon slab. Nichrome or nickel can be evaporated in place through a mask to build up the approximate resistance and trimmed to an exact value by abrasion or electron beam cutting. Other possibilities include the use of resistive inks, which can be directly silk-screened or offset-printed into place. Or, as is more popular today, silicon substrate (semiconductor material) itself can be made into resistors. By controlling the doping level, it is possible to obtain a given resistivity from which a desired resistance value can be derived. A reverse bias technique is used to isolate the various resistors, which are made from *n*-type material.

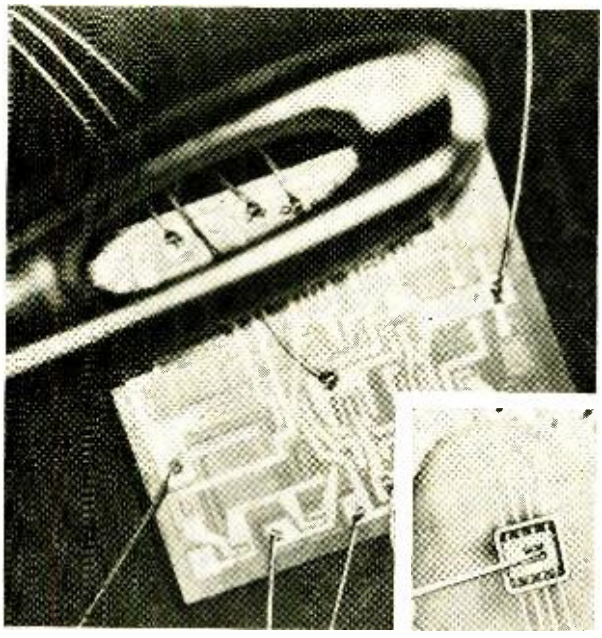
If all resistors are connected to a positive supply, the *pn* junctions formed will be reverse-biased, neatly isolating the resistors from the substrate and from each other, since the junctions cannot conduct current under reverse bias conditions. Newer techniques add a thin layer of glass between the substrate and the resistors to minimize the effects of nonlinear stray capacitance in high-frequency IC's.

Newer transistors like the metal-oxide semiconductor (MOS) variety, and the insulated gate field-effect transistor (IGFET), can be made to exhibit the property of resistance or conductance, depending on the biasing employed. Furthermore, since these transistors do not require any special manufacturing process, they can be formed together with resistors, resulting in higher yields at lower costs.

But the forming of capacitors was a much more difficult task, and IC induc-

grow a new oxide coating. (7) The transistor emitter patterns are etched on the oxide and an N-type impurity is diffused to produce an N-region in the P-material under the etched windows. (8) Successively, every element of the circuit including transistor collectors, diodes, and resistors, is connected by holes etched in the oxide. (9) Contact points are established at every circuit element. The contacts are later brought out to terminals on a case by extremely fine wires. The TO-5 case typifies one of the various forms of packaging in common use. Other types include flat packages of varying dimensions and pin numbers.





Magnified view through eye of needle emphasizes minuteness of tiny welded connections that attach spider-web thin aluminum wire to elements of microelectronic circuit. (Photo courtesy Cutler-Hammer)

tors were essentially impossible to make. Capacitors had to be built up by metallization of silicon or glass, in repeated layers. But even then they were somewhat leaky, and large values of capacitances required large areas of the integrated substrate. As for inductors, it simply wasn't possible to achieve large "L" values or high Q's.

So the circuit designers backed away a bit and decided instead to redesign their circuits to fit the IC's. This meant the elimination of all inductance, and as much capacitance as possible, from the circuit. For r.f. applications, where tuning or filtering is a must, separate LC units were placed in separate miniature cans and used like r.f. transformers. Wherever possible, all circuits are d.c.-coupled to eliminate practically all capacitors. And although this requires the use of more transistors, there is no extra cost. Adding more transistors in an integrated circuit requires only the making of a few more holes in the series of masks used during manufacture. It costs just as much to make one transistor as it does to make a dozen. And a dozen often occupy less space than the single capacitor they replace in a d.c. circuit. The use of numerous transistors is usually less expensive, anyway, since the capacitor manufacturing steps are eliminated.

This is why integrated circuit schematics always seem so complicated. Extra transistors are used to eliminate any component that would be expensive or hard to include in a tiny space.

Common Types of IC's. Every manufacturer has his own way of putting the many tiny components or circuit functions and interconnections into a single IC. However, since production techniques change so fast, it really isn't important for the IC user to know just what manufacturing steps are in use. But there are several basic IC types that

Similar in appearance to a packaged electronic circuit, this Burroughs' IC package features rugged dependability, making its use in electronic equipment subject to shock and vibration most desirable.

are likely to be around for a while. You should learn to recognize these types. Here are some of them:

Monolithic IC's have all their individual components etched out on a solid silicon chip. Their construction is very rugged, and the manufacturing cost relatively low.

Hybrid IC's consist of a number of interconnected monolithic IC's, discrete transistors, capacitors, and possibly power resistors. The hybrids lend themselves to high power outputs and custom-designed circuitry where the interconnections can be altered to suit a particular requirement. They are usually low-frequency devices and generally quite expensive.

Thin-Film IC's employ an IC technique through which layers consisting of a few atoms of a semiconductor material are evaporated onto a ceramic substrate (the newest designs use sapphire) through a series of masks. This technique permits exceptionally high frequency response and extremely small size. Some low-priced models operate with power in the nanowatt range.

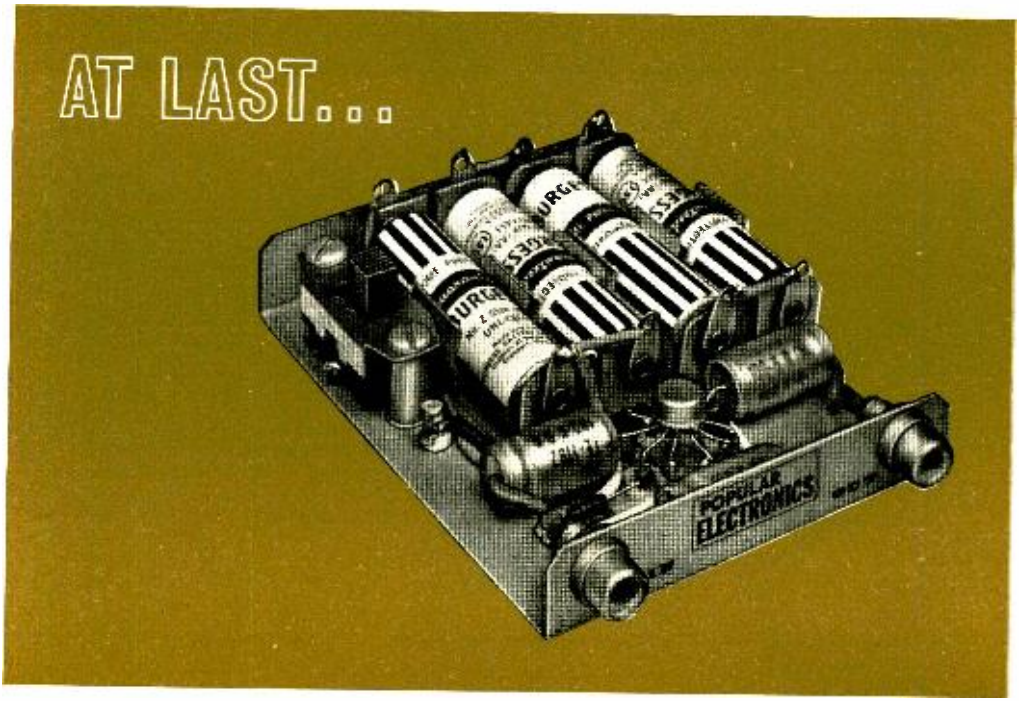
Thick-Film IC's employ an old and cheap method similar to the printed circuit couplates. Resistors are silk-screened or offset printed in place; capacitors are made by overlapping layers of ceramic and metallic material. Ordinary transistors without cases are cemented or ultrasonically welded in place. This type of IC is recognized by its postage-stamp size and shape, and its external protective epoxy dip.

What's Available Now? Today there are thousands of different IC's available.

(*Continued on page* 106)

LOW-COST INTEGRATED AMPLIFIERS FOR THE EXPERIMENTER

CIRCUIT	TYPE	NUMBER	MANUFACTURER	PRICE (Approx.)
OPERATIONAL AMPLIFIER	Linear	uA702	Fairchild Semiconductor	$14.40
R.F. OR I.F. AMPLIFIER	Linear	uA703	313 Fairchild Drive	4.50
COMPARATOR	Linear	uA710	Mountain View, Calif.	7.50
BUFFER	Digital	uL900		1.63
DUAL TWO-INPUT GATE	Digital	uL914		1.63
COUNTING FLIP-FLOP	Digital	uL923		3.95
LATCHING FLIP-FLOP	Digital	MC352	Motorola Semiconductor	4.55
DUAL TWO-INPUT GATE	Digital	MC359	Box 955	3.70
DUAL-COUNTING FLIP-FLOP	Digital	MC790	Phoenix, Ariz.	5.30
OPERATIONAL AMPLIFIER	Linear	MC1430		18.00
1-WATT AUDIO AMPLIFIER	Linear	MC1519		70.00
D.C. AMPLIFIER	Linear	CA3000	RCA Electronic Components	6.80
VIDEO AMPLIFIER	Linear	CA3001	Harrison, N. J.	6.40
I.F. AMPLIFIER	Linear	CA3002		4.40
R.F. AMPLIFIER	Linear	CA3004		4.40
AUDIO DRIVER	Linear	CA3007		6.80
OPERATIONAL AMPLIFIER	Linear	CA3010		12.00
COMPLETE FM I.F. STRIP	Linear	CA3013		2.65
HEARING-AID AMPLIFIER	Linear	SN1220	Texas Instruments Box 5012 Dallas, Texas	16.20
HIGH-GAIN AUDIO AMPLIFIER	Linear	WC183	Westinghouse Electronics	10.00
R.F. AMPLIFIER	Linear	WC1146	Box 7737 Elkridge, Md.	10.00



By DON LANCASTER

AN INTEGRATED CIRCUIT AMPLIFIER

you can build for under $6!

SIMPLE PROJECT OPENS DOOR TO NEW MICROCIRCUITS

HERE'S the "bargain basement" integrated circuit (IC) amplifier that hobbyists and experimenters have been waiting for. Ideally suited for use as a phonograph or dynamic microphone preamplifier, as a boost amplifier in a receiver i.f. or r.f. stage, as well as in practically all applications employing low-level signals, the complete IC amplifier can be built for under $6.00. The IC, packaged in a TO-5 case, contains the equivalent of six 2N918 transistors and seven resistors, and provides a voltage gain of 40, a current gain of 120, and a power gain of nearly 5000.

Frequency response is essentially flat from 20 Hz to 30 MHz, and distortion is negligible at outputs of up to 0.7 volt peak-to-peak. Clipping occurs at output levels of 1 volt peak-to-peak and over. When assembled with the external components itemized in the Parts List, the IC amplifier has an input impedance of 3300 ohms, and an output impedance of approximately 25 ohms.

How It Works. The integrated circuit amplifier (Fig. 1) consists of two separate transistor differential amplifiers (they respond to the difference between

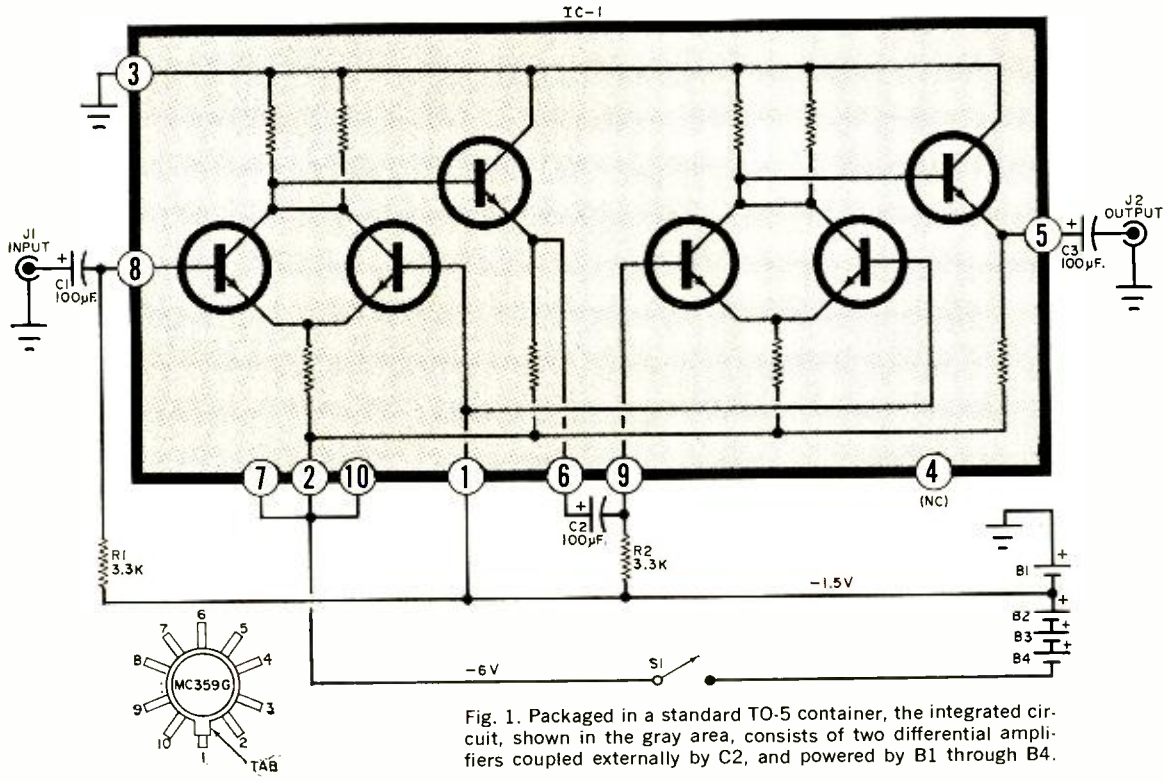


Fig. 1. Packaged in a standard TO-5 container, the integrated circuit, shown in the gray area, consists of two differential amplifiers coupled externally by C2, and powered by B1 through B4.

two voltages or currents), each coupled to an emitter follower stage. The output of the first emitter follower is applied to the base of the second differential amplifier input transistor through coupling capacitor *C2*.

Capacitor *C1* couples the input from *J1* to the base of the first amplifier which is biased through *R1*. Resistor *R2* applies bias to the base of the second differential amplifier input transistor. The IC amplifier output is applied to *J2* through *C3*.

Base bias for the second transistor of each amplifier pair is applied directly from a $1\frac{1}{2}$-volt tap on the 6-volt supply battery. The full supply voltage is applied to the circuit through *S1*.

Important: The values of capacitors *C1*, *C2*, and *C3* determine the frequency response of the circuit. For low-frequency response (about 20 hertz) only, 100-μF capacitors are used; for frequencies above 100 kHz, 0.02-μF disc capacitors are used *instead* of the 100-μF units. For a full frequency coverage (20 hertz to 30 MHz), parallel the two capacitor values.

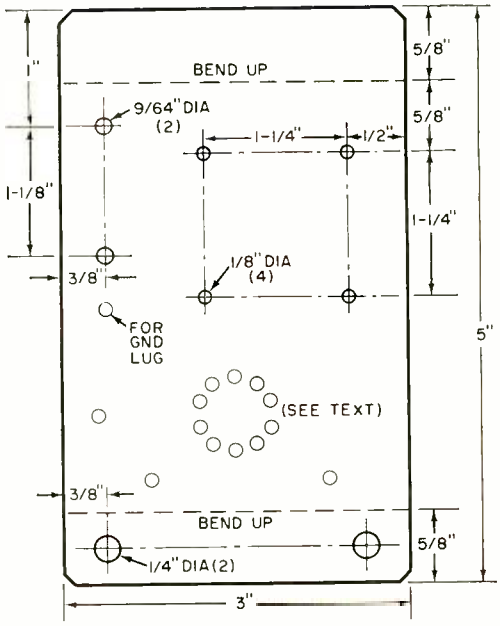


Fig. 2. The complete IC, including the battery supply, can be mounted on a small (3" x 5") aluminum plate, drilled and bent to form a chassis support.

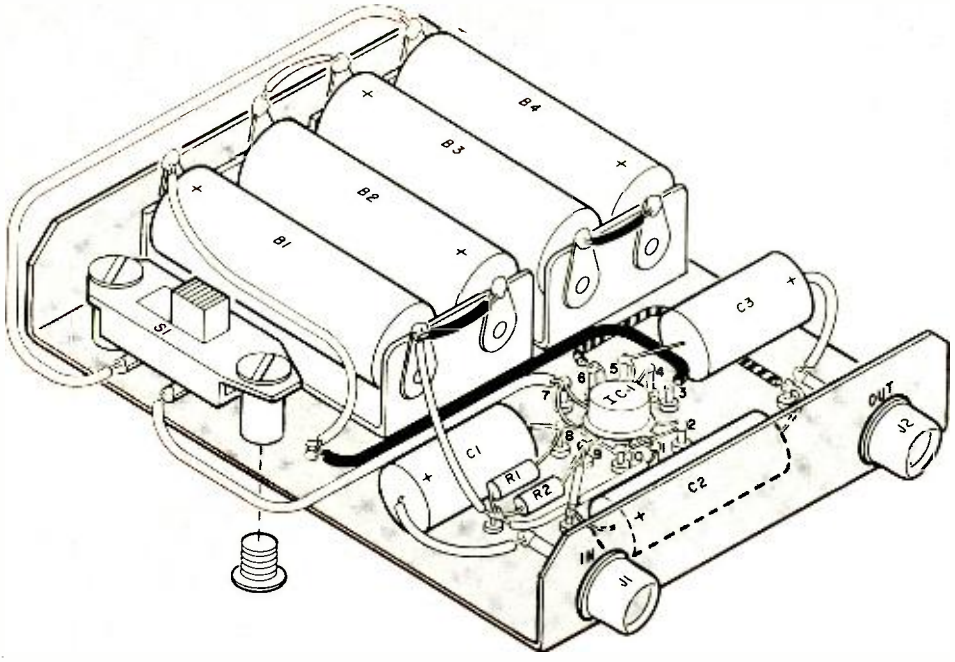


Fig. 3. Pictorial of fully assembled integrated circuit shows simplicity of layout and wiring details. The 10 teflon terminals that mount the TO-5 case can be replaced with one Sealectro IC socket.

Construction. The circuit is easily assembled on an improvised aluminum plate laid out and drilled as shown in Fig. 2. The IC socket used by the author is made up of 10 teflon press-fit standoff terminals inserted into appropriate-sized holes drilled in the plate. Then the leads from the IC case are fanned out and each soldered to a standoff.

However, it is suggested that the builder follow a much easier and efficient procedure. A single Sealectro press-fit socket (see Parts List) can be press-fitted in a $\frac{1}{2}$" hole drilled in the plate instead of bothering with the 10 small holes.

The four $\frac{1}{8}$"-diameter holes in the upper portion of the plate mount the two penlight battery holders that are either riveted or screwed to the plate. Slide switch *S1* is mounted on $\frac{1}{2}$"-long spacers threaded at both ends for #6 screws, through the two $\frac{9}{64}$"-diameter holes. The three unidentified holes in the vicinity of the IC socket accommodate press-fit standoffs that serve as tie points for component leads. The input and output jacks are mounted on the raised front panel as shown in Fig. 3.

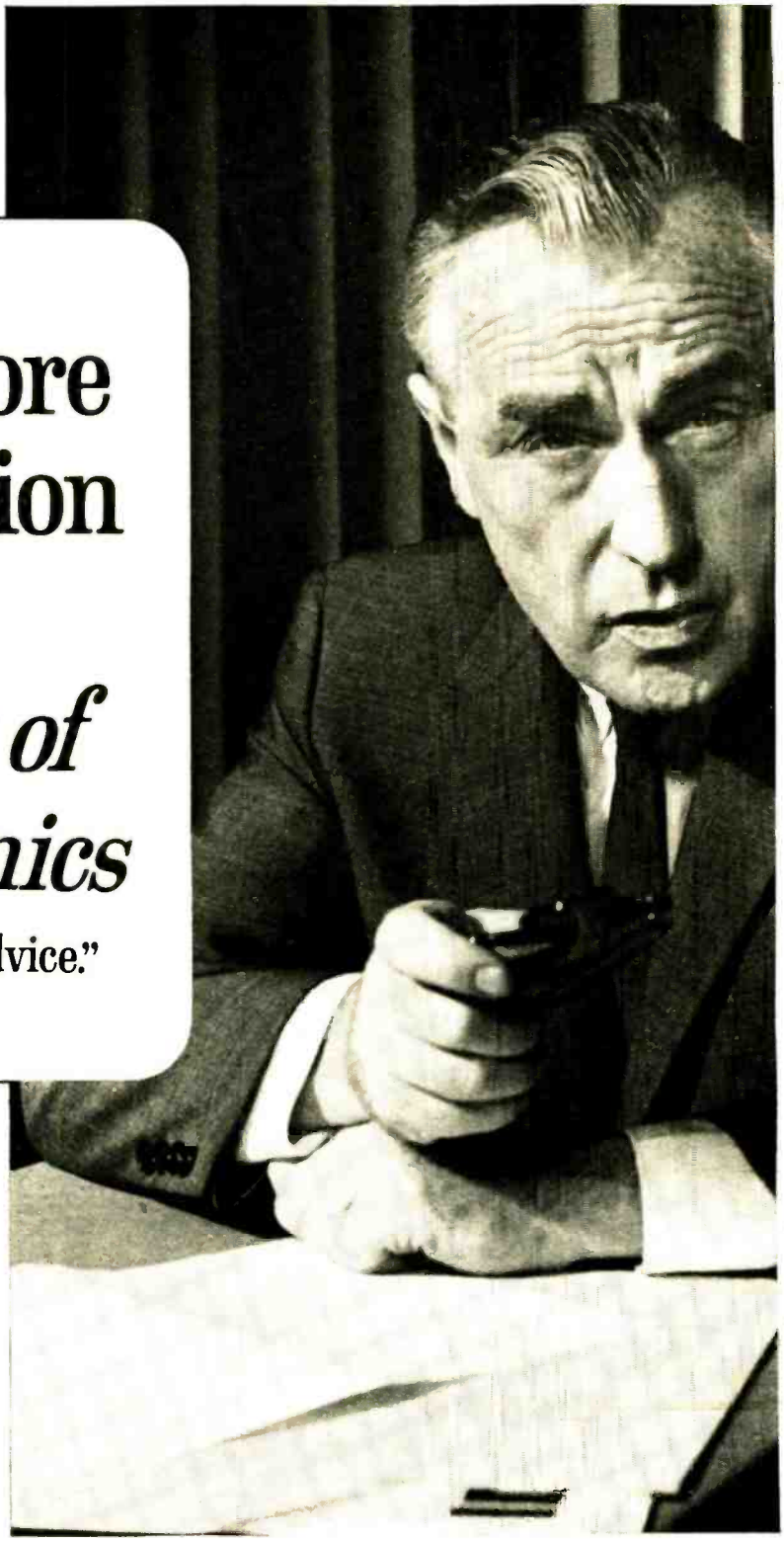
All circuit components should be mounted and wired in place before installing the IC package; but do not

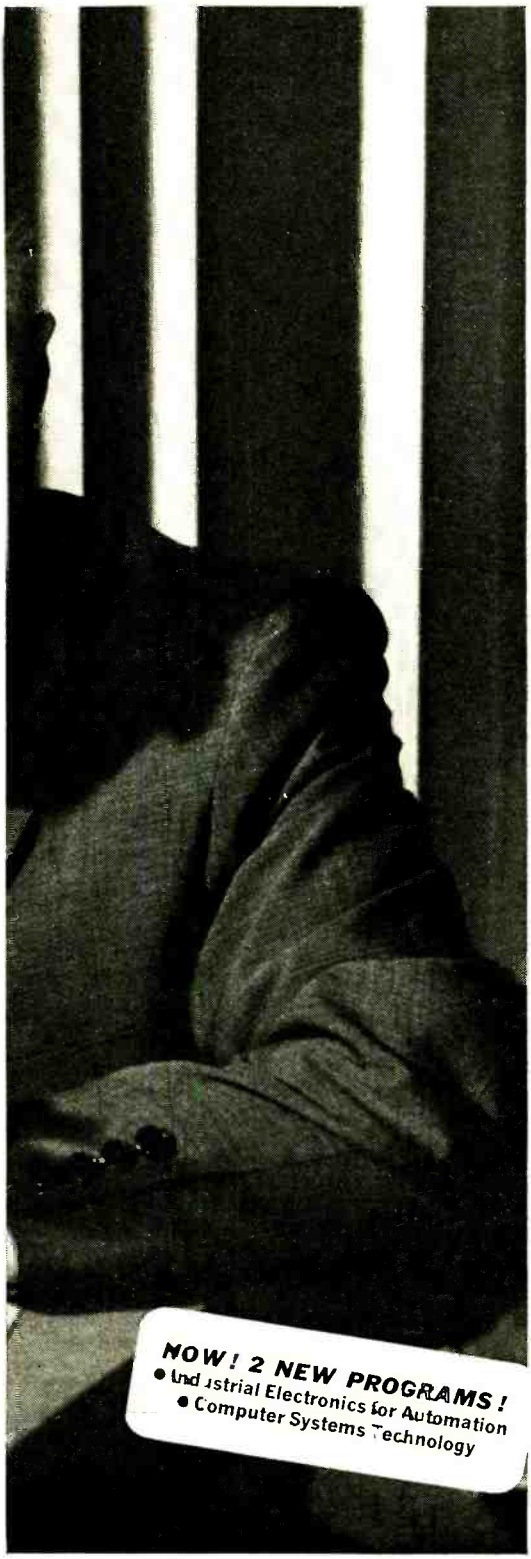
(*Continued on page* 108)

PARTS LIST

B1, B2, B3, B4—1.5-volt penlight cell
C1, C2, C3—100-μF, 6-volt electrolytic capacitor for 20 Hz to 1.5 MHz; 0.02-μF ceramic capacitor (10 volts or more) for 100 kHz to 30 MHz; both values in parallel for full range
IC1—Motorola dual two-input gate MECL circuit (Allied Radio MC359G, $3.70)
J1, J2—Chassis-mounting phono jack
R1, R2—3300-ohm, $\frac{1}{4}$-watt resistor
S1—S.p.s.t. slide switch
1—Sealectro IC 10-pin socket, Part No. RTC-1010 SL (available from Joseph Kurzan, Inc., or Arrow Electronics, Inc., both in New York City
1—3" x 5" sheet of 1/32"-or 1/16"-thick aluminum
Misc.—Battery holders for four penlight cells (2), teflon press-fit terminals (3), ground terminal, $\frac{1}{2}$"-long threaded spacers (2) with #6 $\frac{1}{4}$"-long screws (4), rivets or screws for battery holder, solder, hookup wire

"Get more education or *get out of electronics* ...that's my advice."





Ask any man who really knows the electronics industry. Opportunities are few for men without advanced technical education. If you stay on that level, you'll never make much money. And you'll be among the first to go in a layoff.

But, if you supplement your experience with more education in electronics, you can become a specialist. You'll enjoy good income and excellent security. You won't have to worry about automation or advances in technology putting you out of a job.

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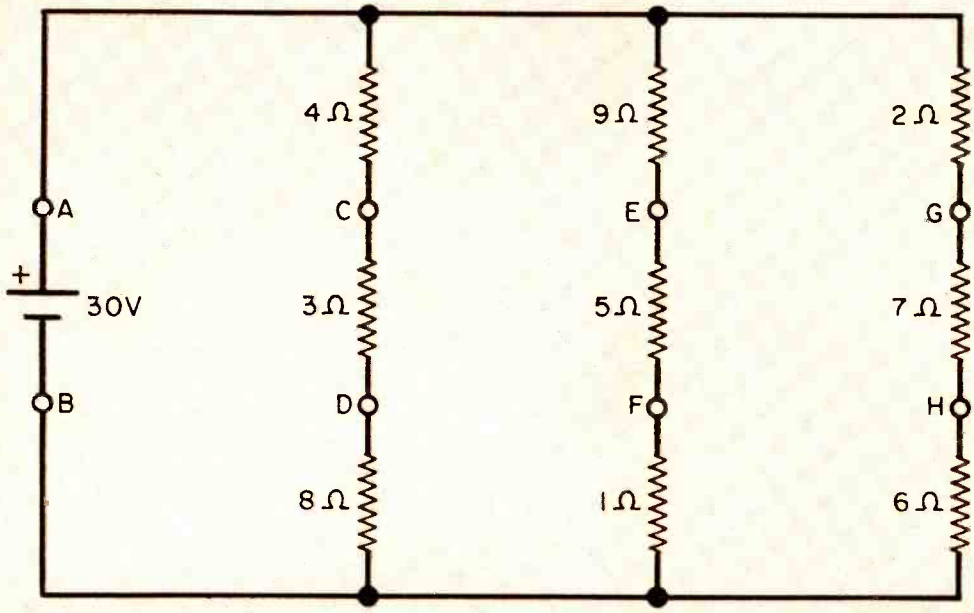
☐ **NEW! Computer Systems Technology**

VOLTAGE DIVIDER QUIZ

By ROBERT P. BALIN

To bat 1000 with this quiz, all you need to know is Ohm's law. Can you determine between which set of terminals (A-H) on the schematic diagram a voltmeter must be connected to read the individual voltages listed below? Some of these voltages can be obtained at more than one set of terminals. Extra space is allotted for your answer where multiple combinations exist. HINT: Start out by letting terminal A or B serve as your reference point.

(*Answers appear on page* 111)



VOLTS	TERMINALS	VOLTS	TERMINALS
0	___	16	___
2	___	18	___ ___
4	___ ___ ___ ___	20	___
6	___	22	___
8	___	24	___
10	___ ___ ___ ___ ___	26	___
12	___ ___	28	___
14	___ ___ ___ ___	30	___

BUILD

HI-FI AMPLIFIER FOR SOLID-STATE PHONO CARTRIDGE

NEW STRAIN-GAUGE STEREO PHONO CARTRIDGE STREAMLINES AMPLIFIER REQUIREMENTS AND PROVIDES BROAD FREQUENCY RESPONSE

By ART TRAUFFER

THE NEW PIEZORESISTIVE semiconductor strain-gauge phono cartridges open up a whole new field of endeavor for hi-fi enthusiasts, experimenters, hobbyists, and record player manufacturers. These cartridges work like variable resistors. Unlike ceramic and magnetic cartridges, they do not generate any voltage. They *do* utilize a varying resistance characteristic to modulate an external d.c. voltage in step with stylus motion. The small voltage needed can be obtained directly from an amplifier

power supply, or from a separate battery.

Interest in these piezoresistive phono cartridges is running high at the present time because of their compatibility with transistor applications. They have several good inherent characteristics: they closely match the inputs of transistorized audio amplifiers; they effectively deliver more power to the amplifier and reduce the number of stages of amplification; frequency response is from d.c. to more than 30,000 hertz; and there are no coils to pick up a.c. hum.

A two-transistor amplifier especially designed for use with one of these cartridges is shown in Fig. 1 and discussed in the following paragraphs.

How Amplifier Works. A stereo cartridge, equipped with a double sapphire flip-over stylus, is coupled to a pair of stereo headphones through a basic stereo amplifier.

The two-channel amplifier is beautiful in its simplicity. It has only four resistors, two capacitors, and two transistors, as shown in Fig. 1. Resistors *R3* and *R4* set up bias for *Q1* and *Q2*, respectively. Capacitors *C1* and *C2* serve as signal couplers and d.c. blockers. A 1½-volt flashlight battery (D cell) is used to operate the transistors.

Voltage from a lantern-type battery (6 volts) is divided equally and oppositely across each element in the stereo cartridge. Any d.c. voltage source on the order of 6 to 18 volts can be used for this purpose. The higher the voltage, the greater the volume. However, comfortable listening levels are obtained with a 6-volt source.

Resistors *R1* and *R2* form voltage dividers with their respective cartridge elements and are hooked up in such a way as to have a negative-going voltage in one channel and a positive-going voltage in the other channel when both cartridge elements are moved in the same direction. Vertical stylus motion (up or down) causes both elements to move in the same direction. Lateral motion moves one element up and the other element down.

This phase-inverting technique is used to obtain an out-of-phase signal for vertical stylus motion and an in-phase signal for lateral motion, to conform to

PARTS LIST

C1, C2—20-μF, 25-volt electrolytic capacitor
J1, J2—Phono jack (RCA type, single-hole mounting)
J3—Three-circuit phone jack (should match headset plug)
Q1, Q2—2N217 transistor
R1, R2, R3, R4—2200-ohm, ½-watt resistor
S1—D.p.s.t. toggle switch
1—Solid-state stereo cartridge (similar to Sonotone 43T)
1—Stereo headphone set (similar to Jensen HS-2)
Misc.—1½-volt "D" cell battery and holder, 6-volt lantern battery, 5-lug terminal strip, ⅜" wood stock for cabinet (see text), ⅛" Formica or composition board, 10,000-ohm miniature potentiometer (optional), hardware, etc.

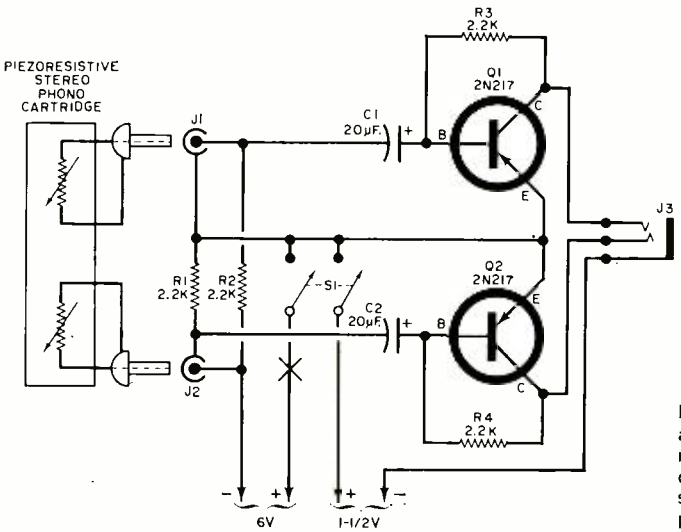


Fig. 1. Strain gauge cartridge acts like a variable resistance and modulates 6-volt d.c. source to drive simple stereo amplifier in step with stylus motion. Text explains stereo phase manipulation.

Fig. 2. Mount all parts except the batteries on the back of the front piece of the cabinet. There is enough room to permit installation of an optional volume control. Observe polarity of capacitors.

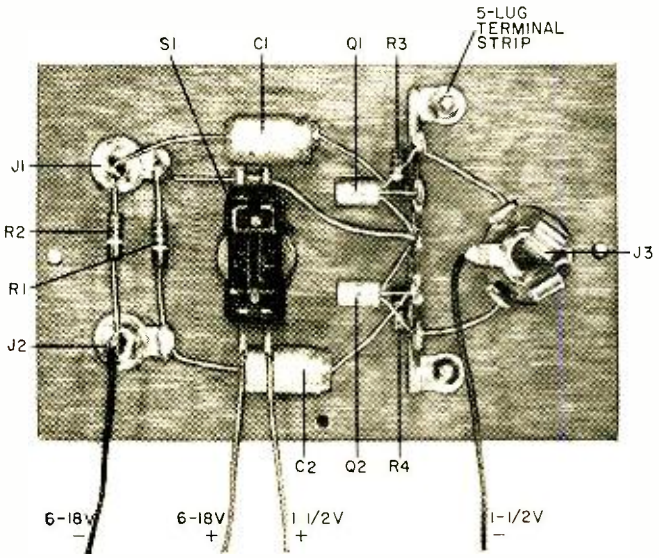
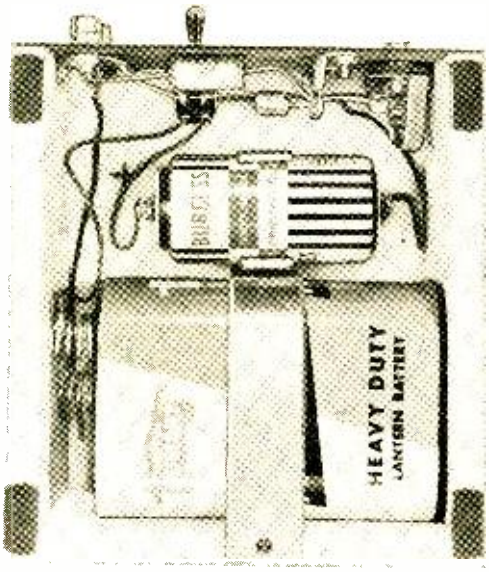


Fig. 3. A wood screw (under the "D" cell) is used to hold down the "D"-cell holder and one end of the metal strap. Countersink the other end of the strap and fasten it to the back of the cabinet.



stereo disc recording standards. It is easier to reverse the phase of the modulating voltage than to flip the wiring of one of the headphones. You cannot reverse the phase of one element in the cartridge by simply reversing the connections to the element, because the elements are resistive.

A 10,000-ohm potentiometer can be wired in at point "*X*" to serve as a volume control. Use a pair of low-impedance dynamic-type headphones similar to the Jensen HS-2.

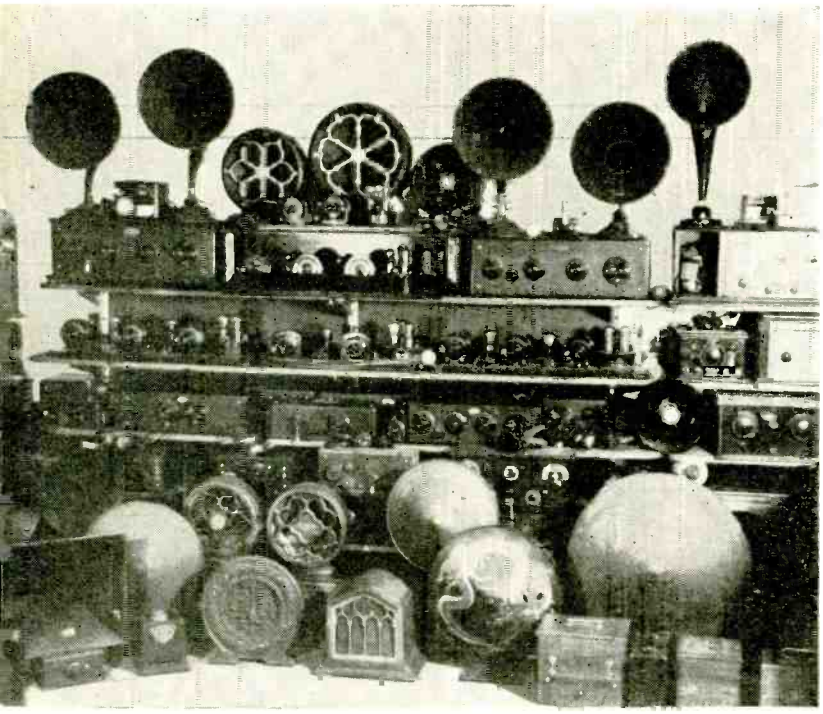
Construction. The same simplicity apparent in the electronic circuitry is passed on to the construction, as shown in Fig. 2. Parts placement is not critical, and if it is desired to install the optional volume control, use a miniature unit and mount it on the panel between *J3* and *S1*. Dress the other components away from the control to prevent short circuits.

A 5″ x $3\frac{3}{16}$″ x $\frac{1}{4}$″ Formica or composition board panel can be used. Resistors *R3* and *R4*, and transistor *Q1* and *Q2* are mounted on a five-lug terminal strip. You can heat-sink the transistor leads with a pair of long-nose pliers to prevent damage to the transistors while soldering. Observe polarity when installing *C1* and *C2*.

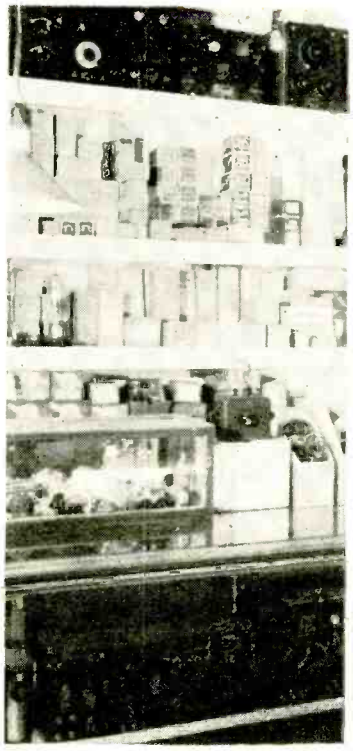
The optimum value of *R3* and *R4* may vary a little from transistor to transistor, but normally is satisfactory as shown. If you wish to obtain maximum fidelity, you can try to vary the bias a bit by changing the value of these resistors.

Figure 3 shows how the batteries are mounted inside the $5\frac{1}{2}$″ x 5″ x $3\frac{3}{16}$″ wood cabinet. Cabinet type and material used for construction is not critical, but size depends upon the size of the batteries you use. The lantern battery is held in place by a sheet metal strap, and the D cell fits into a regular holder. Non-skid rubber or felt pads can be cemented to bottom of cabinet. -30-

FROM



This view shows only a small part of the broadcast receiver collection assembled by Ralph Barnett, W9UIA, 3434 E. Oakwood, Decatur, Ill. 62521. Among these early receivers and loudspeakers are 21 different Atwater Kent models. Altogether, the collection consists of about 150 sets made before 1926.



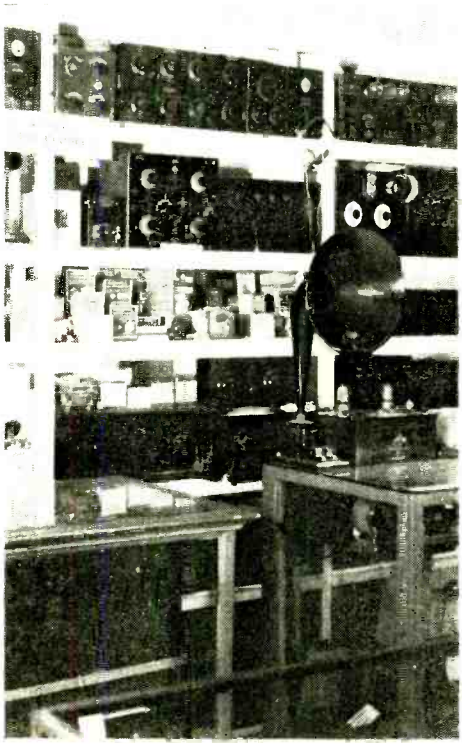
The Antique Wireless Association's Historical Museum in Holcomb, N.Y., even contains a "store." Displayed at right are products found in radio stores 40 years ago. Many of the items are new and in original cartons.

One of the finest wireless museums in North America has been built by Jack Gray, W8JDV, 500 W. Church St., Mason, Ohio 45040. This section of the museum, being viewed by Bruce Kelley, W2ICE, and Linc Cundall, W2QY, shows part of a Crosley receiver collection.

OUT OF THE PAST

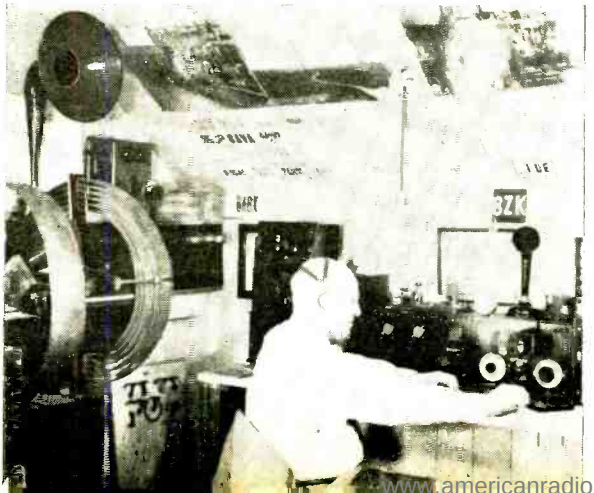
WIRELESS MUSEUMS PRESERVE THE EARLY DAYS OF RADIO

By **THEODORE M. HANNAH,** K3CUI



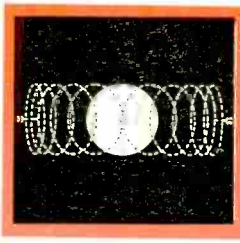
Authentic to the last detail is the working restoration (above) of a Western Union telegraph office as seen 80 years ago. It is part of the unique National Telegraph Office assembled by E. Stuart Davis, W2ZH, 1149 Weber St., Union, N.J. 07083.

In 1922, this was the last word in high-powered ham stations. In 1966, it is one of the stations owned by the Antique Wireless Association, several of which operate under the call W2AN. Shown here is George Batterson, W2GB.

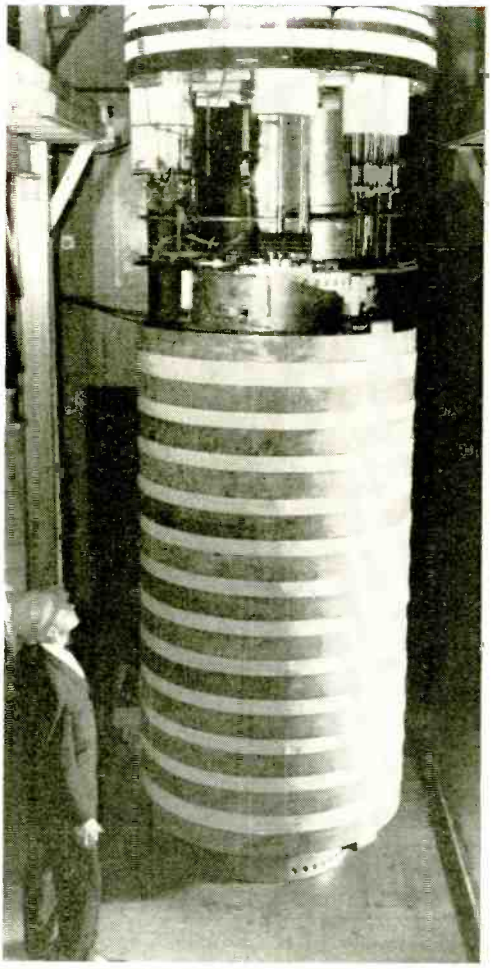


PRESERVING the spirit and the substance of early wire and wireless communications history is the hobby of a growing number of collector-historians. Some 400 of them are members of the Antique Wireless Association, an ARRL affiliate formed in 1953. (If you would like more information on the AWA, write to Bruce Kelley, W2ICE, Main Street, Holcomb, N.Y. 14469.)

The museums shown here are all privately owned, and in most cases they are in the owners' homes. Although most collectors welcome visitors, courtesy requires that you call or write for an appointment. Entering a wireless museum is truly taking a step into the past, into the rich history of the wonderful world of communications. -30-

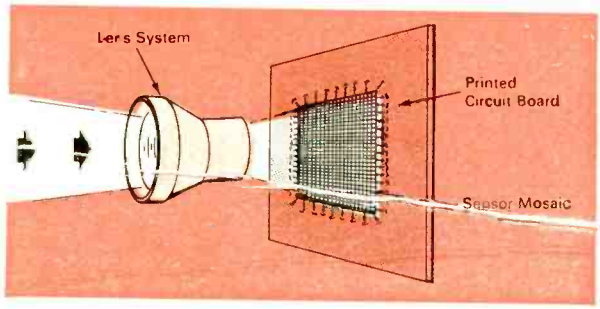


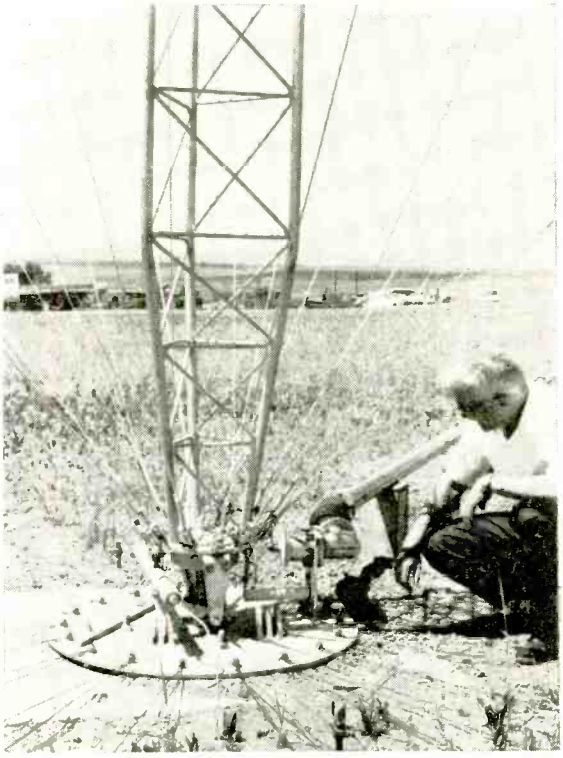
ZERO-BEATING THE NEWS



GIANT MAGNET—What is believed to be the world's largest superconducting magnet, shown on display at Avco Everett Research Laboratory, produces 40,000 gauss over a 5′ x 12″ field region. Weighing 15,675 pounds, the giant magnet stands 10′ high, and stores 5,000,000 joules of energy. Designed for use in a magnetohydrodynamic (MHD) power generator, the saddle-shaped magnet was made possible by a recently developed (by Avco) "stabilized" composite superconductor.

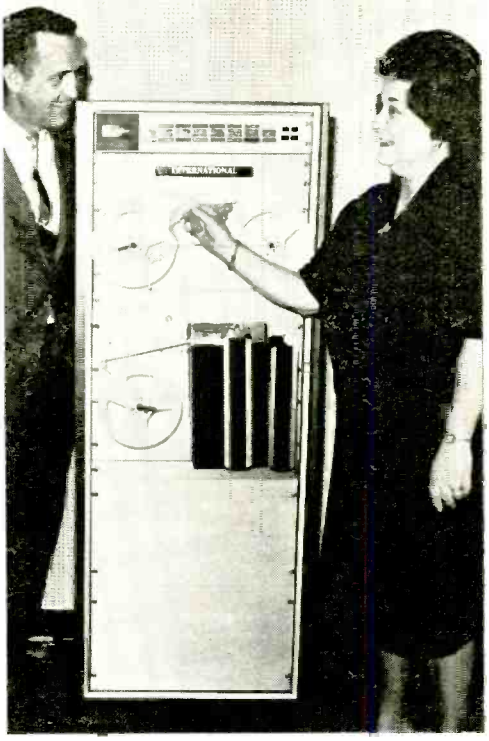
FASE WON'T PHASE COMPUTER—To prevent computer confusion about the relationship of words in a sentence, a new form of English has been devised by Dr. Lee E. McMahon (below) of Bell Telephone Laboratories. Called FASE (for Fundamentally Analyzable Simplified English), it is indistinguishable from ordinary English by a reader, but can be uniquely resolved into parts of speech by a computer.



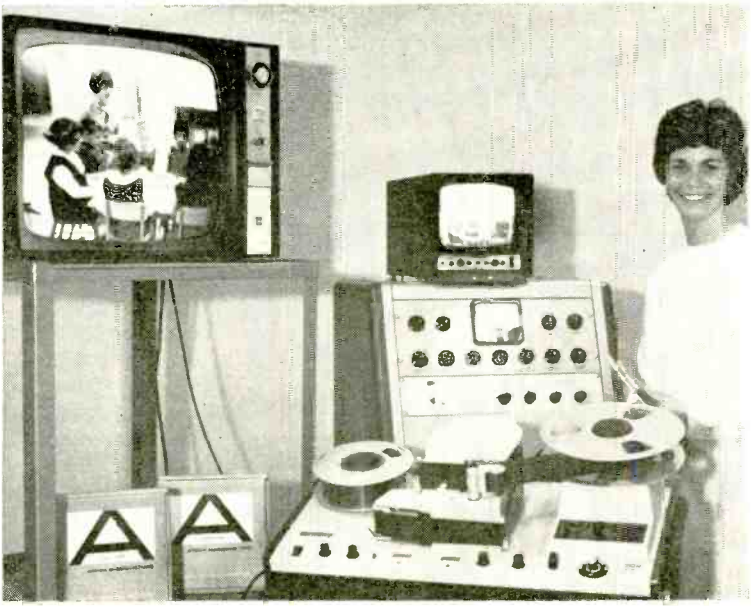


WWV RELOCATES—Construction is nearly completed on the new WWV transmitter building and control center at Fort Collins, Colo., from which the NBS standards broadcast station is scheduled to transmit beginning in December. Photo shows standby antenna fed by 3⅛" coax line.

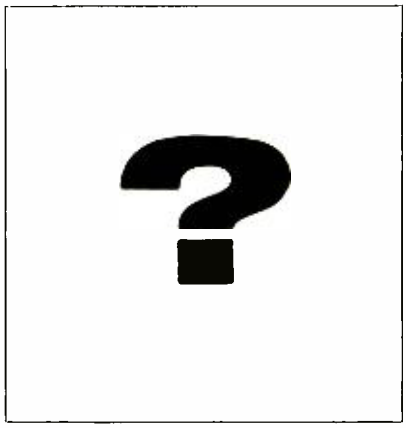
DATEX DATA—A data communications system that transmits 1200 words a minute is now operating between GT&E International's New York headquarters and its Swiss subsidiary in Geneva. Called "Datex," it replaced a "telex" system which had a maximum speed of only 66 wpm.

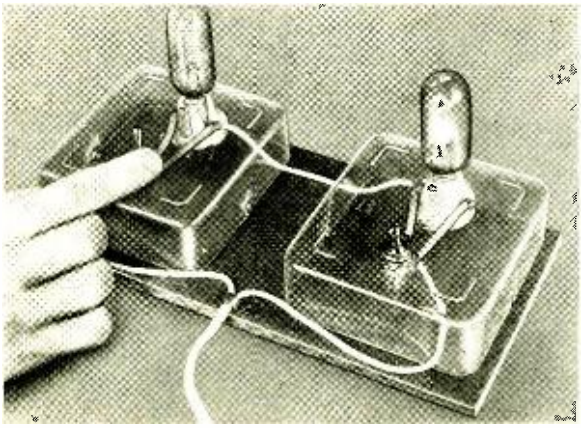


CUTTING RED TAPE—Knox College (Ill.) senior Ingrid Bletzner (right) views playback of Ampex video tape recording of her teaching some 40 first grade pupils during a student teaching assignment. Video tape was then sent to prospective employer—and Miss Bletzer got the job.



TINY TV CAMERA—The vidicon tube has been eliminated in a 6" x 4" x 3½" TV camera designed for NASA by Westinghouse for use in the U.S. space program. Requiring 4 watts of power, the camera uses a solid-state device in the form of a phototransistor mosaic sensor (left) for light-sensing and image conversion.



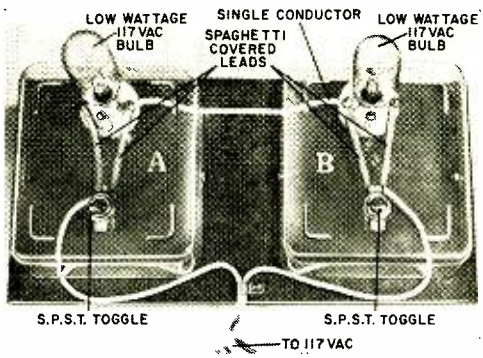


THE "IMPOSSIBLE" CIRCUIT

BAFFLE THE BOSS . . .
CONFUSE YOUR CHUMS . . .
JOLT THE NEXTDOOR GENIUS . . .
TEASE YOUR TEACHER . . .
NAG THE NEIGHBORS . . .

By LUIS VICENS

YOU CAN do all of these things—and more—just by challenging your technically inclined friends to solve *The Case of the Impossible Circuit*. Pictured below, the circuit is really a very simple affair. It consists of two boxes, *A* and *B*, each of which contains a lamp and a switch. There is a single power line lead to each box and a single connecting lead between the two boxes. Whenever a.c. power is applied and switch *A* is thrown *ON*, lamp *B* lights. When switch *B* is thrown *ON*, lamp *A* lights. When both switches are *ON*, both lamps light—and when both switches are *OFF*, both lamps are dark.



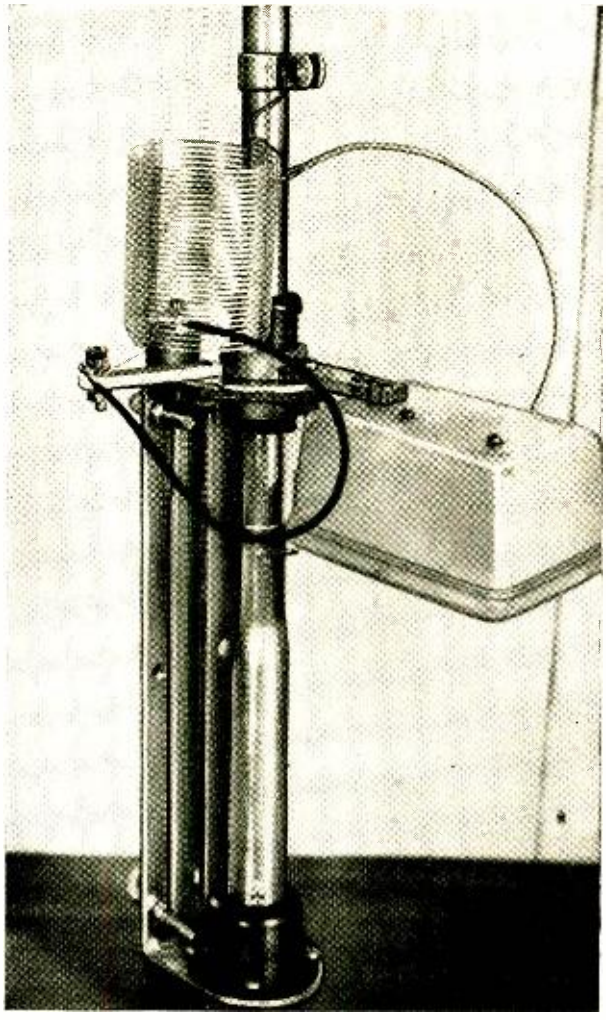
Question: *What is the circuitry in each box?*

Clues: Neither box contains amplifiers, transformers, oscillators, nor relays. The circuits are essentially identical in both boxes. The lamps are standard, identical, ordinary household incandescent bulbs. The power source is a standard 117 volts a.c. But, most important—the circuit is a practical one which can be easily duplicated at home, either for demonstration purposes or as part of a science fair project.

If you can't figure it out—or you think you have a solution and want to check it —turn to page 79. -30-

BUILD AN 80/40 Meter BANDSWITCHING VERTICAL

OR . . . HOW I DECIDED TO CHANGE BANDS FROM INSIDE THE SHACK



By **LOU DEZETTEL,** W9SFW

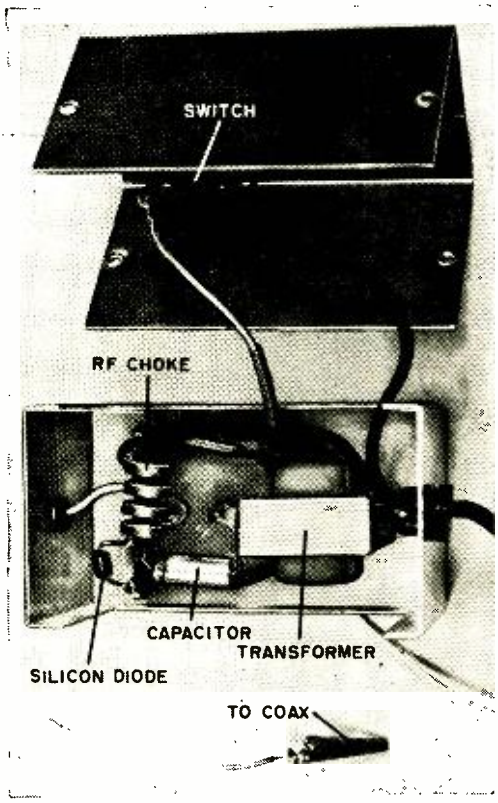
IF CB has nothing else to its credit, it has stimulated the manufacture of vertical antennas. Although many hams preferred vertical antennas in the pre-CB days, it has only been within the past six or seven years that a variety of modestly priced ham-band vertical antennas have been marketed.

Some vertical antennas are designed for switchless operation on 80 or 40, and the higher bands, while others are short verticals (18′) with a loading coil at the base. The latter are much cheaper, but necessitate manual band changing—a gruesome task in the cold, wet, or heat.

Use the Feed Line. The problem of band changing can be resolved by placing a s.p.s.t. relay adjacent to the loading coil and controlling the relay action from the ham shack. When the relay contact is open, the loading coil tap for 80-meter operation is in use. When the contact closes, additional turns on the coil are shorted out and the antenna resonates in the 40-meter band.

The beauty of this arrangement is that it is possible to control the relay using

The author used an inverted plastic refrigerator dish to "weatherproof" the relay. The heavy black lead is the 80-meter tap and the other lead is the 40-meter tap. Relay shorts out coil when it closes.



All parts needed to operate the antenna relay from the ham shack are mounted in a small metal box. Note in the diagram how the small chokes keep the r.f. out of the relay circuit. See text for elbow details.

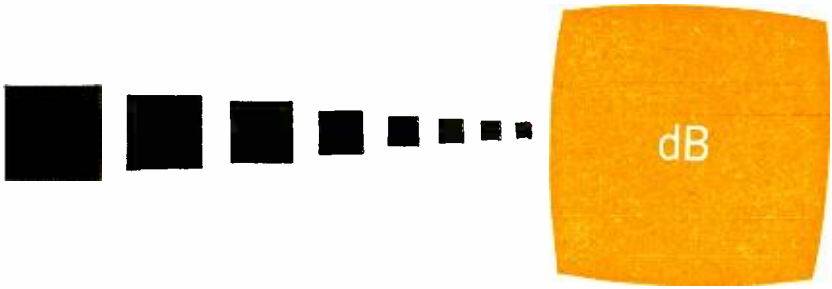
the coaxial feed line—there are no extra wires or cables to be installed. The coax can be made to carry low-voltage d.c. from the shack to the relay while the r.f. is isolated by r.f. chokes. The wiring diagram is shown above.

You may find it advantageous to adapt parts from your junk box for this circuit. The author found a 1500-ohm plate circuit relay and used a small audio transformer (wired backwards) for dropping 117 volts a.c. down to 40 volts. The current drain is about 14 mA and the voltage drop about 20 volts. This jury-built arrangement works, but parts that can be purchased are spelled out in the diagram.

There's nothing difficult about building the power supply, but some care must be exercised in attaching the d.c. to the coax. The preferred method is to use a coax "L" connector. Mount the connector firmly in a vise and cut a 45° slice out of the right-angle bend. Solder a short stub of #12 wire to the exposed inner conductor and clip the power supply output to the stub as shown in the photo.

Getting Good Results. If your experience with a vertical antenna is minimal, bear in mind that results will only be as good as the ground under the antenna—not the physical ground, but the electrical ground. A shortened vertical antenna cut for a quarter-wave is really a half-wave antenna turned on end. One-quarter wavelength extends above ground and the other quarter is in the ground itself.

If the antenna coupling network in your transmitter has an r.f. choke or other direct connection to ground, the setup shown here should not be used—to prevent shorting out the d.c. voltage to the relay. You can run a length of bell wire or other single conductor to the relay and use the shield on the coaxial transmission line as a return. Of course, you can simply run a length of two-conductor line cord to the relay and eliminate the tricky wiring. -30-



WHAT ARE THESE THINGS CALLED DECIBELS?

HERE'S HOW TO USE THEM WITHOUT RESORTING TO MATHEMATICS

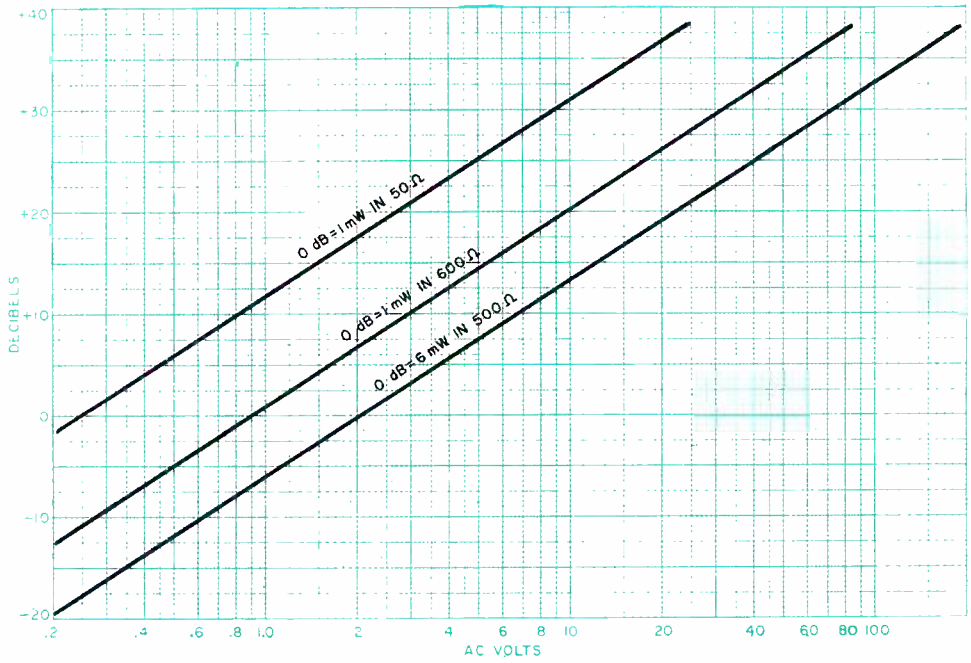
By MARSHALL LINCOLN

DID YOU EVER wonder about the strange language you must learn before you can understand these things called decibels? Some of the electronics measurements given in decibels sure look peculiar, don't they?

For instance, how about the spec sheet on a mike that says it has an output of −55 dB? Now, what kind of output is that? If it's minus, it must be less than no output at all! Yet you could connect the mike up to a 10-watt amplifier and rattle the windows with it.

So just what are decibels, anyhow? What use are they to the experimenter, hobbyist or engineer? Can they be measured like volts, amperes, and watts?

The answer to the latter question is a simple *yes*. Volts (and amperes) are specific units of measurements, but they often represent different things and convey different meanings; the significance of 1 volt of d.c. is not the same as the significance of 1 volt of a.c. Neither is 1 volt of a.c. peak the same as 1 volt of a.c. average, or 1 volt of a.c. r.m.s. Beginning to sound complicated? It isn't really, especially if you have worked with these figures, even for only a little while. Actually, working with dB's is not much more complicated than working with volts and amperes; decibels do have their own body of meanings, but they are essentially dimensionless units.

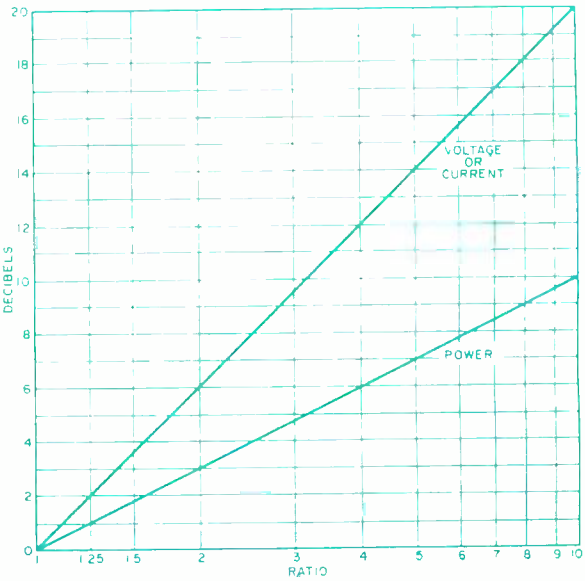


AC VOLTS TO DB GRAPH

To convert an a.c. voltage reading on a VOM or VTVM to dB, find the vertical line that coincides with the reading, follow it up to the point where it touches the diagonal line representing the appropriate zero reference level, and read across to the number of dB's. For example, if you are measuring across a 600-ohm impedance and your reading is 20 volts, the chart shows it to be about 28 dB.

Log Scale Confusion. In an effort to figure out why so many people have trouble understanding the significance of decibels (as units of power measurement), the one thing that stands out is that the progression of one decibel after another follows a log scale while most units of measurements follow a linear scale. Even watts (as units of power which are a function of the square law) have a linear characteristic—the power level of 12 watts is twice as large as 6 watts and four times as large as 3 watts. This is easy for most people to understand. But when 12 dB is twice as large as 9 dB, four times as large as 6 dB, eight times as large as 3 dB, 16 times as large as 0 dB, 32 times as large as —3 dB (following a log scale), that's when the trouble begins.

It doesn't take much to see that for every 3 dB increase, there is a doubling of the power level, and for every 3 dB



RATIO TO DB GRAPH

To convert output-to-input-signal-ratio to dB, find the ratio on the bottom line, read up to the appropriate diagonal, and then across to find the value in dB. For ratios greater than 10 to 1, multiply the bottom line by 10 and add 10 dB for power (add 20 dB for voltage or current). For ratios of less than 1 to 1, divide the bottom line by 10, and subtract 10 dB for power (subtract 20 dB for voltage or current). For example: the difference in output levels in dB between a 200-watt and a 100-watt amplifier is 3 dB; the gain of an amplifier having a 1-volt input and a 20-volt output is 26 dB.

decrease, there is a halving of the power level. From this you could conclude that the decibel system follows some kind of geometric progression; and if your analytical thinking cap is really sharp, you will see that in the above example each 3 dB represents a *ratio* of one power level to another, on the order of 2 to 1.

Don't go away; that's only part of the story. You now know that 12 dB is twice as large as 9 dB, but how large is 9 dB? You really don't know, at least not yet. What you have so far is a *relative* measurement, not a *specific* one.

Specific Measurements. When decibel measurements are made with respect to a specific standard or reference point, they do have specific meanings, and they can be used just like an absolute measurement to enable you to compare equipment, and to solve audio, r.f., and other electronic problems.

For example, when the gain of an audio amplifier is specified in decibels, the number of dB indicates that the output power is a certain number of times greater (or less) than the input power, or it could mean that the output power is a certain specific amount relative to a *standard reference* level of power. The minus sign (−55 dB) in the microphone specification, for instance, means that this level is *below* that of the standard measurement unit which is used as a reference. This specification doesn't mean the mike is defective, but it does represent a definitive level and is in the form of an absolute measurement which the experimenter, technician, or engineer can understand.

Decibels Vs. Watts. A basic understanding of decibels is a mighty handy measuring stick. With it you can compare audio power levels in speaker systems, gain of audio or r.f. amplifiers, performance of antennas, strength of radio signals, and the loss in audio and r.f. transmission lines—just to name a few applications.

Wait a minute, you might say, what's wrong with using watts as a measure of power and as a basis for comparison of signals and equipment? Nothing really —it can be done, but not without a lot of meaningless confusion.

FOR MATHEMATICIANS ONLY

If you like to work with formulas, and if logarithms are no mystery to you, here are the formulas that were used to develop the tables and graphs and to trigger some of the comments in this article:

$$dB = 10 \log \frac{P_2}{P_1}$$

where dB = decibels, P_2 = power output in watts, and P_1 = power input in watts.

$$dB = 20 \log \frac{E_2}{E_1}$$

where E_2 = signal voltage output, and E_1 signal voltage input. The use of 20 times the log instead of 10 times the log when working with voltage and current is due to the fact that power is equal to E^2/Z, or I^2Z, which makes the "long form" of the formula for power ratio look like:

FOR VOLTAGE

$$dB = 10 \log \frac{(E_2)^2}{(E_1)^2} + 10 \log \frac{Z_1}{Z_2}$$

FOR CURRENT

$$dB = 10 \log \frac{(I_2)^2}{(I_1)^2} + 10 \log \frac{Z_2}{Z_1}$$

where Z_2 = output impedance, Z_1 = input impedance, I_2 = current output, and I_1 = current input.

Since the log of a squared number is double the log of the same number not squared, it is sufficient to show the formula as 20 log E_2/E_1 or 20 log I_2/I_1, if the input and output impedance is the same. The + 10 log of Z_1/Z_2 is simply the correction factor that must be added if voltage measurements are made across different impedances. When Z_1 and Z_2 are equal, their ratio is 1; the log of 1 is 0; 10 times 0 is 0; therefore, no correction is needed for measurements across equal impedances. (Notice that for current measurements Z_1 and Z_2 are reversed.)

The above formulas for voltage and current are valid only if output and input measurements are made across the same impedance, unless a correction factor is used.

If you are using a meter calibrated to 0 dB = 1 mW in 600 ohms and measuring power levels across different impedances, you can find the correction factor in dB and add it to your readings by using the following formula:

$$dB = 10 \log \frac{600}{Z}$$

For a meter calibrated to 0 dB = 6 mW in 500 ohms, use:

$$dB = 10 \log \frac{500}{Z}$$

For example, consider a change in a certain amplifier's output from 1 watt to 2 watts, and a change in another amplifier's output from 10 watts to 11 watts. In both amplifiers the change was only 1 watt, yet in the first case the change represented a doubling of power, and in the latter case an increase of only 10%. So you can see that even with watts you must relate your measurements, know their significance, and be able to develop a ratio, or a percentile, or what have you.

VOLTMETER SCALE FACTORS

0 dB=1 mW in 600 ohms		0 dB=6 mW in 500 ohms	
Scale (volts)	Add (dB)	Scale (volts)	Add (dB)
5	10	2.5	0
50	30	10	12
150	40	50	26
500	50	250	40
1500	60	1000	52

Table 1. For meters equipped with a dB calibrated dial, simply add the number of dB to your reading, according to the a.c.-volt scale you are using and the zero reference level of the calibrations.

When decibels are used, they have a unique way of representing a ratio or relationship of one power level to another. When it is said that every 3 dB increase represents a doubling of power, just that is meant, whether you are going from 3 dB to 6 dB, or from 100 dB to 103 dB.

Decibels Minus Math. The basic unit for measuring power ratio is the *bel* (B), named for Alexander Graham Bell, inventor of the telephone and a pioneer in audio research. The bel is too large for most electronic measurements, so the decibel (dB), which is equal to 1/10 bel, is generally used. Decibels can be derived by *comparing* different quantities of power, or voltage, or current.

Decibel calculations with formulas require the use of logarithms, which are an obstacle to many people, and while it's a small hurdle which can be easily overcome, there is an easier way to work with decibels—without formulas. You can use a graphic method and you can work with meters, oscilloscopes, etc.

Essentially, the meters function as a.c. voltmeters and many of them are calibrated in dB to enable you to make measurements directly, and to eliminate the paper and pencil work.

These absolute types of measurements are made possible through the establishment of certain standards for measuring power levels. These standards set forth a "reference level" (zero dB level), and if you work within the framework of the standards you will have done much to eliminate confusion and double-talk. The standards make it possible to express a single dB figure above or below the reference level, and have it make sense. This is what is done in the case of microphones, speakers, S-meters, tape recorders, etc.

The most common "zero dB reference level" used today, particularly in audio work is 1 milliwatt dissipated in a 600-ohm load at 1000 Hz. Remember, this zero dB level is not a zero output level. Any power level above this zero dB level is designated in positive dB, and any power below it is referred to in negative dB.

Another reference level sometimes encountered is 6 milliwatts in a 500-ohm load, and occasionally other standards are used.

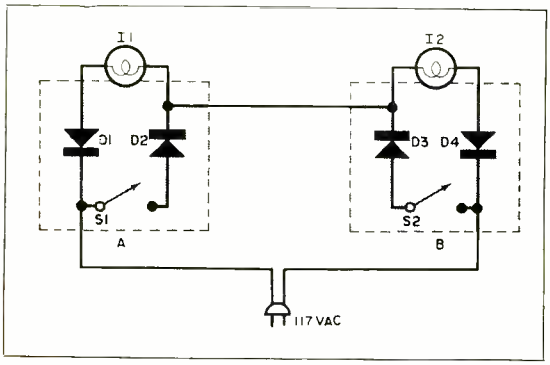
Standards come and go, and zero dB reference levels have been changing accordingly. The dBm is now in vogue and is the most commonly used reference level. It's another way of saying 1 mW in 600 ohms.

The volume unit (vu), a favorite of the audio and telephone industries, is also based on the same reference level as the dBm, except that vu's are used to represent complex waveforms as encountered in voice and music, while dBm's are used in making measurements of simple sine waves. Since vu's represent average levels in a waveform, it is taboo to work with dBm when you should be working with vu and vice versa.

Meter Calibration and dB Readings. The way to tell for sure how your meter is calibrated is to notice what point on the a.c. voltage scale corresponds to zero on the dB scale. If it's 0.775 volt, the meter is calibrated using 1 mW in 600 ohms. If the zero dB point on the

(*Continued on page* 117)

THE "IMPOSSIBLE" CIRCUIT MADE POSSIBLE



ARE YOU STUMPED by the "Impossible" Circuit on page 72? If so, don't be despondent—this seemingly innocent circuit has stumped even the best electronics engineers.

The "trick" in solving the circuit is to *think simple.* Obviously it is not a complicated design using multiple switches, tuned circuits, tunnel diodes, crossbar networks, filters, interlocked gate circuits, or similar techniques.

How "Impossible" Circuit Works. The circuit uses four standard diodes in addition to the lamps and switches. Circuit operation is possible because (A) diodes are unidirectional devices, permitting current flow only in one direction, and (B) an a.c. power source is used.

If both switches are open, the only current path is through diode *D1*, lamp *I1*, lamp *I2* and diode *D4*. But diodes *D1* and *D4* are connected "back to back" and each blocks current flow on alternate half-cycles. As a result, when the switches are both *OFF*, little current flows and the two lamps remain dark.

Suppose that switch *S1* on box *A* is closed. Diodes *D2* and *D4* are now connected in a series—aiding configuration on either side of *I2*. On alternate half-cycles current can flow through *S1*, *D2*, *I2*, and *D4*, and the lamp lights. Lamp *I1* remains dark because current flow through it is still blocked by *D1*.

Similarly, if switch *S1* is open and switch *S2* is closed, diodes *D1* and *D3* are in series, and current can flow through *D1*, *I1*, *D3* and *S2* on alternate half-cycles. Lamp *I1* lights, and lamp *I2* remains dark, for current flow through it is blocked by *D4*.

When both switches are closed, both lamps light, but each only on *alternate* half-cycles of the applied a.c. voltage. However, the thermal lag of the incandescent filaments and persistence of vision combine to produce what appears to be a steady glow, so both lamps seem to be on simultaneously.

Assembling the Circuit. A demonstration model of the "Impossible" circuit can be assembled in a single evening. Neither layout nor lead dress is critical, nor—for that matter—are the component parts. Either standard (Edison) base or candelabra lamp bulbs can be used. The lamps are familiar 117-volt incandescent types, rated at from 7 to 60 watts—take your pick! The switches can be toggle, slide, push-button or rotary s.p.s.t. switches, while the diodes (*D1* through *D4*) may be anything with a 200-PIV (or higher) voltage rating and a 1-ampere (or more) current rating.

The boxes should be of transparent plastic and mounted on a sturdy base, with the external wiring clearly visible. Use an insulating material for the base, such as wood, Masonite, or clear plastic, to avoid the suspicion of a "ground return." The subminiature diodes (International Rectifier Type 804) can be concealed in short lengths of tight-fitting spaghetti tubing.

With *all* wiring apparently visible, the circuit becomes—as the King of Siam would say—a real *puzzlement!* —30—

UNPOPULAR ELECTRONIKS

A SALUTE TO THE FAILURES IN EXPERIMENTAL ELECTRONICS

By CARL KOHLER

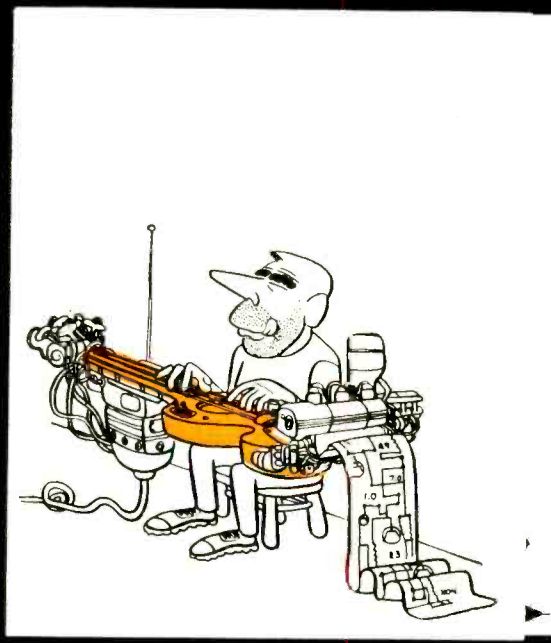
It's a proven theory that into every pastime a little bane must crawl—and the fine old field of electronics is no exception. Populated for the most part by brilliant, inventive people, the electronics hobby has also known its dismal share of dubious types. The otherwise respectable history of electronics is spotted by militantly neurotic individuals whose various obsessions have added nothing to ham radio, SWL'ing, CB'ing, etc. Shown here is a small handful of nuts whose collective quasi-creativity certainly classifies them as "Electroniks." This clumsily minted term aptly describes these bohemians who have vainly wielded screwdriver and soldering gun with a breath-taking lack of success.

SEAN GONNN intrepidly ignored the Reciprocity Theory and succeeded in developing his distinctive "Gonnn Boomerang Signal" which—upon being transmitted—instantaneously returned and thoroughly deactivated its own R/C transceiver.

HYRAM VON KRUUNK labored over his concept of an automatic turntable featuring a specially designed tone arm. The design permitted the stylus to move from corner to corner as Hyram played his vast collection of square Wayne King, square Guy Lombardo, and square Lawrence Welk platters.

LOTHAR SYMTH-SYMTH shrewdly framed his copper-clad laminated etched circuit boards and profitably sold them as electronics abstractions—mainly because all of the circuits were inoperative. No one told Lothar that the copper background is etched off, not the connecting strips.

MARIO SILVERGOLD tackled the formidable task of composing a rather stirring essay on Plasmonics and Hydronics without once mentioning water. This was not a trivial accomplishment since the entire manuscript was in layman's Sanskrit.



NOAH TERWILLIGER ingeniously designed and constructed an electronically controlled instrument that produced graphic sketches of wiring schematics from tonal patterns. However, all of the sketches morbidly tended to induce disastrous feedback.

EUSTACE ROONK diligently studied Laser Beam theory for many years for the sole purpose of perpetrating a practical joke. His energyless "Roonk Lazier Beam" always fell short of the mark.

MORDECAI GHEE, a CB malcontent, sat patiently for more than 33 hours waiting to "break" channel 9. When the opportunity arose, this unfrocked eavesdropper had forgotten what he wanted to say.

REFLEXOMETER REFLECTIONS

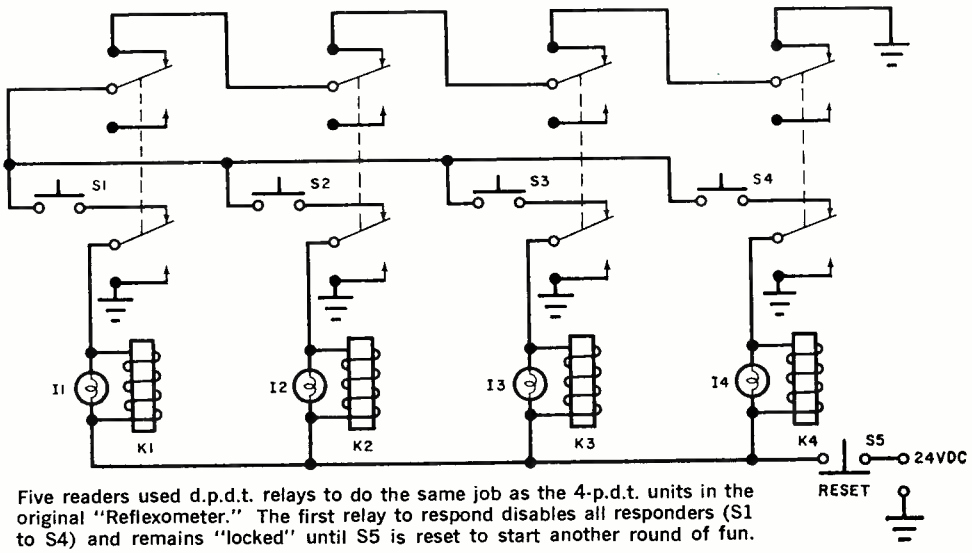
READERS MODIFY GAME CIRCUIT TO EARN CASH AWARDS

THERE MAY BE more ways to skin a cat, but there are almost as many ways to build a "Reflexometer." In the March, 1966, POPULAR ELECTRONICS, on page 47, there is a pretty young lady testing her skill at the game of "Reflex." The idea is to avoid "flinching" while trying to respond to a situation faster than the competition. Whether it's the reaction to the roll of a pair of dice or the winner of a slot-car race, the Reflexometer tells who or what responded first; second best, no matter how tricky, sneaky, or cheaty, just doesn't get paid off.

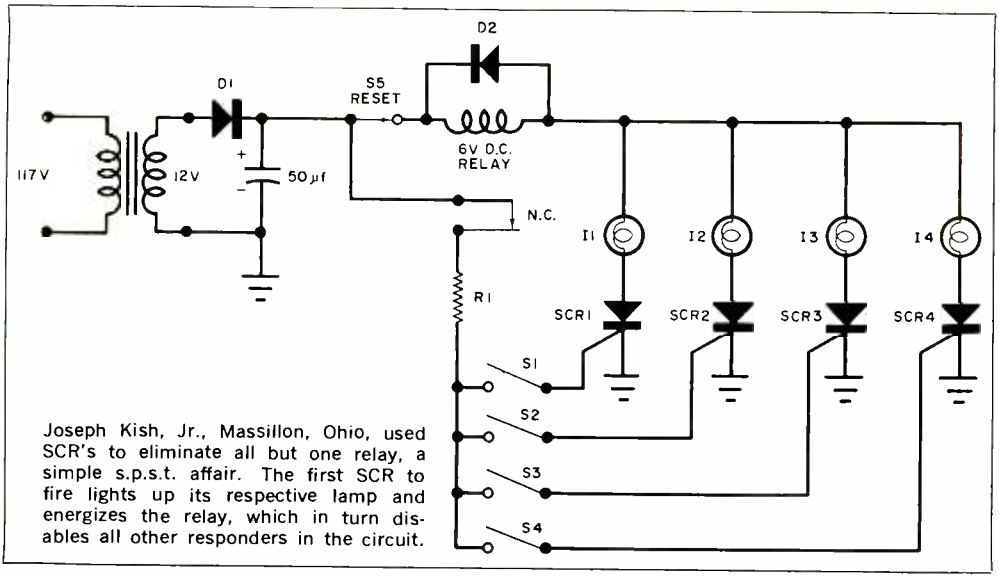
The original gadget was equipped with four-pole, double-throw relays. Since it was published, many readers have sent in versions of their own to let us know how they can do it better, easier, and much cheaper; how to add bells and buzzers; and even how to eliminate the relays altogether. Most of the ideas received looked like they would work satisfactorily; some circuits were more complex and some were quite simple.

In the "Letters from Our Readers" column, June, 1966, we agreed to present in a future issue the best or most unusual modifications, for which cash prizes would be offered. Well, here are the best three entries. Seven cash awards were sent out because five readers sent in the same suggestion.

Simpler Relays. The identical modification was submitted by Rex R. Rickly of Columbus, Ohio; Carl Stanislawski of Adelphi, Md.; John Pobanz of Athens, Ohio; Donald O. Wurst of Wright Patterson Air Force Base, Ohio; and F. I. Shoaf of Clemmons, N.C. Their circuit contains d.p.d.t. relays in place of the 4-p.d.t. relays in the original circuit. The first person who presses the button causes his relay to energize. This throws the relay contacts into their alternate position. The upper pair of contacts disarms all other opponents' switches, and the lower contacts hold the relay closed since the holding circuit is completed to ground. The circuit is reset for another round with *S5*. (See diagram below).



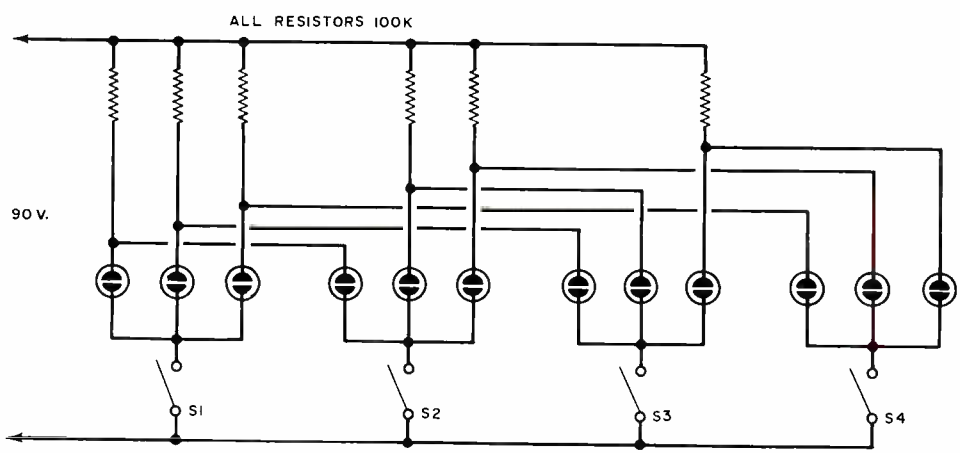
Five readers used d.p.d.t. relays to do the same job as the 4-p.d.t. units in the original "Reflexometer." The first relay to respond disables all responders (S1 to S4) and remains "locked" until S5 is reset to start another round of fun.



Joseph Kish, Jr., Massillon, Ohio, used SCR's to eliminate all but one relay, a simple s.p.s.t. affair. The first SCR to fire lights up its respective lamp and energizes the relay, which in turn disables all other responders in the circuit.

Silicon Controlled Rectifiers. Joseph Kish, Jr., of Massillon, Ohio, used silicon controlled rectifiers (SCR's) to replace the relays. The player who closes his switch first sends a pulse to the related SCR, triggers it into conduction, and causes the lamp to light. When this happens, the single relay energizes, and "disarms" the other players' switches.

No Relays. John T. Hunt, of Pittsburgh, Pa., was honest enough to tell us that the circuit he submitted came from "Signalite Application News," a monthly publication put out by Signalite, Inc. The ability of this circuit to tell who is first, second, third, and fourth, as well as its simplicity, is responsible for its being a winner. The first player to respond causes all three of his lights to go on. The second, third, and fourth responders cause two, one, and no lights to fire, respectively. The switches are of the regular on/off type since they must remain *ON* to register. To play another round, switches are reset to *OFF*. -30-



John T. Hunt, Pittsburgh, Pa., came up with a relay-less circuit, and went one better. This circuit can tell you who came in first, second, third, etc. All three lights go on for the first responder, two for the second, one for the third, and none for the fourth. Switches are not momentary-make types.

SOLID STATE

By LOU GARNER, Semiconductor Editor

EVERY solid-state circuit, no matter how efficient, requires a power supply of some kind. Without question, the most popular power source is the dry battery, since it furnishes a fixed d.c. which can be divided down with dropping resistors or raised to any desired level by adding more batteries in series. Alternating current can also be used to provide the necessary d.c. operating power, once it is stepped down with a transformer, then rectified and filtered. The only drawback here is that such an arrangement is not truly portable. Of course, portability could be achieved if we used an a.c. battery as the primary source instead of the a.c. power line. What? . . . you never heard of an a.c. battery?

The truth is that such a battery has been little more than a dream. In fact, back in the good old days, apprentice electronic technicians were often sent on fools' errands to the supply room to pick up a.c. batteries, much in the same spirit that apprentice machinists were sent to the tool crib for left-handed monkey wrenches. While left-handed monkey wrenches are still as rare as hens' teeth, a.c. batteries may be commercially available within a couple of years!

Engineers of the U.S. Army Electronics Command (Fort Monmouth, N.J.) have developed a battery that is the closest thing yet to an "a.c. battery." About the size of two standard flashlight cells, the unit delivers a pulsating current with its own characteristic waveform and frequency. Prototypes having a peak voltage of 0.8 volt and peak currents of nearly 400 mA have been produced.

Although these units generate power at only 15 Hz, Army engineers hope to develop future models with frequencies of up to 50 Hz. According to a report released by the U.S. Department of Commerce, the batteries use platinized platinum anodes and lead-lead dioxide cathodes, with the electrolyte consisting of formaldehyde dissolved in sulphuric acid.

Another interesting development in the battery field has been announced by the Olin Mathieson Chemical Corp. (460 Park Ave., New York, N.Y. 10022) . . . a battery with a self-contained detector that indicates its condition. Carrying the Winchester brand, it consists of a 1½-volt D-size cell equipped with a built-in "Sight-Test" top. The detector is a litmus indicator with a clear plastic overlay. As long as the indicator remains blue, the cell is in good condition. The blueness gradually fades as the cell becomes weak, eventually changing to pink when the cell becomes unserviceable.

Reader's Circuit. Would you believe that a complete audio power amplifier could be made up of only three transistors and no other components? How about an amplifier with three transistors, one resistor and one capacitor? You're not buying that either? Then look at the circuit illustrated in Fig. 1. Switch *S1*, input jack *J1*, and gain control *R1*, are optional; and the loudspeaker (*SPKR*) and power supply *B1* are accessories . . . hence the amplifier proper consists only of *C1*, *R2* and the three transistors—*Q1*, *Q2* and *Q3*.

This simple, but interesting, circuit was submitted by reader Scott Marovich (2407 S. Rose St., Kalamazoo, Mich.), who writes that he has assembled several successful versions using an almost random selection of components, supply voltages, and speaker impedances. He writes, further, that he has achieved multi-watt operation with reason-

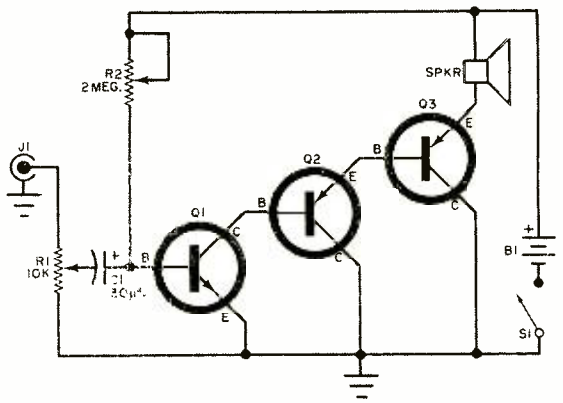


Fig. 1. Audio amplifier featuring input transistor Q1 direct-coupled to Darlington pair Q2-Q3. Overall gain is product of the betas of the transistors.

able fidelity and acceptable bass response. (Wonder if he means milliwatts?)

Surprisingly enough, Scott's circuit is a familiar one to design engineers. It is seldom used in commercial equipment, however, because of its relatively low efficiency (which it shares with all Class A amplifiers), critical bias adjustment, and sensitivity to temperature changes. But, for general use in the home and experimental applications in the lab, this amplifier is hard to beat so far as economy, versatility, and simplicity are concerned.

An input signal at *J1* appears across *R1*, the gain control. Part of this signal, depending on *R1*'s setting, is applied to *Q1*'s base-emitter circuit through capacitor *C1*. Transistor *Q1* is direct-coupled to *Q2* and *Q3*, driving the loudspeaker's voice coil which acts as a low-impedance load. Circuit power is furnished by *B1* through switch *S1*.

Performance can vary considerably from one such amplifier to another, depending on the characteristics of the transistors used. With direct coupling employed throughout, *Q1*'s base bias, established by series resistor *R2*, determines the operating conditions for the entire amplifier. Thus, the adjustment of *R2* can be quite critical. Furthermore, any variation in *Q1*'s base current, such as that produced by temperature changes, can affect overall circuit operation.

Transistor *Q1* is a general-purpose *npn* type similar to the 2N170. Transistor *Q2* is a low-signal *pnp* type such as a CK722 or 2N109. The output transistor, *Q3*, is a medium-to-high power *pnp* type equivalent to the 2N256, 2N301, or 2N441. Jack *J1* is a conventional phono type, and *S1* is any old s.p.s.t. toggle or slide switch. Potentiometers *R1* and *R2* are standard units.

The speaker is a PM type; use any size from 4″ to 10″, and any impedance from 4 to 16 ohms. The power supply, too, is not critical, and the rating of *B1* can vary from as little as 3 volts to as much as 18 volts . . . but it should be capable of supplying several hundred milliamperes. Finally, the coupling capacitor, *C1*, may be any value from 20 to 50 μF, with any voltage rating from 15 to 25 volts.

The only transistor that requires a heat sink is *Q3*. This can be the metal chassis (if one is used), or a fair-sized commercial heat sink if the unit is assembled on a perforated phenolic board or printed circuit board. Be sure to keep input leads short and direct, and allow a wide separation between input and output circuits.

Once the wiring is completed and checked, the speaker and battery can be connected. With an audio signal applied to *J1*, turn on the amplifier and adjust gain control *R1* to its mid-position. Then adjust *R2* for the best compromise between maximum gain and low distortion. Depending on the signal source, *R1* may require readjustment to prevent overload. If high-gain transistors are used in the circuit, it may be necessary to connect a 1- or 2-megohm resistor in series with *R2* (or to replace this unit with a 5-megohm control) to obtain a satisfactory bias setting.

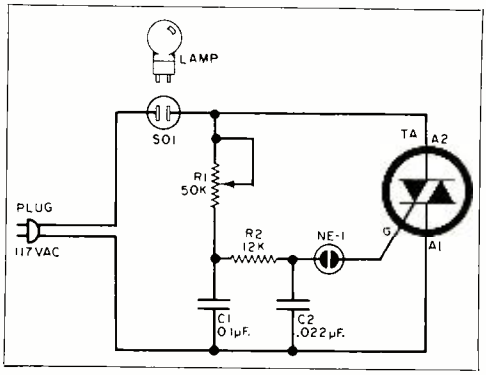


Fig. 2. Lamp-dimming circuit capable of handling up to 2.5 amperes on a continuous basis employs Triac switch (TA) to control current through lamp.

Manufacturer's Circuit. Featuring RCA's new low-cost, sensitive-gate "Triac," the circuit illustrated in Fig. 2 permits the easy control of lamps and a.c. household appliances. Unlike the familiar SCR, which is a unidirectional device and, therefore, conducts only on alternate half-cycles, the Triac is a bi-directional switch and thus permits the full-range control of circuit current. The lamp dimming circuit shown can handle currents of up to 2.5 amperes, r.m.s., and peak surges as high as 18 amperes.

Average current through the lamp is controlled by the conduction period of the Triac (*TA*). In operation, the Triac is switched from a nonconducting high-resistance state to a conducting state by the application of a trigger signal to its gate (*G*) electrode. This switching signal is obtained from a phase-shift network, *R1-C1*, and coupled through an *RC* integrator *R2-C2*, and a neon bulb (*NE-1*), to *TA*'s gate. The Triac's average conduction period, then, depends on the phase relationship between the line voltage and its gate signal.

The dimmer can be easily duplicated, since the circuit uses standard parts. Potentiometer *R1* is a standard radio pot, *R2* a half-watt resistor. Capacitor *C1* is a 200-volt tubular paper type and *C2* can be either a ceramic or paper capacitor. The neon bulb is a type NE-83. Triac *TA* currently carries RCA type number TA2893, but this designation may be changed at a later date to a standard EIA number.

(*Continued on page* 119)

In today's electronics boom, the demand for men with technical education is far greater than the supply of graduate engineers. Thousands of real engineering jobs are being filled by men without engineering degrees—provided they are thoroughly trained in basic electronic theory and modern application. The pay is good, the future is bright... and the training can now be acquired at home—on your own time.

How to become a "Non-Degree Engineer"

The electronics boom has created a new breed of professional man—the non-degree engineer. Depending on the branch of electronics he's in, he may "ride herd" over a flock of computers, run a powerful TV transmitter, supervise a service or maintenance department, or work side by side with distinguished scientists on a new discovery.

But you do need to know more than soldering connections, testing circuits and replacing components. You need to really know the fundamentals of electronics.

How can you pick up this necessary knowledge? Many of today's non-degree engineers learned their electronics at home. In fact, some authorities feel that a home study course is the *best* way. *Popular Electronics* said:

"By its very nature, home study develops your ability to analyze and extract information as well as to strengthen your sense of responsibility and initiative."

Cleveland Method Makes It Easy

If you decide to advance your career through home study, it's best to pick a school that *specializes* in the home study method. Electronics is complicated enough without trying to learn it from texts and lessons that were designed for the classroom instead of the home.

The Cleveland Institute concentrates on home study exclusively. Over the last 30 years it has developed techniques that make learning at home easy, even if you once had trouble studying. Your instructor gives the lessons and questions you send in his undivided personal attention—it's like being the only student in his "class." He not only grades your work, he analyzes it. And he mails back his corrections and comments the same day he gets your lessons, so you read his notations while everything is still fresh in your mind.

Students who have taken other courses often comment on how much more they learn from CIE. Says Mark E. Newland of Santa Maria, Calif.:

"Of 11 different correspondence courses I've taken, CIE's was the best prepared, most interesting, and easiest to understand. I passed my 1st Class FCC exam after completing my course, and have increased my earnings by $120 a month."

Always Up-to-Date

Because of rapid developments in electronics, CIE courses are constantly being revised. This year's courses include up-to-the-minute lessons in Microminiaturization, Laser Theory and Application, Suppressed Carrier Modulation, Single Sideband Techniques, Logical Troubleshooting, Boolean Algebra, Pulse Theory, Timebase Generators...and many more.

CIE Assures You an FCC License

The Cleveland method of training is so successful that better than *9 out of 10 CIE men who take the FCC exam pass it—and on their first try.* This is despite the fact that, among non-CIE men, 2 out of every 3 who take the exam fail! That's why CIE can promise in writing to refund your tuition in full if you complete one of its FCC courses and fail to pass the licensing exam.

This Book Can Help You

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

If you would like to cash in on the electronics boom, let us send you this 40-page book free.

Just fill out and mail the attached card. Or, if the card is missing, write to:

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Cleveland, Ohio 44114
Accredited Member National Home Study Council

VETERANS
If you had active duty in any branch of the Armed Forces after January 31, 1955, you may be entitled to Government-paid tuition for any CIE course.

BUILD A STICK-SHIFT ELECTRIC SHAVER

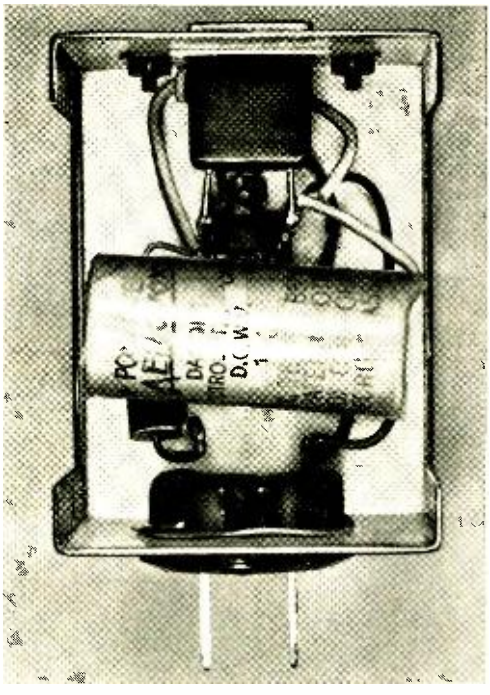
ADAPTER FOR BRISK WHISKER WHISKING

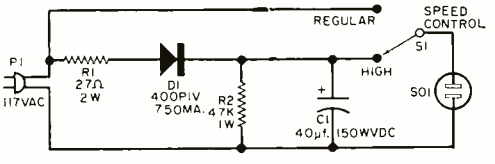
IN ORDER TO make electric shavers "universal" and capable of operating on both a.c. and d.c., there has to be a design compromise in the motor. Most electric shavers will cut faster and smoother if operated from d.c., or even pulsating d.c. But occasionally you may want to slow the electric razor down, and this gadget was built so that "High" and "Regular" speed control could be provided.

Mounting and wiring of the components is obvious from the photographs. A d.p.d.t. slide switch was used so that the extra terminals could be employed as tie points to support some of the wiring. Diode *D1* can be any silicon rectifier diode with a rating of 400 volts PIV and 750 mA. Don't ground any of the wires intentionally or accidentally to the metal box.

To use the shaving aid, simply plug it into a convenient outlet, set the slide switch to "High" or "Regular" speed, plug in your shaver, and you're in business. For maximum convenience—if your shaver is only used in the bathroom—replace plug *P1* with a short length of zip cord and a suitable a.c. cap, and mount the box on the wall.

—Ryder Wilson





You can house this handy electric shaver adapter in a small metal box using an Amphenol 61-M-1 a.c. plug at P1 and a chassis receptacle at socket SO1. Float all of the wiring, and make certain that none of the components accidentally shorts to the box.

AMATEUR RADIO

By **HERB S. BRIER,** W9EGQ
Amateur Radio Editor

THUMBNAIL REVIEW OF "DUO-BANDER 84" SSB TRANSCEIVER

CONSIDERING the number of amateurs who operate exclusively on the 75- and 40-meter phone bands, it was inevitable that some manufacturer would eventually come up with an SSB transceiver for these bands. The one who did it first is World Radio Laboratories, Inc. (3415 West Broadway, Council Bluffs, Iowa), and the transceiver is the WRL "Duo-Bander 84."

The announced intention of WRL in designing the new unit was to give 75- and 40-meter operators the most mileage for the least money in a ready-to-operate SSB transceiver. To achieve this aim, the 9-tube, 7-transistor, 4-diode circuit has been divested of all unnecessary frills; but, after observing the Duo-Bander in operation at two separate locations, your Amateur Radio Editor can report that nothing essential to good performance has been omitted.

The balanced modulator and crystal-lattice filter produce a clean lower sideband signal with excellent suppression of carrier and unwanted sidebands. Both the transmit and receive modes are VFO-controlled. When the "Duo-Bander 84" is used with either its companion 117-volt a.c. power supply or 12-volt d.c. supply, power input is 300 watts, PEP, on both 75 and 40 meters. (A light-duty, 260-watt a.c. power supply is also available.)

Selectivity on receiving is 2.7 kHz, and sensitivity—rated at 1 μV—is more than sufficient to give full output from the built-in loudspeaker for any signal above the noise level on either band. And the unit's a.g.c. system works equally well on transmit and receive modes.

At its price of $159.95, plus $79.95 for the deluxe a.c. power supply or $49.95 for the economy power supply, and $89.95 for the 12-volt mobile power supply, this transceiver should satisfy the amateur on a limited budget who wants a good, basic, 75- and 40-meter SSB transceiver either for fixed-station or mobile work.

AMATEUR STATION OF THE MONTH

Walter Stein, WA5IYK, trustee for station W5TAC located at the Dallas Home and Hospital for Jewish Aged in Texas, is shown demonstrating the station to four residents of the home. The equipment consists of a Galaxy V, 300-watt, CW/SSB transceiver, remote VFO, and deluxe control console. We are sending WA5IYK a one-year subscription (for the pleasure of the residents) for submitting the winner for October in our Amateur Station of the Month photo contest. To enter the contest, send us a clear photo of your station with you at the controls, and some details on your ham career and the equipment you use. Entries go to: Amateur Radio Contest, c/o Herb S. Brier, Box 678, Gary, Indiana 46401.

UPDATED "SECOND OP" AVAILABLE

If you're looking for a handy guide to foreign postal rates, DX country prefixes, great circle bearings, time differentials, etc., you can't afford to be without the new W9IOP "Second Op." This is the fourth revision of the popular rotary slide rule. Also listed on the "Second Op" are the QSL bureaus around the world, WAZ zone designations, continent location, and spaces for maintaining a country QSO and QSL record. Sold by many radio parts jobbers, the updated "Second Op" can also be ordered directly from W9IOP, Electro-Voice, Inc., Buchanan, Mich. Price: $1.00.

Amateur Radio Hall of Fame. An International Amateur Hall of Fame is being organized to provide permanent recognition of individual contributions made by hams around the world to the advancement of amateur radio. Each year five amateurs will be honored by having their names and call letters inscribed on a plaque to be displayed on the premises of the International Amateur Radio Club in Geneva, Switzerland. Each will receive a replica of the plaque.

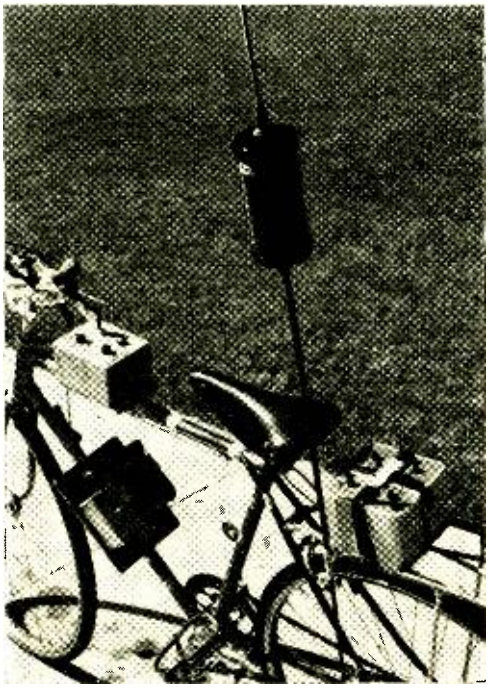
The five amateurs will be selected by a board of judges internationally known to the amateur fraternity from nominations made by fellow amateurs from all parts of the world. Nominations are called for in the following fields of activity: advancements in electronic techniques and equipment; traffic and DX activity; achievements in exotic phases of amateur radio (moon-bounce, space probes, etc.); emergency and disaster communications; and the development of amateur radio. A nominee may be any man or woman holding a radio amateur's license issued by a recognized authority in a member country of the International Telecommunications Union.

Is there anyone that you would like to nominate? Amateurs everywhere are invited to join in honoring those hams who have made significant contributions to the art in their respective fields by submitting their names and call letters, and a brief outline of their accomplishments to Dorothy Strauber, K2MGE, Secretary, International Amateur Radio Hall of Fame, 12 Elm St., Lynbrook, N.Y. 11563, by December 31, 1966. The Hallicrafters Company will provide the plaques and donate advertising space for the International Amateur Hall of Fame as a public service.

Third-Party Messages. In one of the club papers we saw recently, the editor was bemoaning the fact that club members were unwilling to make phone patches for some missionaries in central Africa. The trouble with his concern was that third-party messages via amateur radio are illegal between the United States and the country involved.

The latest FCC list of countries with which U.S. amateurs may exchange unimportant third-party traffic includes: Bolivia (CP); Brazil (PY); Canada (VE, VO); Chile (CE); Colombia (HK); Costa Rica

(*Continued on page* 122)



"Ty" Conboy, WN7DOX, St. Helens, Oregon (above), will probably be signing WA7DOX by the time this is in print. If you need an Oregon contact, try Ty—preferably on Sunday. At left is the transistorized bicycle mobile of Brad Good, WB6LUC, Long Beach, Calif. Brad made several contacts while in motion before the "station" was demolished in an accident; he does NOT recommend that anyone duplicate his experiment. You'll find more information on both of these hams in "News and Views" on page 123.

ON THE CITIZENS BAND

By MATT P. SPINELLO, KHC2060, CB Editor

A NATIONAL wire service has presented a lopsided view of the CB service. Newspapers across the nation have erroneously informed readers that the current state of the CB service can be compared to a city of 800,000 population with only 23 party lines for all of its telephone calls! This is certainly not the type of information to encourage the potential CB'er to put Citizens Band Radio to work for his communication needs. It is unfortunate that the originator of the story was not aware that there is no comparison between 800,000 telephone calls on 23 party lines in *one* city and 800,000 CB calls on 23 channels *spread across* more than 3000 miles of the United States.

Does a bad press establish the CB image? Do the statistical actions of the rule-breakers constitute the image for all licensees? Or are we all a little responsible through lack of interest in the areas that can help or hurt us the most? The CB club newspapers should stand as *the* vehicles to promote the proper use of the CB service, as well as to *inform* all readers of the commendable actions taken by individuals or groups of CB'ers in local activities, for public service or in emergencies. Many club news bulletins do an excellent job in these areas: most do not!

THE CB IMAGE

Who's responsible for the CB image? All 800,000 licensees are! News media will pick up the negative side of a CB story if it's large enough. That sells newspapers. And there's no denying that we have an overabundance of problems on the Citizens Band. If, however, CB clubs, rescue teams, and individuals are quick to report worthwhile CB radio activities on a local basis, time might paint a brighter picture for the uninformed reader of local and national news sheets.

Area newspapers, radio and TV studios are not as apt to pick up a story on your latest coffee "clutch" or board meeting as they are to cover an item pertaining to flagrant misuse of the band, overcrowded conditions during evening hours, or the issuance of a fine from the FCC to a local CB user. The news media might, however, be interested in knowing that a local CB group is working with civil defense, police, and other

(*Continued on page* 124)

Your CB Editor is shown here in a shot taken from a TV screen during one of a series of six telecasts in which he has appeared to inform the public about the worthwhile public service aspects of CB radio.

BROADCASTS FROM AFRICA AND MIDDLE EAST

Prepared by BILL LEGGE and BOB HILL, W1ARR/3

Many countries throughout the world do not transmit broadcasts specifically intended for reception in North America. However, these countries can often be heard in North America if a listener knows on what frequency and at what time to listen. Although some of the broadcasts come through surprisingly well, they are in general more difficult to hear and identify than broadcasts beamed to North America. The following listing gives some of the best times and frequencies for listeners to tune in countries in Africa and the Middle East that do not have special broadcasts to this area.

AFRICA

COUNTRY	CITY	TIME—GMT	FREQUENCIES (MHz)	LANGUAGES
ALGERIA	Algiers	2200-2230	6.175	English
ANGOLA	Dundo	1800-1930	11.687	Portuguese
ASCENSION ISLAND	(BBC Relay)	1700-2000	15.350	English
CAMEROON	Yaounde	0430-0600	4.972	French
CANARY ISLANDS	Tenerife	2300-0400	11.800	Spanish
CONGO REP. (DEM.)	Kinshasa	0400-0600	4.880	French
CONGO REP.	Brazzaville	1900-2000	15.190	English
DAHOMEY	Cotonou	0500-0645	4.870	French
ETHIOPIA	Addis Ababa (ETLF)	1330-1345	15.410	English
		1830-1930	11.875	English
GABON	Libreville	0500-0630	4.777	French
GHANA	Accra	2045-2215	9.545	English
GUINEA	Conakry	2100-2300	9.650	French
IVORY COAST	Abidjan	2100-2400	6.015	French
LIBERIA	Monrovia (ELWA)	2115-2145	15.155	English
MALAGASY REPUBLIC	Tananarive	1600-1700	15.265	Fr. & Eng.
MALI	Bamako	0600-0700	4.835	French
MAURITANIA	Nouakchott	0630-0730	3.222	French
MAURITIUS	Forest Side	0400-0415	9.710	English
MOROCCO	Rabat	2000-2230	11.735	Arabic
MOZAMBIQUE	Lourenco Marques	0400-0600	4.833	English
			11.780	
NIGERIA	Lagos	0430-0600	4.990	English
PORT. GUINEA	Bissau	2200-2400	5.042	Portuguese
RWANDA	Kigali (DW)	2000-2300	15.380	German
SENEGAL	Dakar	0600-0700	4.890	French
SIERRA LEONE	Freetown	0600-0730	3.316	English
SOMALI REP.	Mogadiscio	0315-0330	6.095	English
SPANISH GUINEA	Sta. Isabel	2100-2300	6.250	Spanish
SUDAN	Omdurman	0400-0500	4.992	Arabic
TANZANIA	Dar-es-Salaam	0315-0400	5.050	Kiswahili
TOGO	Lome	2100-2115	5.047	English
TUNISIA	Tunis	0500-0600	6.195	Arabic

MIDDLE EAST

COUNTRY	CITY	TIME—GMT	FREQUENCIES (MHz)	LANGUAGES
IRAN	Teheran	0130-0300	7.065	Persian
IRAQ	Baghdad	2100-2140	6.095	English
ISRAEL	Tel Aviv	2015-2045	9.009	English
JORDAN	Amman	2000-2200	9.530	Arabic
KUWAIT	Kuwait	0225-0330	4.967	Arabic
SAUDI ARABIA	Riyadh	2000-2200	9.720	Arabic
			11.950	
TURKEY	Ankara	2200-2300	15.160	English

SHORT-WAVE LISTENING

By HANK BENNETT, W2PNA/WPE2FT
Short-Wave Editor

IRC'S NOT VALID IN SOME COUNTRIES

USE OF International Reply Coupons (IRC's) is generally considered to be the easiest method of sending return postage to a foreign country when writing for a verification. In the U.S., you can purchase IRC's at most post offices for 15 cents each (be sure to have them postmarked in the left-hand circle), simply attach one to your report, and send it on its merry way. The station in the foreign country can then cash the IRC in at its post office for sufficient postage to cover a reply to you by surface mail and for the minimum weight limit. (If you want a reply by airmail, you'd better enclose two, three, or more IRC's, especially to the most distant countries.)

Not all countries, however, will accept IRC's. An item in an overseas publication listed Peru as being one such country, and a subsequent reference to the U. S. Postal Manual has revealed that IRC's will not be accepted in any of the following areas: Bulgaria, Congo (formerly Leopoldville—now Kinshasa), Peru, Pitcairn Island, Saudi Arabia, Somali, Sweden, Soviet Union, Yemen, and Yugoslavia.

Some of the countries listed above will verify your reports without return postage; others will not. In lieu of IRC's, we suggest that you consider the use of mint stamps of the foreign countries involved. For the face value of the stamps, plus a small fee for the service, you can obtain mint (unused) stamps for virtually all of these countries. They can be purchased from any of the many dealers who specialize in this service. Most Sunday newspapers that carry a stamp column also have listings of stamp dealers.

News Items. *Radio DX'ing Worldwide* (Station WNYW) reports that the American transmitting station, WBOU, Bound Brook, N.J., has been dropped from the *Voice of America* broadcast lists. The station was last used for regular *VOA* service in March, and has since been used for special United Nations transmissions. Now these duties have been assumed by other *VOA* transmitters in Bethany, Ohio, and Greenville, N.C.

Another news item from WNYW states that feminine voices are now being featured over the New York City area's FM air-

(*Continued on page* 126)

COME ON, BROADCASTERS—LET'S GET WITH IT!

There's no great secret to international short-wave broadcasting. You put a signal on the air on the right frequency at the right time of day and a foreign audience is supposed to hear it. But some international broadcasters seemingly ignore the listening habits of the people they're trying to reach.

When Radio Ghana completed installation of its 250-kW transmitters last year, transmissions to North America were scheduled for 2000-2100 GMT on 9760 kHz, and for 0330-0430 GMT on 6110 kHz. The 2000 GMT broadcast reaches eastern North America at 3 p.m., a time when most people interested in short-wave broadcasts are away from home during the week, and likely to be otherwise occupied on weekend afternoons. The night broadcast is from 10:30 to 11:30 p.m., EST, too late for most East Coast listeners, although suitable for the West Coast.

Another example of poor scheduling is Radio Sweden's morning broadcast at 1400 GMT, or 9 a.m. EST, another time when most listeners are not at home. Radio Sweden advises that a new transmission schedule is being worked out, so it is hoped that this month the broadcasts will be moved to 1230 GMT (7:30 a.m., EST), preferably on 15,195 kHz.

Argentina transmits in English to eastern North America from 0300 to 0400 GMT, to western North America from 0600 to 0700 GMT, and to Great Britain from 2300 to 2400 GMT. These late-hour broadcasts stem from the fact that the station has only one high-power transmitter and broadcasts a solid hour of programming to each area. Why not transmit for 30 minutes to permit scheduling of the broadcasts at more convenient or listenable times?

What's the purpose of beating the ether to death with powerful broadcast signals if chances are that the greatest part of your audience is either in bed or at work? Come on, broadcasters—let's get with it! —ROGER LEGGE

ENGLISH-LANGUAGE BROADCASTS TO NORTH AMERICA

FOR THE MONTH OF OCTOBER

Prepared by ROBERT LEGGE

TO EASTERN AND CENTRAL NORTH AMERICA

COUNTRY	CITY	TIME-EST	TIME-GMT	FREQUENCIES (MHz)
		MORNING BROADCASTS		
AUSTRALIA	Melbourne	7:15-8:15 a.m.	1215-1315	9.58
CANADA	Montreal	7:15-8:15 a.m.	1215-1315	5.97, 15.32
DENMARK	Copenhagen	7:30-8 a.m.	1230-1300	15.165
FINLAND	Helsinki	7:15-7:45 a.m.	1215-1245	15.185 (Tues., Sat.)
GREAT BRITAIN	London	9:30-11:30 a.m.	1430-1630	15.35, 17.81
SWEDEN	Stockholm	9-9:30 a.m.	1400-1430	15.195
		EVENING BROADCASTS		
ALBANIA	Tirana	7-7:30 p.m.	0000-0030	7.265
BULGARIA	Sofia	7-8 p.m.	0000-0100	9.70
CHINA	Peking	8-10 p.m.	0100-0300	11.945, 15.06, 17.68
CUBA	Havana	8-11 p.m.	0100-0400	9.525
CZECHOSLOVAKIA	Prague	8-9 p.m.	0100-0200	5.93, 7.115, 7.345
ECUADOR	Quito (HCJB)	9-11:30 p.m.	0200-0430	9.745, 11.915
EGYPT	Cairo	8:30-10 p.m.	0130-0300	9.585
GERMANY	Berlin	8-9 p.m.	0100-0200	6.16, 9.73
	Cologne	8:30-9:50 p.m.	0130-0250	6.075, 9.64
GREAT BRITAIN	London	4:15-10:30 p.m.	2115-0330	7.13, 9.51, 11.78
HUNGARY	Budapest	8:30-9:30 p.m.	0130-0230	6.235, 9.883
ITALY	Rome	8-8:20 p.m.	0100-0120	5.96, 9.63
JAPAN	Tokyo	6:45-7:45 p.m.	2345-0045	15.135, 17.825
LEBANON	Beirut	9:30-10 p.m.	0230-0300	9.575
NETHERLANDS	Hilversum	8:30-9:30 p.m.	0130-0230	9.59 (Bonaire relay)
PORTUGAL	Lisbon	9-9:45 p.m.	0200-0245	6.025, 6.185
ROMANIA	Bucharest	8:30-9:30 p.m.	0130-0230	6.15, 11.94
SOUTH AFRICA	Johannesburg	7:30-8:30 p.m.	0030-0130	9.525, 11.90
SPAIN	Madrid	8-9:30 p.m.	0100-0230	6.13, 9.76
SWEDEN	Stockholm	8:15-9:45 p.m.	0115-0245	9.705
SWITZERLAND	Berne	8:15-9:15 p.m.	0115-0215	6.12, 9.535
U.S.S.R.	Kiev	7:30-8 p.m. (Mon., Thurs., Fri.)	0030-0100 (Tues., Fri., Sat.)	7.31, 9.665, 9.685
	Moscow	5-5:30 p.m. and hourly to 12-1 a.m.	2200-2230 and hourly to 0500-0600	7.15, 9.665, 9.685
VATICAN	Vatican	7:50-8:10 p.m.	0050-0110	5.985, 7.25, 9.645

TO WESTERN NORTH AMERICA

COUNTRY	CITY	TIME-PST	TIME-GMT	FREQUENCIES (MHz)
ARGENTINA	Buenos Aires	10-11 p.m. (Mon.-Fri.)	0600-0700 (Tues.-Sat.)	9.69
AUSTRALIA	Melbourne	5-7 p.m.	0100-0300	15.22, 17.84
BULGARIA	Sofia	8-8:30 p.m.	0400-0430	9.70
CHINA	Peking	7-9 p.m.	0300-0500	9.457, 11.82, 15.095
	Taipei	6:50-7:50 p.m.	0250-0350	11.86, 15.345
CZECHOSLOVAKIA	Prague	7:30-8:30 p.m.	0330-0430	5.93, 7.115, 7.345
GERMANY	Berlin	7:45-8:15 p.m.	0345-0415	6.16, 9.73
	Cologne	9-9:40 p.m.	0500-0540	6.145, 9.735
HUNGARY	Budapest	7-8 p.m.	0300-0400	6.235, 9.833
JAPAN	Tokyo	6-7 p.m.	0200-0300	15.135, 17.825
KOREA	Seoul	7-7:30 p.m.	0300-0330	15.125
PORTUGAL	Lisbon	8-8:45 p.m.	0400-0445	6.025, 6.185
SOUTH AFRICA	Johannesburg	6:30-7:30 p.m.	0230-0330	9.525, 11.90
SWEDEN	Stockholm	7:15-7:45 p.m.	0315-0345	9.705
SWITZERLAND	Berne	8:15-9:15 p.m.	0415-0515	6.12, 9.535
U.S.S.R.	Moscow	7-10:30 p.m.	0300-0730	9.735, 11.755, 11.85

AN INTERCOM that just sits there doing nothing for 90 percent of the time is like a night watchman on the alert for a burglar or a fire but who fails to notice a water leak in the basement that can cause thousands of dollars' worth of damage. Unlike the watchman, however, an intercom can be modified to sound an alert in the event of almost any type of emergency, and it never sleeps.

Because most modern intercoms, especially the transistor types, draw so little current, they cost practically nothing to operate and can be left on all the time; and, since most of them contain suitable electronic circuits, it is possible and desirable to have them perform other duties. As a matter of fact, some commercially available intercoms come equipped with built-in alarm functions.

Burglar, fire, and moisture alarm functions can be incorporated into most intercoms with very little effort. All you need do is install a capacitor to set up a feedback loop and a phone jack to accommodate a simple alarm-type switch. The switch, when activated, will set up a loud howl in your intercom.

How It Works. Fortunately, in intercoms, as in all good audio amplifiers, great pains are taken to suppress or eliminate all extraneous noises, especially those resulting from feedback. The trick is to obtain a feedback howl in an emergency, yet prevent any undesirable noise while the intercom is functioning as an intercom.

BUILD A HIP SQUAWK BOX

INTERCOM DOUBLES AS A BURGLAR AND FIRE ALARM

By CHARLES VLAMOS AND BYRON G. WELS

As shown in the schematic, which is that of the Heathkit GD-51A transistor intercom, a regenerative feedback loop is set up when a portion of the signal from the collector of transistor *X4* is fed back to the base of transistor *X3* through a closed alarm switch plugged into the jack. When the alarm switch is open, or the plug is not in the jack, the intercom functions in a normal manner.

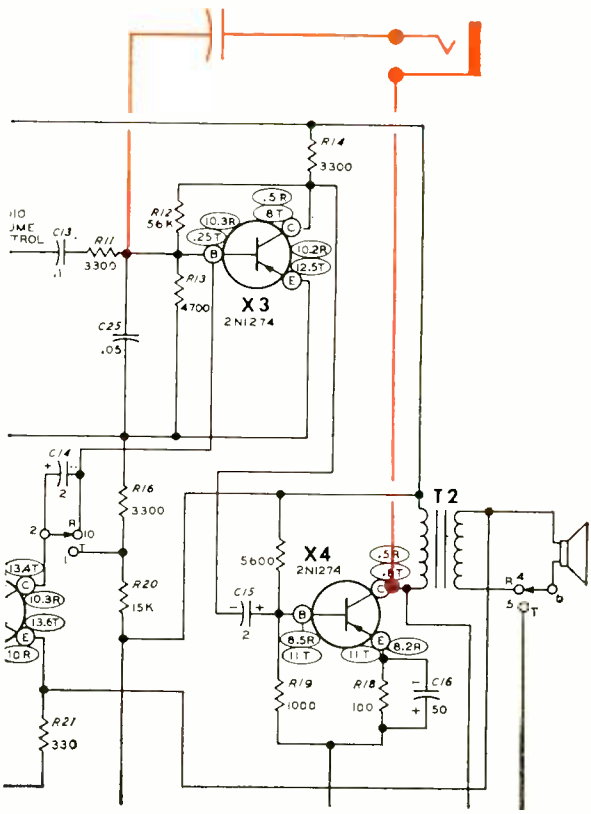
In order for the intercom to function as an alarm, the talk-listen switch must be in the *listen* position. Only the master unit in which the feedback loop is installed will act as the alarm, and nothing else in the intercom system is disturbed.

Almost any intercom can be modified in like manner, including the tube types. Also, you can try various sizes of capacitors to obtain more or less feedback as needed.

The Alarm Switch. Any simple device that will act as a short when it is activated and an open when it is in its passive state will serve as the alarm switch. A microswitch mounted on the sash a few inches above the lower casement of a window makes an effective burglar alarm switch. The window can be lifted to allow ventilation; open it further, and the intercom lets out a loud howl.

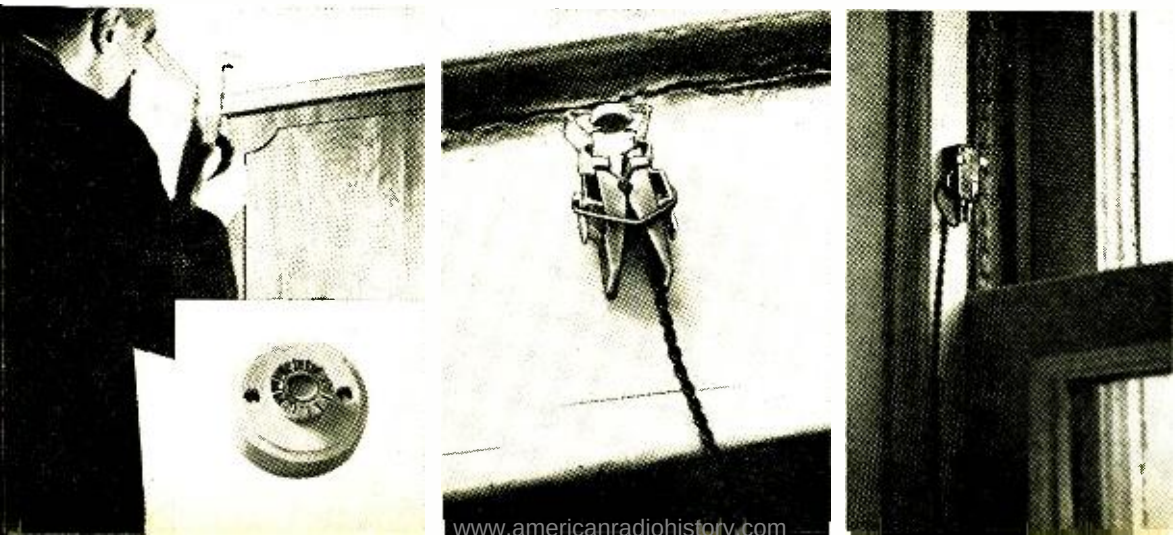
Klixon fire alarm buttons can be placed near stoves, heaters, or any appliance which could cause a fire. A rise in temperature will close the thermostatic switch in the alarm button, and sound an alarm. (Note: There are different types of fire alarm buttons avail-

(*Continued on page* 109)



Lines in color on this partial schematic of the GD-51A Heathkit transistor intercom show simple feedback loop. Capacitance value is not critical. Try 0.01 to 0.1 μF units to obtain maximum howl. Almost any intercom can be modified using this technique.

Several normally-open type fire alarm buttons can be wired in parallel and installed strategically around the house (left, below). Aspirin tablet and antenna clothespin-type connector (center) can be made to serve as moisture detector. A normally-open microswitch mounted on window (right) or door acts to sound an alarm if burglar tries to get in.



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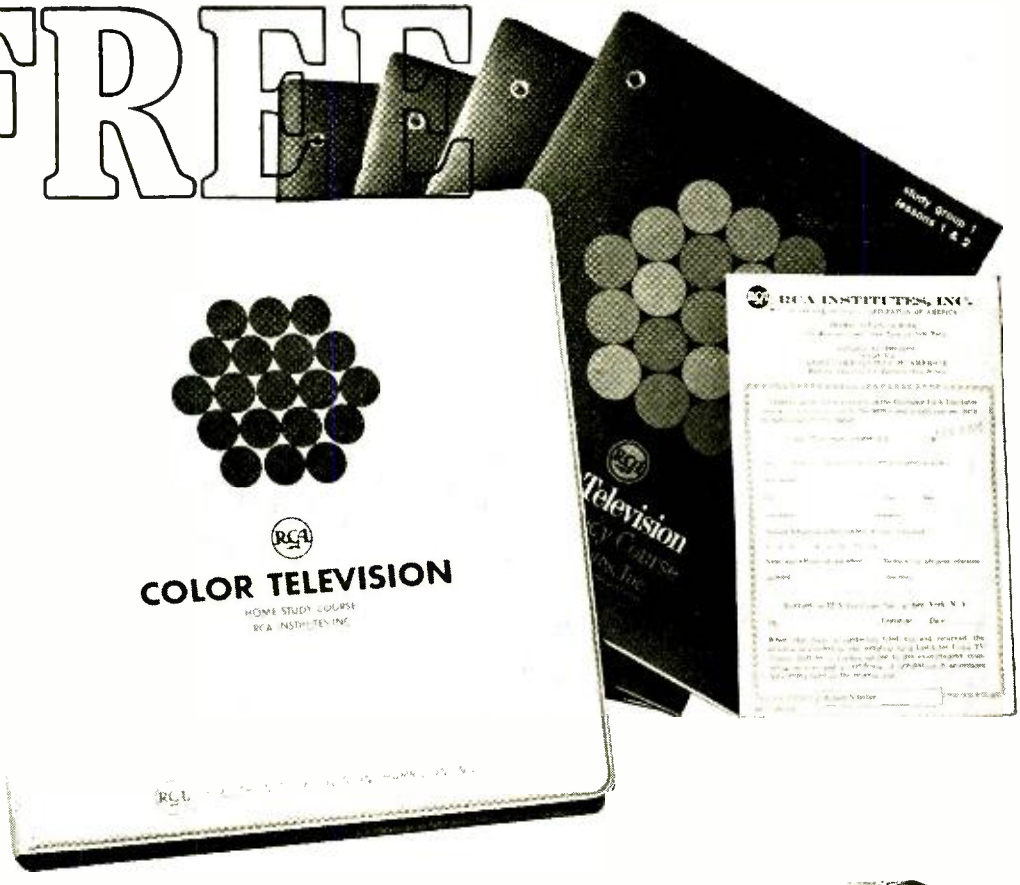

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CIRCLE NO. 39 ON READER SERVICE PAGE

TIPS

(*Continued from page 20*)

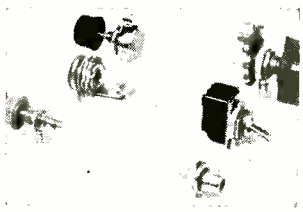
MAGNETIC "FISHING" ROD RETRIEVES SMALL OBJECTS

Screws, washers, nuts, and other small objects that accidentally fall into your wired chassis or along the inner walls of an electronic equipment cabinet can easily be retrieved with a simple "fishing" rod made by gluing a small bar magnet to one end of a steel measuring tape. If the object is nonmagnetizable, wrap a bit of masking tape—sticky side out—around the magnet. The flexibility and slimness of the steel tape enables the magnet to be positioned in extremely close quarters to pick up the fallen object.

—Glen F. Stillwell

EYE SCREWS SUPPORT BREADBOARD COMPONENTS

When breadboarding, use an assortment of ordinary eye screws of the type available in 5 & 10 and hardware stores to mount your potentiometers, switches, phone jacks, binding posts, etc., as shown in the accompanying photo. Determine, by trial, the right size eye screw for the component being mounted. If necessary, open up the screw eye a bit with a pair of pliers. Then, after planning your layout, insert the screw far enough into the breadboard to support the component that is being mounted.



—Art Trauffer

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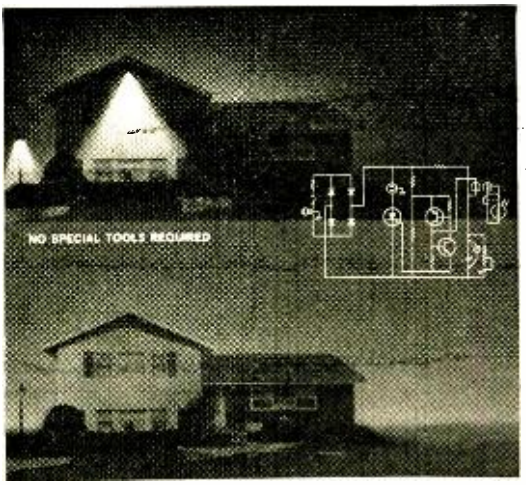

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CIRCLE NO. 59 ON READER SERVICE PAGE

LETTERS (Continued from page 12)

and *Wien bridge* (Wilhelm Wien, German physicist). So why not: *hertz* (Heinrich Rudolph Hertz, German physicist)?

WILLIAM G. O'BARR
South Laguna, Calif.

William, we have been giving some thought to volts and watts and such, too, and we recently made the decision to change our abbreviation style to A for ampere, F for farad, H for henry, V for volt, and W for watt.

"PANIC BUTTON" STILL CREATES PANIC

My friend and I built the "Don't Panic . . . Push the Button" alarm (January, 1966), and on the last day of school we set it down on the floor between two of the tables in the lunchroom and plugged it in. (We also installed a dummy plug as described in one of your reader's letters.) Then, telling the students at the tables not to touch the button, we went to get our food. Sure enough, just as I was putting ketchup on my hamburger, I heard the wail

of the siren rising over the din of the lunchroom. Minutes later, our assistant principal rushed in, and, not knowing what the thing was, carried it out of the lunchroom. Later we found it in the trash can, but unfortunately, in many pieces. All the wires had been torn off the siren module with such devasting vigor that we have been unable to get the thing working again.

DAVE BLOCH
Detroit, Mich.

I built the "Panic Button" and it worked very well on most people, but a few turned over the box and discovered the hidden switch. I believe I have solved that problem. I just installed the parts from the "Tickle Stick" (February, 1966). I did it by covering a wooden box with thin metal, leaving a thin uncovered strip down the middle. Then I hooked up the works to the 60-second delay switch and watched the fun.

DAVE CLARK
Livingston, N.J.

CONNUBIAL COMPUTER

I have been a subscriber to POPULAR ELECTRONICS almost from the beginning of publication, and I do not remember seeing in the magazine any article of lower quality than "The Connubially-Oriented Computer" (July, 1966). The editorial staff must be completely bankrupt! I hope its inclusion was a

LETTERS (*Continued from page* 103)

case of careless judgment, rather than an indication of degenerating taste on the part of the editors. If the latter proves true, I will probably cancel my subscription.

RICHARD W. PRICE
Barker, N.Y.

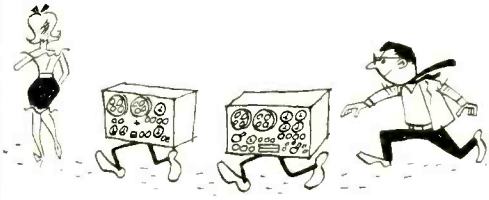
Can you please explain to me how the "luscious and outrageously constructed Redhead" on page 54 turned into a "Brunette Doll" on page 97? Inconsistencies like this can ruin a romance. I know!

ARNOLD GERSHON
New York, N.Y.

I just read the story of Otto Tronix, and I think it was very cleverly done, using electronics as the backbone. I found it extremely entertaining, especially the well-twisted ending. Let's have more of these stories.

BRIAN LO
Vancouver 16, B.C.
Canada

Richard, the last we heard, the two computers were chasing after the Redhead, and we aren't likely to see them again, so don't



cancel your subscription. Arnold, your letter sounds as if you had a bad experience; well, that's what happens when you can't get the story straight—there are TWO "dolls" in this article. Brian, maybe you can catch up with the computers.

NIGHTTIME TV MYSTERY

Soon after my television set is turned on at night, some form of interference completely blanks out both picture and sound. It cannot be the TV set as I have had the same problem with as many as four other sets. Neither is it the antenna, as I have tried a variety of antennas. It is quite maddening to watch U.N.C.L.E. Headquarters under siege and then come under siege myself just at the most interesting part of the story. Is there anything that could possibly be done about this? Do you have a filter that could be attached to eliminate this unwelcome T.H.R.U.S.H. agent?

KEVIN FITZGERALD
Dorchester, Mass.

Sorry, we don't have any T.H.R.U.S.H. filters, Kevin, but you can try a line-voltage regulator. Trouble at night, and not in the daytime, is usually an indication of low-line voltage. —30—

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INTEGRATED CIRCUITS

(*Continued from page* 56)

Some are experimenter units that are priced at less than a dollar each when purchased in large quantities. Others are of the expensive variety, limited to a few critical applications.

The table on page 56 lists some of the lower-priced integrated circuits that can be purchased from distributors as off-the shelf items; data sheets are available from the manufacturers represented. Digital IC's are of the flip-flop switching variety used in computer or counting circuits, while linear IC's are used as r.f. and a.f. amplifiers.

None of the IC's listed is as expensive as the corresponding parts would be if purchased separately, not counting the extra assembly time and reduced reliability that discrete parts provide. Furthermore, with discrete parts it is impossible to obtain the temperature tracking inherent in integrated circuits.

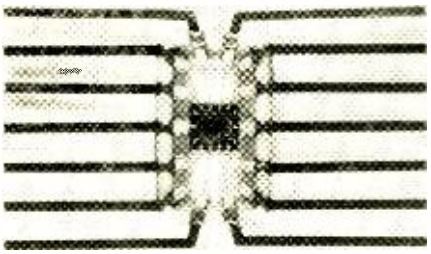
In The Cards For Tomorrow. The trend is plain to see—more, smaller, and better integrated circuits at lower costs. The experts call for a 10:1 price cut in IC's in the next fifteen years. So the time to obtain a working familiarity with these circuits is—now!

Even more exciting is today's development of IC's using some astounding new electronic techniques that will become important factors in the manufacture of tomorrow's distributor components. The MOS-type transistors have essentially infinite input impedance and zero switching time, but are built with half the steps necessary for a conventional transistor and in a tiny fraction of its size.

The *Gunn* effect and the *Read* effect are new techniques through which the avalanching semiconductors directly generate substantial microwave power. Microwave IC's are already in the works, as are switching mode amplifiers—produced through the use of a "why didn't they think of it before?" technique by which a 40-watt amplifier is put in a TO5 case with no heat sink required, and no heat problems either.

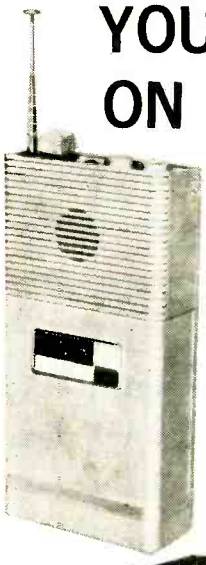
There is also a totally molecular approach by which entire functional blocks are built up on a molecular scale. Then there's a resonant gate transistor—a spanking-new device with a built-in tuning fork that gives you high-Q, stable resonant circuits—from audio to microwave—in extremely cramped quarters. And the list goes on.

Today's laboratories are turning out tomorrow's IC's. Will you be ready for them when they arrive? —30—



Ceramic flat pack is used when maximum miniaturization is required. It occupies less than half the space of a TO-5 transistor package. This configuration sometimes replaces as many as 50 components.

YOU CAN STAKE YOUR LIFE ON POLYTRONICS PERFORMANCE



DUO-COMM 120—Citizens Band
(120B—AM Business Band)
FG-125—Govt./Military
All Solid State Walkie-Talkies

The New POLY-PUP
Smallest 7 channel CB
Transceiver available —
all transistor.

POLY-COMM "B" & "H"
FM Business Band

THE ONLY 2-WAY RADIO TO CLIMB MOUNT EVEREST AND SURVIVE

And you can find a Polytronics engineered transceiver to fit **your** needs and budget . . . equipment you can stake your life on as Willie Unsoeld did when he scaled the peak of Mt. Everest on May 22, 1963.

In addition to the sets pictured, there is the POLY-COMPACT, the world's smallest **eleven**-channel all solid state CB Transceiver; the POLY-COMM 23 offering 23-channel "Spectramatic tuning" for instant operation on any citizens band channel; the amazing POLY-COMM 30 with 23 CB channels and 7 extra "in between" part 15 channels (100mw).

Before you buy, make sure that you have seen the best . . . send in the coupon below for descriptive literature and dealer information.

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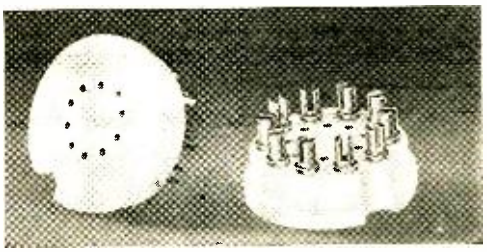
CIRCLE NO. 60 ON READER SERVICE PAGE

INTEGRATED CIRCUIT AMPLIFIER

(*Continued from page 59*)



This type of press-fit socket, put out by Sealectro, can be used to simplify your project. With it you simply plug in your IC as you would a transistor.

solder the leads to the IC socket until the case is in place. When wiring this unit in the circuit, observe that the locating tab on the IC is directly over pin 1. Viewed from the top of the case, the pins are numbered counterclockwise. Also, observe that pins 2, 7, and 10 are tied together and returned to a terminal on *S1*.

Operating Hints. Distortion will result if too large a signal is applied to the amplifier input. For applications not requiring a wide bandpass, a step-up transformer can be used to couple the output of the first differential amplifier to the input of the second amplifier, replacing capacitor *C2*. However, some amount of experimentation is required to select the right transformer, since poor matching of the stages can transform your amplifier into a blocking oscillator due to the sensitivity of emitter folowers to inductive loads.

For additional gain, two or more IC packages can be cascaded together. But care must be taken to keep the signal at a level low enough so that clipping will not take place.

The values of *R1* and *R2* have been chosen for best overall performance and circuit stability. But where it is desirable to change the amplifier input and output impedances, the value of these resistors can be raised to as high as 22,000 ohms with only a slight loss in gain and stability. One advantage of this change is that smaller values are required for *C1* through *C3* for any given frequency response. —30—

HIP SQUAWK BOX

(*Continued from page 98*)

able; those that are open when they are cold, and those that are open when they are hot. Some have different temperature ratings.)

One way to eliminate a wet headache is to place an aspirin tablet between a couple of thumb tacks mounted on a spring-action clothespin, and hang the contraption outside your window. In case of rain, the aspirin tablet will dissolve, the clothespin will close, and the alarm will sound. One tack is fastened to each jaw of the clothespin, and a length of wire is attached to each tack. A clothespin-type antenna connector is ideal for this purpose, but you will have to bend the metal ends towards the center until they touch each other when the pin is closed.

Greater area coverage can be obtained by connecting several alarm switches in parallel. Also, it is possible to create a more sophisticated alarm system by having several alarm stations, each switching in different values of capacitance to obtain a unique sound for a specific location or type of emergency. But you would have to have a good musical ear to identify the different sounds. —30—

CAREERS IN ELECTRONICS

(*Continued from page 51*)

with what goes on in a computer, have a speaking acquaintance with PPM, micro-electronics, radar pulse and Doppler techniques, SSB, etc.

The man who takes a 250-hour course at home may have had excellent training—as far as it goes. But it simply can't cover the same ground as a resident course that takes ten times as much time and effort. And the fellow who thinks he can spend a few spare-time hours for a year or so and come out as a high-level technician is due for an unhappy awakening.

The home-study schools aren't trying to fool any one. Look over the catalogs and you can tell quickly which courses

they've designed to train men to be industrial technicians. The home-study schools offer high-powered courses that will prepare a man to work as a test or calibration technician, or as a junior technician who can look forward to a bright future and to continuing advancement as he becomes ever more expert. (Incidentally, he's likely to find the home-study schools the best place to constantly upgrade his training, once he's on the job.)

One of the easiest ways to pick the courses that will be most valuable is simply to see how long the school estimates it will take you to complete the course. Capitol Radio Engineering Institute's programs in Electronic Engineering Technology, for example, are certainly among the most advanced offered through the mails. These courses will take the average student studying some three hours a day about three years to complete. That means he'll spend upwards of 2000 hours on the course. *And CREI's courses aren't meant for rank beginners.* The school requires that students must already be working in electronics, with some basic knowledge in the field and the opportunity to apply their new knowledge working on actual equipment as they advance. In other words, the amount of time a student spends on such a course begins to approach the amount of time he'd put in if he attended one of the regular engineering technology institutes. Obviously, when a man finishes such a course, he'll have something valuable to offer an employer.

How Much Education Do You Want?

If you want to be an industrial electronics technician and plan to get your training at home, here are a few hints: Compare the school catalogs—not for fancy presentation, but for hard facts about subject matter and course objectives—a communications technician is not an industrial technician. See how long the course lasts—how many hours you'll be putting in. Be realistic and don't expect things of a study course that it was never designed to produce. A good course in basic electronics or radio/TV repair may be worth every cent it costs and more, but it is not in-

tended to train engineering technicians.

To put it another way, if you want to work in industry, think in terms of how *much* education you're going to get—whether you hope to get it at home or in a residence school. Then, with a sound education, no matter where you get it, you'll qualify when you apply for a job with a firm that has up-to-date attitudes.

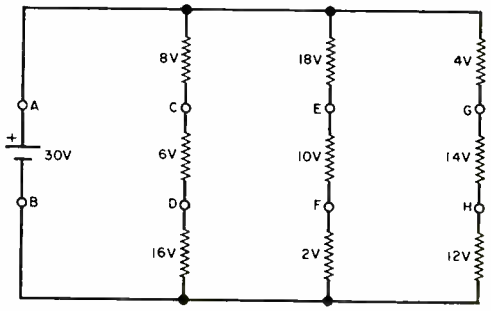
As one employment manager for a computer firm put it, "We don't expect a student to learn everything he'll need at school. But we do look for students who have a sound background, and who have growth potential far beyond their present capabilities. When we find a man like that, we hire him. And we don't care where he went to school." —30—

QUIZ ANSWERS

(*Quiz appears on page* 64)

Since the total circuit resistance is 5 ohms, by Ohm's law the total current is 6 amperes (I = E/I = 30/5 = 6). Thus, the current through each branch is 2 ohms, and the drop across each resistor is as shown in the schematic diagram. The voltage readings, and the test points across which they are taken are listed below.

VOLTS	TERMINALS
0	EH
2	FB
4	AG, DE, HD, GC
6	CD
8	AC
10	CE, CH, EF, GD, HF
12	EB, HB
14	AD, DF, GE, GH
16	DB
18	AE, AH
20	CF
22	CB
24	GF
26	GB
28	AF
30	AB



What's New With Heath These Days?

Harmony-by-Heathkit Electric Guitars & Heathkit Guitar Amplifier

Kit TA-16
$129.95

Available Early November

[B] Kit TG-46
$219.95
(save $109.55)

[C] Kit TG-26
$99.95
(save $45)

[D] Kit TG-36
$119.95
(save $38.55)

[A] NEW Heathkit Transistor Guitar Amplifier
60 watts peak power; two channels — one for accompaniment, accordian, organ, or mike, — the other for special effects . . . with both variable reverb and tremolo; 2 inputs each channel; two foot switches for reverb & tremolo; two 12″ heavy-duty speakers; line bypass reversing switch for hum reduction; one easy-to-build circuit board with 13 transistors, 6 diodes; 28″ W. x 9″ D. x 19″ H. leather-textured black vinyl cabinet of ¾″ stock; 120 v. or 240 v. AC operation; extruded aluminum front panel. 44 lbs.

American Made Harmony-By-Heathkit Guitars
All guitars include instruction book, tuning record, pick, connecting cord, deluxe red leather cushioned neck strap and chipboard carrying case. All wood parts assembled and factory finished — you just mount metal parts, pickups & controls in pre-drilled holes and install strings.

[B] Deluxe Guitar . . . 3 Pickups . . . Hollow Body
Double-cutaway for easy fingering of 16 frets; ultra-slim fingerboard — 24½″ scale; ultra-slim "uniform feel" neck with adjustable Torque-Lok reinforcing rod; 3 pickups with individually adjustable pole-pieces under each string for emphasis and balance; 3 silent switches select 7 pickup combinations; 6 controls for pickup tone and volume; professional Bigsby vibrato tail-piece; curly maple arched body — 2″ rim — shaded cherry red. 17 lbs.

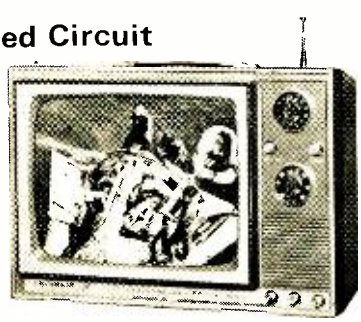
[C] Silhouette Solid-Body Guitar . . . 2 Pickups
Modified double cutaway leaves 15 frets clear of body; ultra-slim fingerboard — 24½″ scale; ultra-slim neck for "uniform feel"; Torque-Lok adjustable reinforcing rod; 2 pickups with individually adjustable pole-pieces under each string; 4 controls for tone and volume; Harmony type 'W' vibrato tail-piece; hardwood solid body, 1½″ rim, shaded cherry red. 13 lbs.

[D] "Rocket" Guitar . . . 2 Pickups . . . Hollow Body
Single cutaway style; ultra-slim fingerboard; ultra-slim neck, steel rod reinforced; 2 pickups with individually adjustable pole-pieces for each string; silent switch selects 3 combinations of pickups; 4 controls for tone and volume; Harmony type 'W' vibrato tailpiece; laminated maple arched body, 2″ rim; shaded cherry red. 17 lbs.

NEW 12″ Transistor Portable TV — First Kit With Integrated Circuit

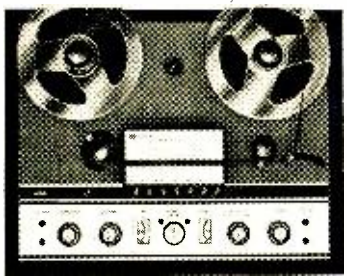
Unusually sensitive performance. Plays anywhere . . . runs on household 117 v. AC, any 12 v. battery, or optional rechargeable battery pack ($39.95); receives all channels; new integrated sound circuit replaces 39 components; preassembled, prealigned tuners; high gain IF strip; Gated AGC for steady, jitter-free pictures; front-panel mounted speaker; assembles in only 10 hours. Rugged high impact plastic cabinet measures a compact 11½″ H x 15¾″ W x 9⅜″ D. 23 lbs.

Kit GR-104
$119.95
AVAILABLE LATE OCTOBER



9 New Kits You Can Build

NEW Heathkit® /Magnecord® 1020 4-Track Stereo Recorder Kit



Kit AD-16
$399.50
(less cabinet)

Save $170 by doing the easy assembly yourself. Features solid-state circuitry; 4-track stereo or mono playback and record at 7½ & 3¾ ips; sound-on-sound, sound-with-sound and echo capabilities; 3 separate motors; solenoid operation; die-cast top-plate, flywheel and capstan shaft housing; all push-button controls; automatic shut-off; plus a host of other professional features. 45 lbs. Optional walnut base $19.95, adapter ring $4.75

NEW Deluxe SB-301 Amateur Band Receiver Kit

Kit SB-301
$260.00
(less speaker)

Complete coverage of 80 thru 10 meters with all crystals furnished, plus 15 to 15.5 MHz coverage for WWV; full RTTY reception capability; built-in switch-selected ANL; front-panel switching for control of 6 and 2 meter plug-in converters; crystal-controlled front-end for same rate tuning on all bands; 1 kHz dial calibrations — 100 kHz per dial revolution; plus the same styling and features of the famous Heathkit SB-300 Receiver. 23 lbs.

2-Watt Walkie-Talkie

Assembled
GRS-65A
$99.95

New . . . Factory Assembled. Up to 6 mile range; rechargeable battery; 9 silicon transistors, 2 diodes; superhet receiver; squelch; ANL; aluminum case. 3 lbs. 117 v. AC battery charger & cigarette lighter charging cord $9.95. Crystals $1.99 ea.

NEW Portable Phonograph Kit

Kit GD-16
$39.95

All Transistor. Assembles in 1 to 2 hours. Preassembled 4-speed automatic mono changer; 4" x 6" speaker; dual Sapphire styli; 45 rpm adaptor; olive & beige preassembled cabinet; 117 v. AC. 23 lbs.

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CIRCLE NO. 22 ON READER SERVICE PAGE

TIME-SIGNAL RECEIVER

(*Continued from page* 46)

author found that indoor reception could be improved by placing the receiver's antenna close to a telephone or an electrical fixture.

If you find it hard to decide which "band" of frequencies is best suited to your location, you can monitor each frequency for a period of time with a communications receiver. The optimum frequencies and listening time can be determined quickly in this manner.

To change frequencies in the receiver, simply plug in the appropriate crystal, and tune *C2* and *C6*. Remember, you can cover *two* time-signal stations with the 10-μH coils, and *three* stations with the 5.6-μH coils. —30—

TIME SIGNAL BROADCASTS

CHU Reception of CHU on 7.335 MHz is possible along most of the eastern seaboard (north of South Carolina) at any time between 0400-1100 and 1400-0100 EST. On the frequency of 14.670 MHz, CHU is heard throughout the remainder of the eastern seaboard and as far west as Denver, Colo., from 0800 to 2100 CST. CHU on 14.670 MHz is also audible along the West Coast in the early evenings.

WWV Pending the move of WWV from Maryland to Colorado, it is difficult to accurately predict reception on either 10.0 or 15.0 MHz. However, it is believed that the 10.0-MHz broadcast will be audible with good signal strength throughout most of North America from 0800 to 2200 EST. At the present time, West Coast users should tune to 10.0 MHz or 15.0 MHz for the transmission of WWVH, Maui, Hawaii.

It will be necessary to choose the "listening" frequency best suited to your needs and to your geographical location. Reception 100% of the time, day and night, is not possible on one frequency only (unless, of course, you live close to the transmitters). Some frequencies are better at night, others during the day.

Complete information on the technical services provided by the NBS standard time stations can be found in "Standard Frequency and Time Services of the National Bureau of Standards, Miscellaneous Publication 236," which is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 15 cents. Complete technical information on CHU is contained in a leaflet entitled "Time Service Bulletin B-16," available from the Department of Mines and Technical Surveys, Dominion Observatory, Ottawa, Canada, at no charge.

DECIBELS

(*Continued from page 78*)

scale is opposite 1.732 volts on the a.c. scale, then the meter is calibrated using 6 mW in 500 ohms as the reference level.

Just as different a.c. voltmeter ranges require different scale markings or multipliers, so do the different ranges affect the dB readings. However, for dB readings you simply add a fixed number of dB to the direct readings, depending upon which range you are using. For example, if the signal is strong enough to throw the meter off scale, you should switch to a higher a.c.-volts range, and add the number of dB to the dB scale reading as shown in Table 1, which appears on page 78.

Suppose your meter reads +4.5 dB and the range switch is set to the 150-volt range (where 0 dB = 1 mW in 600 ohms). The true dB reading would be +4.5 plus 40, or +44.5 dB, if measured across a 600-ohm impedance.

If the indicated reading is below 0 dB, remember that this is a negative quantity and must be added *algebraically* to get the true reading. For example: if the indicated reading is −3.5 dB, and the function switch is set to the 500-volt range, the true reading is −3.5 + 50 or +46.5 dB.

Making dB Measurements. Even if your VOM does not have a dB scale, you still can obtain dB measurements. Just make a.c. voltage measurements across a 600-ohm impedance, or 500-ohm impedance, depending upon which reference you want to use, and use the "Volts to Decibels" graph to find the dB value.

But, what if you can't measure across a 600-ohm or 500-ohm impedance in the circuit you want to measure? For instance, can you measure dB across an 8-ohm load, such as a speaker? Yes, you can. First measure the a.c. voltage across the impedance you are dealing with, and apply it to the same graph to obtain an "unadjusted" dB value. If your meter has a dB scale, you can read the meter instead of the chart to obtain this unadjusted dB value.

To save you the fuss of using a for-

mula to find the correction factor to adjust your reading, just add the number of dB as shown in Table 2. If, for example, you measure the signal across an 8-ohm speaker voice coil, you must add 18.8 dB to the "unadjusted" dB reading (if your meter is calibrated to 0 dB = 1 mW in 600 ohms) to obtain a true reading.

When making dB measurements, be sure you are measuring the signal only —don't allow your meter to be influenced by other voltages, such as bias and B+ voltage. Most VOM's with dB scales have a separate test-lead jack or function-switch position which puts a capacitor in series with one of the test leads to block d.c. voltage. If your meter doesn't have a capacitor connected in this manner, you should insert one between one test lead and the measuring point. A 0.1-μF tubular, 600-WVDC capacitor is ample for most conditions.

When measuring low-level high impedance circuits, such as the input grid of a tube, even a high-resistance VOM can impose enough of a load on the circuit to produce "false" readings. In such cases, a VTVM should be used. Its high-input resistance is not likely to appreciably load most circuits.

Many VTVM's have a dB scale which is used in the same way as the dB scale on a VOM. If your VTVM does not have a dB scale, use the a.c. volt scale, refer to the graphs, and forget about the formulas. –30–

IMPEDANCE CORRECTION FACTORS

0 dB = 1 mW in 600 ohms		0 dB = 6 mW in 500 ohms	
Impedance (ohms)	Correction (dB)	Impedance (ohms)	Correction (dB)
600	0	600	−0.8
500	+0.8	500	0
300	+3.0	300	+2
250	+3.8	250	+3
150	+6.0	150	+4.8
50	+10.8	50	+10
8	+18.8	8	+18
3.2	+22.7	3.2	+21.9

Table 2. If for some reason you cannot make dB measurements across a reference impedance, you can still use your meter. Simply add the appropriate correction factor. You can drop the fractional part of a dB and work to the nearest whole number.

SOLID STATE

(Continued from page 85)

The Triac comes in a TO-5 case, and the other components are small enough to fit on a 1″ x 2″ circuit board which can then be placed in a standard electrical box beneath the outlet. With care, the complete circuit could be assembled in a lamp base or even in a lamp socket.

New Developments. Several new items can be reported this month:

● Industry's first plastic-encapsulated power transistor for audio applications has been announced by Texas Instruments, Inc. (Dallas, Tex.). Designated as Type TIP24, the new transistor is an epitaxial planar silicon device designed for Class B operation with up to 20 watts r.m.s. power. The TIP24's collector is in electrical contact with a special mounting tab, as shown in Fig. 3. This permits the unit to be mounted on a heat sink or chassis by means of a single hole, and with one sheet-metal screw.

● Motorola Semiconductor Products (Phoenix, Ariz.) has introduced a line of four digital-type integrated circuits as part of its expanding HEP line. To guide experimenters in the use of these new devices, Motorola has also published an interesting 100-page "Integrated Circuit Projects" manual. Selling for one dollar, the book describes a number of IC projects, including a binary computer, square-wave generator, and an electronic organ.

● Meanwhile, back at the research labs, IBM has discovered a negative-resistance effect in metal-oxide-semiconductor (MOS) junctions which may lead to a simple, in-

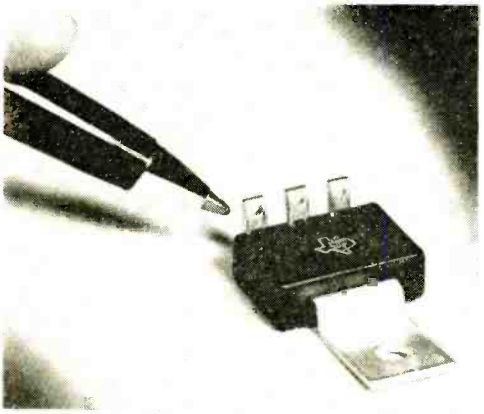

Fig. 3. Produced by Texas Instruments, Inc., this plastic encapsulated power transistor can handle up to 20 watts r.m.s. of audio frequency power.

expensive process for manufacturing tunnel diodes. In another area, IBM has developed a device which might be used for tuning monolithic integrated circuits . . . a sort of "tuning fork" consisting of a cantilevered silicon chip that vibrates at its given resonant frequency.

Transitips. In the last paragraph of his letter containing this month's featured circuit, reader Scott Marovich asked for tips on determining the amount of feedback needed by an oscillator circuit. Here are a few:

Theoretically, the feedback needed in a given circuit can be determined mathematically by taking into account the *Q* of the tuned circuits used, transistor gain, estimated circuit losses, coupling coefficients (if inductive feedback is used), and similar factors. In general, the feedback needed approximates the transistor's output signal level divided by stage gain.

In practice, however, the actual technique used by most engineers is a combination of intuition, measurement, calculations, testing, and empirical values. In other words, it is an "educated guess" followed by experiments and readjustments.

The feedback signal level is important if optimum circuit operation is to be achieved. If too little feedback is used, the circuit will not oscillate at all. If a critical amount is employed, the circuit may be unstable, either shifting frequency or dropping in and out of oscillation. If too much feedback is used, the circuit may again be unstable or may deliver a distorted output signal containing unwanted harmonics. Finally, if the feedback is excessively high, the oscillator may "block" at a rate determined by the circuit's *RC* time constant. With optimum feedback. the oscillator will be fairly stable, and deliver a clean, harmonic-free signal.

Three standard oscillator circuit configurations are illustrated in Fig. 4. They are (A) tickler feedback, (B) Hartley, and (C) Colpitts, using *pnp* transistors in common-emitter configurations. Tuning capacitors have been omitted to simplify the explanations, except where they are essential to circuit operation. However, *npn* transistors can be used in any of the circuits if battery polarities are reversed. Also, modified forms of the circuits can be used in common-base and emitter-follower configurations if desired. With suitable component values, all three circuits can be used at frequencies ranging from audio through UHF, and at input power levels in the microwatt or multi-watt range.

Looking at the tickler feedback circuit in Fig 4(A), coil *L1* serves as *Q1*'s collector load. In practice. this coil is generally

tuned by a shunt capacitor. Coil *L2*, inductively coupled to *L1*, provides an in-phase feedback signal to *Q1*'s base through capacitor *C1*. Base bias is furnished through *R1*.

The level of the feedback signal is determined primarily by the turns ratio of *L1* and *L2*, as well as by the degree of coupling. In practice, the turns ratio used is proportional to *Q1*'s gain, its base input impedance vs. collector output impedance, and circuit losses. The *L1-L2* turns ratio used with average transistors varies from 10:1 to 20:1. In heavily loaded power oscillator circuits, or in circuits where low-gain transistors are used, the turns ratio can be as low as 2:1. In high-gain, low-loss, lightly loaded circuits, on the other hand, ratios as high as 50:1 or 100:1 can be employed.

The Hartley oscillator in Fig. 4(B) is generally similar to the tickler feedback circuit, except that feedback is provided by an autotransformer or tapped coil (*L1*) rather than by a two-winding transformer. As before, the feedback signal is coupled to *Q1*'s base through capacitor *C1*, while base bias is supplied through *R1*. Here, the point at which the ground (or emitter) tap is made is based on the same factors which determined the *L1-L2* ratio in the previous circuit. In typical oscillators of this type, the tap can be from 5% to 10% of the total number of turns, counting from the base end of the coil. In special cases, the tap can range from 50% of the turns to 1%.

In contrast to the Hartley circuit, which features a tapped inductor, the Colpitts os-

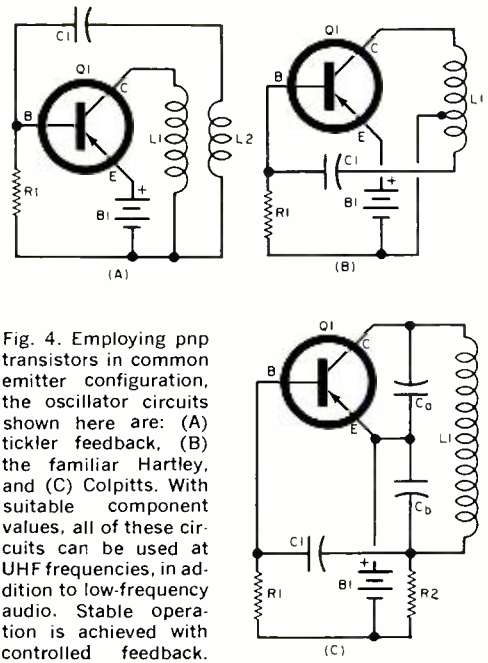

Fig. 4. Employing pnp transistors in common emitter configuration, the oscillator circuits shown here are: (A) tickler feedback, (B) the familiar Hartley, and (C) Colpitts. With suitable component values, all of these circuits can be used at UHF frequencies, in addition to low-frequency audio. Stable operation is achieved with controlled feedback.

cillator uses a tapped capacitor to furnish feedback. In Fig. 4(C), feedback is provided by series capacitors C_a to C_b, with $L1$'s tuning determined by their combined value (always *less* than the smallest capacitor in the series circuit). The actual ratios used for C_a and C_b range from 1:10 to 1:20 in practical circuits, but may drop to as low as 1:1 or go as high as 1:100 in critical designs. In a typical circuit, for example, C_a may have a value of 500 pF and C_b about 10,000 pF (or 0.01 μF).

As a general rule, tickler feedback and Hartley-type oscillators are preferred where the circuit must cover a band of frequencies, as in receivers and signal generators, while the Colpitts circuit is used in fixed tuned applications, as in code practice oscillators, transmitters and signal calibrators.

That concludes our *Solid State* story for this month, fellows . . . until next month, may your transistors all have high *beta*'s and low leakage!

—*Lou*

AMATEUR RADIO

(*Continued from page 92*)

(TI); Cuba (CM, CO); Dominican Republic (HI); Ecuador (HC); El Salvador (YS); Greenland (stations whose call letters begin with XP); Haiti (HH); Honduras (HR); Israel (4X); Liberia (EL); Mexico (XE); Nicaragua (YN); Panama (HP); Paraguay (ZP); Peru (OA); Venezuela (YV); and all U.S. territories—without restriction.

Running patches or handling messages with countries *not* on this list is no way to score points for our side, but doing so with countries *on* the list is excellent public relations work.

NEWS AND VIEWS

Frederico "Fred" Po, DU1FP, 77 Mayon St., Quezon City, Philippines, built the "High Performance Transmitter" described in our January, 1962, column with the hope that he could work locals with it. The "locals" turned out to be all over the Philippines, Australia, India, Japan, Korea, Malaysia, Okinawa, and the 5th, 6th, and 7th U.S. call areas—not too bad for a 6L6 running 20 watts feeding a 40-meter dipole on 40 meters! Fred works into the United States best between 0800 and 1400 GMT . . . **Ron Azark, WN9RHU,** 8453 S. Hermitage St., Chicago, Ill., works the three low-frequency Novice bands with a Knight-Kit T-60 transmitter and two receivers. One receiver is a Lafayette HE-40, and the other is a "home-brew" unit which covers 10 through 160 meters. When not hamming, Ron is usually SWL'ing; he thinks that Generals are missing a good bet by not using 160 meters more for local contacts. If all goes according to plan, Ron will be a General when you read this and may be practicing what he preaches . . . **Patrick Devlin, WA5BPS,** president of the Tulsa

Repeater Organization, reports that they operate an "open" 2-meter repeater station on top of a 30-story building in the center of Tulsa. Talk-in frequency is 146.94 MHz; talk-out frequency is 146.34 MHz. The primary receiver is located on a water tower eight miles from the transmitter, and secondary receivers are being installed 20 and 35 miles away. Transmitter power is 330 watts, and all functions of the repeater are controlled via leased telephone lines and a 448-MHz radio link. Reputed to be the most sophisticated amateur repeater station in the United States, WA5LVT covers northeastern Oklahoma, southeastern Kansas, and adjacent parts of Arkansas and Missouri. It has also been heard with a "full-quieting signal" in Baltimore.

Ever since he earned his General Class license at the age of 12 back in 1961, **John Yurek, K3PGP,** Trafford Harrison City Rd., R.D. #6, Irwin, Pa., has been setting higher goals in amateur radio for himself—and reaching them. His latest achievement was to win first place in a Pennsylvania Junior Academy contest for an oral presentation of his success in bouncing his 432-MHz signals off the moon and back to the earth. John's next goal is to span the half-million mile round-trip journey to the moon on 2300 MHz. On the lower frequencies, K3PGP's Heathkit DX-100 transmitter and SB-10 SSB adapter, and Hallicrafters SX-100 receiver, have worked all states and many countries in all continents. An RCC certificate indicates that John likes to rag-chew, too—probably about his coin collection . . . **Brad Good, WB6LUC,** 4420 Charlemagne, Long Beach, Calif., installed the "Camper's Special" transmitter described in the August, 1965, issue on his bicycle and worked several stations, including a W7, on 3718 kHz CW. Then, Brad connected a carbon microphone in series with the battery lead to the output transistor and almost got himself killed. He was talking to W6KCX when he had an accident which demolished the bicycle and his receiver and left him bleeding from a deep gash in the chin and with a broken finger. Although he could not hear replies, Brad sent out a call for help, to which W6KCX and WB6OFD responded. After this experience, Brad feels that that "bicycle mobile" is entirely too dangerous to be recommended . . . **Dave T. Motooka, WH6GBC,** 3812 Paki Ave., Honolulu, Hawaii, runs 70 watts to a home-brew transmitter feeding a Hy-Gain 14-AVQ vertical antenna on 40 meters; he receives on a venerable Hammarlund HQ-129A. Dave has worked Japan and American Somoa and has cards from 12 of the 13 states he has worked. With 2000 miles to go to the nearest one, Dave feels he may have a slight handicap in working all states, but he already has managed to work Georgia, North Carolina, and other states east of the Mississippi River.

Gary Thomas, WN1FJJ, 1973 East St., Pittsfield, Mass., keeps his home-built 25-watt transmitter and converted ARC-5 war-surplus receiver on 80 meters (the only amateur band the latter will tune, incidentally). He has QSL cards from nine of the 13 states he has worked, but he didn't mention whether any of the Canadians he has worked have come through with cards . . . **Phil Flick WA9NVY,** 1851 Church St., Wauwatosa, Wis., works AM and CW on all bands between 80 and 10 meters, and AM on two meters. A Johnson "Ranger" transmitter handles the lower bands and a Gonset G-63 does the receiving. A Heathkit "Twoer" and a converter ahead of the G-63 take care of 2 meters. Phil likes to collect certificates and just rag-chew—preferably on CW . . . **Terry "Ty" Conboy, WN7DOX,** 1670 Tualatin St., St. Helens, Oregon, has managed to get an 80-meter inverted-V antenna, a 15-meter "long wire," and a 15-meter vertical on a 100' x 65' lot. Supplementing the antennas with an EICO 723 transmitter and a Hammarlund HQ-170A receiver, Ty had Japan and 40 states worked when he passed his General examination. Ty will sked you—preferably on

Sunday—if you need Oregon or a Rag Chewer's Club certificate.

Let's see *your* "News and Views" in next month's column. Pictures and club bulletins are welcome. Send them to: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P.O. Box 678, Gary, Ind. 46401.

73, *Herb, W9EGQ*

ON THE CITIZENS BAND

(*Continued from page* 93)

authorities to help when and where needed with communications, first aid, and other types of assistance. There's an even better chance that they would do a story involving an emergency where CB radio lent a helping hand, regardless of whether the assist involved a lone CB'er in his car, or an entire network involving the city, county, or state.

Follow these guidelines the next time your group has an item you feel would be of interest to area and national readers and viewers:

(1) Carefully, with necessary detail, type the story on one side of as many pages as needed, double-spaced. Be factual, but not wordy. Be sure to identify the source of the material, the writer, and where he may be contacted for further information. (If the story originates from a club that publishes its own newspaper, the same printing process can be used for the story.) Be sure to identify the item as a "Press Release" or "News Release."

(2) Send copies of the story to all radio stations within reception range of your area. Send copies, with a good, clear glossy

"Us CB operators would rather fight than switch channels."

The latest in CB gear was displayed by local dealers during the Rock River Valley CB Club's second annual jamboree in the Rockford, Ill., Armory.

photograph pertaining to the story, if possible, to all newspapers in your city or town; an 8″ x 10″ print is usually preferred, but a 4″ x 5″ size is acceptable in some instances. And send copies to all TV stations covering the vicinity. Television stations can also use polaroid prints (in addition to 8″ x 10″ photos) by shooting them on "live" TV cameras. Most TV stations are also equipped with 35-mm. projection equipment to show black and white or color transparencies.

(3) If the story is of the utmost urgency, (in the case of an emergency assist), *telephone* the local news media as soon as possible. They will take your story by landline and then rewrite prior to air or press time.

(4) Finally, take the same story in its original form, or in the form of a reprint from the newspaper, plus photo if possible, and forward it to Matt P. Spinello, CB Editor, POPULAR ELECTRONICS, One Park Avenue, New York, N. Y. 10016. Newspapers and TV studios will usually cooperate by supplying you with a print and permission to reprint. We'll spread the same story to our half-million readers to help promote the CBI (Citizens Band Image) to those who should know that "*there are two sides to every story.*"

Successful Jamboree. The Rock River Valley CB Club, of Rockford, Ill., advises that attendance at its second annual hoopla last summer was nearly double that in 1965. An estimated 9000 to 10,000 passed through Rockford Armory doors during the one-day event. The jam featured a long list of entertainment, nearly a hundred prizes, and excellent displays by local and area dealers. Club membership is currently 220.

1966 OTCB CLUB ROSTER

The following are recently organized CB clubs or groups reporting to "On the Citizens Band" for the first time:

Lake Charles, Louisiana—*Pelican CB Club.* Attached to REACT, this club assists in all community emergencies. Membership: 18. Officers: Alvin O. Chambers, KMR5245, president; David Sweet, KMR6814, vice president; Mrs. Bettie Chambers, secretary; J. B. Clark, KMR1952, treasurer; Edmond Vital, KKR3902, secretary/treasurer; Essie May Vital, business manager; and Wilfred Mathew, KKR3877, assistant business manager.

Bronx, New York—*North East Bronx REACT.* Club monitors REACT official calling channel 9, plus channel 21. Six mobiles have been appointed to various parts of the city to serve the Bronx, Manhattan, and Westchester. Current membership: 12. Club coordinators: Tom Gregor, KMD4148; and Dave Nager, KOD0761.

Port Townsend, Washington—*Jefferson County CB Club.* Also registered with REACT, this group monitors channel 9 on a 24-hour basis, and keeps in contact with police and sheriff departments, both monitoring CB radio. They are also associated with CD activities and search and rescue. Membership: 42. Current officers: Cres Raines, KLD0066, president; Willie Stratton, KLD2246, vice president; Maxine Doubek, KLD2589, secretary; and John Doubek, KLD2589, treasurer.

I'll CB'ing you!

—*Matt, KHC2060*

SHORT-WAVE LISTENING

(*Continued from page* 95)

ways—thought to be a first for this area. According to this item, WNEW-FM has five girl broadcasters who are on the air, live, 14 hours daily, seven days a week.

The North American Short-Wave Association has decided to restrict club activities to the short-wave broadcasting band. Heretofore, the NASWA had considered reporting on BCB, utility stations, TV & FM, plus short-wave DX. Don Jensen and Ron Luyster will share the duties of collecting DX information. You can get more details on the NASWA by writing to William Eddings, 1503 Fifth Ave., Apartment A2, Altoona, Pa. 16602.

A new pirate station has been noted by West Coast listeners. Operating on about 5675 kHz, or "55 meters" as stated by the station, it has been heard around 0500-0530 with American rock-and-roll records. The identification is *The Voice of the Purple Pumpkin,* and the station urges its listeners to "protect your country from the Communist conspiracy, support the Vietnam Day Committee and the John Birch Society." As is generally the case with American bootleg stations, its broadcasters will probably continue to have their fun and believe that they cannot be located. Then the FCC will knock at the door!

CURRENT STATION REPORTS

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

Andorra—*R. des Vallees,* La Vieja, is definitely operating; it was noted erratically on 6305 kHz. A recent QSL gave no schedule or other program information.

Ascension Island—*R. Sweden* reports that the BBC relay installation here is expected to be in operation and that monitors should check 15.350 kHz after 1800. An item received at deadline time indicates that the station may already be on the air; it was noted at 1645 in Somali to W. Africa although no positive ID was given.

Austria—*Osterreichischer Rundfunk,* Vienna, was logged on 17,875 kHz at 0558-0630 with German music and ID's in German, English, and French to the Middle East and India.

Bechuanaland—The BBC relay, Francistown, is now scheduled weekdays at 0400-0800 and 0945-2045 and on Sundays at 0400-2045 on 602 and 926 kHz, with 50 kW power; daily at 0400-0515 and 1700-2045 on 4845 kHz; weekdays at 0530-0800 and 0945-1645 and on Sundays at 0530-1645 on 7295 kHz. A station was noted on 7295 kHz at 0505 with an ID for the BBC World Service but the signal is far too strong for listening in non-target areas.

Bolivia—A new station, tentatively identified as *R. Trigal*, Trinidad, has been found on 4958 kHz until 0200/close; there is a world news bulletin in Spanish at 0045. *R. Union*, unlisted and possibly new, has been heard on 6305 kHz at 0139-0200 with Latin American programs, no advertising.

Brazil—Seldom-heard *R. Nacional*, Brasilia, was found on 15,445 kHz at 2324 with native music. *R. Rio*, also listed for this channel, apparently is inactive. *R. Jornal do Comercio*, Recife, has moved up from 11,825 to 11,838 kHz, dual to 9565 kHz, and was heard around 2128-2135. Also look for *R. Sao Carlos* on 2420 kHz evenings (local time) with music, including some Eng. selections.

Brunei—*R. Brunei*, 4865 kHz, is noted at 1023-1045 with Eng. pop tunes and anmts in an Oriental language, possibly Chinese. Time pips and anmts are given at 1045.

Congo—What is possibly *R. Bakwanga* is being heard around 0430 with native African music and a soft African dialect. Listed for 7295 kHz, it was logged on 7298 kHz.

Dominican Republic—Though listed as inactive, HIBE, *R. Mil*, Santo Domingo, is being noted from 0115 to 0400 in Spanish with Latin American vocals and some U.S. records. S/off is reported to be 0500. Tune for it on 4940 kHz.

Ecuador—Station HCJB, Quito, has been found on 15,325 kHz at 2000 s/on in German and at 0357 s/off on 6040 kHz. Station HCGB4, Esmeraldas, was noted from 0337 with Latin American vocals and some "teen" music to 0401/close on 2495 kHz; different sources list it as *La Estacion de la Alegria* and *R. Nacional Espejo*. Station HCOB5, *R. Ondas Azules*, Cuenca, listed for 5025 kHz, is currently on 5023 kHz, which represents a move from the former 5105-kHz spot; the best time to hear it is 0230 and later.

SHORT-WAVE ABBREVIATIONS

anmt—Announcement	QRM—Station interference
BBC—British Broadcasting Corporation	QSL—Verification
B/C—Broadcast	R.—Radio
Eng.—English	s/off—Sign-off
ID—Identification	s/on—Sign-on
IS—Interval signal	WRTH—*World Radio Television Handbook*
kHz—Kilohertz	xmsn—Transmission
kW—Kilowatts	xmtr—Transmitter
N.A.—North America	

Egypt—A new frequency for Cairo is 9580 kHz; the station can be heard in Eng. at 0130, but there are others on the channel, so you may have to dig for it.

Ethiopia—Station ETLF, Addis Ababa, has been caught on 15,400 kHz at 1625 s/off, following a program in native language but with closing anmts in English.

Ghana—This is the latest program schedule from Accra: to N.A. and the Caribbean on 6110 kHz at 0330-0430 and 11,800 kHz, dual to 9760 kHz at 1930-2130; to Ethiopia, Sudan, Somalia, India, Pakistan, China, Japan and the Far East on 6103 kHz at 0230-0330, 9545 kHz at 0430-0530, 15,280 kHz at 1830-1900, and 17,910 kHz at 1330-1430; to S. Africa, Central Africa, and Australasia on 9760 kHz at 0430-0530, 0600-0630, and 1430-1530; to W. Africa on 3240 kHz at 0530-0730 and 2000-2230, and on 6130 kHz at 1400-1945; to Europe on 9545 kHz

at 0630-0730 and 2030-2230; to E. Africa on 6070 kHz at 0230-0330, on 15,285 kHz at 1630-1730, and on 21,720 kHz at 1430-1530.

Greece—Here's a list of active local Greek stations which differs from the latest *WRTH* listing: Larissa, 5954 kHz; Tripoli, 6003 kHz; Mytilini, 6240 kHz; Karpenission, 6500 kHz; Chios, 6590 kHz; Sidirokastron, 7000 kHz; Serrai, 7028 kHz; Janina, 7099 kHz; and Kozani, 7948 kHz.

Guam—DX'ers have a good opportunity to verify this country via KUK25, an RCA utility station. On 15,475 kHz, it operates Saturdays, Sundays, and some weekdays from 1800 to as late as 0400, relaying telephone calls from servicemen. Listen for its beeper tone, sent out at 3-second intervals. This station verifies willingly, and no return postage is required. Reports go to 66 Broad Street, New York, N. Y., c/o RCA Communications, Inc.; mark them to the attention of C. N. Macpherson, Plant Opns., Eng.

Honduras—Station HRN, *La Voz de Honduras*, Tegucigalpa, is still on 5875 kHz and readable after 0000 in Spanish. Station HRHR, *La Voz de Occidente*, Santa Rosa de Copan, has been tuned at 0030 with commercials in Spanish and Latin American pop tunes on 5960 kHz.

Hungary—*R. Budapest* suffers intense BBC QRM on 9766 kHz at 0430 when news is presented in English.

India—*All Indian Radio*, Delhi, now has four General Overseas Service Eng. xmsns. Frequencies listed on the new schedule were given in meter bands only: at 2245-0115 to E., S.E., N.E. Asia, including Japan on 25, 31, 41, 49, and 75 meters; at 1000-1100 to China, Korea, Japan, Australia, and New Zealand on 16, 19, and 25 meters; at 1330-1500 to S. E. Asia on 19 and 25 meters; and at 1745-2230 to the United Kingdom and W. Europe (and to E. Africa to 1945, N. & W. Africa from 1945 to 2045, and Australia and New Zealand from 2045) on the 25-, 31-, and 41-meter bands.

Netherlands—The tentative schedule for *R. Nederland* for the period from November 6, 1966, to March 5, 1967, to N. A. is as follows: 0130-0400 on 9590 kHz (via Bonaire); 1600-1630 on 11,730 and 15,425 kHz; 1845-2030 on 15,115 kHz; 1930-2100 on 11,730 kHz; 2000-2200 on 6085 and 9590 kHz; and 2030-2100 on 9715 kHz.

Religious services for Dutch ships on the North Sea are broadcast from the Dutch hospital/church ship "De Hoop" on 2316 kHz, 500 watts, on Sundays at 0930-1030 and 1745-1830, Wednesdays at 1800-1900. Reports go to Damrak 95, Amsterdam.

Pakistan—Karachi was noted on 17,741 kHz, but weak, at 0355 in Urdu or a similar language; the ID, which was given in the same language at 0400, began a rapid fade. The dual outlet on 11.885 kHz was not readable.

Forty countries logged, 30 verified, is the record of Stephen Toder, WPE2NYR, of Kingston, N.Y. Steve's receiver is a Knight-Kit "Star Roamer."

SHORT-WAVE CONTRIBUTORS

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William Graham *(WPE2LMU)*, Binghamton, N. Y.
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C. N. Coombe *(WPE2MOB)*, Trenton, N. J.
Bill Hafner *(WPE2OJJ)*, West Islip, N. Y.
Glenn Malec *(WPE2OTO)*, Wildwood Crest, N. J.
Don Jewler *(WPE3GGH)*, Takoma Park, Md.
Dan Henderson *(WPE4GIV)*, Laurel, Md.
David Jones *(WPE4HHD)*, Albany, Ga.
Mike Pearce *(WPE4IVE)*, Ahoskie, N. C.
Danny Jamison *(WPE4JEK)*, Richmond, Va.
Walter Fair, Jr. *(WPE5ECA)*, Houston, Texas
Eric Sands *(WPE5ENH)*, New Orleans, La.
Mac Wood *(WPE6EQO)*, Piedmont, Calif.
Trey Clegg *(WPE6FAF)*, Fresno, Calif.
Robert Eddy *(WPE8EQW)*, Newport, Ohio
Robert French *(WPE8FGH)*, Bellaire, Ohio
William Carlile *(WPE8HSO)*, Columbus, Ohio
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John Beaver, Sr. *(WPE0AE)*, Pueblo, Colo.
John Orwen *(WPE0AYU)*, Beatrice, Nebr.
Dave Carlson *(WPE0EOB)*, St. Louis, Mo.
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Dave Alpert, Morton Grove, Ill.
Roger Dooley, Buffalo, N. Y.
Bob Hill, Washington, D. C.
Roy Langlands, Jr., Cranbrook, B. C., Canada
Bernie Lansing, Rochester, N. Y.
Edward Ramras, Queens Village, N. Y.
Robert Smith, Jr., U. S. Embassy, Saigon, Vietnam
George Stradtman, Jr., Bloomsburg, Pa.
DX'ing Worldwide, New York, N. Y.
Sweden Calling DX'ers, Stockholm, Sweden

Peru—Station OAX61, *R. Universidad de Arequipa*, is now on 6245 kHz and can be noted at times with lengthy classical music; peak listening time is around 0130 and later.

Philippines—The Far East Broadcasting Corp., Manila, has been monitored on a new frequency of 11.890 kHz, dual to DZH8, 11.855 kHz, in Russian to the Soviet Union with religious talks and music.

Portuguese Guinea—Bissau is thought to be the station noted leaving the air at 2359 with a Portuguese speaker after "A Portuguesa"; if so, this is a move back to 5042.5 kHz from the previously used 5017 kHz.

South Africa—*R. South Africa* is operating on a new and unlisted frequency, 5980 kHz, as logged at 0510/close, with an Eng. newscast being given just before that time. A new DX program has been introduced for Europe on Fridays in Eng. at 2245 on 9525 and 7270 kHz.

Sudan—*R. Omdurman* was noted twice with a move in frequency to 4950 kHz, and with s/on at 0400.

Switzerland—*R. Switzerland*, Berne, has Spanish to Central America on 9695 kHz from 0300 s/on, and Arabic to the Middle East on 17.830 kHz, from 1645 to 1715 with news, talks, and music.

USSR—*R. Moscow* was observed using 11,570 kHz for the Home Service in Russian at 2238, but the station switched to the N. A. Service at 2300. A station announcing as *R. Kiev* has been noted on 11.850 kHz on Fridays at 0455 with a mailbag program.

Vatican City—*Vatican Radio* was noted on 15.285 kHz from 2300 in Portuguese and on 15.135 kHz to 1752/close with Eng. to Africa.

Vietnam (South)—We have received the following schedule for *R. Vietnam* through the courtesy of the U.S. Embassy in that country. Channel A, 9620, 6165, and 4877 kHz, is beamed north in Vietnamese (this schedule is printed in Vietnamese, and our best translation shows that Channel A operates 24 hours daily—Ed.). Channel B, 7245 kHz, beamed north-south, operates at 2200-0200, 0330-0700, and 0900-1600 (with Eng. dictation-speed news daily except at 1530-1600). Channel C, 9755 kHz, is beamed to Cambodia, at 2158-0000, 0400-0500, and 1015-1300 (Eng. lessons at 2230-2300, 2330-

0000, and 1415-1130; Eng. dictation-speed news at 1200-1230; Eng. program listed for 1230-1300). Xmtr power is listed as 10 kW on 9755 kHz, 50 kW on 9620 kHz, 20 kW on other channels.

Zambia—The Zambia B/C Service General Service is scheduled weekdays at 0400-0445 and 1800-2105 on 2455 and 3275 kHz, at 0445-0630 and 1430-1800 on 3275 kHz and at 0630-1430 on 4911 kHz. The same schedule applies to Sundays except that opening is at 0500 and closing at 2010. The 2455-kHz outlet made a surprise appearance in East Coast areas at 0405 with Eng. news and at 0413 with the weather; the dual 3346-kHz channel (not listed in the latest schedule—Ed.) was barely audible.

Clandestine—*R. Euzkadi* was noted varying in frequency between 15,030 and 15,080 kHz, with best reception from 2030 to 2205 s/off (it may run as late as 2305 at times); close-down includes an anthem and IS. The only Eng. heard seems to consists of ID's at 2030 and 2130. *The Voice of the Basque Underground.* —30—

DX PROVINCES AWARDS PRESENTED

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

TWELVE PROVINCES VERIFIED

Frank Diehl (WPE2GUJ), Buffalo, N. Y.

TEN PROVINCES VERIFIED

Ziba Knapp (WPE6EOG), South San Gabriel, Calif.
Conrad Durocher (WPE1ASP), Framingham, Mass.
Thomas Lachajczyk (WPE9HJO), Chicago, Ill.
William Chapman (WPE1DRZ), Middletown, Conn.
John Reasoner (WPEØCLU), Bowling Green, Ky.
James Eudaily, Jr. (WPE4GLQ), Millers Creek, N. C.
James Neff (WPE2RS), Springville, N. Y.
Ron Kusmack (VE4PE4U), Winnipeg, Manitoba, Canada
Jack Winther (WPE6BJD), Moraga, Calif.
Edward Fellows (WPE7BLN), Seattle, Wash.
Jack Lane (WPE9EVU), Lafayette, Ind.

EIGHT PROVINCES VERIFIED

Pete Sils (WPEØEAX), Cedar Falls, Iowa
William Gardiner (WPE2DLX), Perry, Fla.
Jan Stetson (WPE2NSQ), Albion, N. Y.
John Schnaidt (WPE6CDU), Shafter, Calif.
Paul Kilroy (WPE3FOB), Washington, D. C.
Jerry McMahan(WPEØSS), Cedar Rapids, Iowa
David Kaplan (WPE1FIJ), Hartford, Conn.
Charles Dobbins, Jr. (WPE8BEV), Detroit, Mich.
Peter Bartlett (WPE1FSX), Marshfield Hills, Mass.
David Johnson (WPEØELO)., Denver, Colo.
Robert Crowell (WPE4HKO), Fort Walton Beach, Fla.
Le Roy Ackerman (WPE7BXS), Phoenix, Ariz.
Kenneth Coyne (WPE2LSI), Long Beach, N. Y.
Arthur Peterson (WPE6FMV), San Pablo, Calif.
Tim Kerfoot (VE3PE1TH), Toronto, Ont., Canada
William Rodgers (WPEØEX), Florissant, Mo.
George Hemingway (WPE1DYC), Taftville, Conn.
Edward Smith (WPE7AVQ), Corvallis, Oreg.
James McFadden (WPE2OKV), Pleasantville, N. J.
Jack Forbing (WPE9AMH), Fort Wayne, Ind.
Roger Camire, Jr. (WPE1GEK), Manchester, N. H.
Stephen Schmidt (WPE2IXG), Webster, N. Y.
Charles Matterer (WPE6DGA), San Leandro, Calif.
Michael Fletcher (WPE4DPS), Marietta, Ga.
Ernest Wesolowski (WPEØAHV), Omaha, Nebr.

SIX PROVINCES VERIFIED

Thomas Blossom (WPE9FHQ), Fort Wayne, Ind.
Frank Halpin (WPE2GRC), Queens Village, N. Y.
Daryl Salmon (VE7PE1BC), Burnaby, British Columbia, Canada
Pat Laird (VE5PE5F), Swift Current, Saskatchewan, Canada
Dwain Davis (WPE1GJO), Cranston, R. I.
James Mason (VE3PE2FB), Kingston, Ont, Canada
Mike Doherty (VE3PE2FJ), Willowdale, Ont., Canada
Tom Layde (WPE9HWS), Milwaukee, Wis.
Walter Pratt (WPE1FHE), Shrewsbury, Mass.
James Smedley (WPE3BSB), Sykesville, Md.
Richard Lauhead (WPEØDTX), Elwood, Nebr.
Lothar Koenig (WPE2NTB), Brooklyn, N. Y.
Paul Petosky (WPE8ASF), Pickford, Mich.
Victor Lipinski (WPE4HTV), Alexandria, Va.
John Martorana (WPE3FPS), Bridgeville, Pa.
Ray Salvo (WPE6DEM), Hayward, Calif.
Clarence Hagerman (WPE2NRU), Delaware, N. J.
John Creamer (WPE2OCT), Syracuse, N. Y.
Jack Page, Jr. (WPE5DXH), Pontotoc, Miss.
Bruce Reynolds (WPEØEKU), Warrensburg, Mo.
Allan Jones (VE3PE2AM), Islington, Ont., Canada
Lawrence Bennett (WPE2NEU), Forest Hills, N. Y.
Tom Kelly (WPE2MRB), Norristown, Pa.
Neil Hauser (WPE2LQQ), Lake Success, N. Y.
H. Zimberg (VE4PE6Q), Winnipeg, Man., Canada
Roger Burket (WPE3EKS), Altoona, Pa.
Leo Baca (WPE5CLR), Bernard, Texas
David Miller (WPE2MNS), Medina, N. Y.
Aldridge Salisbury (WPE4HLD), Falls Church, Va.
Bob Du Buisson (WPE1GGL), Longmeadow, Mass.
Ronald Whiffen (WPE2NFX), Richmond Hill, N. Y.
Michael Plihcik (WPE2JDF), Woodside, N. Y.
Irwin Tatelman (WPE9HIF), Chicago, Ill.
John Draut (WPE2JVI), Bronx, N. Y.
Michael Hayden (WPE7CGZ), Winslow, Wash.
Stuart Miller (WPE1GMT), Marblehead, Mass.
Alvan Fisher (WPE1GHE), Newton, Mass.
Elliott Straus (WPE2NOO), West Orange, N. J.
Edward Bassett (WPE9EHF), Toledo, Ill.
Harold Allen (VE2PE1JM), Arvida, Que., Canada
Robert Chrysler (VE6PE6K), Edmonton, Alta., Canada
James Myers (VE3PE2EJ), Val Caron, Ont., Canada
John Zaharek (WPE1GUM), Torrington, Conn.
Robin Martin (WPE2GEH), Glen Head, N. Y.
Don Hollingsworth (VE6PE7B), Edmonton, Alta., Canada
Lyle Lunsford (WPE3GGK), Baltimore, Md.
Ralph Vatalaro, Jr. (WPE1GQP), Somerville, Mass.
Mike Jeffrey (WPE7CLK), Wenatchee, Wash.
Salvatore Trapasso (WPE1EQI), South Peabody, Mass.
Paul Slater (WPE1FRT), Medford, Mass.
Ron Hopkins (VE7PE7P), Trail, B. C., Canada
Drew Kalman (WPE8ILL), Dearborn, Mich.
William Via (WPE3FHB), Baltimore, Md.
Robert Wilson (VE3PE2GA), Ottawa, Ont., Canada
Donald Lee (WPE3EVB), Lebanon, Pa.
Richard Cooper (WPE1GHI), Wayland, Mass.
Robert Braunwart III (WPE7CJO), Moses Lake, Wash.
Viktor Decyk (WPE1FCD), Colrain, Mass.
Park Barton (WPE4INA), Troy, Ala.
Robert Johnston (VE3PE1SX), Oshawa, Ont., Canada

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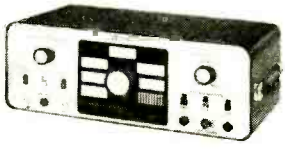

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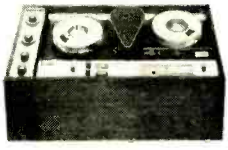

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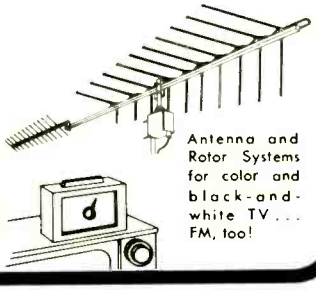

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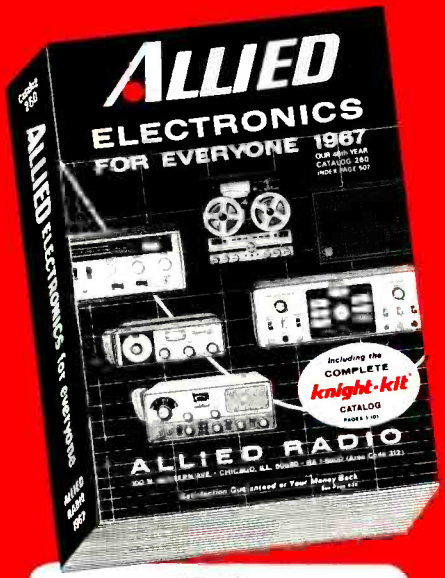

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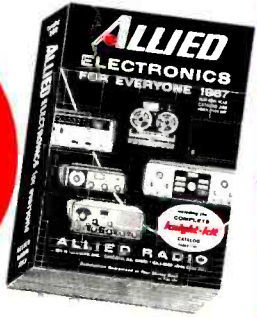

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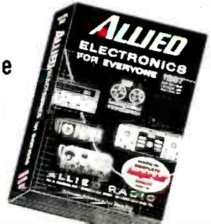

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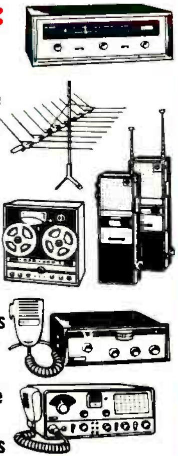

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