ELECTRONICS HOBBYIST

1967 EDITION $1.00

PROJECTS for Home, Car, Science Fair, Ham-CB-SWL Radio, Test Bench, Audio/Hi-Fi, Darkroom

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SCR Slave Photoflash
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BUILD A WALKIE-TALKIE

All solid-state, 6-meter 1/4-watt transmitter & super-regen receiver

By the Editors of RADIO-TV EXPERIMENTER and ELEMENTARY ELECTRONICS

1967 EDITION

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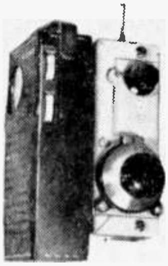

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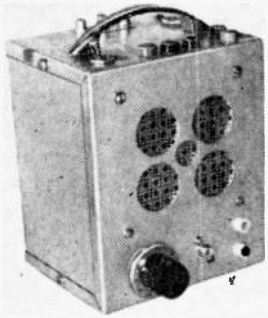

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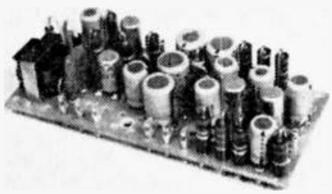

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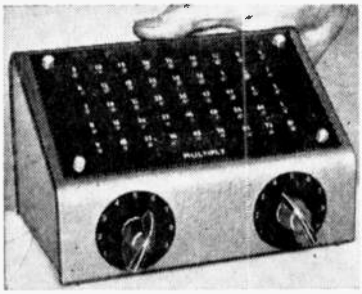

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▲ Cover Art by Joseph Rakowsky

1967 EDITION
ELECTRONICS HOBBYIST

Dedicated to America's Electronics Experimenters

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***Kit GR-180,** everything except cabinet, 102 lbs. **$379.95**

GRA-180-1, walnut cabinet (shown above), 30 lbs...18¼" D x 28¼" W x 29" H. **$49.95**

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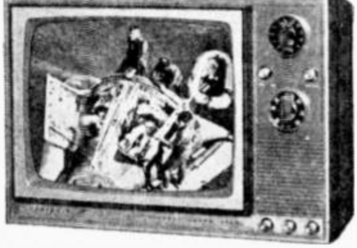
NEW 12" Transistor Portable TV — First Kit With Integrated Circuit

Unusually sensitive performance. Plays anywhere . . . runs on household 117 v. AC, any 12 v. battery, or optional rechargeable battery pack ($39.95); receives all channels; new integrated sound circuit replaces 39 components; preassembled, prealigned tuners; high gain IF strip; Gated AGC for steady, jitter-free pictures; front-panel mounted speaker; assembles in only 10 hours. Rugged high impact plastic cabinet measures a compact 11½" H x 15¾" W x 9⅜" D. 27 lbs.



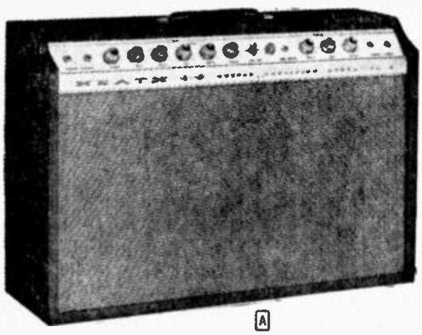
Kit GR-104

$119^{95}

Turn Page For More New Kits From HEATH

9 New Kit Ideas From Heath . . .

Harmony-by-Heathkit® Electric Guitars & Heathkit Guitar Amplifier



[A] Kit TA-16
$129.95

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

[C] Kit TG-28
$99.95
(save $45)

[D] Kit TG-38
$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! Deluxe Solid-State FM /FM Stereo Table Radio

Kit GR-36
$69.95

Tuner and IF section same as used in deluxe Heathkit transistor stereo components. Other features include automatic switching to stereo; fixed AFC; adjustable phase for best stereo; two 5¼" PM speakers; clutched volume control for individual channel adjustment; compact 19" W x 6½" D x 9¼" H size; preassembled, prealigned "front-end"; walnut cabinet; simple 10-hour assembly. 17 lbs.

A Message from the Editors of the Davis Electronics Group

Julian M. Sienkiewicz
Editor

Richard A. Flanagan
Managing Editor

Elmer C. Carlson
Technical Editor

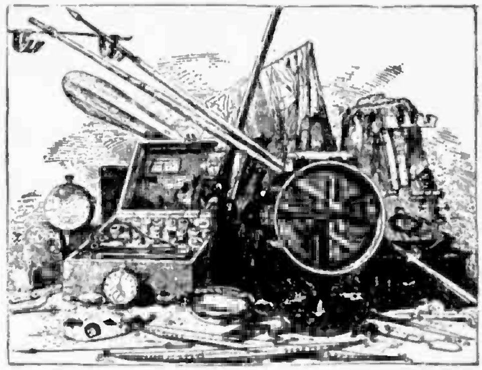
LAUNCHING a new publication is a little bit like firing up a new project. After that last double-check, you throw a switch or two, turn a knob or two, and, if all goes well, glow with pride from ear to ear.

To be sure, there are no switches or knobs on the "front panel" of the ELECTRONICS HOBBYIST. But its Editors are as pleased with the new magazine as with any project they've ever completed. For here within the confines of two covers lies one of the most enticing assortments of projects ever assembled—projects certain to interest everyone who is interested in hobby electronics.

Because of the great number of projects presented, we've deliberately grouped them in four general categories. Thus, the "Communications" grouping includes receivers, transmitters, converters, and similar devices for the Ham, the CBer, the SWL and DXer. Similarly, the "Test Bench" section offers devices and gadgets designed for servicing and repair. Still other sections, whose titles are more or less self-explanatory, include projects for both Home and Car and, last but not least, the ever-attractive Science Fair.

In all cases, our intent has been to make each and every project as easy and foolproof as possible. Each project is presented complete with theory, construction tips, parts lists, diagrams, photos, and whatever else is needed to make its construction a sure-fire undertaking.

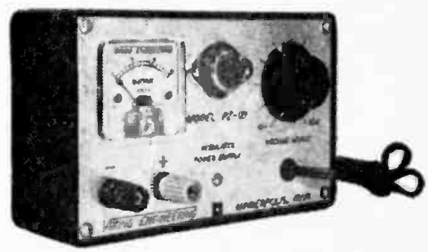
In short, we have strived to make the ELECTRONICS HOBBYIST everything we think a magazine for the electronics hobbyist should be. We are pleased with the results of our efforts, and we are confident that you will be, too. ▲



NEW PRODVCTS

Bargain Regulated Power Supply

Here's a bargain for the experimenter or service technician who needs a low-cost variable source of ripple-free regulated DC power. Model PZ-121, available in factory assembled or kit form, delivers stable, continuously variable output from 0-15 volts DC and usable currents to 250 ma. from an AC line. This compact (6¼ x 3¾ x 2 in.), solid-state



unit provides regulation better than ± 0.2 volts and AC ripple of less than 5 mv for outputs to 100 ma. Zener-reference model PZ-121 features burn-out proof circuitry and transformer isolated output. Price—a mere $13.95 in kit form, $19.95 assembled, from Viking Engineering of Mpls., PO Box 9507, Minneapolis, Minn. 55440.

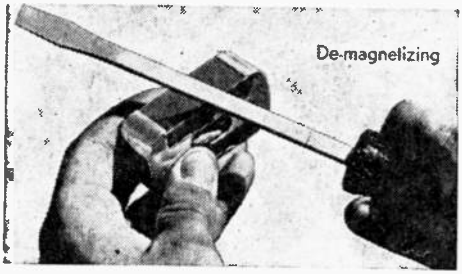
20,000 Ohms-per-Volt VOM

Knight-Kit has a new VOM, model KG-640, listed in complete detail in Allied's 1967 catalog No. 260. The KG-640 has a total of 57 ranges starting as low as 0.8 VDC, covered by a positive-action range/function switch and range-doubler switch that virtually doubles the effective number of ranges. Repeatability of readings is promised by its rugged taut-band meter movement. No damage is possible to the protected movement, even with 1,000 times overload. The new Knight-Kit 20,000 ohms-per volt VOM, with test leads, batteries and detailed instructions, is priced at $39.95 in kit form, $59.95 assembled. Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680.

New Products

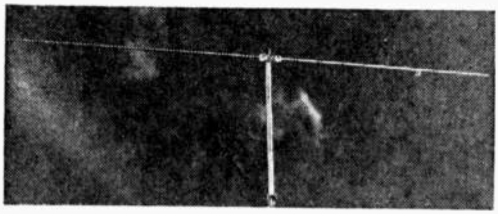
Magnetizer Demagnitizer

This beautifully simple little tool eliminates the need for special magnetized tools. To magnetize a screwdriver just insert into one of the holes in the Sure-Nuf. The screwdriver retains its new magnetic properties until it is drawn across one of Sure-Nuf's outside metal plates. This breaks the magnetic field, and voila! it's back in its non-magnetic state. Smaller than a cigarette pack and weighing less than four ounces, the Sure-Nuf's permanent magnets never need recharging. Retail price is $2.89 from New Enterprises Inc., PO Box 338, Reno, Nevada 89504.



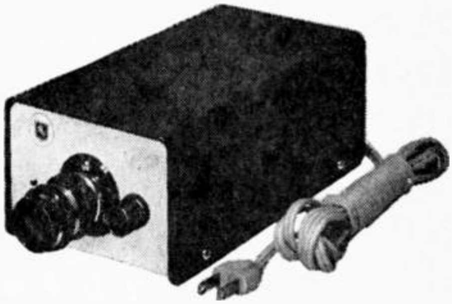
Go-Anywhere Antenna

The Trik Stik (Model TS-1) antenna can be mounted vertically or horizontally anywhere, under any conditions, for the following applications: Citizens Band, business radio (low and high band), SWL, monitor, aircraft, Civil Defense, amateur, experimenter, television, FM. Assembly is accomplished in minutes for permanent installations, temporary stations or test purposes and complete instructions are supplied with measurements for setting Trik Stik to the correct dimensions for any of the services listed. Price is $6.45 and it comes from Cush-Craft, 621 Hayward St., Manchester, N. H. 03103.



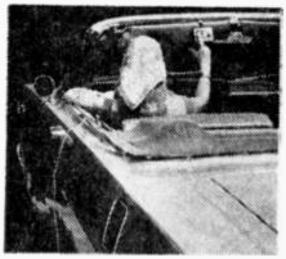
Be Your Own TV Producer

A new closed-circuit TV camera, model SS-310, using less space than a telephone, is priced in the hobbyist range. Resolution at center of picture is 350 horizontal lines or better with monitors, and 300 lines or better with conventional receivers. The camera circuit contains 19 silicon transistors, 2 germanium transistors, and 14 diodes. A clear picture can be obtained with a minimum amount of illumination, using f1.4 lens supplied with the camera. The SS-310 has an automatic electronic circuit that instantly compensates for wide and sudden lighting changes, assuring a clear picture under virtually all light conditions. Plug-in modular circuit boards facilitate replacements with a minimum of downtime. User price of the SS-310 with f1.4 lens, 25 feet of coaxial cable with connectors, is $289.95. Maker is Squires-Sanders, Inc., Martinsville Rd., Millington, N. J. 07946.



Transistorized Doorman

This pocket-sized garage-door controller, the Electro-Lift, opens, closes, locks the garage door and controls the garage light from 100 feet away. Meeting FCC rules, the Electro-Lift uses a new radio coding system called pulse-tone modulation. The 2¾ x 3¾ x 1-inch, 10 oz. transmitter can be carried in purse or pocket, clipped to the sun visor or under the dashboard. The receiver fastens to the wall of the garage; not overhead as in other versions. The Electro Lift gives double protection against mishaps with both pushbutton and automatic stop features; handles single or double one-piece doors up to 20 feet wide and 8 feet high, sectional doors up to 10 feet wide. The complete Perma-Power Electro-Lift system sells for $179.95, and is friction-driven (the Perma-Power model G-670 is a chain-drive unit). Available nationally, or write to Perma-Power Co., 5740 N. Tripp Ave., Chicago, Ill. 60647.

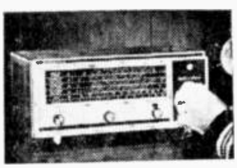


Updated Second Op

Coincident with a rapid increase in good band conditions on most shortwave frequencies comes the revised, fourth edition of W9IOP's Second Op. This is a simple DX computer on laminated card stock, giving beam headings to every country in the world from major geographic locations in the United States, immediate identification of prefixes including specific location of the prefix, time zone, continent, postage rates. Included on the periphery of the Second Op are provisions for logging contacts and receipt of confirmation. Send your name and address and $1.00 to Electro-Voice, Inc., Dept. PR-4, Buchanan, Mich. 49107 (or visit your local Electro-Voice distributor).

2—New Receivers—2

Both these new Hallicrafters receivers are AM/FM. The FM-66, shown on the right, has a hand-rubbed walnut cabinet, two built-in antennas, printed circuit chassis, and a 5-inch permanent magnet speaker. It measures 14½ x 7½ x 5¾ inches, list price is $64.95.



And on the left, Model S-210 has 4 short wave bands as well as AM and FM. This one has "spread" tuning, accomplished by electronically spreading apart distant stations to relieve congestion, permitting highly selective tuning on 49, 31, 25 and 19 meters. Power supply is the same as the FM-66—105-120 volt, 60 Hz AC. Has 3 dual-purpose and 3 single-purpose tubes. The vinyl-covered metal cabinet is 14½ x 7½ x 5¾ inches, and the unit lists for $89.95. If you don't have a Hallicrafters distributor near you, their address is Hallicrafters Co., 4401 W. 5th Ave., Chicago, Ill. 60624. ■

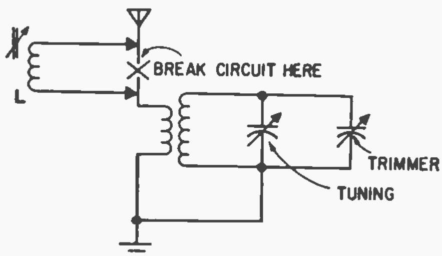
QUESTION BEE BONANZA

The Editors of RADIO-TV EXPERIMENTER *and* ELEMENTARY ELECTRONICS *bring to the readers of* ELECTRONICS HOBBYIST *the knowhow of electronics experts. Whenever space permits, questions sent to the Editors are answered in* RADIO-TV EXPERIMENTER *and* ELEMENTARY ELECTRONICS. *To get your question answered in an early issue, send it to The Editors, in care of one of the above magazines you read regularly. The address: 505 Park Avenue, New York, New York, 10022.*

Adding Antenna Tuning

I notice the antenna trimmer on many sets is a variable capacitor in parallel with the main RF tuning capacitor. As such, it seems to me that this is merely a means of correcting tracking error. Right? It then follows that a true antenna tuner (one to electrically make a longwire a half wavelength) is a useful addition too. If not, what is the functional difference between the set's antenna trimmer and an outboard antenna tuner?

—J. T. H., Pittsburgh, Pa.



You are correct. The antenna trimmer usually corrects tracking error which is caused by variations in antenna capacitance loading. You can add a variable coil (L) in series with the antenna which functions as an antenna loading coil. The inductance of the coil is changed by adjustment of its ferrite core (Miller 4400 series, etc.) with a threaded rod. Too bad they don't make them with a tuning shaft to which a knob could be attached.

Novice-Ham Ticket

Where do I have to go to take an examination for a novice amateur radio license?

—D. S., Flushing, N. Y.

You can take the exam at home. Just find a licensed ham and ask him to give you the code test (5-words per minute) and to write to the FCC for a set of test questions. He then supervises the taking of the test and submits a report to the FCC.

TV QSL for DX

I received the Palm Beach, Florida, Channel-5 TV station for 32 minutes. So I can get a QSL card from that station, please give me its full address.

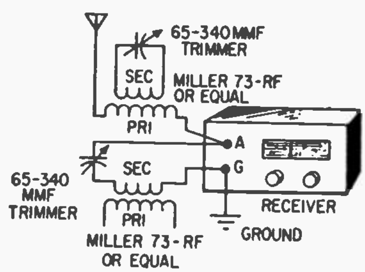
—S. K., Wheeling, W. Va.

Your letter or card addressed simply to "TV Channel 5, Palm Beach, Florida" should be adequate. (But in 32 minutes you should have been able to get their call at least once.) Describe program details—time, sponsors, actors, etc.

Needs Realignment?

Two nearby, powerful stations, one on 850 kc, the other on 900 kc, overlap and block out a distant station on 840 kc. I use a good radio with an outside antenna. What can I do to receive the station on 840 kc?

—D. W., White Rock, British Columbia

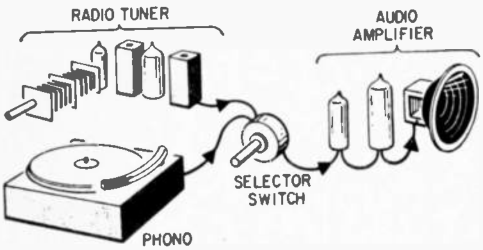


First try realignment. With many home radios, it is almost impossible to separate stations only 10 kc (kHz) apart when one is nearby and powerful. Try using a shorter antenna. Add a parallel-resonant wavetrap in series with the antenna and a series-resonant wavetrap across the antenna and ground terminal as shown in the diagram. Tune one trap to attenuate the 850-kc signal and the other to 900 kc, or both to 850 kc. However, the traps might not be selective enough and may also attenuate the desired 840-kc signal.

Sorry About That!

I have a radio-phonograph that has a switch with four functions: radio, record playing, record recording and one which is unmarked. Is there any way I can use it for AM radio and record playing and use the other two switch positions for other radio bands?

—D. D. M., Temple City, Cal.

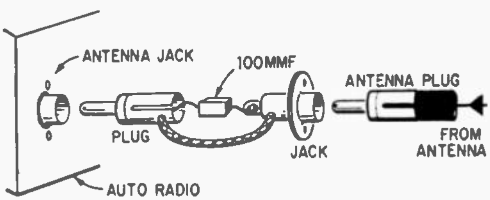


The switch is in the audio circuit. To convert the receiver to multiband operation would be a big job. All you have going for you is a convenient switch which probably doesn't have enough contacts.

Signal Loss

I have twin antennas on my car. One is a "dummy" and not connected. The antennas are small and at the rear of the car. For some reason the signal weakens quite a bit at a distance from the transmitter. Is there any way I can connect the two antennas together to increase the signal?

—L. B. K., Knoxville, Tenn.



Don't use either. Instead, add a 57-inch side-mount auto radio antenna near the radio so the shielded lead-in will be as short as possible. The long lead-in loses signal strength and the high-capacitance between the inner conductor and the shield often "loads" the RF stage tuned circuit. Check the adjustment of the peaking trimmer on the radio—usually near the antenna input jack. Tune in a station near the high end of the dial—around 1300 kHz (kc) and adjust this knob for maximum volume. If there is no definite increase and decrease as you turn that little knob there is probably too much lead-in capacitance. Reception can be improved by connecting a capacitor in series with the lead-in—try about 100 mmF, but not larger. Special connectors were manufactured (some 10 years ago) to couple dual rear antennas to the radio—they are not listed in recent catalogs.

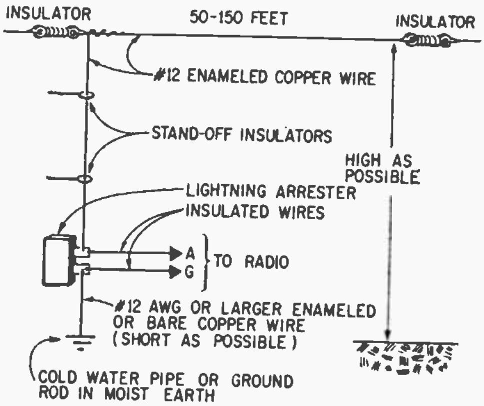
Question Bee Bonanza

BCB Antenna For DX

In order to receive stations in New York and Chicago regularly, what kind of antenna do I need?

—*B. M. Hess, Englewood, Ohio*

Since Chicago is to the northwest and New York is eastward, a single directional antenna is not practical. Furthermore, a directional antenna with significant gain at one frequency might have far less gain at the other end of the band. A really effective directional antenna would require acres of space. The conventional antenna is an inverted-L wire antenna as shown in the diagram. You might be able to get



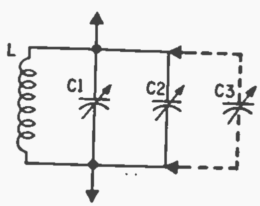
Chicago stations (on clear channels) via the direct ground wave. New York stations would probably be received via the sky wave and, therefore, not reliably—try after sunset. A long, straight vertical wire—it's not directional—will give good reception in some locations.

Adding Bandspread

Would you please give me a circuit and a pictorial diagram for installing a bandspread on an AM-FM receiver?

—*D. A., Mill Valley, Cal.*

Simply connect a low-value variable capacitor across the AM-band oscillator section of the receiver's tuning capacitor as shown in the diagram. You can use a Johnson 160-130, Hammarlund MAPC-35 or similar capacitor with



about 35 mmf maximum capacity. In the diagram L represents the oscillator coil, C1 the tuning capacitor, C2 the existing trimmer and C3 the added capacitor. Don't bother with bandspread for the FM band where the stations take up 150 kc and are spaced far apart. You don't need it. A pictorial diagram can't be given since receivers vary considerably.

CB Abuser

There is an idiot who monopolizes Channel 9 and uses foul language. He never announces his CB call sign. What can be done about it?

—*T. G., New York, N. Y.*

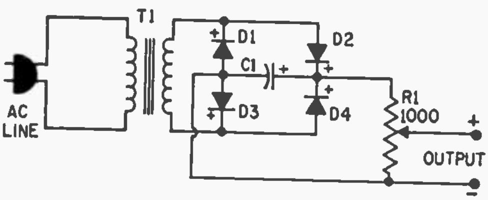
Call the local FCC office, listed in the telephone directory under "United States Government," and give the details. Your tip will be appreciated. This same type of rule violator was recently arrested and probably will go to jail. He turned out to be a 50-year old TV repairman who should know better.

Variable Battery Eliminator

Can you give me a circuit for an AC to DC power supply which delivers from 0 to around 12 volts at 6 milliamperes?

—*L. D., Bradenton, Fla.*

In the diagram T1 is a 12-volt filament, transformer, C1 is a 500-mf, 15-volt electrolytic capacitor, R1 is a 1000-ohm linear-taper potentiometer. The diodes may be of the garden variety.

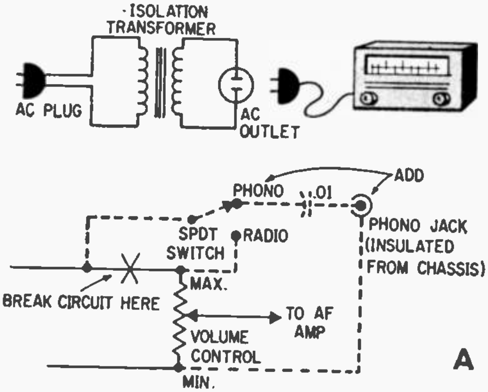


PHONO INPUT FOR RADIO

How can I connect a phono jack to an AC/DC radio?

—*R. T., Vineland, N. J.*

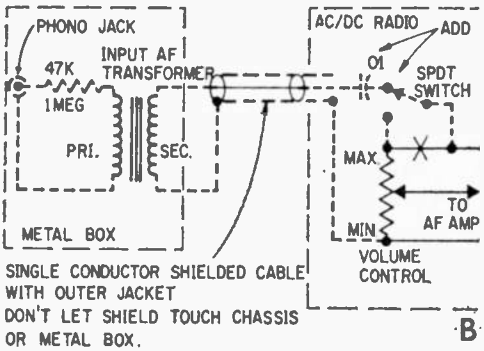
Shock hazard is a problem. One way to avoid shock is to use an isolation transformer (Stancor TA-452, etc.) between the set and the power line as shown in diagram A. You can



A

then install and connect a phono jack as also shown in the diagram.

You can also use an interstage audio transformer connected as shown in diagram B to



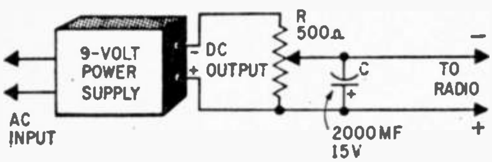
isolate the phono pick-up from the set's wiring. You may have to use a phono cartridge with relatively high output to make up for the loss in the impedance matching network (R) at the transformer primary. You may also have to try various RC filter networks to get the desired frequency response. But don't expect to get hi-fi when using an inexpensive AC/DC radio as an amplifier.

9-Volts to 6-Volts DC

How can I use my AC power supply, which delivers 9-volts DC, with my 6-volt radio?

W. A., Des Moines, Iowa

Put a voltage divider (potentiometer R) and storage capacitor (C) across it as shown in the diagram. Adjust R for 6-volts output with the radio turned *on* while measuring the voltage



across C with a DC voltmeter. It had better be a transistor radio. Automobile radios often draw as much as 9 amperes.

Use Converter—Don't Convert Set

I have an old receiver that tunes through the BCB and three shortwave bands up to 22 mc. How can I convert the set to tune up to 420 mc using the same wiring but with a VFO added for use as a frequency shifting device?

—O. M., Pembroke, Mass.

Forget it. Different type tubes would be required for operation at 420 mc. Coils aren't used at those frequencies either. You could use a converter though—connect it to the antenna terminals of the shortwave receiver and to its own 420 mc (MHz) antenna.

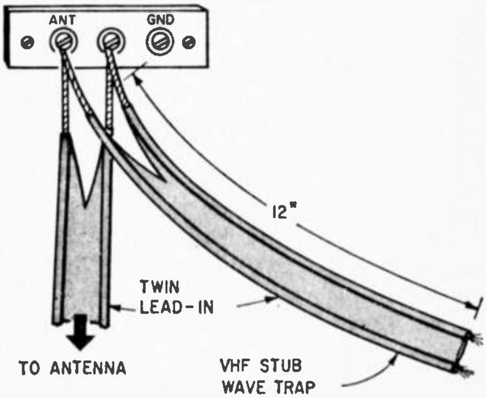
Question Bee Bonanza

VHF Wave Traps

On my FM receiver, I get interference from a Channel-11 TV station just above one of our local FM stations. Is there a filter I can add to remove the TVI?

—J. A. B., Kingston, Ontario

Your trouble could be due to intermodulation of strong local signals. The picture carrier of Channel 11 is at 199.25 MHz (mc) and the sound carrier is at 203.75 MHz. When your receiver is tuned to 96.525 MHz, the local oscillator operates 107.225 MHz, if your set has a 10.7-MHz IF. Now, if the receiver mixer picks up the second harmonic of the local oscillator signal, this harmonic at 214.45 MHz heterodyned with the 203.75 MHz signal apparently gets through the RF circuits of your receiver.



Try a series-resonant filter or wave trap across your receiver's antenna terminals as shown in the diagram. The wave trap is a one-foot length of twin lead. Snip off its free end an eighth of an inch at a time until the interference is minimized.

Defines A1, A2

What do A1 and A2 on my shortwave set stand for?

—C. C. S., Clifton, Colorado

A1 stands for unmodulated, carrier and A2 for tone modulated carrier. Either can be keyed for code transmission. When your receiver is set to A1, a BFO is turned On, and turned Off when set to A2.

Imagine That!

I have an inexpensive shortwave receiver which works quite well on all bands. However, I hear 40-meter band amateur stations quite strongly at around 6.3 mc. I also hear them on the 40-meter band. What can I do about it?

—C. S., Hagersville, Ontario, Canada

Sounds like *image* trouble. If your set doesn't have a TRF stage, add one and the image problem will probably disappear. ■

the VHF extender

By Jim Kyle and Jim Speck
K5JKX W5PPE

Build this plug-in front end and extend your listening past that 30 mc dead end!

Any radio buff worthy of the name knows there's a world of excitement to be found in the VHF (very high frequency) range of the radio spectrum, but all too few of us have had a chance to get in on it. General-purpose receivers, for a number of good reasons, usually stop at about 30 megacycles—and the VHF receivers currently available as do-it-yourself projects or in military surplus hardly compare in performance with that we're used to on lower bands.

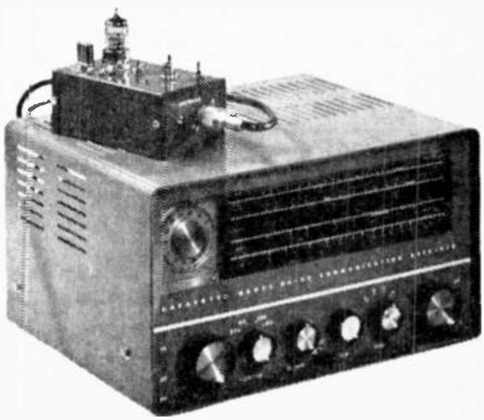
The VHF Extender is a device which can change all that for you, and let you get in on the fun for a minimum outlay of cash. Performance will be equal to that of your present SW receiver, since the purpose of the VHF Extender is simply to *extend* the frequency range of your present rig into the VHF region.

The VHF Extender can be used for any 4-megacycle-wide segment of the spectrum between 30 mc. and approximately 170 mc. and with only slight extra expense can be modified at will to cover a new slice should you tire of your first choice. This feature lets you listen to police, fire-department, aircraft-radio, or ham operators at will.

Theory Before Hookup. Before we get into the construction details of the VHF Extender, let's take a brief look at how it works. This will help you when it comes time to make the various parts-value choices needed in construction.

The VHF Extender is, primarily, a *new front end* for your receiver, which connects into the line between antenna and receiver itself. It translates the VHF signals down into the range covered by your existing receiver, so that while the on-the-air signal may be at a frequency of 136.040 mc. (for example), the signal fed into your existing receiver is at a frequency of 640 kc.—in the broadcast band.

Since the *translating* frequency is determined by a crystal-controlled oscillator, you can rely upon the dial calibration of your receiver. Thus should you be hunting a satellite signal at 136.050 mc., you could set your receiver dial to 1,050 kc. and use a 45-mc. crystal in the VHF Extender. Any signal appearing in the receiver would have to be a 136.050-mc. signal at the antenna



VHF Extender connects between antenna and receiver to expand your listening world.

VHF extender

(the 133.950-mc. *image* frequency is reduced greatly by the input RF amplifier circuit).

High performance in the critical VHF region is assured by the RF amplifier tube, a 6DS4 *Nuvistor*. The other tube, a type 6U8A, serves as both crystal oscillator and mixer. Power for the VHF Extender can be taken from the existing receiver, if it uses a transformer. Be sure to fuse the B+ (¼ a.) and 6.3-vac (1 a.) leads to the Extender.

Get Ready to Build. The only tools absolutely necessary to build the VHF Extender are a drill, a screwdriver, cutting pliers, and a soldering iron. A grid-dip oscillator can prove very useful, however, if you happen to have one on hand. With the *GDO*, you can get along without the coil tables, simply by dipping each coil to its proper frequency.

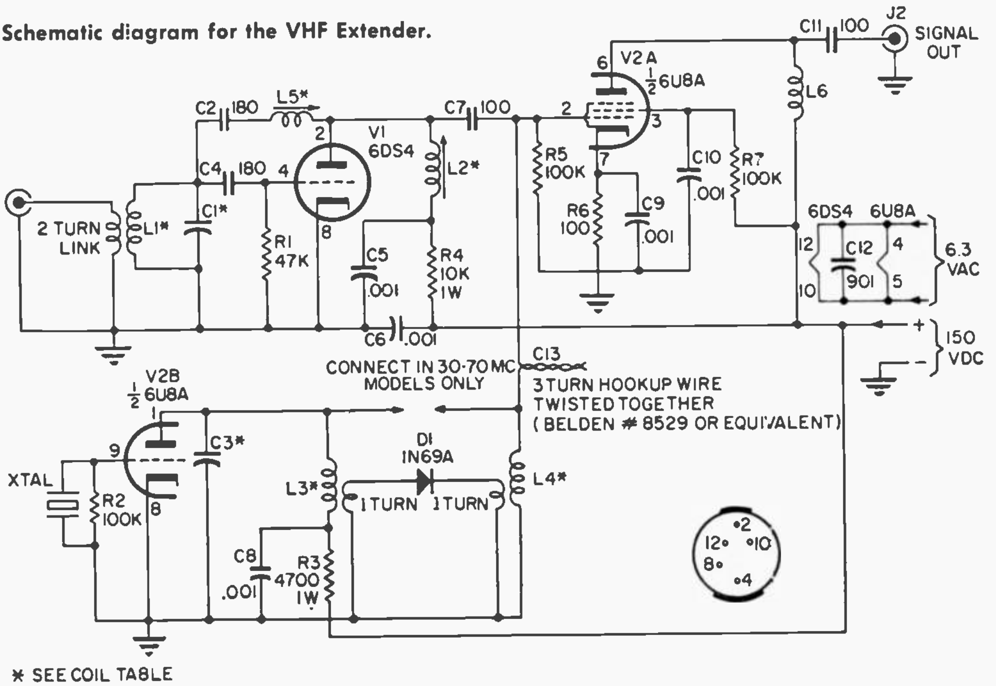
To determine the values to be used for XTAL frequency, L1/C1, L2, L3/C3, and L4, use the tables or follow these rules. L1/C1 must tune to the desired VHF frequency band. For satellite reception, for instance, they should tune to 136 mc. L2 should tune to this same frequency when installed in the circuit and with the 6DS4 plugged in. For input frequencies between 30 and 70 mc., the XTAL frequency should be equal to the frequency of the lower end of the desired VHF band, minus the frequency of the lowest desired output frequency. For best results, the 7-11 mc. portion of the existing receiver's coverage should be used, which would make the XTAL equal to input signal frequency minus 7 mc. For input frequencies between 70 and 170 mc., proceed as before but divide the result by three. For 136-mc. input and 7-mc. output, the XTAL frequency would be 136-7 or 129/3, or 43.0 mc. L3/C3 should tune to the XTAL frequency, whatever it is determined to be, and L4 should tune to three times XTAL frequency.

If you're using the coil table rather than a *GDO*, simply take the values shown there.

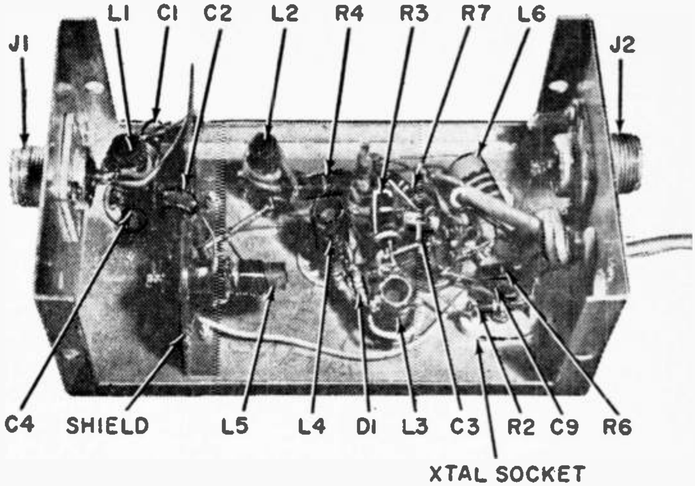
Putting It Together. The VHF Extender is built on a 2⅛" by 3" by 5¼" aluminum chassis box, using the long flat side for most parts installation as shown in the photograph. Lay out and drill the box as shown in the chassis detail drawing.

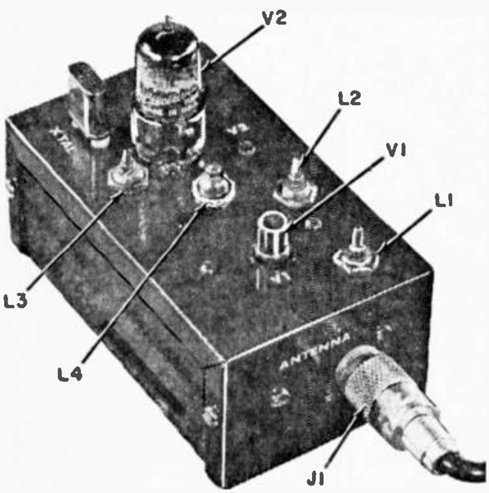
Next, select the necessary coils using data from the coil tables. Install each in its proper location. Mount the tube sockets. The 6DS4 Nuvistor socket is secured by crimping its lips over tightly against the chassis. Several short wires are then soldered to the lips, and later will be soldered to the shield plate across this socket.

Schematic diagram for the VHF Extender.



The VHF Extender is an advanced project for the SWL experimenter. Part location is critical and should be followed closely. See photo at right and below. To make your unit identical with the author's, follow the detail drawings given in the article and follow the text without alterations.





Wire the filament leads as shown on the schematic diagram before installing the copper shield partition on the 6DS4 socket, and mount the two coax connectors, J1 and J2, in place. Then mount the partition (which must be made of copper or brass; this can usually be located at an auto-supply wholesaler under the name of 3-mil shim stock) and make the rest of the connections to the tube sockets. Refer to shield detail drawing to fabricate piece.

Note from the photos that all leads must be kept as short as possible and no wiring is "fancy". Everything must take the most direct route. This makes the lower layer of wiring tough to get to later on, so check and double check at every step to make certain your connections are correct. If your wiring looks like a tight-knit rats nest—you're doing a good job.

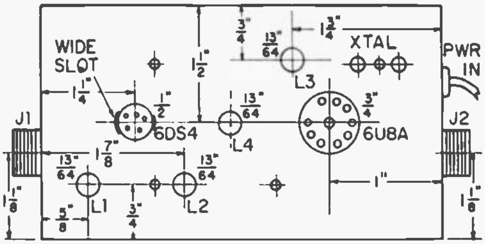
Wiring Differences. With all coils in place and all tube-socket-connections made, the final stages consist of wiring the coils in and connecting the links between them. Only two of these are particularly unusual. Note how the long lead from the 1N69A diode, D1, is used as its own coupling link to L3. The other end of the diode wraps around L4 in the same way. Diode D1 and L4 are omitted on the 30 to 70 mc. models; this is the "extra expense" mentioned earlier to switch to other frequency bands. The other unusual connection is the twisted-wire "gimmick", C13 coupling L4 to the 6U8A pentode's grid. In the 30-70 mc. model, this wire connects to the top of L3 instead of to L4 as shown in the schematic diagram. Be extremely careful that the two wires do not short-circuit together; they form a low-value capacitor through which oscillator voltage is injected into the mixer stages, V2A.

Turn It On. When all connections are complete and rechecked, you can apply power to the VHF Extender. The 6U8A filament should light immediately, and the 6DS4 should feel warm to the touch after a few seconds. If it is hot, remove power quickly and check wiring, espcially near L5.

If all proceeds well, connect a coaxial cable from the output jack of the VHF Extender to the antenna terminals of your receiver and tune to about 7 mc. Briefly disable the 6U8A mixer, V2A, of the VHF Extender by shorting pin 3 to ground with an insulated screwdriver. Noise output from

VHF extender

the receiver should diminish at the same time. If it does not, tune L3 until the noise rises sharply and suddenly. Adjust L3 carefully for maximum noise, then repeat the previous test. Don't be worried if a few 7-mc. short-wave signals come through during all this;



Detail drawing of chassis top part's layout.

COIL TABLE FOR 30-70 MC.

VHF Band (MC.)	L1, L2	C1 (mmf.)	L5	7-11 Mc. Output XTAL (mc.)	L3	C3 (mmf.)	BC-Band Output XTAL (mc.)	L3	C3 (mmf.)
30-34	20A156RBI	10	4205	23.000	20A106RBI	20	29.400	20A106RBI	20
34-38	20A156RBI	10	4205	27.000	20A106RBI	20	33.400	20A106RBI	15
38-42	20A106RBI	10	4204	31.000	20A106RBI	20	37.400	20A106RBI	15
42-46	20A106RBI	10	4204	35.000	20A106RBI	15	41.400	20A827RBI	15
46-50	20A687RBI	10	4204	39.000	20A106RBI	15	45.400	20A827RBI	10
50-54	20A687RBI	10	4204	43.000	20A827RBI	15	49.400	20A827RBI	10
54-58	20A687RBI	10	4204	47.000	20A827RBI	10	53.400	20A687RBI	10
58-62	20A687RBI	10	4204	51.000	20A827RBI	10	57.400	20A687RBI	10
62-66	20A687RBI	4.7	4203	55.000	20A687RBI	10	61.400	20A687RBI	4.7
66-70	20A687RBI	4.7	4203	59.000	20A687RBI	10	65.400	20A687RBI	4.7

Coil numbers are J. W. Miller Co. part numbers. Wind two-turn link of No. 22 hookup wire around grounded end of L1. BC-Band XTAL frequencies are for lowest megacycle of 4 Mc. VHF bands; add one mc. to XTAL for each higher megacycle desired. For instance, to cover 41-42 mc., table gives 37.4-mc. XTAL but this is upper megacycle of VHF band; add 3 mc. to XTAL frequency and use 40.400-mc. crystal.

COIL TABLE FOR 70-172 MC (7-11 MC OUTPUT)

XHF Band (MC.)	L1, L2	C1 (mmf.)	L5	7-11 Mc. Output Only (mc.)	L3	C3	L4
70-74	20A477RBI	4.7	4203	21.000	20A106RBI	27	20A156RBI
74-78	20A477RBI	4.7	4203	22.333	20A106RBI	20	20A156RBI
78-82	20A477RBI	4.7	4203	23.667	20A106RBI	20	20A156RBI
82-86	20A477RBI	4.7	4203	25.000	20A106RBI	20	20A106RBI
86-90	20A477RBI	4.7	4202	26.333	20A106RBI	20	20A106RBI
108-112	20A227RBI	4.7	4203	33.667	20A827RBI	15	20A106RBI
112-116	20A227RBI	4.7	4203	35.000	20A827RBI	15	20A106RBI
116-120	20A227RBI	4.7	4203	36.333	20A827RBI	15	20A827RBI
120-124	20A227RBI	4.7	4203	37.667	20A827RBI	15	20A827RBI
124-128	20A227RBI	4.7	4203	39.000	20A827RBI	15	20A827RBI
128-132	20A227RBI	4.7	4202	40.333	20A827RBI	15	20A827RBI
132-136	20A227RBI	4.7	10T#	41.667	20A827RBI	15	20A827RBI
136-140	20A227RBI	4.7	10T#	43.000	20A827RBI	15	20A827RBI
140-144	20A227RBI	4.7	8T#	44.333	20A827RBI	15	20A678RBI
144-148	20A227RBI	4.7	8T#	45.667	20A827RBI	15	20A687RBI
148-152	20A227RBI	4.7	8T#	47.000	20A687RBI	10	20A687RBI
152-156	20A227RBI	4.7	6T#	48.333	20A687RBI	10	20A687RBI
156-160	20A227RBI	4.7	6T#	49.667	20A687RBI	10	20A477RBI
160-164	20A227RBI	0	6T#	51.000	20A687RBI	10	20A477RBI
164-168	20A227RBI	0	5T#	52.333	20A687RBI	10	20A477RBI
168-172	20A227RBI	0	5T#	53.667	20A687RBI	10	20A477RBI

Coil numbers are J. W. Miller part numbers. L5. for bands above 132 mc. is wound on a Miller 4200 coil form with No. 24 wire, with the number of turns shown in the table. 0 value for C1 indicates part is not required.

COIL TABLE FOR 70-172 MC (BC-BAND OUTPUT)

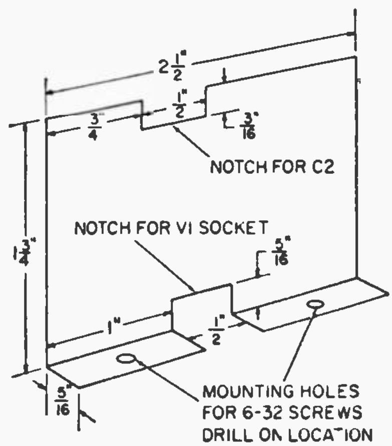
L1, L2, L5, and C1—same as given in Coil table for 70-172 mc. with 7-11 mc. output.

L3—J. W. Miller type 20A106RBI from 70 mc. to 86 mc.; 20A827RBI from 86 to 140 mc.; and 20A687RBI from 140 to 172 mc.

C3—20 mmf from 70 to 86 mc.; 15 mmf 86-140 mc.; and 10 mmf 140-172 mc.

L4—Miller 20A156RBI from 70-78 mc; 20A106RBI 78-112 mc; 20A827RBI 112-136 mc.; 20A687RBI 136-152 mc.; and 20A477RBI 152-172 mc.

XTAL—23.133 mc. for 70-71 mc.; 23.467 mc. for 71-72 mc.; 23.800 mc. for 72-73 mc.; 24.133 mc. for 73-74 mc.; 24.467 mc. for 74-75 mc.; etc., increasing by 333⅓ kc. for each megacycle increase of VHF band. For 136-137 mc. coverage (satellites) Xtal is 45.133 mc., and for 145-146 mc. (Novice portion of ham 2-meter band) use 48.133 mc. Output will be from 600 to 1600 kc. on BC band, with 600 kc. equal to lowest frequency in band (136.000 mc. on satellite band; 136.040-mc. satellite would come in at 640 on BC dial).



Detail drawing of the copper shield partition installed inside the VHF Extender. Dimensions may vary slightly depending upon how accurately Nuvistor socket is placed.

they won't when the bottom cover of the VHF Extender is in place.

Before proceeding, you will have to locate a signal in the VHF region you're interested in. Tune it in as best you can; it may have an extremely ragged or "whistling" sound which is due to regeneration in the 6DS4 stage of the VHF Extender. Adjust the slug of L5, using an insulated tuning tool, to remove all distortion. Then tune L1 and L2 for best signal strength. You may find that readjustment of L3 (and L4) will strengthen the signal still more.

Next, unsolder either end of the 100,000-ohm resistor, R4, in the 6DS4 plate circuit, while still tuned to the VHF signal. This adjustment is best made with the strongest VHF signal you can find. Readjust L5 until the signal (with resistor disconnected) is as weak as you can get it. *DO NOT READJUST*

(Continued on page 124)

PARTS LIST

C1, C3—See Coil Tables for values—select ceramic disc NPO type capacitor
C2, C4—180-mf., 300 WVDC or better, disc or tubular ceramic NPO type capacitor
C5, C8, C9, C10, C12—.001-mf., 1000 WVDC or better, disc type capacitor
C6—.001-mf., button-bypass, standoff capacitor (Erie Ceramicon 323X5U101M or equiv.)
C7, C11—100-mmf., 1000 WVDC or better, disc type capacitor
C13—Gimmick capacitor (See text)
D1—1N69A diode (Sylvania)
J1, J2—UHF coaxial connector, receptacle chassis type (Military No. SO-239 or 49194, Amphenol 83-1R, or equiv.)
L1, L2, L3, L4, L5—See Coil Tables
L6—RFC choke, 10-millihenry, ferrite core for 7-11 mc. output. Use 100,000, ½-watt resistor in place of RFC for BCB output
R1—47,000-ohm, ½-watt resistor
R2, R5, R7—100,000-ohm ½-watt resistor
R3—4700-ohm, 1-watt resistor
R4—100,000-ohm, 1-watt resistor
R6—1000-ohm, ½-watt resistor
V1—6DS4 Nuvistor (RCA)
V2—6U8A tube (GE)
XTAL—See Coil Tables for value. Select type with .050-in. diameter pins spaced .486-in. apart, .01% (.005% preferred)
1—XTAL socket (National CS-7 or equiv.)
1—2½"x3"x5¼" aluminum chassis box (Bud CU-2106A or equiv.)
1—Nuvistor socket for 5-contact tube
1—9-pin miniature tube socket with tube shield base
Misc.—Cable, wire, hardware, grommet, dials, copper shield, cement, solder, etc.

Estimated cost: $20.00
Estimated construction time: 12 hours

BUILD THE SAFE-LITE

This ingenious circuit will put eyes in the back of your head so you'll know at a glance whether your stoplights and brake light switch are working

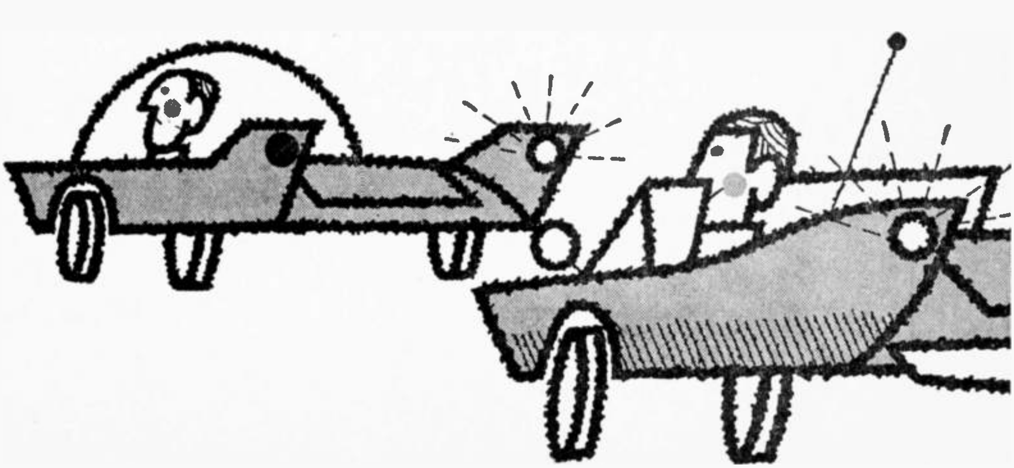
By Herbert Friedman, W2ZLF/KB19457

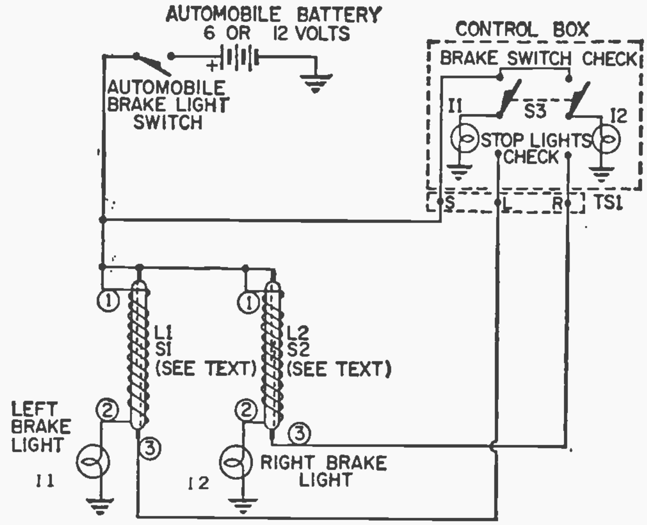
■ Driving your car with defective brake lights is a sure way to make it a candidate for the junk heap, not to mention the possibility of your incurring a few hospital bills. And even if you don't suffer a fender-bender there's always John Law ready to hand out citations for defective lights. So why risk a summons, or worse yet *your life,* when you can build the *Safe-Lite* and be years ahead of Detroit's built-in safety options.

What It Does. The Safe-Lite gives you an instantaneous check of your *brake light switch* and the *individual stoplights* merely by flicking a switch; and you don't have to get out of the car to do it, you test the stop light system in seconds from the driver's seat. And at no time does the Safe-Lite interfere or affect the normal operation of the brake switch and stop lights.

The Safe-Lite consists of a dash mounted control box and two electromagnet trigger switches, one for each stop light. The control box contains two pilot lamps—one for each stoplight—*which light if the stop lights are working.* When a stoplight fails, the representative pilot lamp also fails. The pilot lamps also double as a brake switch tester.

How It Does It. The two hearts of the Safe-Lite are the trigger switches, which are actually nothing more than a magnetic coil surrounding a reed switch. When the current to the stop lights flows through the coils (L1 and L2), a magnetic field is established around the reed switches (S1 and S2)

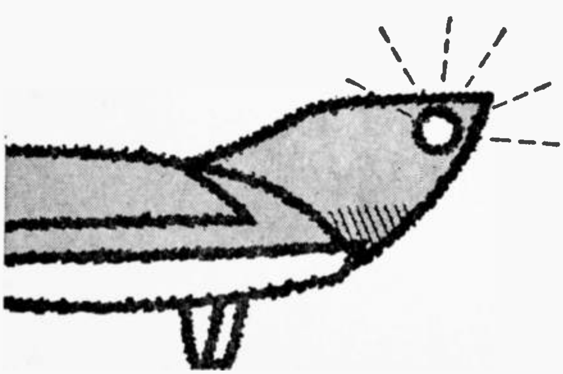




The schematic diagram shows wiring of the Safe-Lite circuit itself as well as its incorporation into your automobile's brake light circuit. The brake light switch is usually found on your hydraulic master cylinder; the trigger switches are best secured in the trunk near the stoplights; and the control box can be mounted under the dashboard, or for more custom installation, right in the dash.

and the contacts close, thereby activating the supply voltage to the pilot lamps (I1 and I2) in the control box. (See schematic diagram.) If the left stoplight should fail the left pilot lamp won't light when the brake pedal is depressed. Similarly with the right stoplight. S3, the test switch, also sets up the two pilot lights, I1 and I2, to indicate proper operation of your auto's brake switch. If both I1 and I2 fail to light when S1 is set to the SWITCH position (and the brake is depressed) it is the brake switch that is defective.

How It's Built. The control box is built on the main section of a 5¼"x3"x2⅛" miniature chassis box. On one end mount the pilot lamp assemblies I1 and I2, and the center-off test switch, S3. On the opposite end mount a 3-lug screw terminal strip. Use at least No. 18 stranded wire for connections, No. 16 is preferable, however. Under no circumstances use No. 20 or No. 22 hook-up wire.



What good is knowing your stoplights are defective and you're twenty miles from the nearest auto supply store? So, store spare bulbs in the cabinet cover as shown. Two common spring type tool holders—available from your local hardware dealer—are used to hold the spare bulbs. They can be either screwed or epoxy cemented to the cover. Just make certain they are positioned such that they will not force the bulbs against the switch or pilot lamp assemblies when the cover is in place.

For proper operation the electromagnetic triggers, the combination of L1 and S1, and L2 and S2, must be carefully assembled. The triggers are made from G.E. type X-7 reed switch assemblies and a wind-it-yourself coil. Enclosed in each X-7 reed switch package is a reed switch, coil form, magnet and instructions. Discard the magnet and ignore the instructions.

The electromagnet coils L1 and L2 are made using No. 18 solid enameled wire. Before winding the coils the wire must be tensilized or the coils will unwind. Clamp one end of a 10-foot section of wire in a vise and pull the other end with a pair of pliers until the wire goes *dead slack*. Don't pull too hard, just enough to remove the wire's resilience.

Press the wire into a slot on the left end of the coil form—allow about 6 inches for a lead—and wind a tight, closewound coil until you reach the right end. When you reach the right end, keep winding the coil in the same direction but wind a second layer from right to left, making a double wound coil. Snip off the excess wire leaving a 6-inch lead, push the lead into a retaining slot and the coil is completed.

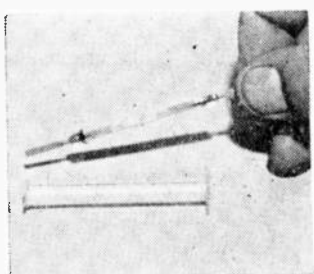
Insert the reed switch through the coil centering it so the reed terminals are at each end of the coil. Scrape away the insulation from either coil lead (it becomes the No. 1 lead), wrap the exposed lead around the adjacent reed terminal and solder. To the remaining reed terminal solder a 6 inch length of No. 16 stranded wire (this is lead No. 3). The remaining coil lead is lead No. 2.

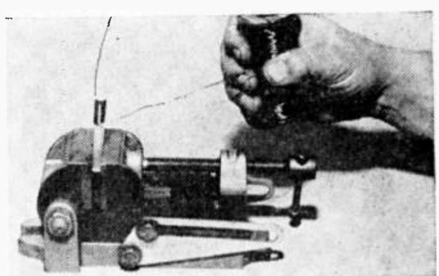
Select a section of ½-inch aluminum or copper tubing just a little longer than the overall length of the reed (including the end terminals) and scrape all burrs from inside the tubing. Apply a liberal amount of G.E. RTV silicone rubber sealant on the coil (and force some into the coil around the reed switch) and insert the reed assembly into the tubing, then pack both ends of the tubing with RTV Sealant. Allow 24 hours for the sealant to dry. It will form into a resilient rubber which will absorb any shocks and vibration, thus protecting the reed switches which are glass enclosed. Repeat the above steps for the second trigger switch.

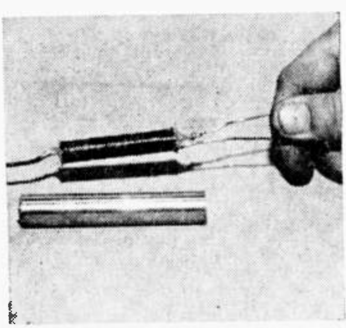
How It's Installed. Mount the control box under the dash or any other convenient location, making certain the box makes a good electrical connection to the car body. Locate the triggers in the trunk compartment near the stoplights. Sometimes some body screws protrude into the trunk, and a cable clamp mounted to these screws will retain the triggers. Now locate the brake light switch. If you have difficulty finding it, consult your shop manual or a mechanic to show you where it is. The brake switch has two terminals; one connects to the battery and one connects to the stop lights. Connect a section of No. 16 wire to the stoplight terminal and connect the other end to the *S* terminal on the control box.

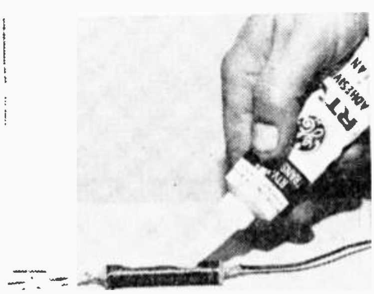
Attach two wires to the *L* and *R* terminals (use different color wires or coding to indicate the left and right wires) and run these

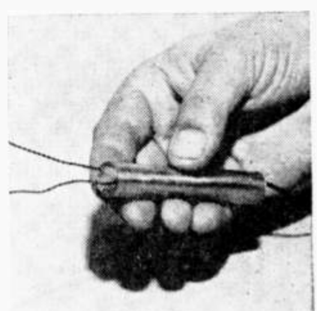
The fabrication of the trigger switches is shown in these photographs. The long reed switch is inserted in the coil form which is then wound with No. 18 enameled wire. Assembled trigger combination is then enclosed in ½-inch tubing cut to length as shown below. Rubber sealant completes job.











wires to the trunk compartment. This can be done by passing the wires under the rear seat or they can be placed in the existing channel which carries the manufacturers wiring to the trunk. The channel can be found by tracing the stoplight wires from the trunk forward.

Next, locate the brake light wires by tracing out the stoplight bulb socket(s). (Most bulbs are the two terminal type, one for the parking/signal light and one for the stoplight.) Cut the stoplight wires at a point near the triggers and connect the free wire coming from the brake switch to trigger lead No. 1. The wire from the brake lamp connect to lead No. 2. The wires coming from the control box connect to lead No. 3. These connections can be soldered and taped or connecting plugs can be used.

How It's Used. Turn the ignition switch on. Set S3 to the *SWITCH* position; depressing the brake pedal will cause *both* indicators to light if the brake switch is working. If the brake switch is defective *both* indicators will fail to light. To test the stoplights set S3 to the LIGHTS position and depress the brake pedal. If both stoplights are operative both indicators will light. Test the circuit to make certain there are no wiring errors by removing the left stoplight—the left pilot should extinguish. Similarly test the right stoplight.

If in the course of your travels a stoplight should fail simply replace it with a spare bulb from the control box.

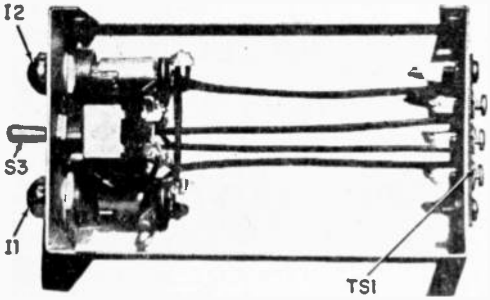
The Safe-Lite in addition to being a unique safety device, gives you that extra bit of *rear-end protection*, so important for motoring pleasure. ■

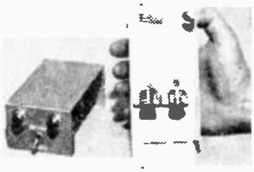
PARTS LIST

- I1, I2—Control box indicator lamp assemblies (Dialco Series 810B-432 [green] or equiv.) with GE No. 1133 or 1488 lamps for 6- or 12-volt systems, respectively
- L1, L2—Approximately 53 turns No. 18 solid enameled wire wound on reed switch coil forms. (See text)
- S1, S2—Electromagnetically actuated reed switches (GE-X7 or equiv.)
- S3—D.p.d.t. toggle switch
- TS1—3-lug screw terminal strip
- 1—5¼" x 3" x 2⅛" aluminum chassis box (Bud 3006A or equiv.)
- 1—½-pound spool No. 18 plain enameled magnet wire (Allied 48T104)
- Misc.—½-inch metal tubing, silicone rubber sealant (GE RTV-type or equiv.), No. 18 or No. 16 stranded wire, panel marking, hardware, solder, etc.

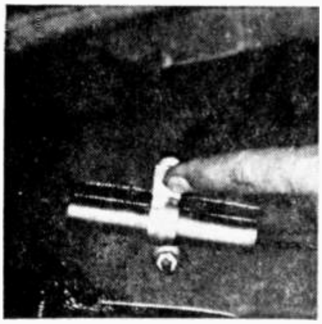
Estimated cost: $6.00

Estimated construction time: 3 hours (plus sealant curing and installation time)

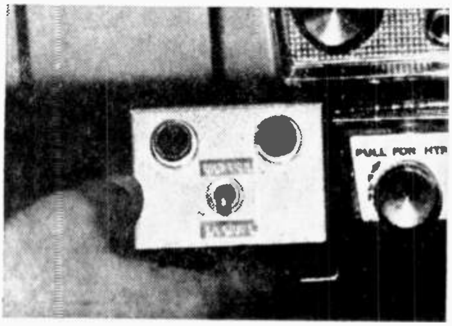


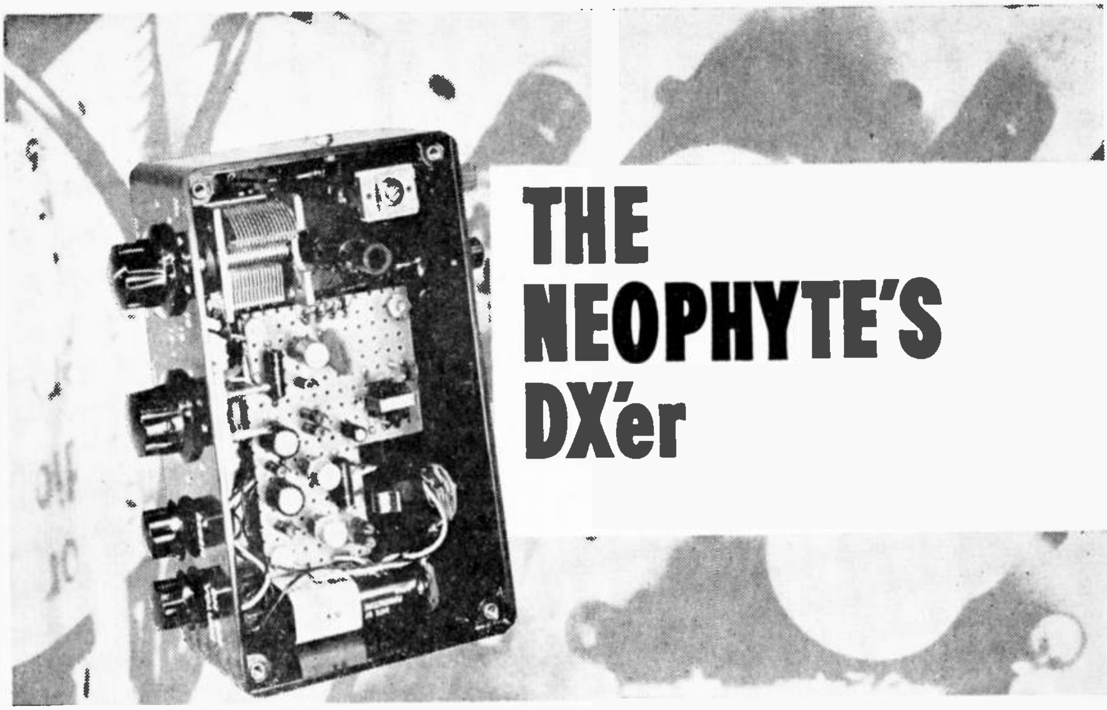


If you use an under-the-dash control box to mount the switch, indicator lights and terminal strip, construct it as shown at the left. There is room left in the enclosure after the wiring of components to mount a couple of spare emergency brake light lamps.



The trigger switch at the left is clamped into the trunk on the inside of the rear fender. Mounting is quick and simple. At the right, the optimum installation position for the control box is determined. Study the passenger compartment of your car before enclosing the Safe-Lite to find the best place to install it.





THE NEOPHYTE'S DX'er

Here's an inexpensive receiver, tailor made for the beginner. It'll cost about fourteen dollars to build from all new parts. With a good antenna you'll be able to hear stations from all parts of the globe and send for their acknowledging QSL card to prove it. Interested? No wonder!

The Neophytes' DX'er is a transistorized regenerative short wave receiver with excellent sensitivity and covers the short-wave bands from 4 to 15 megacycles. However, the receiver can be easily modified to cover any band from 500 kilocycles to 30 megacycles. More about this later. Easy to build, it can be built by a novice in eight hours.

The Circuit. Signals picked up by the antenna-ground system are coupled into the tuned circuit C2, C3, L1 by the antenna trimmer C1. Stations are tuned using capacitors C2 and C3, the primary and vernier tuning controls, respectively. Operating bias for the detector, Q1, is supplied by resistor R1.

A tickler feedback arrangement is employed in the collector circuit of Q1. Regeneration is controlled by potentiometer R2. Coil L1 is tapped down to match the low input impedance of Q1. Transformer T1 couples the demodulated audio into the two-transistor audio amplifier. The output of the secondary of T1 is fed into the base of Q2 through capacitor C6. Resistors R3 and R4 provide bias for Q2. Resistor R5 adds a measure of stabilization, it's bypassed by capacitor C7. The volume control, resistor R6, is the collector load for Q2. The second audio stage is very similar to the first except that the collector load for Q3 are your headphones.

Mechanical Construction. Before drilling any holes in the case, lightly center punch the spots where holes are called for. Don't use too much pressure when you're drilling or you stand a good chance of cracking the bakelite case. Make the larger holes by first drilling a small hole, then enlarge it with a reamer to the proper size.

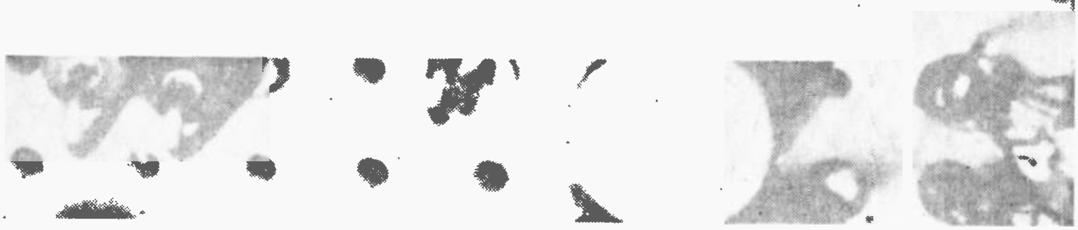
Glue a piece of rubber, 2⅛ inches by ¾ inches by ⅜ inches to the inside of the lid for the case. This piece of rubber presses down on the battery when the lid is closed and prevents the battery from shifting. Cement four small rubber pads to the under side of the case; they act as non-skid feet. When you cement the rubber parts to bakelite, use a cement like *Ply-O-Bond,* which is excellent for this purpose.

Before you mount capacitor C2, attach the ground lug to the frame of the capacitor. Make sure that the mounting screw is not long enough to press against the rotor plates of the capacitor. If you can't find a screw short enough, put several washers or a nut under the head of the screw.

Several washers are used on the shaft of

A receiver no bigger than a QSL card! You'll get your first and many more to prove its size . . . and performance!

By Edward A. Morris, WA2VLU



C2 to prevent the plates from being warped when you tighten up on the mounting screws. You can prevent the washers from shifting around by first lightly cementing them over the mounting holes in the frame of C2. Then when you position C2 you won't find that the washers won't stay in the proper position long enough to mount the capacitor.

Mount the rest of the controls on the case along with binding posts BP1 and BP2 and phone jack J1. Cut the shafts on the regeneration and volume controls R2 and R6, down to ⅜ inch. The shaft of the vernier tuning control, C3, should be cut to a length of ½ inch.

The Antenna Coil. Wind coil L1 on a 1½-inch long piece of ⅜-inch o.d. plastic tubing. Coil L1 consists of twenty-five turns of number 26 plain enameled wire, close wound. The coil is tapped ten turns from the ground end. The easiest way to place the tap on L1 is to cut off a measured 36-inch piece of wire, and place the tap 14¾ inches from one end. This allows for two-inch pig-tail leads. Now wind the tapped piece of wire around the coil form.

Coil L2 is ten turns of number 26 wire close wound over coil L1. Take special note of the fact that both L1 and L2 should be wound in the same direction, be it clockwise or counter-clockwise. Cover the coil windings with a layer of epoxy or Duco cement. This will keep the coil windings from shifting position. When the windings are dry, cement or mount the coil form in the case. The proper position can be seen in the photographs.

Electrical Construction. Wire the unit according to the schematic diagram. Don't wire in resistor R1 at this time, its exact

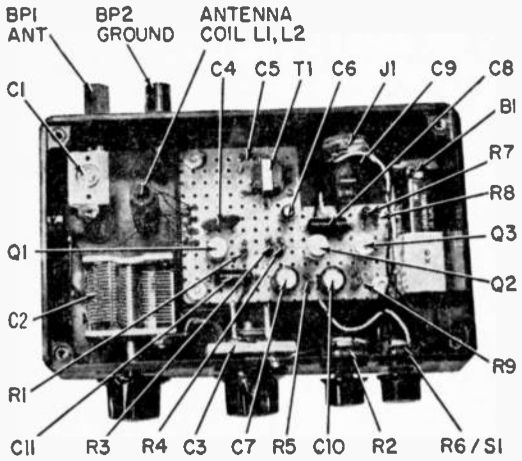
Receiver's front panel consists of tuning, regeneration, volume, and power controls.

value will only be determined later. Be sure to observe polarities where indicated.

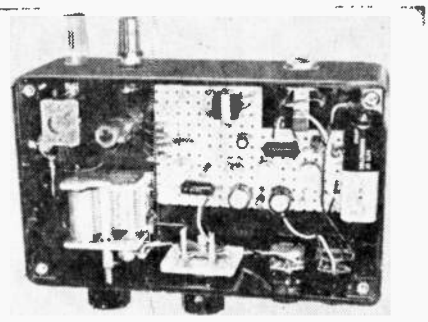
The transformer specified for T1 in the parts list has a center tap on its secondary. This center tap is not used, and may be cut off near the case.

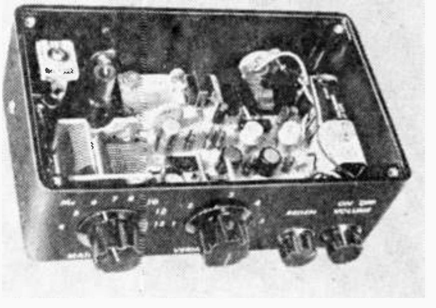
The general parts layout can be seen in the photographs. Parts are close enough together so that most connections can be made by using the pig-tail leads on the com-

NEOPHYTE'S DX'ER



These top views of the receiver with the cover removed show the location of all the components. Note how the phenolic circuit board, which is secured in the chassis with stand-offs, is shaped to fit around jack J1.





ponents themselves. Run the leads under the perforated phenolic circuit board.

Although the author used transistor sockets in his model, the transistors may be soldered directly into the circuit if you choose. If you solder them directly, use a heatsink on the leads, and make the connections as quickly as possible to prevent damage to the transistors.

For regeneration to occur, coils L1 and L2 must be wound in the same direction, be it clockwise or counter-clockwise. They must also be wired into the circuit correctly. If you follow the detail winding drawing and schematic, you should have no trouble.

Final Construction. Wire a 50,000-ohm resistor in series with one arm of a 10 megohm potentiometer. Connect the free end of the fixed resistor, and the center terminal of the 10 megohm pot into the circuit in place of resistor R1. Hook up a 25- to 50-foot antenna to the antenna terminal, and plug in your head set. When you turn on the DX'er you should be able to hear a hissing sound at some setting on the regeneration control, R2. The best value for resistor R1 is now determined experimentally: vary the 10 megohm potentiometer and note the results. If the value of R1 is made too small, the stage will not demodulate the received signal well. On the other hand, if the value is picked too high, you may not be able to get the set to go into regeneration over all parts of the band.

This means you will have to pick some compromise setting of the potentiometer. When you think you have obtained the best results, disconnect the potentiometer from the circuit, being careful not to disturb its setting. Measure the total value of the 50,000-ohm resistor and the potentiometer. Replace it with a fixed resistor which has the closest value. A 4.7 megohm value proved optimum for the unit we built.

If you can't get the receiver to break into regeneration, try reversing the leads to L1 or L2, but not both.

Operation. If you are to get maximum results from the DX'er, you should use a good antenna-ground system. A good antenna would be about 50 feet long, and would be as high as you could get it. A ground need not be more than a cold water pipe, but a ground rod is better still. Sometimes good results can be obtained by just using a good antenna, and a lot will depend on your location.

Let's say you want to tune for an A.M. station. Turn the volume control on-off switch, R6-S1, to about its mid-position. Advance the regeneration control so that it just starts to squeal. As you tune with the main tuning control, you will notice that as you pass over a station the squeal will drop in pitch. Tune to the point of lowest pitch, now reduce the regeneration control, R2, just below the point where the squealing stops. Congratulations, you have tuned to a with your Neophyte's DX'er.

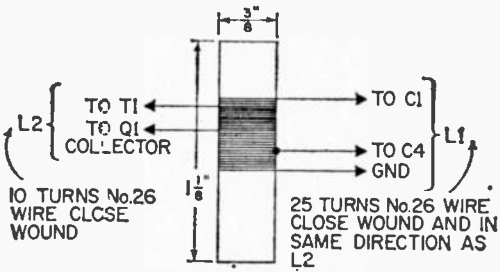
If you hear another station on top of the one you want to hear, use the vernier tuning control. If this doesn't help, reduce the capacity of the antenna trimmer C1 by turning it slightly counter-clockwise. The antenna trimmer should normally be set for best sensitivity over the entire tuning range. To receive a continuous wave (CW) station, set the regeneration control just past the point where the squeal starts.

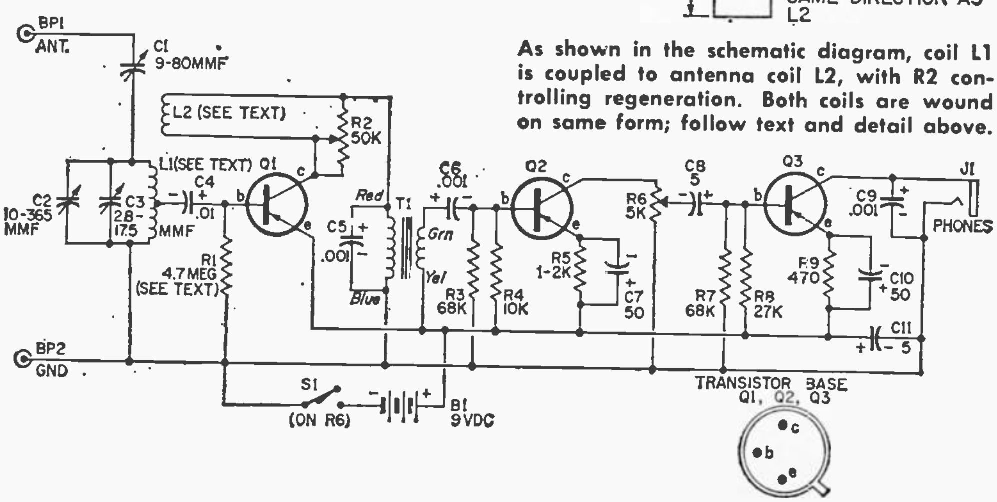
Modifications. Earlier we mentioned the DX'er could be modified to cover any band from 500 kilocycles to 30 megacycles; here's

PARTS LIST FOR NEOPHYTE'S DX'ER

- B1—9-volt battery (Burgess 2U6 or equiv.)
- BP1, BP2—Red and black binding posts
- C1—9-180-pf. mica compression trimmer capacitor (Lafayette 34G6831) or equiv.
- C2—10-365-pf. variable capacitor (Lafayette 32G1103) or equiv.
- C3—2.8-17.5-pf. variable capacitor (Hammerlund HF-15) or equiv.
- C4—.01 mfd. ceramic capacitor
- C5, 9—.001 mfd. ceramic capacitor
- C6—4 mfd. miniature electrolytic capacitor 6 WVDC
- C7, 10—50 mfd. miniature electrolytic capacitor 6 MVDC
- C8, 11—5 mfd. miniature electrolytic capacitor 6 MVDC
- J1—¼-inch phone jack
- L1—25 turns No. 26 wire close wound, on a ⅜-inch diameter, 1⅛-inch plastic coil form (Lafayette Radio 34G8913) Tapped 10 turns from gnd. (See text)
- L2—10 turns of No. 26 wire close wound over L1 (See text)
- Q1—Pnp rf transistor (Lafayette 19G4211 or equiv.)
- Q2, 3—Pnp germanium audio transistor (Lafayette 19G2701 or equiv.)
- R1—4,700,000-ohm ½-watt resistor (see text)
- R2—50,000-ohm miniature potentiometer (Lafayette 32G7359) or equiv.
- R3, 7—68,000-ohm, ½-watt resistors
- R4—10,000-ohm ½-watt resistor
- R5—1,200-ohm, ½-watt resistor
- R6—5,000-ohm miniature potentiometer with on-off switch (Lafayette 32G7363)
- R8—27,000-ohm, ½-watt resistor
- R9—470-ohm, ½-watt resistor
- S1—S.p.s.t. switch (see R6)
- T1—Audio transformer, 10,000-ohm primary; 2,000-ohm secondary (Lafayette 19G6126 or equiv.)
- 1—6¼" x 3¾" x 2" plastic case and cover panel (Lafayette 19G2001 and 19G3701, respectively)
- 2—Tuning knobs, ¾-inch diam., ⅛-inch shaft Burstein Applebee 12A849)
- 2—Tuning knobs, 1⅛-inch diam., ¼-inch shaft (Burstein Applebee 12B60)
- Misc.—Nuts, bolts, hook-up wire, transistor sockets, battery clip, rubber scoop, perforated circuit board, solder, etc.

Estimated cost: $14.00
Estimated construction time: 8 hours





As shown in the schematic diagram, coil L1 is coupled to antenna coil L2, with R2 controlling regeneration. Both coils are wound on same form; follow text and detail above.

NEOPHYTE'S DX'ER

how: For minor changes in frequency, from those originally covered by the DX'er, remove or add a few turns to L1. If you add turns the tuning range will be lowered in frequency. If you remove turns, the tuning range will increase in frequency. For major variations, the number of turns on both L1 and L2 will have to be changed, along with the tap on L1. The tap on coil L1 will be about ⅕ to ¼ of the way to the ground end of the coil. Coil L2 will be about 15 to 25% of the turns on L1.

The DX'er can be made to cover the standard broadcast band by substituting a tapped ferrite antenna coil (such as the Lafayette 32G4108) for L1. Coil L2 will be about 15 turns of No. 30 wire wound on top of the ferrite antenna coil.

In the modification outlined above, some experimentation will be necessary to find the best position for the tap on L1, and the number of turns on coil L2.

Although the DX'er was meant to be used with high impedance (1 to 4 kilohm) headsets, enough output is obtained on strong signals to drive a small speaker. To use a speaker with the DX'er, connect the primary of a matching transformer such as the Lafayette 99G6201 (2-kilohm primary, 10-ohm secondary) to jack J1. The secondary winding is connected to the speaker.

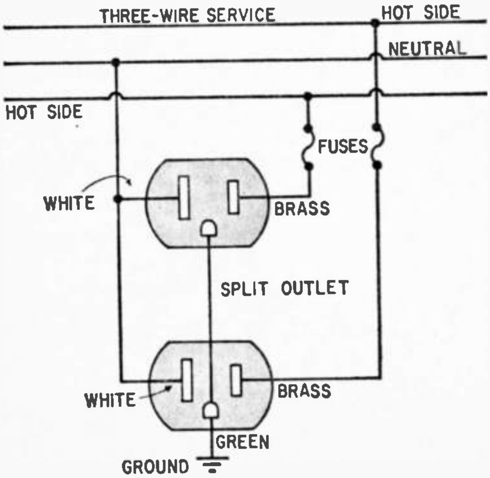
Crystal earphones can be used with the DX'er by connecting a 2.2-kilohm, ½-watt resistor in shunt with the terminals on J1. Now listen in to some good DX. ■

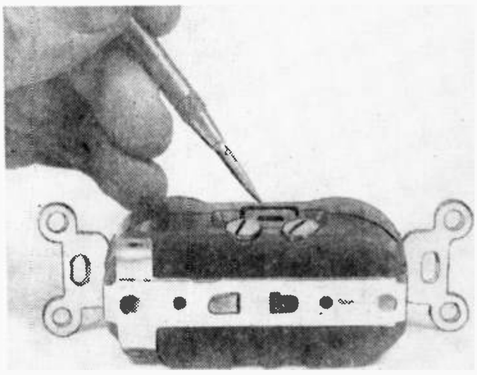
SPLIT OUTLET

■ Does the line fuse go *pfft* when you plug two heavy-current appliances such as a toaster and a coffee pot into a duplex wall outlet? If your dwelling has three-wire service, either 115/230 or 120/208 volts, you should take advantage of the safety and convenience afforded by outlets of the *split type*. Oddly, very few people know about these.

Actually, a "split" outlet is manufactured as a common double unit, with two white screws for the grounded side of the line, two brass screws for the "hot" side, and one green screw for the separate grounding prong of standard three-wire plugs.

However, if you examine the terminals closely, you will note that the two screws of each pair are joined by a link with a slot in it. Insert a screwdriver blade in the slot of the *brass* terminals, twist, the link comes off, and the outlet is now "split" electrically. Connected as shown, each outlet is connected to the AC main through separately fused lines. Therefore, the load on one outlet will not load down the line when the other outlet is working near its peak current. ■





Drawing shows connection for split outlet to three-wire AC line. Fuses are part of house wiring. Photo shows brass link to be removed.

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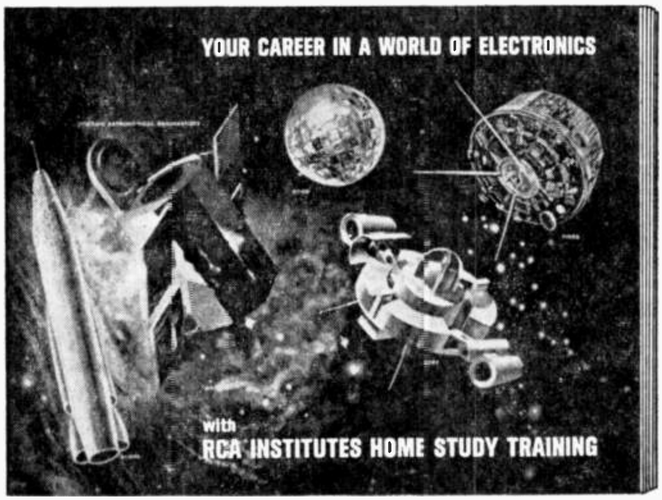

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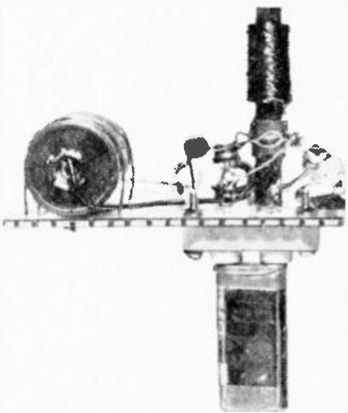
100 kc xtal CALIBRATOR

Low-cost standard makes exact tuning much easier

■ Before you read on to the next paragraph take a look at the *high-priced*, top-quality receivers shown in Allied's, Radio Shack's or Lafayette's catalog. Note that they all feature a "standard" item, namely a 100 kc. calibrator. And if the calibrator isn't supplied as original equipment provision is made for one to be easily connected. In fact, the better a receiver's calibration the more dependent it is on an accurate receiver standard to which the selected calibration can be "locked."

For you newcomer's to Ham radio or SWLing, we'll explain. A calibrator is a device which generates a signal every 100 kc. across the dial from 100 kc. to generally 30 mc. Some calibrators even go past 30 mc., some as high as 6 or 2 meters; and some calibrators provide 1 mc. markers, though they are rare as 100 kc. is far more convenient. Thus, regardless of the receiver's bandspread or main dial calibration the user can at least peg the tuning close to the desired frequency. For example, suppose you are trying to find an SWBC station at 7310 kc., and your receiver is a typical budget job with calibration at 7 and 8 mc. Obviously there's a lot of space between the 7 and 8 mc. markers. But if you have a calibrator, the third 100 kc. signal after the one tuned in with the dial set at 7 mc. is 7300 kc. At least now you're close, ease the dial a *smidgen* as you find the station at 7310.



Or say you're a Ham with a two dial receiver, one dial being the Ham band bandspread. If your transmitter is VFO controlled only, how to calibrate the main dial so the bandspread is accurate can be a formidable problem. But not with a calibrator. For example, for 20 meter calibration you might set the bandspread to 14.4 mc. Then, adjust the main tuning around the 20 meter index mark (usually 14.4 mc.) until you pick up the calibrator's signal—*voila*, the bandspread is calibrated.

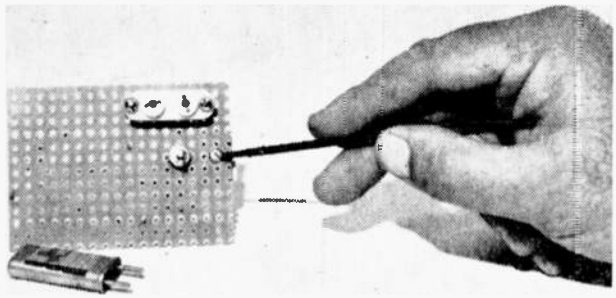
While you can always buy a calibrator that will dangle at the end of a few power cables tapped into the receiver's power supply, or a transistorized job in a relatively large box that becomes another accessory to take up valuable desk space, you can build a Perf-Board calibrator which can be tucked inside the receiver's cabinet, thereby becoming an integral part of the receiver.

Make Your Own. The Perf-Board calibrator shown in the photographs is built on a stock section of 2$^{7}/_{16}$ x 3⅜ inch unclad perforated board (unclad means no copper coating for printed circuits). Flea clips are used for terminal points.

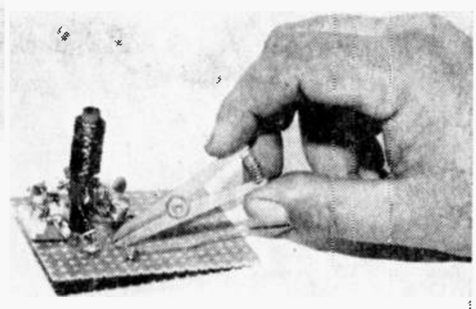
Transistor Q1 can be any *I. F. amplifier* type, even the two or three for a buck *surplus specials* will do.

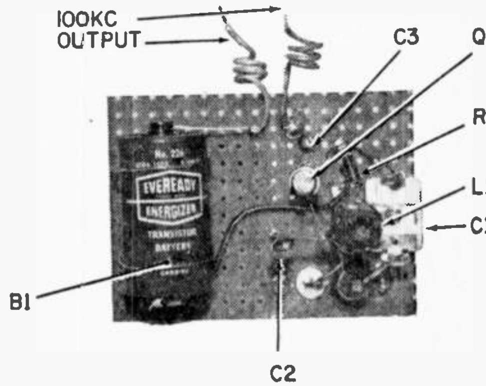
To simplify wiring (actually to avoid a *rat's nest*) the crystal socket and L1 are mounted so their terminals are on the component side of the board (see photograph). To facilitate C1's adjustment, which zero-beats the calibrator with WWV, drill a ¼ inch hole in the board so you can get at the adjustment screw even though C1 is mounted "face up" on the wiring side of the board. Make certain C1 is mounted rigidly by using at the least #20 wire for its connecting leads.

Note L1's connections carefully as there



A ¼-inch hole in the perf board, left, is drilled for access to C1 adjusting screw. A heat sink, below left, is placed on each lead of the transistor before soldering. Top view of completed calibrator shows all components except the 100 kc crystal which is on other side.





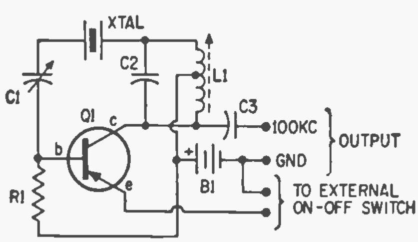
is no color-dot or other code on the coil. One coil terminal has two internal wires while the remaining terminals have only one wire. Orient L1 so that when facing the coil, not the slug adjusting screw, the terminal with two wires is pointed down; then, as shown below, the collector terminal is at the right and the crystal terminal (connected to crystal socket SO1) is at the left. If you have any doubts double check with an ohmmeter. The collector terminal measures about 3.2 ohms to the two wire terminal while the crystal terminal measures approximately 2.8 ohms to the two wire terminal.

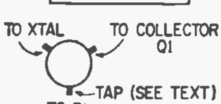
Q1's leads should be kept short, to avoid soldering heat damage a heat sink on each of Q1's leads when soldering is *a must*. If you don't have standard soldering heat-sinks you

PARTS LIST

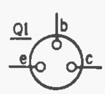
B1—9-volts battery (Eveready 226 or equiv.)
C1—4-80-mmf. trimmer (Lafayette Radio 34R-6B30 or equiv.)
C2—500-pf., 500-WVDC ceramic disc capacitor
C3—50-pf., 500-WVDC ceramic disc capacitor
L1—1.5-mh. tapped width coil (Miller 6321)
Q1—IF pnp transistor (Lafayette Radio 19R-1504 or equiv.)
R1—91,000-ohms, ½-watt resistor
SO1—Socket for xtal (Texas Crystals CE-1 or equiv.)
Xtal—100 kc. crystal (Texas Crystals TX-100 or equiv.)
Misc.—Perforated board, Flea clips, wire, solder, etc.

Estimated cost: $11.00.
Estimated construction time: 1½ hours.





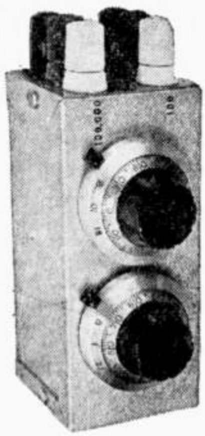
TOP VIEW OF L1 (COIL NEAREST OBSERVER)



can use an alligator clip, preferably a copper one with tight jaws to carry away the excess heat.

B1 can be any 9 volt transistor radio battery—round or flat it doesn't make a difference.The battery is held in place with two wire "straps" passed through the board and twisted together. Since the battery will last its shelf life of one to two years (assuming normal service) there's no need to use battery

(Continued on page 130)



dial-a-ohm

resistance substitution box

by e. norbert smith W5MQL

■ As every electronic experimenter knows, a good resistance substitution box is an invaluable aid—a timesaver in breadboard and troubleshooting work. They range in price from less than $6.00 on upward—depending upon accuracy, number of resistance values available, and their power capabilities.

There are three commonly used varieties, each with different applications. The simplest circuit is a selector switch (Fig. 1.) which picks one of several different-value resistors, usually ±10 or ±20% tolerance for quick substitution in radio and TV repair work. These are inexpensive but have two drawbacks; First only a limited number of resistance values are possible leaving many wide gaps and unless ±1%, or better tolerance, resistors are used they are not too useful when accurate substitution is required..

The second, and most commonly used type, is the resistance decade box which consists of several selector switches, with each selector switch having 10 positions, with 9 resistors, see Fig. 2. For example, a 6-switch decade would be capable of any resistance value from 1 ohm to 999,999 ohms in increments of 1 ohm. Of course, this unit would be rather expensive. Considering ±1% resistors at one dollar a piece it will cost (prices vary, of course, with type, manufacturer and power ratings) $54.00 plus selector switch, etc. Another disadvantage is when several resistors are added, the tolerance of the larger may override the resistance of the smaller. For example, assume the resistance of 100,000 ohms is selected, the 1% value of 100,000 is ±1,000 so the 100 ohms is insignificant.

The third type is more of a novelty but merits attention. The circuit in Fig. 3 illustrates a switching type decade in which only 4 resistors are required per switch. The disadvantage of this type are first, a more expensive switch is required and again the tolerances create a cumulative error overshadowing the smaller values and second if one resistor should become damaged several resistance values would be lost.

A New Approach. A simpler, and quite precise method has been used by the author for some time with excellent results. The circuit in Fig. 4 shows simply two, ten-turn potentiometers (pot) (with calibrated turn-counting dials) used as independent substitution resistors. Both are ±3% accurate with .25% linearity. With the turn-counting dials, resolution is accurate to 1/1000 the total value or .1 ohm for the 100-ohm pot and 100 ohms for the 100K pot. This would be equivalent to having a decade box with 7 selector switches and 63 precision resistors.

Using the Variable Decade. Connect the variable decade in the circuit being worked with and adjust the knob until the circuit is functioning properly. Then read the calibrated dial. With the 100-ohm pot each scale division is .1 ohm—each full turn is 10 ohms. The 100K dial reads 100 ohms for each scale division—10K for each turn.

After reading the resistance indicated on the dials refer to the Standard Value Table, and select the standard value of the desired

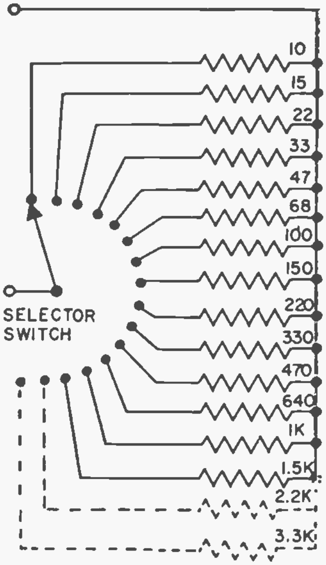
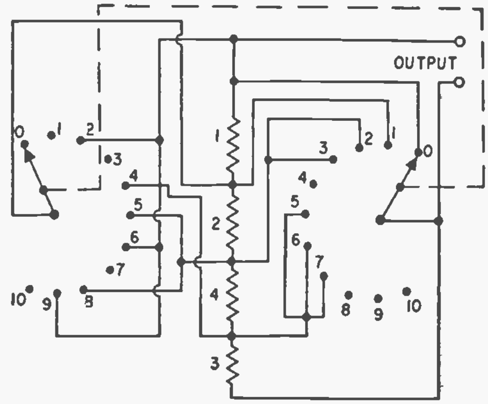


Fig. 1. Circuit of resistance substitutor.



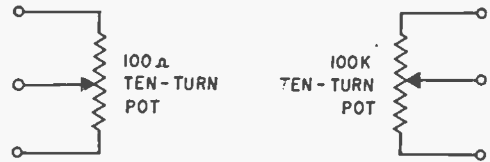


Fig. 3. (top, right) Four resistors and a 2-gang switch form one resistance decade.
Fig. 4. (above) Potentiometer-type circuit.

tolerance nearest the indicated resistance reading and readjust the variable decade to the standard value you intend using and make certain the circuit still functions properly, if not perhaps a closer tolerance resistor must be used.

As with any substitution box caution must be observed to keep the current to a safe value. Current should not exceed 200 milli-

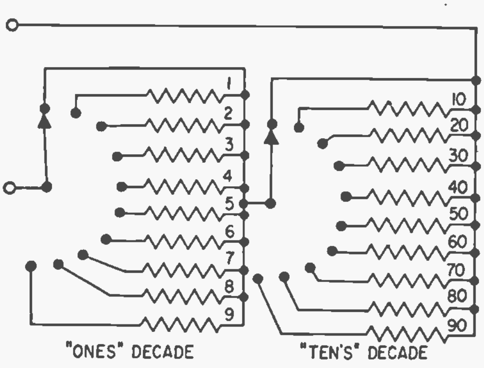
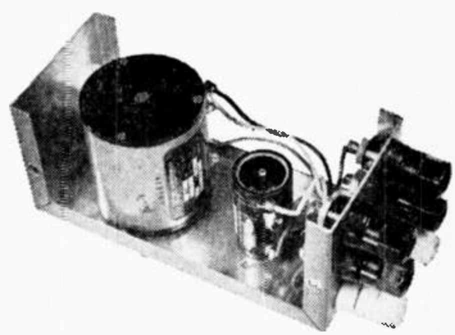


Fig. 2. Nine resistors and a single-gang selector switch are needed for a decade.

amperes in the 100-ohm pot and 200 microamperes in the 100K pot if you use units identical to those used here. Check the specifications of your units carefully. Some 10-turn potentiometers have ratings of 1½ watts—others are rated as 2, 3 and 5 watts.

Sometimes wattage, current and voltage ratings conflict—for example you may not be able to get maximum wattage at maximum resistance without exceeding the voltage rating. *Check all potentiometer specifications carefully.* ■



Completed unit shows 10-turn "pots" in a chassis box wired to 5-way binding posts.

Standard Fixed Resistor Values

20%	10%	5%	20%	10%	5%
10	10	10	33	33	33
		11			36
	12	12		39	39
		13			43
15	15	15	47	47	47
		16			51
	18	18		56	56
		20			62
22	22	22	68	68	68
		24			75
	27	27		82	82
		30			91

Higher standard values may be formed by adding zeros up to 22 megohm

SCR Slave Photoflash

Fill in unwanted shadows in your photographs with a second flash unit that's instantly activated by the light from your camera flash

by Clarence Jones

■ Ever look at a professional photographer's. flash shots and wonder, "what's he got that I haven't?" Probably, a slave—an extension flashgun.

For seven dollars, you can build a wireless slave photoflash that outperforms anything now on the market. It's small enough to slip into a shirt pocket and can be put together in about an hour.

Professional photographers never use one flashgun when they can take the time and trouble to rig more. Pictures lighted by a single bulb near the camera are harsh and unreal. Aunt Brawnhilda, close to the bulb, comes out flat and pasty. Uncle Baskerville is that shadow lurking behind her.

Auxiliary flash units are rarely found in amateur gadget bags. The flashguns rarely have an outlet for an extension flash that is connected to the main flash by a two-conductor wire. And stringing a wire across the room ties down the photographer anyway. Most wireless units—the true slaves—are strobe lights. Rather sophisticated, bulky pieces of equipment with price tags to match.

Light Activation. This wireless slave is essentially a battery-capacitor flashgun, triggered by a GE-X2 silicon-controlled rectifier. SCR1 functions as a light-activated switch for the circuit. (See the schematic diagram.) It becomes a conductor the instant the flashbulb near the camera ignites. There's no lag to amplify the current. The slave flashbulb fires simultaneously with the main flash, in perfect synchronization at speeds up to 1/250th of a second. As an example of this performance, the closest competition in the photo stores is a unit not recommended for speeds faster than 1/25 of a second and it lists for $19.95.

Everything in the parts list for constructing this home-brew is available at most electronics and camera stores. The only odd-ball is the metal *Sucrets* throat lozenge box which makes an ideal case for the unit. But any small metal or plastic box with a hinged lid that you can find will work fine.

Start By Drilling. Drill seven holes in the hinged box as follows: (See photo.)

1. 5/16-in. centered in the left end panel. This will hold SCR1. Drill low enough to clear the lid rim when it's closed.

2. 3/16-in. at left center of the lid. Lead wires to the flashbulb socket will come through here.

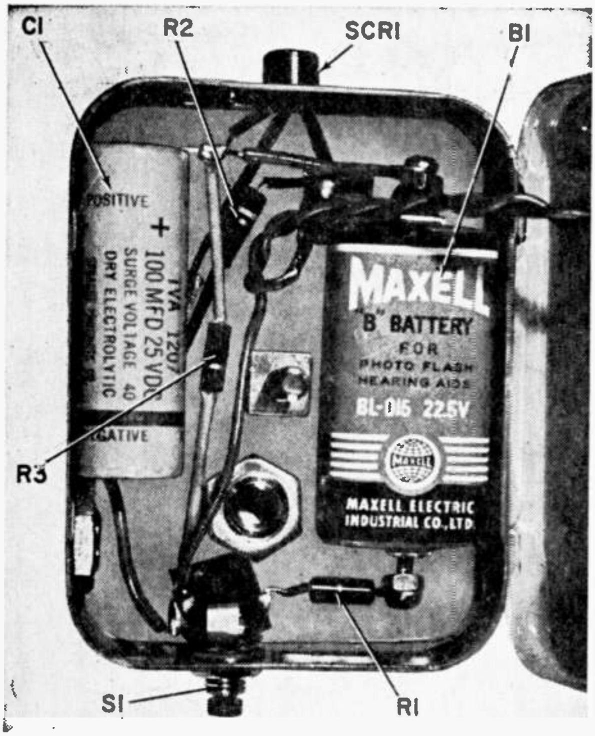
3. and 3A. 3/16-in. through the center of both lid and case bottom, for the socket mounting stove bolt.

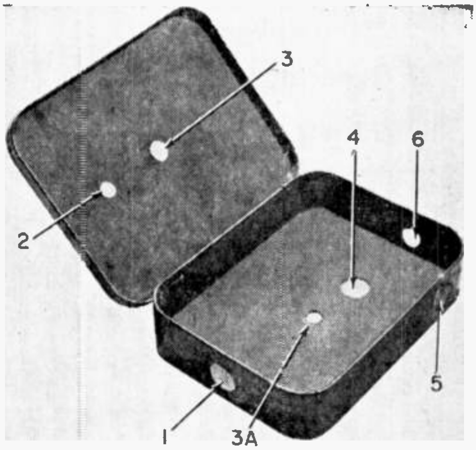
4. 5/16-in. at right center of bottom, for tripod socket adapter.

5. 5/16-in. at right front panel, for tripod socket adapter.

6. 1/4-in. at left center of right end panel for switch S1.

Now ream the 3/16-in. hole (3) in the lid to 1/4-in. so it will close more easily when the stove bolt is installed. Smooth all holes and make sure components will fit.





Refer to the text for dimensions of the holes drilled in the hinged metal box shown above. After drilling, deburr the holes and, after preliminary wiring, mount and finish wiring the components as shown at the left.

Screw the tripod socket adapters into holes 4 and 5, fastening on the inside of the case with ⅜-in. flat hex nuts. Fit the stove bolt up through hole 3 and secure it with a corresponding nut. Install switch S1 in hole 6.

Wire As You Go Along. For all wiring, use sleeving or insulated hookup wire. This will prevent a short circuit if the unit gets dropped hard enough to dislocate a component. Solder resistor R1 between the gate and cathode leads of SCR1. Use a heat sink to prevent overheating of both parts on an alligator clip between the soldering point and the component which will act to drain off the heat.

Install SCR1 in hole 1. Use a thin strip of plastic friction tape to hold it flush against the left end panel. Dress the gate and cathode leads flat against the bottom of the case.

Binding posts for the contacts of a 22.5-volt "B" battery are made by force-threading 1/10-in. machine screws into the battery poles. Thread a nut onto each screw before threading the screw into the battery pole. Be careful not to damage the battery. Place the battery in the case, with its positive pole toward SCR1 at the left.

Place capacitor C1 in the case, positive lead toward SCR1. Now wire the positive lead to the positive binding post of B1. Make a hook in the wire and tighten the nut on the binding post so that the wire is clamped securely between the nut and the screw head. Leave the capacitor lead long enough to brace the battery and C1 against opposite sides of the case.

Connect the anode lead of SCR1 to the positive lead of C1, close to the capacitor. Do not solder yet.

Now attach the negative lead of C1 to the common pole of switch S1. Do not solder yet.

Connect one lead of resistor R2 to the negative binding post of the battery. Tighten the nut to make a good contact. Solder the other lead of R2 to a pole of S1 so that the circuit between the battery and C1 will be complete when the switch is at normal position.

Connect a lead of resistor R3 to the remaining post of S1 and solder. Connect the other lead of R3 to the positive lead of C1, where the anode lead of SCR1 is crimped. Solder the connection using a heat sink. Pressing the button on S1 now should break the connection between the C1 negative lead and the battery and unload the capacitor through R3. *(Continued Overleaf)*

Cut two lengths of insulated hookup wire about 8 inches long. Twist them together to make a two-wire lead. Feed the twisted lead through hole 2 in the case lid. Fasten one of the wires to the cathode lead of SCR1 and solder. Solder the other wire to the pole of S1 where the negative lead of C1 is attached.

Close the lid and using a washer and a wing nut, install the flash socket on the stove bolt protruding through the lid. Solder the twisted lead wires tc the socket poles, leaving the lead long enough to swing the socket easily. The slave is now ready for work.

A Number 5 flashbulb can be used in the socket without a reflector, or bayonet-base adapters with built-in reflectors and bulb ejectors, available at all camera stores for both AG-1 flashbulbs and miniature-base bulbs such as the M-2 and M-3, can be used.

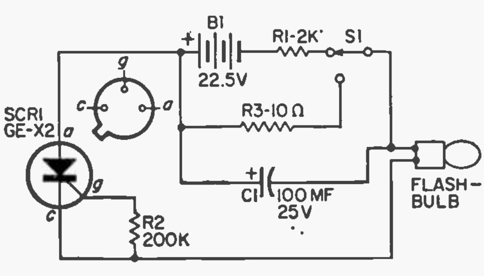
Caution: Be sure to press the button on S1 while inserting a bulb in the slave. This unloads the capacitor and prevents a misfire. After the bulb is firmly in the socket, release the button.

PARTS LIST

B1—22.5-volt "B" battery (Eveready 412 or equiv.)
C1—100-mf, 25-volt electrolytic capacitor
R1—2000-ohm, ½-watt resistor
R2—200,000-ohm, ½-watt resistor
R3—10-ohm, ½-watt resistor
S1—S.p.d.t. subminiature momentary contact switch (Switchcraft 963 or equiv.)
SCR1—Silicon controlled rectifier, light activated power switch (GE-X2 or equiv.)
1—Small metal or plastic chassis box (see text)
1—3/16" x 1" stove bolt; 2 nuts, 1 washer, and 1 wing nut to fit
1—Bayonet-base flashbulb adapter for AG-1 or M-3 flashbulbs, and reflector
2—European-American tripod socket adapters
2—1/10" x ¼" machine screws with nuts
2—⅜" flat hex nuts
Misc.—Hookup wire, spaghetti, solder, etc.

Estimated cost: $7.00
Estimated construction time: 2 hours

Schematic diagram of the slave photoflash shows how S1 provides capacitor unloading.

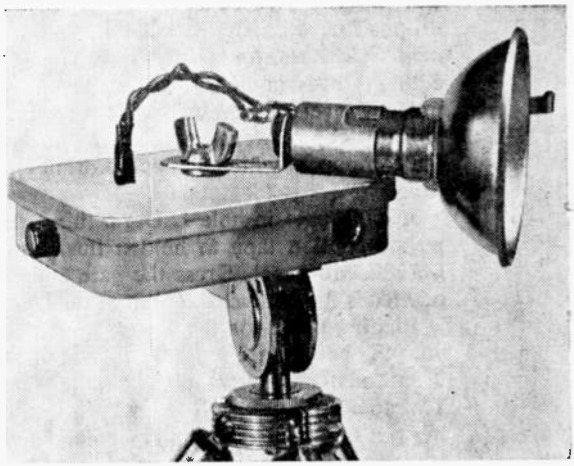


Let There Be Light. To add a new dimension to flash shots of an individual or group, place the slave high and at either side of the subject, outside of camera range. It is also an effective back-light. The two tripod sockets and the wing nut swivel adjustment for the flash head give a complete circle of coverage while the SCR is pointed at the main flash.

When your picture has a great deal of depth, use the slave to light the area farthest from the camera. The light from the slave can also be bounced against the ceiling to give a soft fill-in that eliminates all harsh shadows. If you're shooting color, make sure the ceiling is white.

Effective distance at which the slave will fire depends on the brightness of the main flashbulb. A No. 5 bulb will fire the slave from about 30 feet. Maximum range when activated by an M-3 or M-5 is 20 feet. An AG-1 or M-2 will trigger the slave about 15 feet away.

There is no need to adjust the slave for variable lighting conditions. It won't accidentally fire except in direct sunlight or when SCR1 is brought within about a foot of a bright indoor light. Sensitivity of the GE-X2 varies with the resistance between the gate and càthode. The higher the resistance, the greater the sensitivity. The author found the 200,000-ohm resistance gave ideal sensitivity for most photo jobs with maximum safety from misfires. ■



The completed slave photoflash can be mounted on a tripod as shown here. Enough twisted lead is left so the flash can be swiveled in any direction by loosening the wingnut.

by Edward A. Morris, WA2VLU

That RF signal isn't any good unless you can hear the audio—compress peaks to increase average modulation.

■ If your Ham or CB rig does not seem to be getting out the way you think it should, and your contacts remark that your signal is hard to copy—it could be your modulation! What's the answer? Boost your modulation! How? With this compact 4-transistor audio compressor!

Even though your modulation meter says that you're hitting at or near 100% on peaks, if you're not using voice compression, your average modulation is likely to be only 35% —some 10 db of audio lower.

The only ways you can boost your signal, to the guys at the other end, are: to use a more powerful transmitter, put up a high-gain antenna, or to use voice compression. Obviously the easiest method is to use voice compression.

The voice compressor described here is a small, compact, unit that can be built right into the transmitter or transceiver it's to be used with. Its modest cost, less than $10.00, won't crimp a small budget. Easy to build, it can be assembled in several hours time.

How it works. The compressor is somewhat unique in its method of operation. That is to say it uses a transistor, Q4, biased so as to act as a variable resistor which shunts part of the output signal to ground whenever the output level rises above a certain value.

Transistors Q1 and Q2 and their associated components form a two-stage common-emitter RC coupled amplifier. Operating bias for Q1 and Q2 is obtained from the voltage dividers formed by resistors R1, R2 and R5, R6. Emitter resistors R3, R7 stabilize the output over a wide range of temperature. Capacitors C3 and C5 bypass the emitter resistors and prevent signal degeneration.

Output from the first stage, developed across the collector-load resistor R4 is fed into the base of Q2 through C4. The output from the amplifier is taken across potentiometer R8 through C6. Note however, that part of the output is coupled into the base of transistor Q3 through capacitor C9 and resistor R10. Resistor R10 limits the signal. Bias for Q3 is set by R12 and potentiometer

R11, which also serves as the compression control.

The output from Q3 is full-wave rectified by diodes D1, D2, and filtered by capacitor C12.

Bias for transistor Q4 under no signal conditions (that is without someone speaking into the microphone) is set by resistors R14 and R15. This transistor is normally operated close to saturation. Any increase in forward (negative voltage) bias will drive the transistor into saturation. When Q4 saturates, its internal resistance drops. This low AC impedance is shunted across the output of the preamplifier—from the collector-load resistor for Q2, through C13 and C14. These capacitors are connected back-to-back to form a large-value non-polarized capacitor.

So we can see that the greater the input signal level, the deeper into saturation transistor Q4 is forced. As a result, more output signal is shunted to ground. The overall action is to compress the peaks so the output signal remains relativity constant, despite variations in the input-signal level.

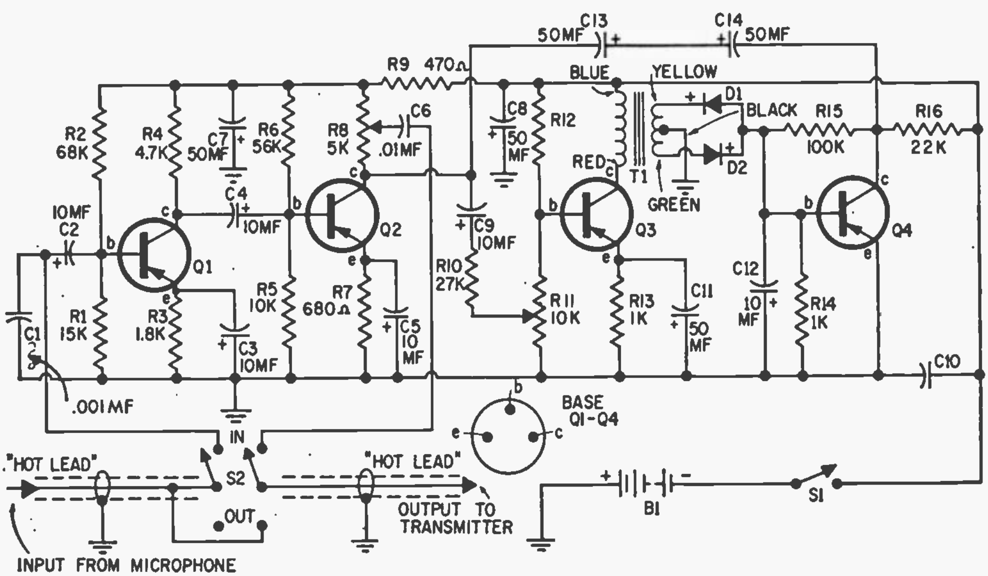
Construction. The use of perforated board simplifies the construction. All components are inserted upright, with their leads passing through the holes in the board. Miniature eyelets, inserted in the proper holes, serve to anchor leads and to provide additional rigidity to the wiring. All capacitors used are miniature types designed for upright mounting. Resistors are mounted on end to conserve space. The general parts layout can be seen in the photographs. All components, except capacitor C1, are mounted on one side of the board, with the wiring on the reverse side. Do not wire in resistor R15 at this time—its exact value for your particular unit will be determined later.

As all components are mounted close together, the pigtail leads on the components themselves can be used as the interconnecting wiring. Use plastic insulation (spaghetti) where necessary to prevent accidental shorts.

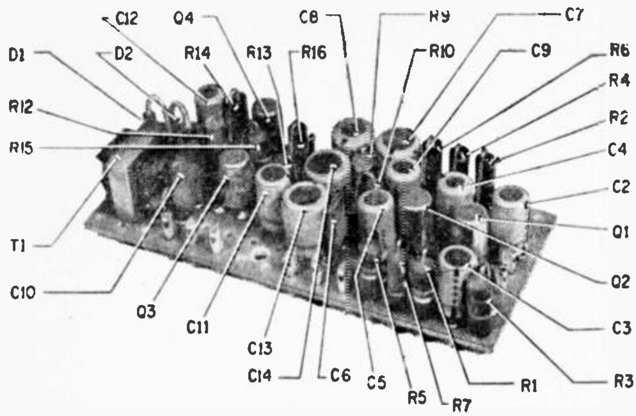
Special care must be taken to prevent damage to the transistors and the diodes when soldering them into the circuit. Complete the soldering operation as quickly as possible. The leads are short and a heat sink is not always practical.

When the compressor is completely wired, double check it against the schematic for possible errors.

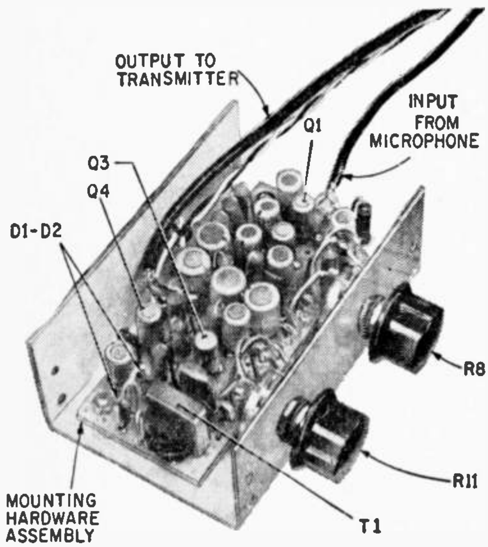
Whether or not the compressor is built into the transmitter it's to be used with, the compressor must be housed in a metal container. The compressor must be shielded well to prevent feedback. If the compressor is built into a transistorized transmitter, switch S1 and battery B1 may be eliminated. The compressor can be connected to the voltage source in the transmitter making a separate ON-OFF switch unnecessary. The com-



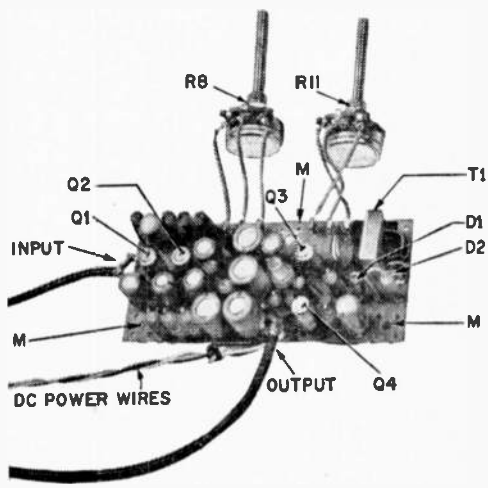
Switch S2 can be eliminated if you want the Compressor to be in the circuit at all times.



Mounted vertically the components resemble the skyline of a large city. This technique allows more components to be packed into each square inch of perforated board. Wafer-thin C1 is mounted against underside of board.



Depending on transmitter layout the leads for audio signals and DC power may be run through either or both ends of chassis box.

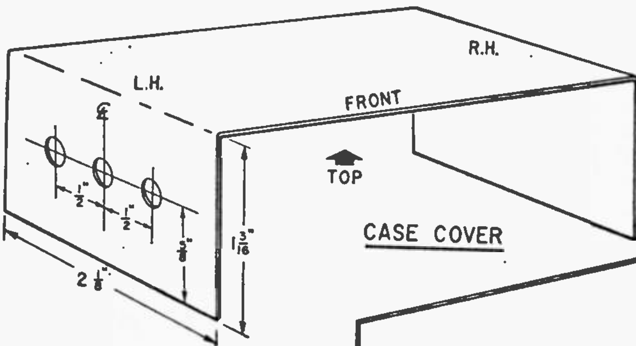


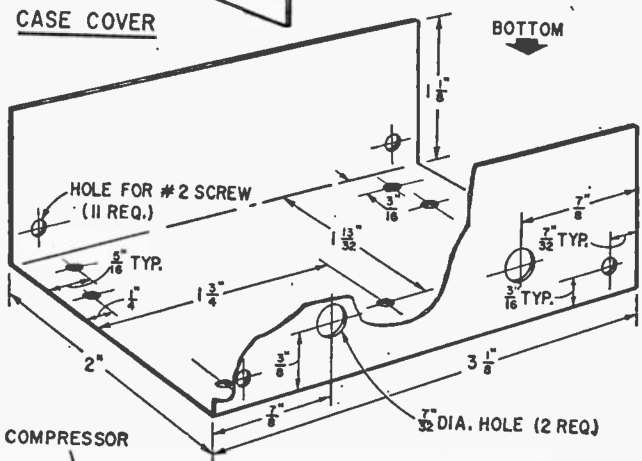
Control shafts for R8 and R11 can be cut short and slotted for screwdriver adjustment to save space required to clear small knobs.

PARTS LIST FOR AUDIO COMPRESSOR

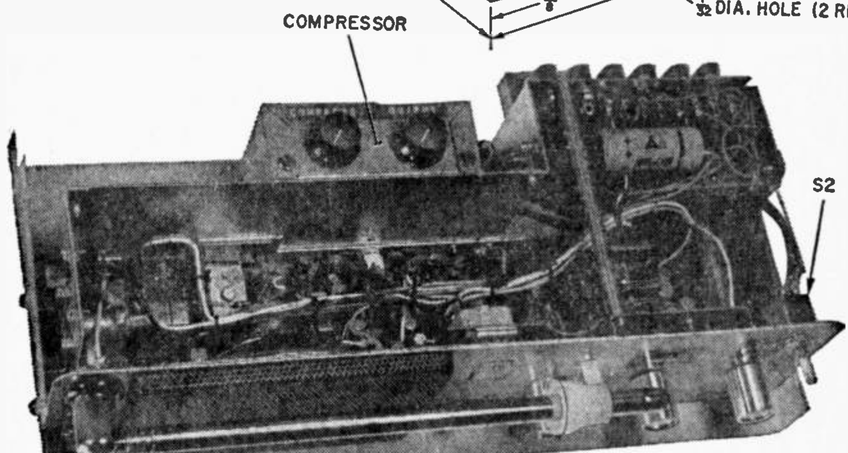
B1—9-12-volt battery (see text)
C1—.001-mf., miniature ceramic capacitor
C2, C3, C4, C5, C9, C12—10-mf., 12-volt miniature electrolytic capacitor (Lafayette 99R6082 or equiv.)
C6—.01-mf., minature ceramic capacitor
C7, C8, C11, C13, C14—50-mf., 12-volt miniature electrolytic capacitor (Lafayette 99R-6085, or equiv.)
C10—.05-mf., miniature ceramic capacitor
D1, D2—Diode, 1N34, 1N51, 1N105, 1N267, 1N295 or equiv.
Q1, Q2, Q3, Q4—Transistor, pnp, 2N217, 2N320, 2N407, 2N118 or equiv.
R1—15,000-ohms, ½-watt resistor
R2—68,000-ohms, ½-watt resistor
R3—1,800-ohms, ½-watt resistor
R4—4,700-ohms, ½-watt resistor
R5—10,000-ohms, ½-watt resistor
R6—56,000-ohms, ½-watt resistor
R7—680-ohms, ½-watt resistor
R8—5,000-ohm miniature potentiometer (Lafayette 32R7355 or equiv.)
R9—470-ohms, ½-watt resistor
R10—27,000-ohms, ½-watt resistor
R11—10,000-ohms, miniature potentiometer (Lafayette 32R7356 or equiv.)
R12—100,000-ohms, ½-watt resistor
R13, R14—1,000-ohms, ½-watt resistor
R15—100,000-ohms, ½-watt resistor (see text)
R16—22,000-ohms, ½-watt resistor
S1—S.p.s.t. switch (see text)
S2—D.p.d.t. switch, miniature toggle (Lafayette 99R6162 or equiv.)
T1—Audio transformer, miniature 10,000-ohm primary; 2,000-ohm secondary (Lafayette 99R6126 or equiv.)
1—Aluminum chassis box, 3¼ x 2⅛ x 1⅝-inches
Misc.—Solder; eyelets; perforated board; spaghetti; wire; etc.

Estimated Construction Cost: $8.00
Estimated Construction Time: 6 hours





Layout of chassis box is not critical. Holes in case cover can be either on right or on left. Placement of front-panel controls is also subject to a change in spacing and position.



Compressor was installed inside cabinet of this Lafayette HA-650 6-meter transceiver.

pressor draws only a few milliamperes.

Initial Adjustment. Once the compressor has been wired and checked for errors, connect a 39,000-ohm resistor in series with a 250,000-ohm potentiometer. Wire this combination into the circuit in place of resistor R15. With the OUTPUT control at mid-position, and the COMPRESSION control fully counterclockwise, whistle into the microphone and reduce the resistance value to the potentiometer until the output level *just* drops. Remove the combination from the circuit and measure their combined resistance with an ohmmeter. Replace the combination with a resistor which comes the closest to the measured value. Typical values will range from 50,000 ohms to 150,000 ohms, depending upon the individual characteristics of the transistor used for Q4.

Some Modifications. If the compressor is to be used with a high-impedance microphone, a transformer will be needed to match the high impedance of the microphone to the low-impedance input of the compressor. A suitable unit would have a 100,000-ohm pri-

(Continued on page 130)

A GO-GO STEREO COMPACT

BY HOMER L. DAVIDSON

Set your brain a' bubbling with a little in-crowd ingenuity and you'll transform that toy phonograph that was once used for Mother Goose's recorded rhymes into a music maker for the jerking generation!

■ How about digging up that discarded children's phonograph and setting it spinning again? But do more than just getting it to crank over: convert it to a stereophonic phonograph or—as it's more popularly known—a stereo compact!

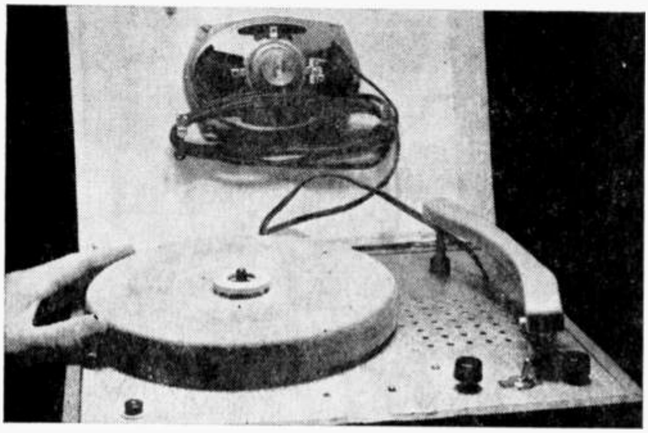
All it takes is two transistor amplifier circuit boards, a stereo cartridge, an inexpensive power supply, and a second speaker. Just put 'em all together.

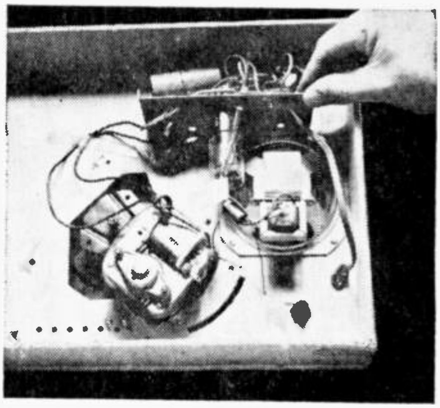
A New Twist. It makes no difference that the original one-tube amplifier in the old phono is on the *bum*, because you'll be replacing it with two circuit boards. Each amplifier circuit board uses 4 transistors and delivers a push-pull output of 1 watt. The complete board is readily available (see parts list) and need only be mounted and wired into the phonograph.

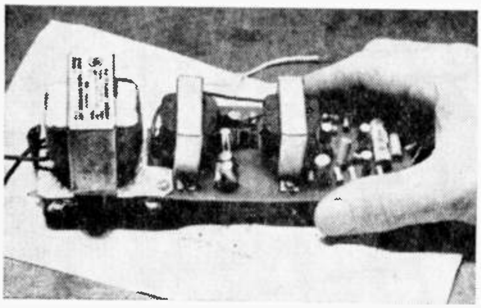
The amplifiers are designed to work into 8-ohm speakers, but they'll push the 3.2-ohm speakers usually found in the small phono with practically no noticeable difference. The speaker cone on the unit shown here was damaged so two new 4 x 6-inch oval 8-ohm speakers were used.

In and Out. A glance at the schematic diagram shows the stereo cartridge pickup which passes the signal to the left and right channel balance controls through a scratch filter. Switch S1 switches the scratch network in and out. Controls R2 and R4 are 25,000-ohm balance adjustments for the right and left channels, respectively.

The 12-volt power supply is transformer operated and uses a filament step-down transformer, T1. The 6.3 vac output of the transformer is boosted in a unique voltage doubler circuit. (Refer to the schematic diagram.) Voltage doubler capacitor C3 and CR1 and CR2 form a voltage doubling network. Actually, the output voltage from the positive side of CR1 is 14 volts DC. A filtering network of R6, C4 and C5 takes out the AC ripple from the power supply. You will note that resistor R6 is a very low value.







As shown, above left, the original phono speaker is mounted in the enclosure (note perforations). The second speaker is mounted in the cover of the phonograph. In selecting the speaker, make sure it clears turntable and arm when the cover is closed. The speaker lead is run out of the turntable board at the rear and is coiled around the fabricated brackets. The original tube amplifier, above, is removed from phono and replaced with amp board, left.

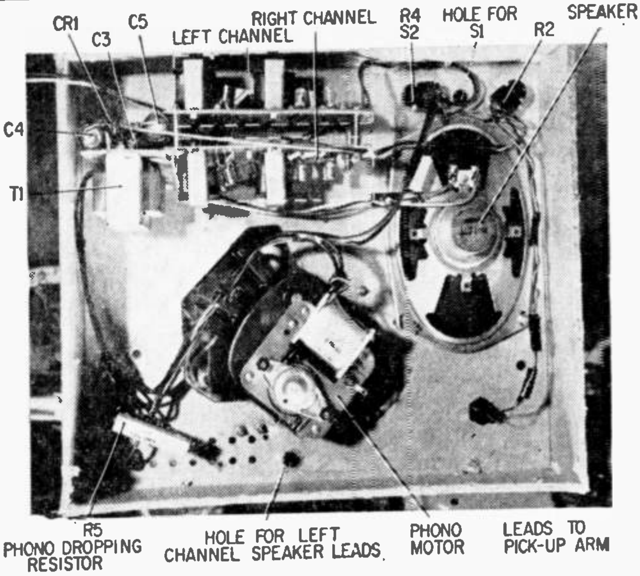
Also, capacitors C4 and C5 are very high in capacity. With the two transistor amplifiers pulling 8 milliamperes of current, R6 can only drop the output voltage 2 volts. No 60-cycle hum is heard with a high capacity filter network. A 2200-ohm resistor, R7, is a stabilizing resistor and helps lower the B+ voltage to 12 volts.

Mono to Stereo. Start by removing the old one-tube amplifier from the turntable mounting board. Take off the amplifier and volume control. Remove the old crystal cartridge from the pickup arm. Cut the AC phono-motor wires going to the small amplifier. If this phono motor operates directly from the AC line, without being in series with the amplifier tube, the additional voltage dropping resistor, R5, shown in our schematic will not be needed. (See the drawing of the phono motor hookup.) Most phono motors that are in series with the filament of the amplifier tube are 85 or 90-volt AC motors. Simply use a 100-ohm 50-watt resistor in series with the motor if this happens to be your case.

Cut a piece of aluminum to use as a chassis for the transformer. Drill and prepare the power supply chassis to mount on one end of the transistor amplifier. Mount the chassis on the end where the speaker

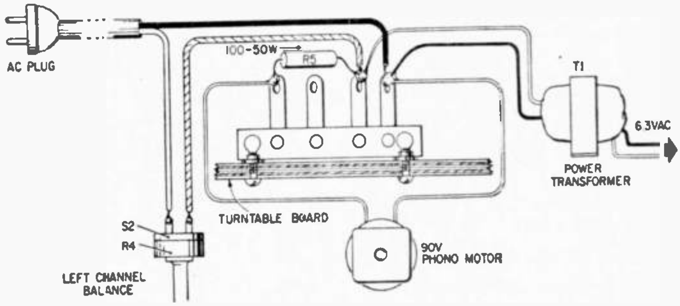
PARTS LIST FOR A GO-GO STEREO COMPACT

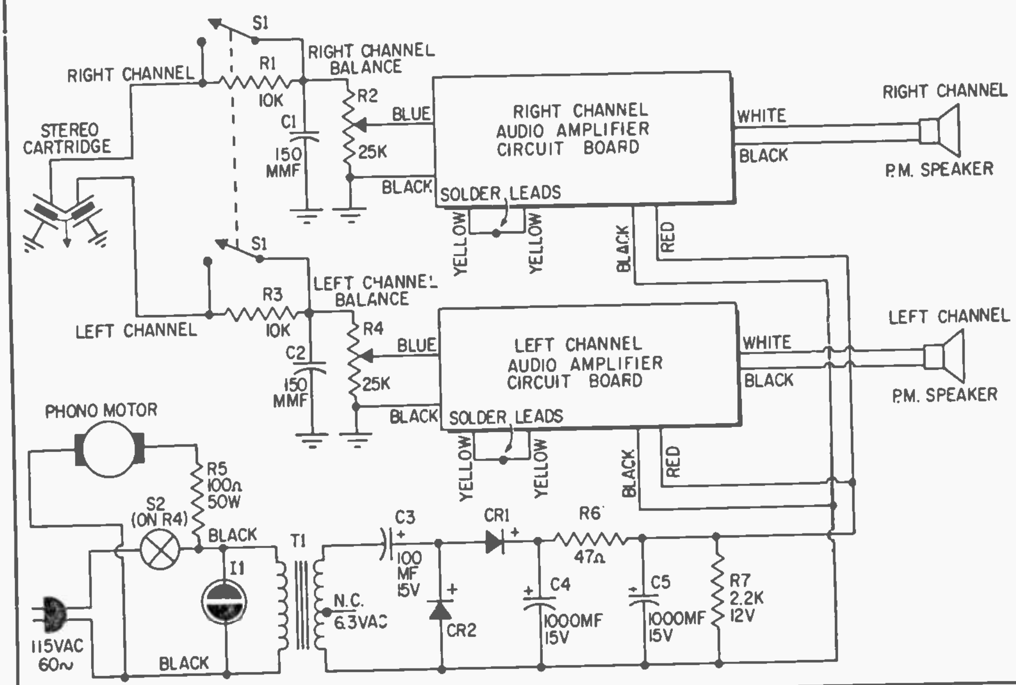
C1, C2—150-mmf fixed capacitors
C3—100-mfd, 15 WVDC electrolytic capacitor
C4, C5—1000-mfd, 15 WVDC electrolytic capacitors
CR1, CR2—Silicon diode rectifiers, 750 mil 400 PIV (Lafayette Radio 19R5002 or equiv.)
I1—Neon indicator lamp assembly (Leecraft "Snaplite" or equiv.)
R1, R3—10,000-ohm, ½-watt fixed resistors
R2, R4—25,000-ohm volume controls (with s.p.s.t. switch S2 on R4)
R5—100-ohm, 50-watt fixed power resistor
R6—47-ohm, ½-watt fixed resistor
R7—2200-ohm, ½-watt fixed resistor
S1—D.p.s.t. toggle switch
S2—S.p.s.t. switch (on R4)
T1—Filament transformer (Stancor P4134 or equiv.)
2—1-watt, solid-state, push-pull, transistor audio amplifier circuit boards (Lafayette 99R9038)
1—Stereo/monaural crystal cartridge (Sonotone 12-TH-RS77 or equiv.)
1—4-inch PM speaker (or size to match present speaker)
Misc.—Aluminum mounting angles, terminal strips, hardware, hookup wire, panel marking, speaker grille, solder, etc.
Estimated cost: $22.00
Estimated construction time: 4 hours



Nearly completed conversion of the phonograph is shown from the underside. Amplifier circuit boards are piggy-backed and the power supply components are attached to one of the boards on their own subchassis. There is generally more than enough room under the average phonograph to easily mount all the components. Note the placement of R5 and the perforations in the turntable board. The resistor becomes quite hot so be sure to position it away from wiring and components and provide vent holes above it.

Detail drawing, right, indicates how phonograph is converted to supply 12 volts DC to the amplifier circuit boards and the AC voltage to the phono motor. Schematic diagram, below, shows connections from transformer to rectifier and filter network. Leads from the boards are color coded.





transformer is located. You will then keep all AC components away from the crystal input, eliminating possible hum pickup.

A ⅜-inch hole is drilled near the power transformer mounting for a rubber grommet. The 6.3 VAC leads go through this opening. The power transformer is a Stancor R6134, although any 6.3 VAC filament transformer will do. After the power transformer is mounted, wire the other smaller components into place as the soldering process goes on. Keep the small components as close together as possible. Use a 4-lug soldering terminal strip to hold these small parts in place. Tape up the yellow center-tapped unused voltage lead.

After the power supply wiring is completed check the output voltage. You will note that when there is no load on the power supply, the DC voltage is quite high. Now bolt the power supply chassis to the perforated transistor amplifier board. Use short bolts to hold the unit, as they will be pulled out later for long spacer bolts.

Now cut four plastic or metal spacers ¾-inch in length. Small copper tubing or small aluminum TV antenna bars will make good solid spacers. Cut and bend two small L-brackets to secure the amplifier boards to the turntable board.

Wiring the Amplifiers. Bolt the two transistor amplifiers together with spacers between. Use long bolts and cut off any protruding ends. Attach the small L-brackets to the amplifier boards.

Run the red leads from each amplifier to the B+ connection of the power supply. Solder the black leads to the negative terminal. Cut off the yellow leads and solder them together. These two yellow leads were the wire terminals for an on-off switch. We are switching the unit on and off at the primary of the power transformer.

Plug the AC transformer leads into the AC outlet and check the voltage on the power supply. This voltage should be close to 12 volts. You will notice a hum when the blue leads are touched on the amplifier. Be careful when working around the transistor boards that no parts are disturbed and shorted.

Bolt the amplifier units to the turntable board. This amplifier section should be no bigger than the old one-tube job. If the compartment under the turntable is too small, the transistor amplifiers can be mounted flat against the sides. If the small PM speaker is going to be replaced for a larger one, drill out and pull off before the amplifiers are mounted.

Run another flexible phono wire up through the arm to the stereo cartridge. Mount the small turnover cartridge in place of the old one. If there happen to be lead weights glued on the plastic arm, remove them. Solder the small cartridge connectors to each wire. Cut a flexible piece of wire one inch long and solder the small tip on one end and the other end to the black or ground lead. Slip the four tips over the small cartridge male prongs. A key to left, right and ground connections will be given with the cartridge you purchase.

Bring the cartridge leads down through the arm to the scratch-filter switch S1. Wire up each balance control.

Left Channel Speaker. Cut off 8 feet of regular flat rubber AC cord and solder to the left channel amplifier speaker leads.

Prepare your stereo compact for a left channel speaker by removing the hinge pins from the phonograph cover. Cut off one half of the hinge and solder the pin to the top end. Now the top lid will slip right into the stationary hinge on the bottom unit. Take a circle cutter and cut two holes for the speaker opening. Drill the four speaker holes and four holes for a metal or plastic grille.

Solder the two wires to the speaker and bolt into place. Use a plastic strip to secure the cord to the cover and keep it from pulling out of the speaker terminals. Fasten the grille in place and on the back side, at the bottom, mount two cord brackets. The speaker cord can be wrapped around them before closing the top lid.

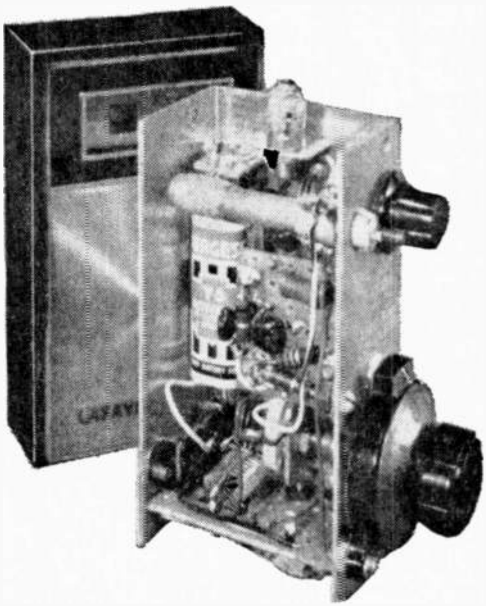
Final Assembly. Hookup the phono motor as shown in the photograph. This motor happens to be a 90-volt unit and a 50-watt resistor is wired in series. Position the resistor so its heat is dissipated through the perforations in the turntable board. Tie a knot in the AC power cord so it cannot be pulled out and solder the leads to the terminal tie point.

Drill a hole for the neon indicator, I1, in the front of the turntable board, so it can be seen. The hole should be snug to keep the unit in place. Solder the leads of I1 to the primary of the power transformer. Mount the balance controls on the turntable board and complete wiring.

Check Out. Turning on the left channel volume control. Rub your finger lightly over the crystal cartridge. Now turn the left chan-

(Conitnued on page 128)

Build the Aero Bander



by Edward A. Morris, WA2VLU

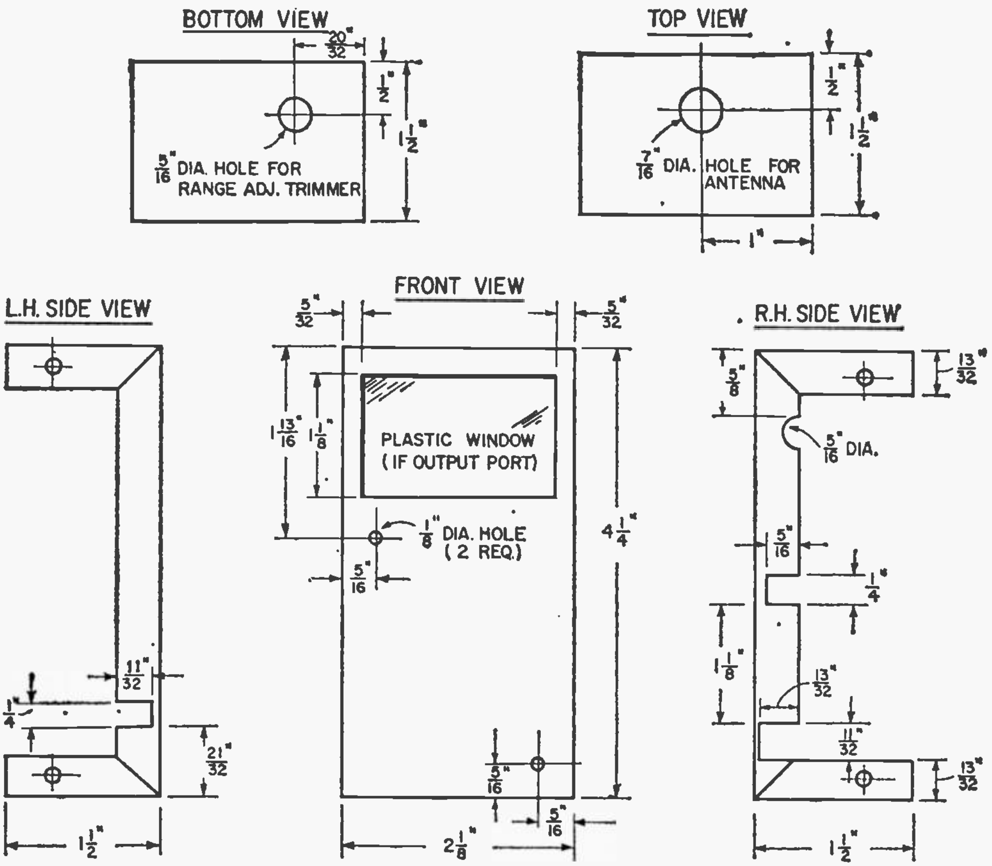
Use any transistor radio to listen to the activity on 108 to 135 MHz.

■ Here is a simple project that'll give you many hours of construction and listening delight. The Aero-Bander is a self contained converter that adapts your pocket portable transistor broadcast radio to receive the aeronautical communications that fill the bands 'round the clock. You'll be able to listen to planes taking off and landing, ground controllers, pilots requesting weather information, and much, much more.

The Aero-Bander is both easy and fun to build. A rank novice should be able to put it together in less than 5 hours! It's inexpensive, building it won't put a crimp in your wallet. Using all new parts, the total tab is less than ten dollars.

The Circuit. The Aero-Bander uses a single transistor in an Autodyne oscillator-mixer configuration. See schematic diagram. The oscillator is somewhat unique in that it operates at one-half the desired injection frequency, that is from 54.2 mc. to 66.7 mc.

Signals picked up by the antenna are coupled into the base input circuit of transistor Q1 by capacitor C1 and coil L1. The base input is peaked with variable capacitor C2, which together with coil L2 resonate at the desired incoming signal frequency. The incoming signal mixes with the second harmonic of the oscillator—that is, from 108.4 mc. to 133.4 mc.—and produces an intermediate frequency signal of 1600 kc.—which



Flanged half of the chassis box is prepared as shown above; cement window inside chassis.

is the converter's intermediate frequency.

The IF signal is radiated into the transistor pocket radio by L3, which is placed in close proximity to the receiver's antenna coil. The radio is tuned to the converter's IF signal, 1600 kc.—the "top of the dial."

Tuning is accomplished by varying capacitor C7, which together with C4, C6, and L4, control the frequency of the oscillator. Capacitor C6 serves a dual function, it sets the frequency range that will be received by tuning C7, and is also part of the feedback network that starts and sustains oscillation.

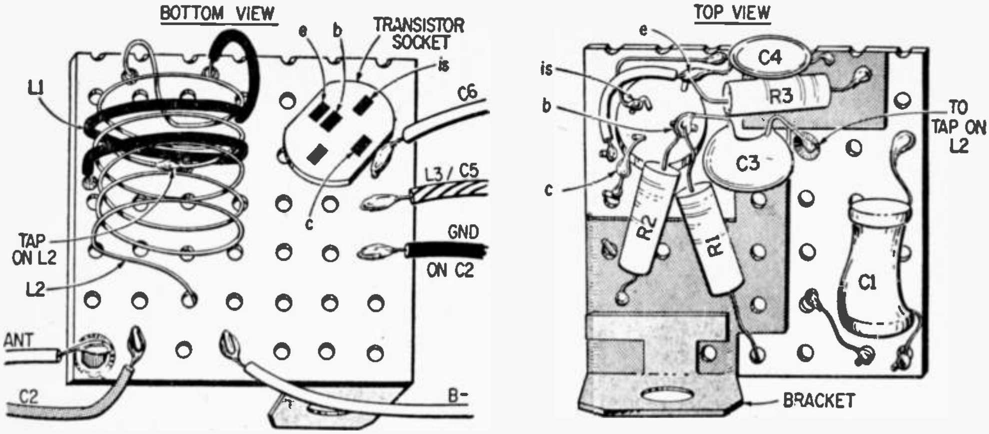
Bias current for transistor Q1 is supplied through resistors R1 and R2. Resistor R3 helps to stabilize the circuit, and is by-passed by capacitor C4.

As we said, the output of the converter appears at L3, which is tuned to the IF frequency of 1600 kc. by capacitor C5. Capacitor C5 looks much like a short circuit to the very much higher frequency signal of the oscillator, and in effect connects the collector of Q1 to coil L4.

Mechanical Construction. Begin construction by laying out the spots to be drilled on the chassis box. The larger holes are easily formed by first drilling a smaller hole, then enlarging it to the proper size with an aluminum or steel reamer. Two detail drawings, one for the chassis box cover and one for the case, give complete specifications for preparing the box prior to assembly. Follow these plans closely—do not deviate.

The opening for switch S1 can be made by drilling two ¼-inch holes ¼-inch apart, center to center. The ¼ x ½" rectangular slot is then formed with a small triangular file.

Mounting brackets for C2, C7, J1, and battery B1 are fashioned out of two size "AA" battery holders. Drill out the rivets which hold the spring clip to the body of the holder. These clips are used as a battery holder for B1. Next the rivets holding the solder tabs to the body of the holder are drilled out. The bodies of the holders are then cut apart to provide mounting brackets



Top and bottom of larger of the two perf boards are shown here for construction details.

for capacitors C2, C7, and for jack J1.

Battery terminal clips for B1 can be had by separating the terminals from the bakelite strip of a used transistor radio battery.

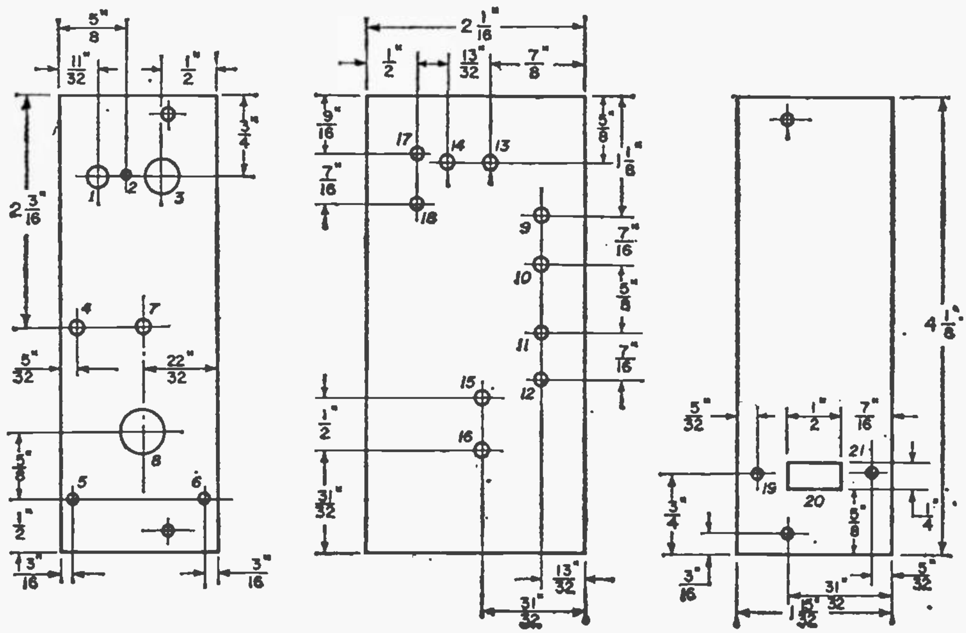
Cut a piece of 1/16-inch thick plastic and cement on the inside of the case, over the opening for the IF output port.

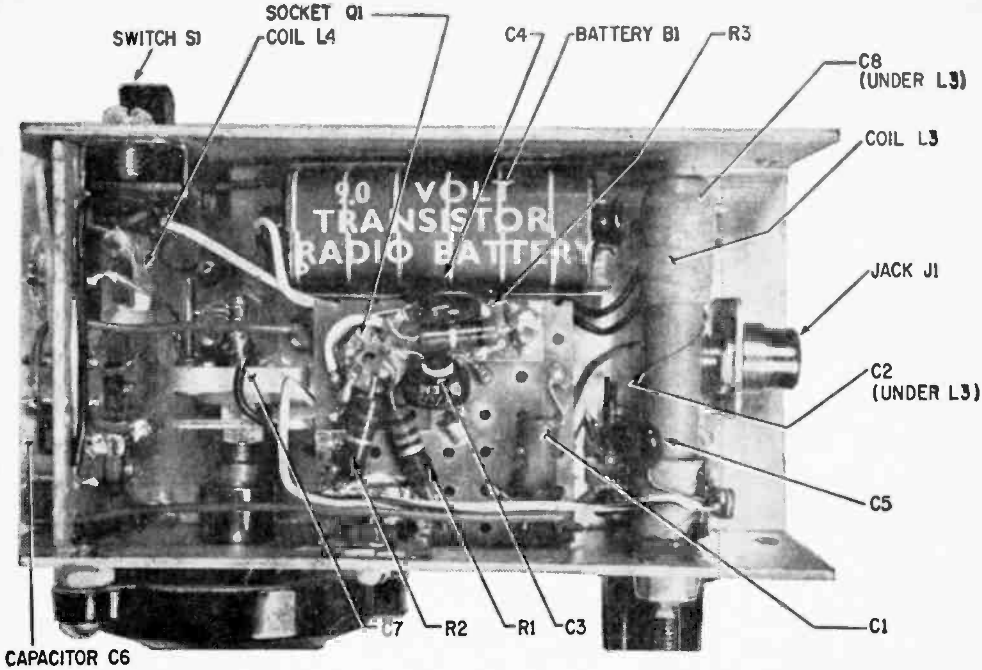
The shafts of capacitors C2 and C7 are 3/16 inch in diameter. These shafts will not directly fit either a standard 1/4 inch knob, or the vernier dial which was made for use with 1/4 inch shafts. An adapter can be made from common 1/4-inch o.d. copper tubing, which has a 3/16 i.d. A length of tubing is cut, and if necessary straightened. The adapter is slid

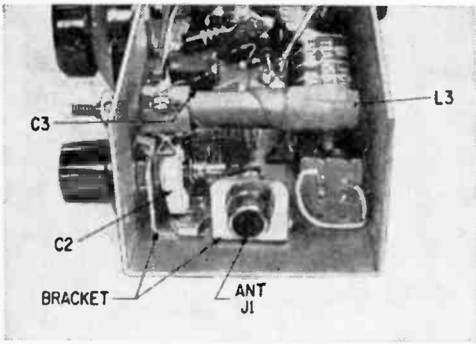
CHASSIS HOLE NUMBER KEY

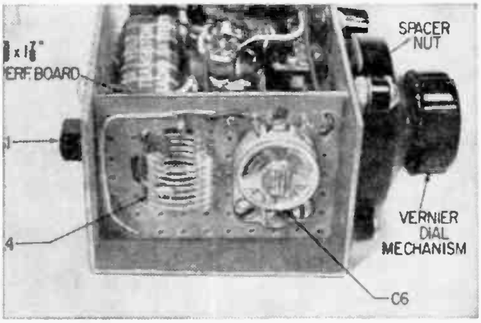
1: 5/16" diam. for L3. 2: 1/16" diam. for L3. 3: 3/8" diam. for C2 shaft. 4: hole for #4 screw to mount perf board. 5, 6, 7: hole for #4 screw for vernier dial. 8: 7/16" hole for vernier dial shaft. 9, 10, 11, 12: holes for #6 screws to mount battery clips. 13, 14: holes for #6 screws to mount antenna bracket, J1. 15, 16: holes for #6 screws to mount bracket for C7. 17, 18: holes for #6 screws to mount bracket for C2. 19, 21: holes for #6 screws to hold S1. 20: 1/2" x 1/4" cut out for on-off slide switch S1.

All components are mounted on "cover" half of the chassis box; holes are keyed by number.









Various views of chassis show the mounting of perf boards, and the location of components.

over the shaft, and cemented in place with epoxy cement.

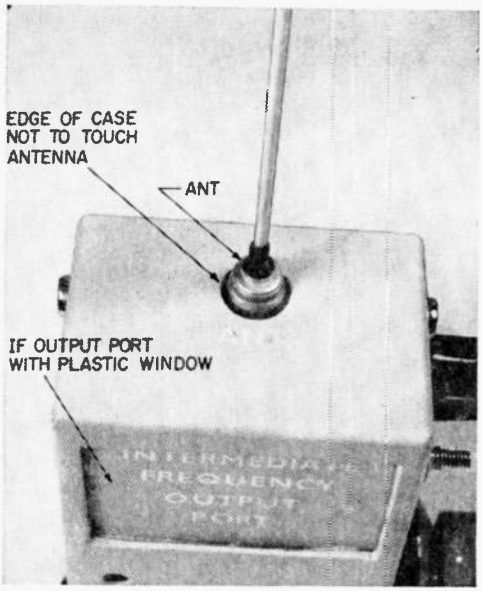
Finishing It Off. A professional appearance can be had when the case is neatly painted, and decals applied. Before painting, carefully clean the case to remove any dirt or grease which would mar the finish. The case can then be spray painted following the manufacturers directions. Remember, two thin coats are better than one thick coat. Allow for sufficient time for the first coat to dry before applying the second. Decals can be applied when the paint has thoroughly dried. Two coats of clear spray lacquer can be applied to protect the decals.

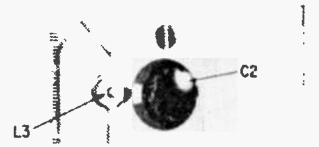
After the case has been prepared, mount the vernier dial using 4-40 hardware. Note that the vernier dial is not mounted directly against the case, but is mounted with a 3/16 inch spacer between it and the case. This is done so the lip of half "A" of the case will go under the vernier dial, otherwise the two halves of the case will not mate.

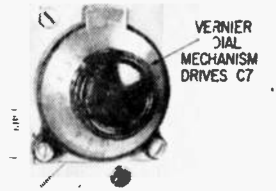
Capacitors C2, C7, and jack J1 are mounted using 6-32 hardware. Insert L3 in the mounting hole provided for it, and mount switch S1 with 4-40 hardware.

Take special note that if you alter the mechanical lay-out presented here, that the coil on L3 must be located as close as possible to the antenna coil in the radio.

Remember too that the position of the plastic window in the case will have to be changed if the position of L3 is changed. It should be directly between the coil on L3 and the antenna coil in the radio. The con-







Close-up views of front panel and top of the chassis show details of construction. Notching of chassis for L3 and tuning dial is shown above; antenna mounting details and IF output port are shown in view at left.

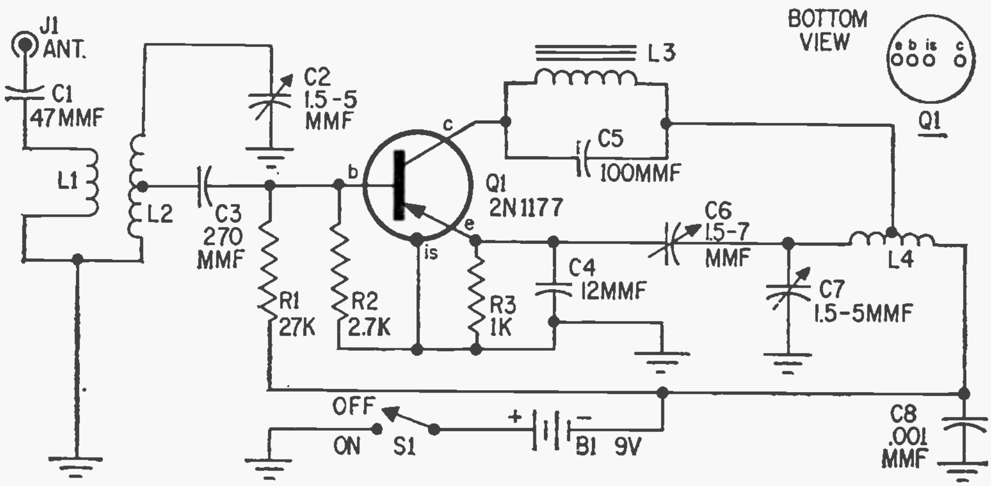
verter will not operate properly if L3 is located too close to the sides of the case.

Electrical Construction. As shown in the photographs, the unit was built on two sections of perforated board. The first section, 1⅜-inch by 1⅞-inch is located near the bottom of the unit. This section holds the range adjustment capacitor C6, and coil L4. Coil L4 is mounted in a cutout in the board, and is held in place with epoxy cement. Capacitor C6 is mounted with 4-40 hardware. Flea clips are used as terminal points. After this is wired and assembled, glue it in place with epoxy cement.

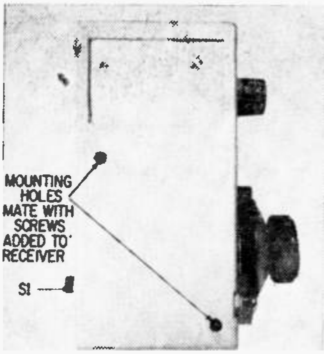
The second section of perforated board holds capacitors C1, C3, and C4, as well as resistors R1, R2, R3, and transistor Q1. The general parts lay-out can be seen in the photographs. Flea clips are again used as terminal points. The board is mechanically held in place with a bracket and 4-40 hardware.

Although the author chose to use a transistor socket for mounting Q1, the transistor may be soldered directly into the circuit. If you plan to solder Q1 in directly, be sure to use a well tinned low wattage iron and a suitable heatsink to prevent damage to the transistor. Complete the soldering quickly.

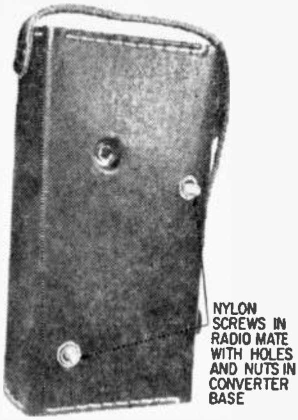
In view of the very high frequencies involved in the operation of the converter be sure to keep all leads as short and as rigid as possible. Make every effort to keep every-

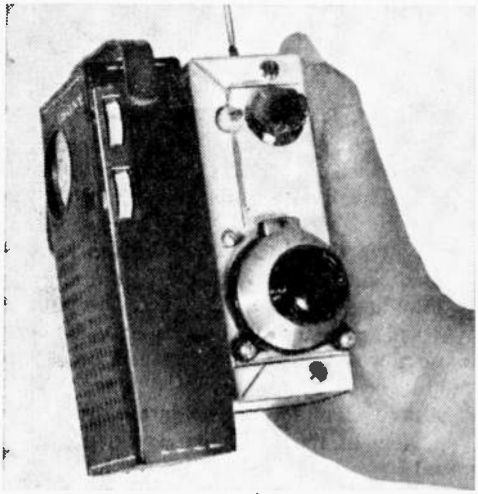


Schematic diagram of the Aero-Bander: notice the apparent absence of any output from unit!



To give your Aero-Bander a pro look bolt the unit to your transistor BCB receiver — rubberbands look messy. Place nylon studs on the receiver with mating holes in the cove of the Aero-Bander.





Piggy-backed to a standard broadcast receiver, the Aero-Bander is all set to pull in DX.

thing as mechanically solid, otherwise the stability of the Aero-Bander converter will be adversely affected.

When you're finished, recheck all wiring to be sure the unit is wired as shown in the schematic diagram. Be especially careful with the wiring to the transistor, and to battery B1.

A suitable antenna can be made from an 8-inch piece of coathanger wire. Scrape the paint from the last inch or so from one end, and tin with a soldering iron. Solder on an RCA phone plug, being careful not to use an excessive amount of solder that might cause a short inside the plug. Slip a piece of insulating tubing down along the wire, and part

(Continued on page 128)

PARTS LIST FOR AERO-BANDER

B1—9-volt battery (Eveready #E-177 or equiv.)

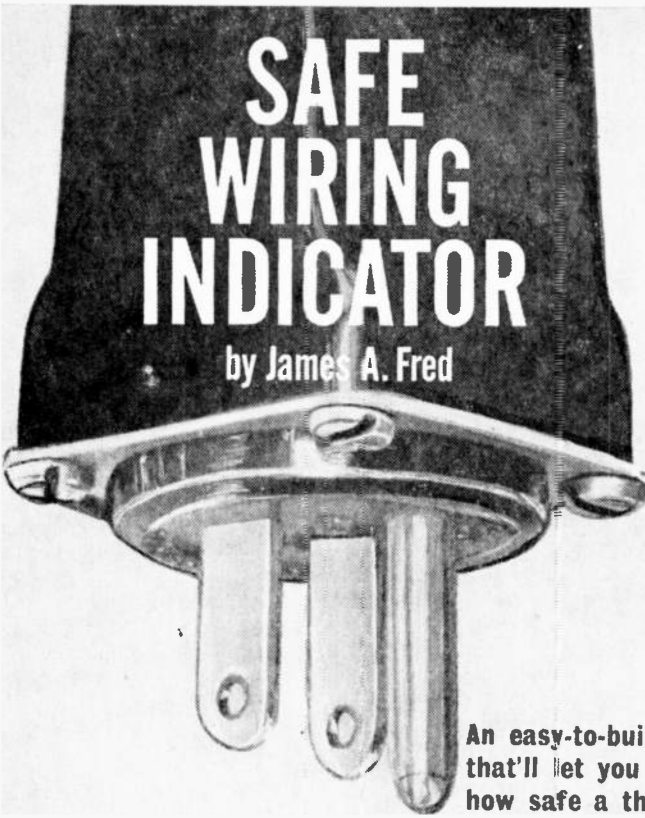
All fixed value capacitors are Eimeco type DM-10 Dipped Silver Mica capacitors, unless stated otherwise.

C1—47-pf capacitor (Lafayette #30G3518)
C2, C7—1.5-5-pf miniature variable capacitor (E. F. Johnson #160-102)
C3—270-pf capacitor (Lafayette #30G3538)
C4—12-pf capacitor (Lafayette #30G3506)
C5—100-pf capacitor (Lafayette #30G3527)
C6—1.5-7-pf ceramic trimmer (Centralab type 825EZ)
C8—.001-mf ceramic capacitor
J1—RCA single hole mounting phono jack
L1—2 turns #22 hook-up wire over gnd. end of L2
L2—5 turns B & W Miniductor #3002, tapped at 2 turns from gnd. (Lafayette #40G1611)
L3—Ferrite loopstick antenna (Lafayette #32G4108)
L4—7 turns B & W Miniductor #3003 center tapped
Q1—2N1177 transistor (RCA)
R1—27,000-ohm, ½-watt resistor
R2—2,700-ohm, ½-watt resistor
R3—1,000-ohm, ½-watt resistor
S1—S.p.s.t. slide switch (Lafayette 34G3703 or equiv.)
1—4¼" x 2⅛" x 1½" aluminum chassis box
1—2" x 1⅜" x 1/16" plastic sheet
1—Vernier dial mechanism (Lafayette 99G6031 or equiv.)
2—Size AA battery clips (Keystone #137 or equiv.)
1—RCA phono plug for antenna
Misc.—Nuts, bolts, hook-up wire, transistor socket, perforated circuit board, solder, knobs, etc.

Estimated construction time: 8 hours
Estimated cost: $10.00 or less

SAFE WIRING INDICATOR

by James A. Fred



An easy-to-build $2 gadget that'll let you know for sure how safe a three-wire outlet is!

■ Would you spend two dollars to make a small neon indicator that might save your life? Simple to build and even easier to use, the Safe Wiring Indicator will point out *safe* and *unsafe* AC outlets before you discover them the hard way. As you know, homes and factories are being wired with grounded electrical outlets. This means that you have the two regular blade openings plus a round opening in each electrical outlet. The round socket is wired to a ground wire that goes from each receptacle and metal box back to a ground rod at the meter box or to a water pipe. There is also a brass screw in each outlet that is supposed to connect to the black wire and a white nickel screw that is supposed to connect to the white wire in the Romex or other wiring cable used.

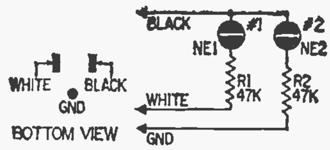
Some communities have laws that prevent a homeowner from doing his own electrical wiring. Fortunately, I live in a small community where I can add to my own house wiring without interference. I know that my receptacles are wired correctly and thus are polarized to prevent dangerous shocks. But what happens when you go to a neighbor's or relative's home to do some work? Or maybe you are a professional repairman or carpenter doing some remodeling. How are you to know that the receptacles that you plug your power tools into is wired correctly?

How It's Done. If you have one of my Safe Wiring Indicators you can plug it into the outlet you want to use and if both indicator bulbs light it is safe to go ahead and use the receptacle. The Safe Wiring Indicator can answer one of six possible questions:

1. Has the receptacle been wired correctly?
2. Is the black "hot" wire open circuit?
3. Is the white wire open circuit?
4. Is the ground wire open circuit?
5. Are the black and white wires reversed?
6. Are the black and ground wires reversed?

Completed indicator unit shown plugged into AC outlet. Neon bulbs are at top of case. Remember this won't work unless the ground terminal of receptacle is really grounded.

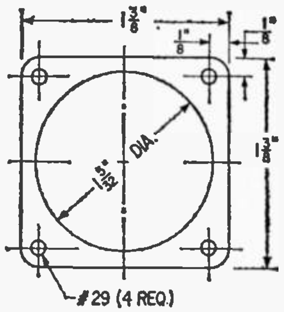
SCHEMATIC DIAGRAM



PARTS LIST

NE1, NE2—Neon indicator (Econoglow Type 117-Red, Allied Radio 7EE900, or equiv.)
R1, R2—47,000-ohm, ½-watt resistor
1—Plastic case for mounting relay (Allied Radio 75P55B or equiv.)
1—AC plug, three terminal (Amphenol 160-11)
Misc.—Sleeving, screws, sheet metal, solder, etc.

Estimated construction cost: $2.00
Estimated construction time: 1 hour



Since mounting plate for 3-wire AC plug is not readily available, it can be made from sheet metal using dimensions shown here.

You can refer to the Indicator Lights Chart for the proper light sequence. This is all done by two neon bulbs with series resistors wired to a grounding type AC plug. To make the unit convenient to use the parts are mounted in a plastic case adapted to plug into any grounded electrical receptacle. It can be "whipped" together for about $2.00 or less in an hour's time. The indicator will give you a lifetime of protection from improperly wired electrical outlets.

Making It. The mounting plate for the AC plug must be made since no known company supplies one ready made. The neon bulbs on plastic lenses can be pressed into 5/32-inch diameter holes. If necessary, a few spots of model cement may be used to lock them into place. Use 47,000-ohm, ½-watt series resistors to make the neon bulbs burn brighter. Since the neon bulbs will only be lit briefly, their life should be practically forever. Use sleeving on all bare wires to prevent shorts. You can paint the inside of the plastic case with black model paint to hide the interior wiring.

Once the Safe Wiring Indicator is finished either test it by plugging it into a properly wired outlet or by using clip leads connect it to a conventional wall outlet and the ground to a nearby cold water pipe. If the indications are correct (refer to the chart) you can put it away until you need it to test an unfamiliar electrical outlet.

INDICATOR LIGHTS CHART

Explanation of indication	Light No. 1	Light No. 2
Wiring is safe to use	On	On
Black wire open	Off	Off
White wire open	Off	On
Ground wire open	On	Off
Black and white reversed	On	Off
Black and ground reversed	Off	On

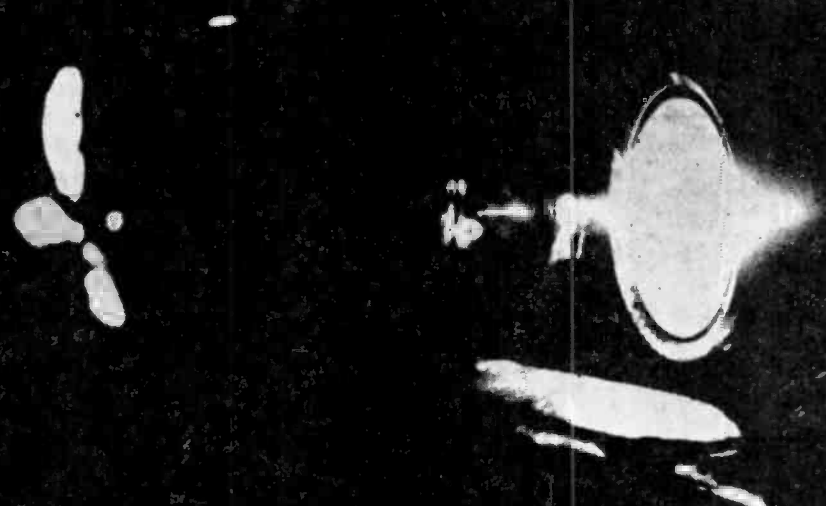
CAUTION! There are two things this device won't tell you:

1. When the white and ground wires are reversed. This isn't too important since in most cases the white wire is grounded at the meter box anyway.
2. Whether or not the ground wire is in place at the meter box. A visual inspection will soon verify this fact. ■

Electronic Light Watchman

by Edward P. Nawracaj

Headlights or parking lights can't accidentally run down the ignition-system storage battery when this little computer is on duty — always alert.



NO DOUBT you have at one time or another parked your car, locked it and walked off. Only looking back, by chance, did you discover that you had forgotten to turn off the lights. Sure, it's an inconvenience to go back and shut them off – but it's better than returning several hours later and making that discovery after your battery had run down to where it couldn't start the car.

Here is a warning device to connect to your car. It sounds an alarm and flashes a light whenever you turn your ignition *off* and leave your lights on.

A simple computer. This circuit has been designed to indicate whether certain voltages are present or absent – whether the headlights are *on* when the ignition is *off*.

The circuit uses two *npn* transistors – both are wired to act as switches. When a positive voltage is applied to their base circuits they become a closed switch (the transistor is *saturated*). Without voltage at the base the switch is open (the transistor is *cutoff*). In the schematic diagram (Fig. 1) transistor Q1 (continued overleaf)

is a logic circuit; Q2 is just a switch for indicator lamp I1 and a contact protector for K1 (I1 draws about 150 milliamperes—the coil of K1 about 20). As warning indicator I1 blinks or flashes rapidly, as K1 also clicks out its warning that your lights are still *on*.

How it works. Referring to the schematic diagram (Fig. 1) let us first assume that both the automobile headlights and ignition are turned *off*. Since the entire circuit is without power no alarm will sound.

With the ignition turned *on* and the headlights *off* (as you would for daylight driving) voltage is applied to the base of Q1 but none is applied to the collector because that circuit gets its voltage from the headlight switch which is *off*. Some base-to-emitter current flows in Q1 but not in Q2—without collector current an alarm cannot be sounded.

When both the lights and ignition are *on* Q1 conducts because the collector and base are at the same potential (+ 12 volts). Q1 is now a closed "switch"—current flows through R1 and relay coil (K1) is shorted by Q1 and the relay contacts remain in their normal (deenergized) position. Again no alarm is sounded.

The alarm will be given only when the headlights are left *on* and the ignition is turned *off*. When the ignition is off the voltage applied to the base of Q1 is absent. The collector-to-base current through Q1 stops and relay coil K1 is not shorted any longer (its "switch" is open). Resistor R1 is now in series with the coil of K1 and, since their resistance value is about equal approximately half of the 12 volts from the battery will appear across R1 and the rest across

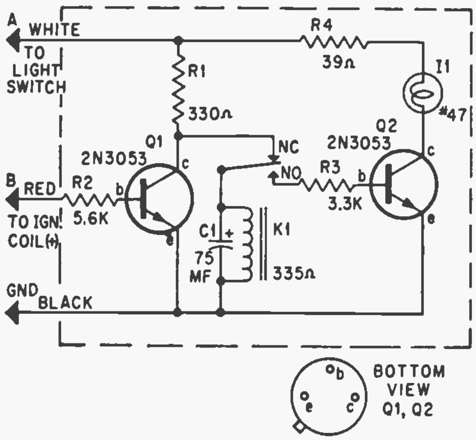
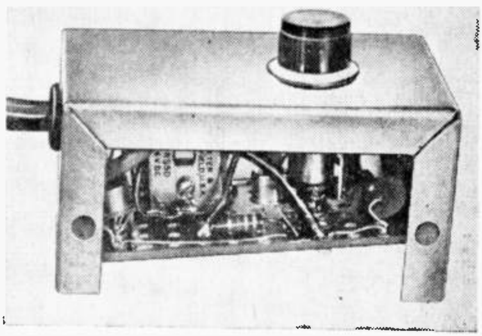


Fig. 1. In the circuit above, capacitor C1 can be increased in value to slowdown clicking of relay K1 and flashing of warning lamp I1.



Completed unit above is held into chassis box only by the pilot-lamp assembly jewel bezel.

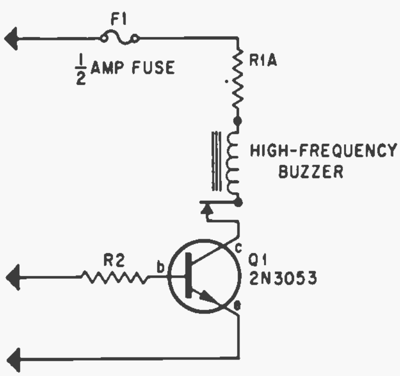


Fig. 2. Resistance R1A (1000 ohms) limits current through the high-frequency buzzer and drops the voltage so that rated value is measured across high-frequency buzzer terminals.

PARTS LIST

- C1—75-mf 15-volt electrolytic capacitor
- F1—Fuse, 1/2-amp, instrument type
- I1—Pilot lamp, Type 47
- K1—6-volt, 335-ohm coil (Potter & Brumfield RS5D)
- Q1, Q2—2N3053 or equivalent npn transistor
- R1—330-ohm, 1-watt resistor (See Fig. 2 for alternate value)
- R2—5600-ohm, 1/2-watt resistor
- R3—3300-ohm, 1/2-watt resistor
- R4—39-ohm, 1/2-watt resistor (See Fig. 3 for alternate value)
- 1—Buzzer, high-frequency Code-Practice (Lafayette 99R2556)
- 1—aluminum chassis box (Bud CU2101 or equiv.)
- Misc.—perforated phenolic board, eyelets, wire, pilot lamp assembly, lugs, aluminum for bracket, etc.

Estimated construction cost: $7.00
Estimated construction time: 1 1/2 hours

the 6-volt DC coil of flasher relay K1.

The 6 volts across K1 causes the relay armature to be attracted to the core. As it is pulled closer the *normally closed* (NC) contacts are opened and the *normally open* (NO) contacts close momentarily. The coil of K1 deenergizes and the NO contacts open and the NC contacts close—starting the energize-deenergize cycle over, again and again, until either the lights are turned *off* or the ignition turned *on*.

The frequency of the energize-deenergize cycle depends on the flexibility of the contacts of K1 and the capacitance of C1. With C1 discharged it takes a certain time for the voltage to build up across K1 as C1's charging current is limited by R1. When K1's NC contacts open the charge on C1 keeps the coil energized for a time after the NC contacts open—keeping the NO contacts closed. Normal RC time-constant calculations do not work here since the *on-off* time is affected by the pull-in and drop-out characteristics of the relay—the capacitor does not charge fully or discharge completely during the energize-deenergize cycle. To slow down the repetition rate of the clicker and flashing light increase the capacitance value of C1. Do not change R1 unless another relay, with different coil resistance, is used.

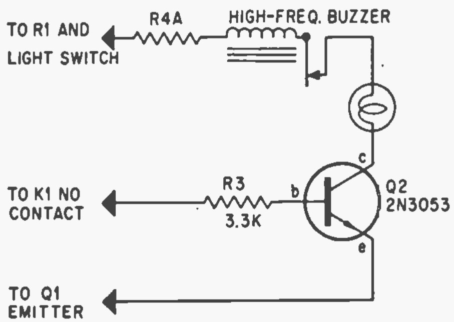


Fig. 3. When using this circuit wire a 10-ohm resistor across buzzer to pass additional current to light lamp I1 properly. Resistor R4A should be 27 ohms, 1/2 watt for a #47 lamp.

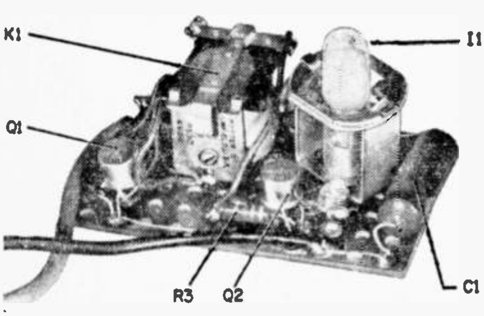


Fig. 4. Basic parts layout may seem a bit crowded—parts placement is not critical. Pilot-lamp jewel bezel threads into ring of pilot-lamp assembly that surrounds lamp I1.

Flasher Switch. The other half of the circuit is just a "switch" that controls the current through I1. The base bias of Q2 is just the charge on C1. When the NO contacts close +6 volts is applied to the base of Q2 through R3 and current flows through the collector-emitter circuit of Q2 lighting I1. R4 is a current limiting resistor and about 6 volts drop appears across it when current flows through I1 and Q2.

Some Changes. If you feel that the clicking of K1 is enough warning for you just forget about R3, R4, I1 and Q2. Without them K1 will still click about 5 times each second. (For a more audible click the relay (K1) should be mounted directly on the metal case instead of on the phenolic perforated board.)

For an even louder attention-getting warning a low-voltage, low-current, high-frequency buzzer can be used in the circuit. Connected in series with R1 (Fig. 2) you can eliminate K1, C1, R3, R4, I1 and Q2. This brings the cost of the project down to about $2. Of course the buzzer can be connected in series with R4 and I1 too. (Fig. 3). If you connect the buzzer into the circuit be sure to change the value of R1 or R4 as indicated in the schematics.

Construction. Component layout is not at all critical as long as you make sure that nothing touches the aluminum box to make an accidental short circuit. Fuse F1 (Fig. 2) can be included to automatically disconnect the unit from the light switch—it will not protect the transistors under all of the pos-

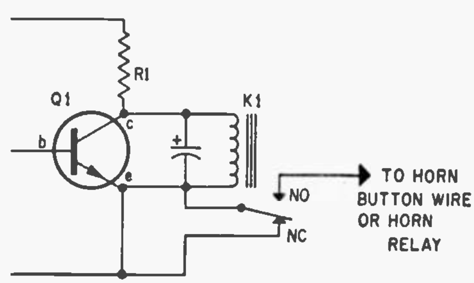
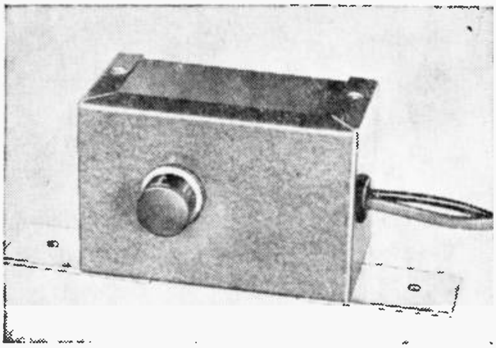
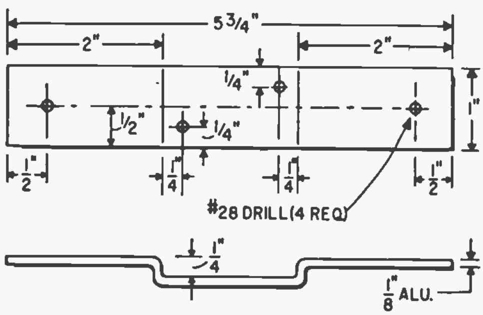


Fig. 5. Rewiring relay K1 allows vehicle horn-button circuit to become part of the Light Watchman. It is hard to ignore a rapidly beeping horn—if local laws permit such use.



Light Watchman with dashboard mounting bracket that fits holes drilled in dashboard.



Details of mounting bracket—bend offset to clear the box's flanges or use spacers or nuts.

sible problems that can arise from improper wiring or sloppy construction.

In the parts layout in Fig. 4 fuse F1 was not used. About three 75-mf capacitors can be stacked (connected in parallel) on top of C1 if you want to make the click slower or flash interval longer. This can be a lot easier than laying out new positions for the components in a larger case just because a higher capacitance unit will not fit in the space for C1.

Use Your Horn. In areas where it is not prohibited, circuit for relay K1 can be rewired (Fig. 5) so that the NO contacts can be used to actuate the horn *relay*—do not use the contacts of K1 to operate the horn directly since this heavy current will burn the contacts of K1.

Parking or Headlights. If your local laws do not require you to leave your parking lights on while your car is parked on the street at night connect while lead (A) to the tail-light circuit. These lights are on a separate switch contact—they are *on* when the parking lights are *on* and they are *on* when the headlights are *on*. No matter which circuit you use you can check the connection with a test lamp before making it permanent.

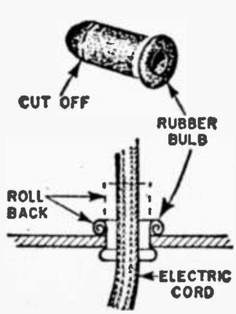
Installation. Once you have decided on where you can mount the case that contains the circuitry you'll know whether you need a bracket to mount the unit under the dashboard. Without a light as an indicator you can mount the unit on the fire wall with a couple of self-tapping screws.

With a few under-dash contortions you can connect the white wire (A) to the light switch—just check your terminals first to make sure you connect to the correct terminal.

The red lead (B) can be connected to any of the accessories that go *on* and *off* with the ignition—putting the ignition switch in the *accessories* position (if your car is so equipped) will allow you to park with your lights *on* and ignition *off* if this should ever be necessary. The ignition circuit uses a separate contact on the 3-position ignition switch. With a sealed ignition switch it may be necessary to connect directly to the ignition coil "hot" terminal—not the one that goes to the distributor breaker points. ■

Emergency Rubber Grommet

• A medicine-dropper bulb makes a handy rubber grommet for use where a power cord passes through a metal chassis. Cut off the tip, insert the bulb through the hole, and roll back the projecting end to provide a flange to hold the rubber grommet in place. ■



For a Really Sharp TV Picture

• To focus a TV set for clearest picture reception, hold a large reading glass to the screen and adjust the focus control for the tiniest size scanning lines practicable.

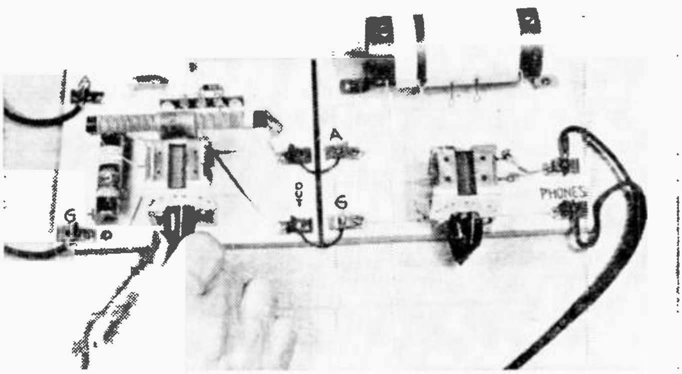
Mending an Electric Filament

• To mend the burned-out filament of an electric toaster, iron or other heating appliance, twist the loose ends of the heating element together, apply a little borax to the connection, and plug in the appliance. The borax will cause the two loose ends to weld together in an electrically perfect joint.

TRANSISTORIZED TRF AMPLIFIER STAGE

by Art Trauffer

Give your crystal detector rig half a chance to pick up DX stations by pepping up the input soup with a one transistor selective RF amp



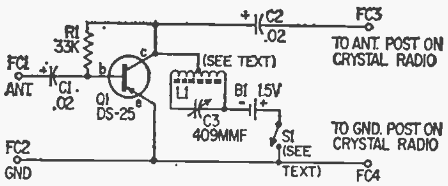
■ Want an extra boost of performance from your crystal radio? This tuned RF amplifier is the perfect new front end for your crystal set. There have been many construction projects for crystal radios, many of which include one or more stages of transistorized audio frequency amplification to boost the signal after detection. But this transistorized tuned radio-frequency amplifier stage will boost the signal before detection. This makes it possible to use a shorter antenna or just plain be ahead of the game before the signal is detected.

Matching Components. The amplifier stage was breadboarded to match the Allied Knight-Kit crystal set shown at the right of the amplifier in Fig. 1. Simplicity was the rule in building the amplifier which gives good results with only a 1.5 volt battery. The battery is connected in the circuit as shown in Fig. 2.

The components of the amplifier are mounted on a 6-inch by 4½-inch piece of ⅜-inch plywood and located as shown in Fig. 3. The 409 mmf variable capacitor, C3, is mounted using small angle brackets. Use short screws to secure the brackets to C3 so the screws don't touch the rotor plates. The ferrite core coil, L1, is mounted on the back of C3 using a strap of insulating material such as fibre, plastic or cardboard. Details of winding the coil will be given shortly.

Transistor Q1 is mounted on a 3-lug terminal strip by its own leads. Remember the heat sink when soldering the leads in place. Use long nose pliers if you don't have a heat sink. The battery can be quickly and easily mounted between two angle brackets that act as its holder. A neat trick to even get around the need for a switch to cut the battery out of the circuit is to insert a piece of insulating material between the negative end of the battery and the angle bracket (see Fig. 4).

Roll Your Own. The drawing of Fig. 5 shows you how to make the ferrite core coil,

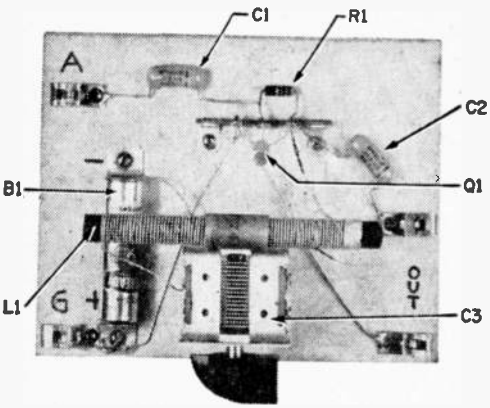


Simple? You bet it is! Only one tuned circuit is used to eliminate tracking error. Transistor Q1 is not critical. Almost any *pnp* unit rated at 2 mc., hfe 10 will do the job. Aside from units given in parts list, the following may be used for Q1: 2N247, 2N252, 2N274, 2N308-310, 2N315, 2N370-374, 2N384, 2N501, 2N504 and other pnp rf units.

PARTS LIST

B1—1.5-volt battery
C1, C2—.02 mf, 200-volt capacitors
C3—409 mmf variable capacitor (Allied Radio 13L524 or equiv.)
L1—Self-wound ferrite core coil (see text)
Q1—RF amplifier transistor (Delco DS-25, Lafayette 19R4220, or equiv.)
R1—33,000-ohm, ½-watt resistor
S1—See text
1—⅜" x 6" x 4½" plywood base board
Misc.—Fahnestock clips, terminal strip, pointer knob, solder lugs, Litz wire and ⅜" ferrite rod (see text), scrap sheet metal, hardware, hookup wire, solder, etc.

Estimated cost: $6.00
Estimated construction time: 2 hours



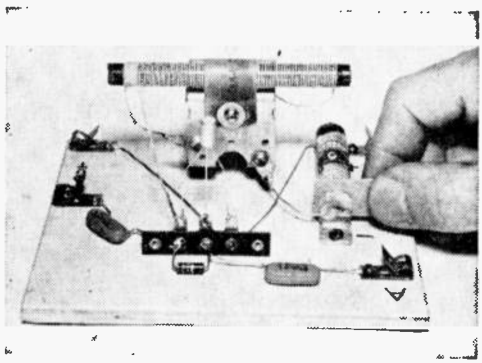


Photo above illustrates breadboard layout used by author. At left, piece of cardboard is used as switch to disconnect battery.

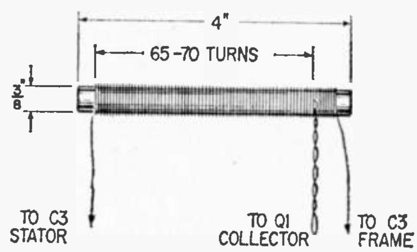


FIGURE 5

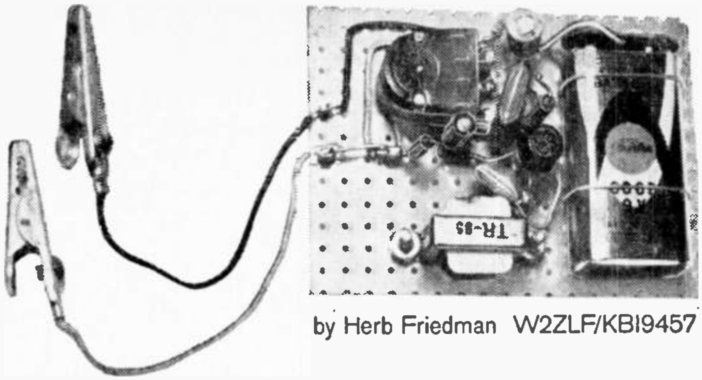
Detail drawing of fabricated coil L1. Make no substitutions and follow plan carefully.

L1. The coil works fine as an RF coil and you can also use it as an antenna coil in another project. A length of 10-38 Litz wire and a ⅜-inch diameter ferrite core was used in this project, but alternate materials can be used. For example, Belden 7-41 Litz (Lafayette 32G1485) can be wound on .33-inch ferrite core (Lafayette 32G6102). Or simply use No. 26 enameled cotton-covered magnet wire instead of Litz. Note from Fig. 5 that the first 10 turns of the coil are close-wound while the remainder of the turns are slightly spaced. Use Duco or coil cement to hold the wire at the ends of the coil and to secure the twisted tap to the collector of Q1 from the tenth turn on the coil.

Circuit Operation. The antenna input to the amplifier is through capacitor C1 which blocks DC and passes RF in case your antenna accidentally contacts a power line. Resistor R1 is the base bias resistor for transistor Q1. Coil L1 and variable capacitor C3 form the RF-tuning tank in the collector circuit of Q1. The collector is tapped close to the ground end of the coil to better match the transistor's low output impedance; this gives better selectivity. Capacitor C2 blocks DC and passes the amplified RF signal to the antenna post of your crystal radio.

As with a crystal radio, this RF amplifier works best with a good ground and a good outdoor antenna. TRF amplification can be increased a bit by using two AA batteries in series to provide 3 volts. Keep polarity in mind when wiring the circuit: the Delco DS-25 used in the project is a pnp transistor so negative terminal goes to the collector. ■

TEST AUDIO OSCILLATOR



by Herb Friedman W2ZLF/KBI9457

This signal source is the greatest for signal tracing audio circuits.

■ One of the handiest items to have in an experimenter's shop is an easy to set-up and easy to use audio frequency (AF) test oscillator; for when it comes to checking out or servicing amplifiers, tape recorders, speakers or just a home-brew throw-together circuit nothing beats having a steady signal you can follow from input to output. It sure beats going "woof test" and trying to read several meters at once.

And of course, a steady signal is all that's generally needed to check out modulator breakdowns in CB and amateur transmitters.

While a low distortion factory-built AF oscillator is always the best bet, they are expensive; and often the experimenter who has one isn't in the mood to bother with setting it up. But, take out an hour or so, throw together a handful of parts—most of which you've probably got lying around—and you can come up with the Perf-Board Audio Test Oscillator, a low distortion AF oscillator having an output frequency of about 1500 cps at .2 volts.

If you want to cut costs to absolute rock-bottom—less than $5—build it just as shown, without a cabinet; it will work the same with or without a fancy cabinet.

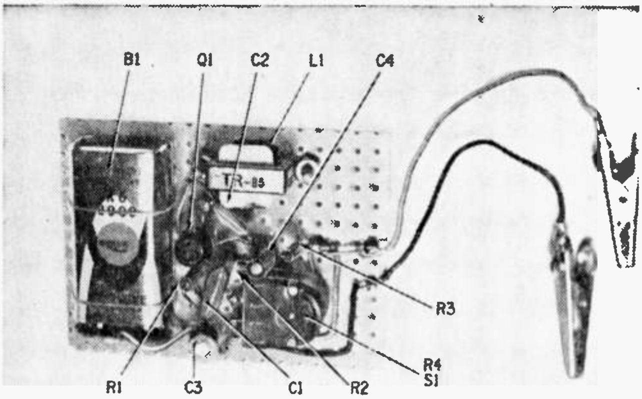
Making One. The oscillator is a transistorized Colpitts running about 1% distortion with the specified values. No component values are really critical so low-priced components can be used throughout. Nor is the wiring layout critical, just as long as the parts are connected as shown you're virtually guaranteed the project will work. While we've sort of squeezed everything together there's nothing to stop you from using a larger board, nor will there be any adverse effects if you mount the oscillator in a metal cabinet.

The unit shown is built on a 2⅞ x 3⅜-inch section of perforated phenolic board (Perf-Board). This is a stock size so you won't have to do any cutting. Flea clips are used as terminal points and all wiring is kept on the same side of the board. End-mount capacitors—with both leads coming through the same side—are used to avoid large "wire loops" which are prone to short-circuits.

Mounting is Easy. Start construction by pre-mounting the major components; volume control R4, choke L1 and battery B1. R4 is a subminiature potentiometer with built-in switch, S1; a standard size pot will crowd the board and make assembly difficult. L1 is a modified transistor output transformer; the modifications consist of cutting off the primary center-tap and the secondary leads —only the blue and brown leads are used. B1 is the miniature 9-volt transistor radio battery; it is held to the board by two wire bands wrapped around the battery, passed through holes in the Perf-Board and twisted together under the board.

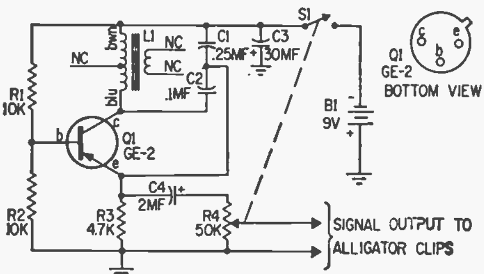
If Q1's leads are cut shorter than ½ inch, of if the soldering iron is rated more than 50 watts, use a heat sink such as an alligator clip on each of Q1's leads when soldering.

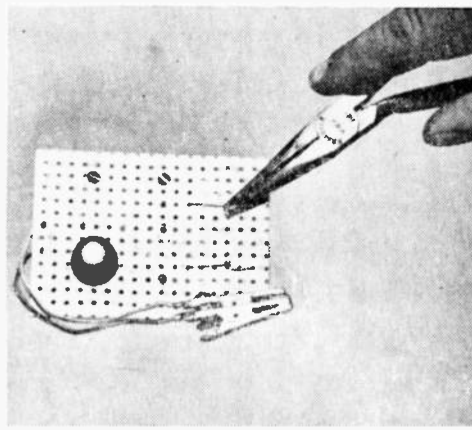
Note carefully the polarity of C3 and C4; if the polarities are reversed the oscillator won't work. Also, do not substitute for the specified Q1 unless you use a transistor which the *GE-2 is supposed to replace.



Finished project may be used without a cabinet. Two audio output leads are at right, ending with alligator clips.

Carefully follow Q1 lead layout shown in schematic and bottom view diagram. Battery is replaced (right) by untwisting wire.





PARTS LIST

B1—9-volt transistor battery (Burgess 2U6 or equiv.)
C1—.25-mf., 75-WVDC micro-miniature ceramic capacitor (Lafayette 99R6067 or equiv.)
C2—.1-mf., 75-WVDC micro-miniature capacitor (Lafayette 99R6066 or 99R6069, or equiv.)
C3—30-mf., 12-WVDC miniature electrolytic capacitor (Lafayette 99R6084 or equiv.)
C4—2-mf., 15-WVDC miniature electrolytic capacitor (Lafayette 99R6043 or equiv.)
L1—Miniature transistor output transformer, see text for modification (Lafayette 99G6123 or equiv.)
Q1—GE-2 transistor (General Electric)
R1, R2—10,000-ohms, ½-watt resistor
R3—4,700-ohm, ½-watt resistor
R4—50,000-ohm, miniature potentiometer with s.p.s.t. switch (Lafayette 32G7367)
S1—S.p.s.t switch, part of R4
1—Perf-Board, (perforated phenolic board) unclad, 2-7/16 x 3⅜-in. (Lafayette 19G3605 or equiv.)
1 pkg.—Flea clips (Lafayette 19R3301 or equiv.)
Misc.—Alligator clips, battery clips, wire, solder, hardware, etc.

Estimated cost: $5.00
Estimated construction time: 1 hour

Check the position of C1 and C2 before they are soldered into the circuit; make certain C1 is connected on the battery side of L1 while C2 is connected on the collector side—the oscillator might not work if their positions are reversed.

Any capacitors can be used as long as their voltage rating is 12 volts or higher. Voltage values given in Parts List were determined by availability and low price.

Finally, use two flea clips as tie pints and connect the AF output leads: two short lengths of wire about 6 inches long with alligator clips. If longer leads are desired shielded cable should be used.

A Tip. The oscillator can be used with any equipment whose input impedance is greater than 50,000 ohms. If it is to be used with lower input impedances, say 500 ohms, volume control R4 should not be advanced beyond the mid-position (thereby keeping at least 25,000 ohms series resistance in the oscillator's output circuit). ■

* **GE-2** replaces 2N112A, 113, 114, 123, 135, 136, 139, 140, 2N247, 252, 273, 274, 2N311, 2N409, 410, 411, 412, 413A, 414A, 415A, 2N1284.

BINARY-SWITCHING CAPACITANCE DECADE

By Jack Brayton

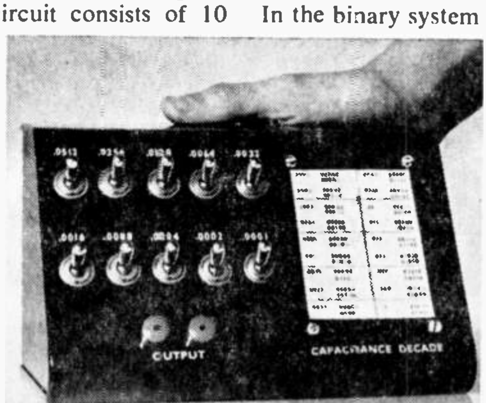
A thousand capacitance values at your finger tips—from one compact unit that occupies less bench space than a VTVM

■ Have you ever needed an unknown value of capacitance and would have given anything, except the high price, for a capacitance decade box? If you're like most of us experimenters you have; but you need not ever again.

Technically, decade isn't the right word to use since it denotes a system based on tens instead of twos. However, the word describes an instrument that performs the same job as a decade although using a different system.

This is a unique capacitance substitution box which can be built for pennies. Its range starts at 100 mmf and extends to over .1 mf! And, more important, this is covered in .0001 mf (100 mmf) steps! In short—more than 1000 distinct values are available!

If you've glanced at the schematic (Fig. 1) you've seen that the circuit consists of 10 capacitance values and 10 s.p.s.t. switches. It seems unbelievable that such a simple circuit could provide even a hundred different values let alone a thousand. But we assure you it can.



The Secret. Most of us have heard the joke about the "foolish" man who offered to work for a penny a day, doubled every day, for thirty days. In spite of how little this might sound—the fact is—that even as early as the 21st day the man would be making $10,485.76 a day! And, up to that point, he would've earned a total of nearly $21,000. This doubling principle (powers-of-two) is used with the binary number system—a system used in computers because it saves parts. Our capacitance box operates on a similar system and illustrates the part savings.

Two main differences exist between the decimal (the conventional number system) and the binary system. First, instead of using ones, tens, hundreds, thousands, etc. the binary system uses powers-of-two (ones, twos, fours, eights, etc.) as column values. Next, the numbers 0 through 9 aren't used under these values as in the decimal system. In the binary system only *ones* and *zeros* are used. A *one* indicates that the column value is present and, of course, a *zero* indicates that the column value isn't present. Any number can be made up in this manner.

Again, looking at Fig. 1, we can see that the values of C1, C2 and C3 are 100 mmf, 200 mmf, and 400 mmf respectively;

Table at right lists the values of capacitance that must be connected in parallel to obtain the correct total capacitance for accurate results from binary—powers-of-two decade box.

Table Of Capacitors

Capacitor Number	Micro-farads	Standard Values Used			
		First	Second	Third	Fourth
C1	.0001	100 Mmf			
C2	.0002	200 Mmf			
C3	.0004	400 Mmf			
C4	.0008	750 Mmf	50 Mmf		
C5	.0016	1500 Mmf	100 Mmf		
C6	.0032	.003 Mf	200 Mmf		
C7	.0064	.005 Mf	1300 Mmf	100 Mmf	
C8	.0128	.01 Mf	2200 Mmf	500 Mmf	100 Mmf
C9	.0256	.02 Mf	.005 Mf	500 Mmf	100 Mmf
C10	.0512	.047 Mf	.004 Mf	200 Mmf	

every capacitor is *double* the value of the preceding capacitor. These, of course, correspond to the 1, 2 and 4 values of the binary column headings.

Each switch in the circuit represents either a *one* or *zero* under its heading. Whether a *one* or *zero* is represented depends on the position of the switch contacts—closed they're *one*—open they're *zero.* Of course, the values of the capacitors with closed switches add since they're in parallel. As a result, the value of the capacitance across the output is *the sum of the capacitors with closed switches;* or the column headings with a one underneath.

How To Set and Use The Switches. At first it might appear that our substitution box is difficult to set but nothing could be further from the truth.

The eighteen most often used values are listed with their respective ones and zeros in Fig. 2. Notice that each value has two rows of binary numbers; the top row represents the 5 top switches on the panel while the bottom row represents the 5 bottom switches. Of course, a *one* means the switch goes up (on) while a *zero* indicates that it goes down or off.

Other Values. Any value, within range, can be easily set *by subtracting the largest column heading which can be subtracted from the desired value and putting this column's switch in the up or on position.* In the case of a remainder you do the same with it until there's nothing left.

To illustrate, let's suppose we wanted a 700 mmf capacitance. Looking at the panel we see that the largest column heading which will subtract from 700 mmf is 400 mmf so we put the 400 mmf switch up or on. We have a 300 mmf remainder. The largest column heading which will subtract from this is 200 mmf so we put its switch in the up position. This, of course, leaves a 100 mmf

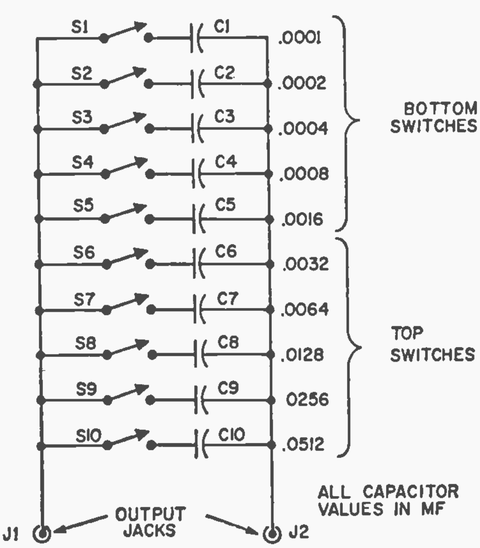


Fig. 1. Simple schematic diagram shows circuit of s.p.s.t. switches and capacitors.

.0001	00000 00001	**.0047**	00001 01111
.0002	00000 00010	**.0068**	00010 00100
.0003	00000 00011	**.01**	00011 00100
.0004	00000 00100	**.015**	00100 10110
.0005	00000 00101	**.022**	00110 11100
.001	00000 01010	**.033**	01010 01010
.0015	00000 01111	**.047**	01110 10110
.0022	00000 10110	**.068**	10101 01000
.0033	00001 00001	**.1**	11111 01000

Fig. 2. Some capacitance values are given with off (0) and on (1) switch positions.

remainder which we subtract from the 100 mmf heading (also putting its switch up) which leaves no remainder. Thus, the 100, 200 and 400 mmf switches are closed and these add to give us the desired value of 700 mmf.

The only point which should be remembered is whenever you're subtracting be certain that both numbers are in the same units. (Don't accidentally use a .001 for a .0001 value.) Of course, to change an mmf value to its mf equivalent the decimal point is moved 6 places to the *left*. It's moved to the *right* 6 places when converting from mf to mmf.

Getting Started. The first step toward building a project is always obtaining the necessary parts. This, of course, is simple enough. However, because we've used quite a few capacitors, much time can be saved if we steer you to their source. Other types of capacitors may, of course, be substituted but those listed are both low in cost and come in the values best suited to the project.

All of the capacitors used, in the original model, except the .047 mf, are Sprague, temperature-stable, 10%, 1000 volt ceramics and are available from Allied Radio. The .047 mf is a 1000 volt paper tubular.

As for the switches—almost any slide or toggle s.p.s.t. switch will work except those designed for low voltage applications.

Construction. Fig. 3 shows the locations of the panel-hole centers. To prevent marring the cabinet, the centers should be first marked on a sheet of graph paper (4 by 7 inches). This can then be taped (or rubber cemented) to the front panel and the hole centers punched. Since a sloping-face chassis is used, the hole centers should be *deeply* punched and the drill bits sharp to prevent the drill from "walking" across the panel—use a small-size drill first, then a larger one.

The size of the switch holes depends, of course, on the switches selected. Those specified mount in 15/32-inch holes. If another type is substituted check their size before drilling.

PARTS LIST

C1-C9—make from one or more of the following 1000-volt ceramic-disc capacitors: 1—50 mmf; 5—100 mmf; 3—200 mmf; 1—400 mmf; 2—500 mmf; 1—750 mmf; 1—1300 mmf; 1—1500 mmf; 1—2200 mmf; 1—.003 mf; 1—.004 mf; 2—.005 mf; 1—.01 mf; 1—.02 mf; 1—.047 mf.
J1, J2—Tip jacks or banana jacks.
S1-S10—S.p.s.t. Toggle switch (Allied Radio 34 U 527) or slide switch (Allied Radio 35 U 023) or equivalent.
1—Bud 1609 Chassis or equivalent.
Misc.—2 pkgs. Flea Clips; 1—perforated, unclad phenolic board (2 7/16 by 3 3/8-inches); 22 awg Bus wire, 4—standoffs (see text) tapped for 6-32; 8—1/4-inch, 6-32 machine screws.
Estimated cost: $10.00—$3 less when slide switches are used.
Estimated construction time: 4 hours.

If decals or wax transfers are to be used as panel markings they should be applied *before* the components are installed in the cabinet. It's hard to align them otherwise. The switch markings are 1/2" above the hole *centers* and adhesive cellulose tape, of this width, applied to the panel serve as guide lines.

Capacitor Sub-Assembly. All of the capacitors are mounted on a piece of perforated, unclad phenolic as shown in Fig. 4. The board size (2 7/16x3 3/8 inches) is a stock size and no cutting is necessary. Both the perforated board and the flea clips (2 packages required) are available from Lafayette Radio or other electronics parts suppliers.

The first step in building the sub-assembly is enlarging the four corner holes using a 9/64-inch bit. These holes match those on the panel. The four stand-offs can be of any length from 1/2 to 3/4 inch and they're fastened to

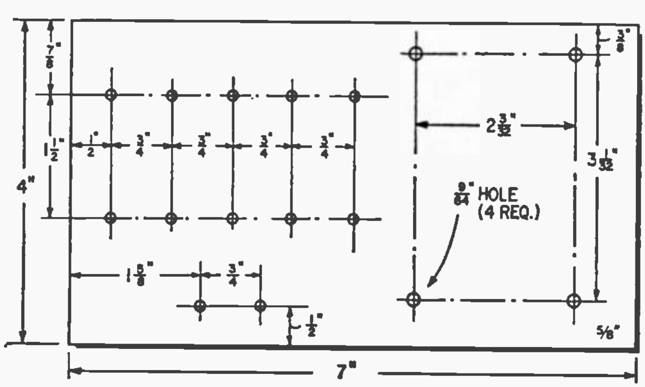


Fig. 3. Front-panel layout is for a 4- by 7-inch sloping-front cabinet. The four 9/64-inch holes on the right must be marked and drilled accurately to mate with tapped spacers. Tubular-type spacers allow more sideplay but assembly becomes a bit more difficult.

the perf-board with 6-32 machine screws.

The flea clips (2 lines of 10 each) are inserted in the *second row of holes from the edge of the board*. The first five clips in each row are *spaced 1 hole apart* while the following five are put in *every other hole*.

Ten basic capacitors are used in the project. However, because these capacitors are not standard values they have to be made up from several standard values in parallel. Table 1 lists the values used for each capacitor.

Space on the board is limited. Therefore, the larger ceramics have to be staggered—one toward one side and one toward the other. Care should be taken to insure that the leads of one group do not touch those of the next. And, as a general rule, the largest capacitor, in each group, should have the smaller capacitors soldered across them. Attach the leads close to the larger capacitor's body. The leads of the largest capacitor can then be used to mount the entire group. However, the ceramics across the .047 mf tubular *are not* fastened to the .047's leads—instead they go directly to the flea clips. Also the leads on the .047 must be bent so the body of the capacitor is over the edge of the board slightly and *its other edge doesn't extend past the flea clips.* Its leads can then be shoved down the center of the clips and cut-off on the bottom. A short length of bus-wire (22 awg) is run down one side of the board (shown in Fig. 4) and soldered to *each* terminal in the row. Before the board is mounted on the panel a wire must be soldered to each of the ten remaining terminals—to the bottom of the clips on the underside of the perforated phenolic board.

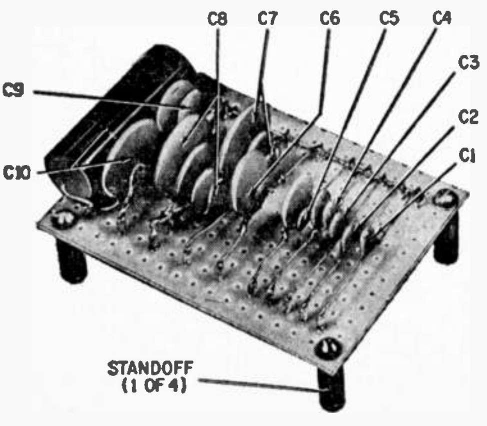


Fig. 4. Capacitors C1, C2 and C3 on board are not paralleled values—all others are.

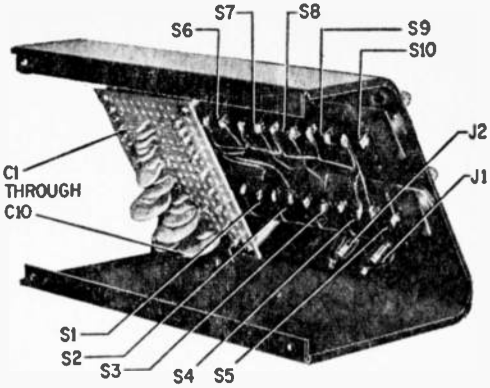


Fig. 5. Unit can be half as wide if capacitor board is mounted to cover the switches.

The final wiring is done according to the schematic shown in Fig. 1 and consists of merely connecting the wires to one terminal of their respective switches. The other terminal, of each of the switches, connected to a common bus-wire as shown in Fig. 5. One output jack is then connected to the bus-wire on the switches and the other to the bus-wire on the capacitors.

Checking The Unit. After construction is complete the unit should be checked visually for shorts, poor solder connections and, if possible, continuity checks should be made in the following order.

1. Check for continuity from the bus-wire on the capacitor board to J2.

2. Put all the switches in the *down* position and check for continuity from *each* of the 10 capacitor terminals to J1. (Continuity *should not* exist.)

3. Check for continuity from the terminal of C1 (side opposite the bus-wire) to J1. Turn S1 *on* and *off*. (Continuity *should* be present with the switch *up* and *should not* be present with the switch *down*.)

4. Repeat the above step for each of the other switches making sure only one switch is *on* at a time.

5. Make a final check of the capacitors, be sure each group contains the right values.

The above checks assure you the unit is wired correctly and the proper capacitors are connected to the right switches.

The last step is attaching the chart shown in Fig. 2 to the front panel. ■

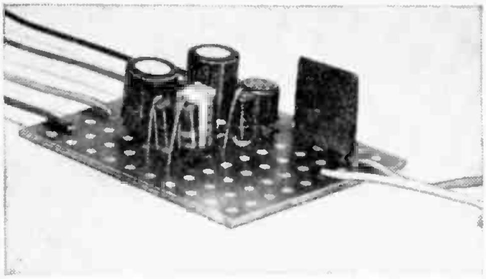
Transi-Match

You don't need large audio transformers —just change your transistor circuit.

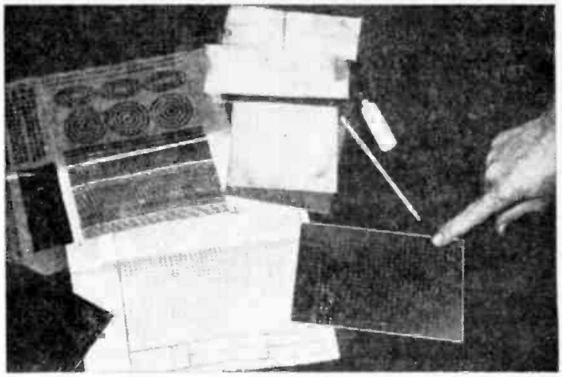
By Herb Friedman,
W2ZLF/KB19457

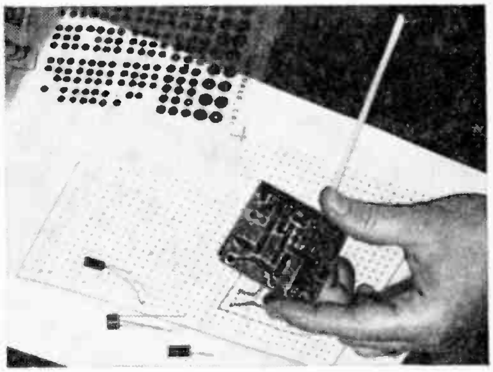
■ Until all electronic gear is fully transistorized—or to use the newer term, all solid-state—the average experimenter and hobbyist will have his hands full trying to utilize *tube* components with transistor equipment. A good case in point is the ordinary microphone. Many hobbyists, be they audiophiles, CB'ers or hams, have a collection of microphones which are all but useless with transistor circuits. In the case of crystal and ceramic mikes, which are designed to work into high-impedance loads (of 1 megohm or more), the low input impedance of typical transistor amplifiers loads down the mike, resulting in almost no low-frequency response and sharply-reduced output voltage. Even the high-quality, high-impedance dynamic mikes used by audiophiles and tape recordists suffer from low-impedance loading.

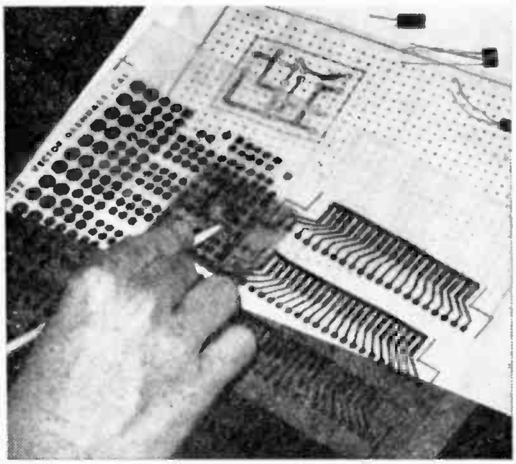
Want a specific instance of the problem? Then take those inexpensive four-channel mike mixers generally used by tape fans to mix two or more mikes into a home recorder with only one mike input. While there's no difficulty in feeding the low-impedance mixer output into the high-impedance mike input on the recorder, the relatively low input impedance of the mixer (usually between 100K to 500K) will drop the "fi" right out of any mike designed for a high-impedance load. *(Continued Overleaf)*



It's hard to believe that the neat little Transi-Match (above) grew from a handful of papers and a piece of perforated phenolic board (top, right) contained in a kit for making experimental printed-circuit-boards. Circuit is first transferred to polka dotted layout sheet then resist is applied to board and unwanted copper etched away.



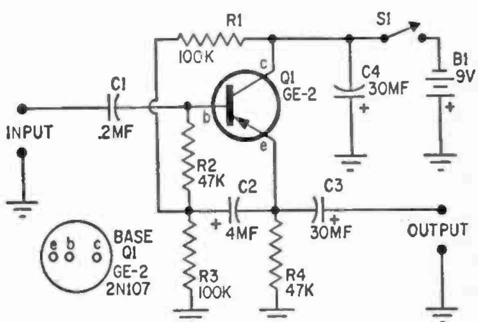




Following layout sheet, resist pattern is applied to perforated phenolic board that has been precut to size indicated on layout sheet (left). Circuit is now doublechecked. An error can still be changed. Even components should be inserted or positioned to see if they can fit the allotted space on circuit board.

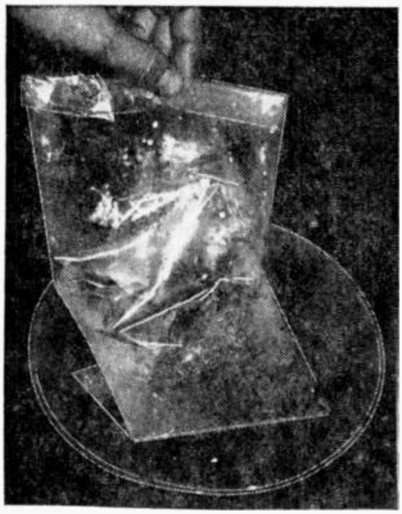
Again, the same problem occurs when one tries to replace the mike supplied with an inexpensive solid-state tape recorder with a good-quality/high-output ceramic mike; again, the low-impedance loading destroys the mike's frequency response.

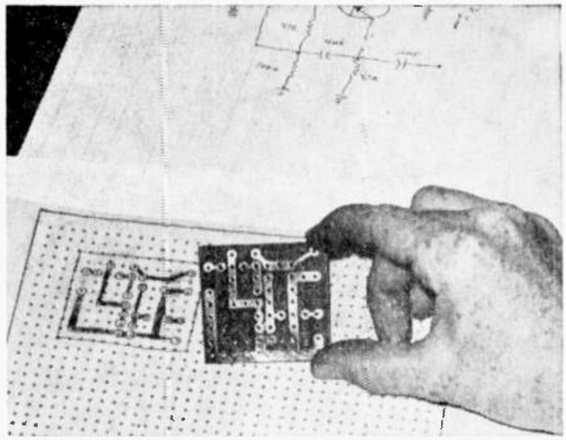
Or maybe you don't have an impedance matching problem *yet*. Perhaps you've got a good case of hum on a long mike line; a quick conversion from high to low impedance is all that's needed to restore a good signal-to-noise ratio. High-impedance microphone lines are notoriously sensitive to hum pickup. Further, the longer the line the greater the high-frequency losses due to the center-to-outer-conductor capacitance of the shielded mike cable. But, if the mike's high impedance is transformed to a low impedance *at the microphone*, the line's hum sensitivity falls to almost nothing, as do the high frequency capacitance losses. Transform the impedance of even a crystal mike to 50 or 150 ohms and you can run a couple of hundred feet of line with virtually no hum or frequency loss problems.

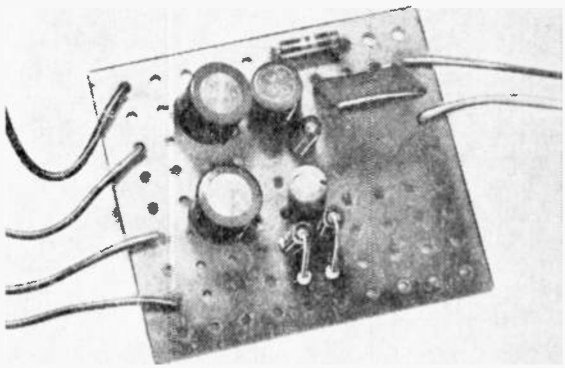


The output of the one-transistor circuit can be connected to input of an amplifier.

Impedance Matching. The solution to the high-low problem is the Transi-match







Only after the resist pattern has been doublechecked and you are certain everything is completely correct is it safe to slip the copper-clad board into the small plastic bag containing the etching chemicals (above). After a few minutes the copper, unprotected by the press-on resist, will start to disappear. When all of the unwanted copper is gone, the etched board must be taken from the chemicals and washed and rinsed carefully—the resist is scrubbed from the remaining copper with steel wool (top, right) and the components are mounted (right).

PARTS LIST

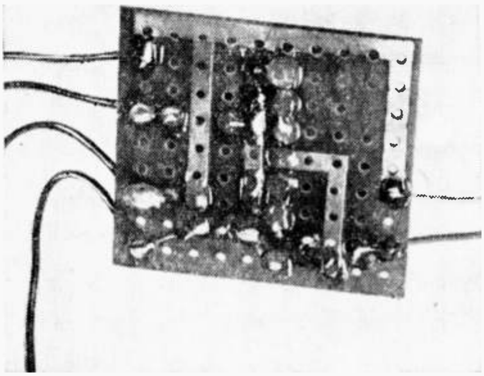
R1, R3—100,000 ohms, ½ watt, 10%
R2, R4—47,000 ohms, ½ watt, 10%
C1—.2 mf, 75 WVDC
C2—4 mf, 15 WVDC
C3, C4—30 mf, 15 WVDC
Q1—Transistor, GE-2 (General Elec.), SK-3010 (RCA see text), 2N107, 2N404, 2N508, 2N1191, etc.
B1—9 volts (Burgess 2U6 or equiv.)
S1—SPST
Misc.—Vector Printed Circuit Kit #27X-A for printed circuit version.
Estimated cost: $4.00
Estimated construction time: 1 hour (does not include printed circuit version)

shown in the schematic diagram, a one-transistor circuit whose sole function is to match a very high impedance to a very low impedance. In terms of amplification—there is none. There is actually a loss of 2 db or so since this is an emitter-follower type circuit.

Actually, the Transi-match is an old friend—the *bootstrapped* amplifier, which simulates (to the source) a high-impedance load by using positive feedback. A portion of emitter (output) signal is returned to the base via C2.

The Transi-match is ideally suited to the hobbyists as it's input impedance is nominally 1.5 megohms. With loads ranging from 50 ohms up it is flat (within ± 1 db) from 20 cycles to over 50 kc. While some capacitor values are considerably larger than those usually used in a circuit of this type, the specified values have been chosen to make the Transi-match universal—the frequency response being virtually independent of load.

Typical of any high-impedance amplifier, care must be taken to avoid "hum" pickup in the input circuit. While the usual low input impedance of transistor amplifiers allows the use of ordinary hook-up wire,



Underside of board shows 'solder connections between components and copper foil.

unshielded Transi-match input leads will result in severe hum; use normal shielding techniques—just as you would for a tube-type amplifier.

The Power Supply. While a 9-volt battery is shown the Transi-match can be used with any 6- to 12-volt DC supply. Since the current drain is quite low, about 100 microamperes, it does not place a strain on any battery-pack supply and can be added to most amplifiers.

The schematic shown uses a negative power supply with the positive battery terminal grounded. A positive supply with a negative ground can be used if Q1 is replaced with an NPN transistor like the RCA SK-3010, a general replacement type. Also, make certain you reverse the polarity of all capacitors.

Since the Transi-match involves only a handful of components it can be easily assembled on a small printed-circuit board (PC board) which can then be built into a solid-state amplifier. A typical PC version is shown in the photographs.

A Printed Circuit. Making your own PC board(s) is not difficult, even for the beginner, and with a modern PC design kit such as the Vector 27X-A you can learn the tricks of miniaturization which may be used for many projects.

The Vector kit is especially designed for quick-and-dirty one-shot boards; it is very useful to the hobbyist because the boards are made without special resist inks or photographic processing. The heart of the Vector process is a transfer resist similar to the rub-off characters supplied in children's toys. You know the type, the child cuts out a picture of Dick Tracy, turns it over, rubs the back of the transfer with a stick and Dick Tracy is transferred to another surface. The Vector resist works the same way; you turn over a sheet containing resist circles, lines curves and swirls, rub the paper with a stick and the resist is transferred *neatly* to the copper foil.

Several pieces of copper clad board are supplied, with one being more or less designed for the rank beginner at PC boards: this board is pre-drilled with component lead holes arranged in a grid. This arrangement eliminates the need to drill component holes.

A PC Transi-match. Copy the schematic —and make it BIG. Note that if you lay the actual components over the schematic they actually fall into place as they would be arranged in a printed circuit version. Use the Vector layout sheet. It has a grid of dots corresponding to the holes in the pre-drilled copper-clad board. Layout the PC wiring so it conforms exactly to the schematic. Position the components on the grid so their leads fit through the holes. Draw a circle around each dot where a component will pass through the board to the copper foil. Use a separate dot for each lead. Don't try to jam two or three leads through the same hole. Be sure to make the common (ground) lead extra heavy (wide) and run it along one or two edges so the mounting screws will ground the Transi-match to the associated equipment.

When your sketch is finished draw the boundary line and cut a section of perforated board to the exact finished dimensions. Transfer the drawing to the copper foil with carbon paper or just match the resist designs to the drawing and apply the resist directly to the copper foil. Just as with the drawing, transfer the resist circles which are the terminal points and then connect them together with resist lines. A hint—chemicals last longer with least etching.

The chemicals supplied with the kit etch away the undesired copper—the copper that has not been protected by the resist. After being immersed, for a few minutes in the chemical solution, the undesired copper will disappear. Remove the PC board, strip off the resist—follow the manufacturers instructions exactly. Then push the components through the proper holes, solder, and the PC Transi-match is completed.

If you need several Transi-match units it is best to prepare all the PC boards with resist and then etch them all at once. ■

POLARITY TATTLETALE

by

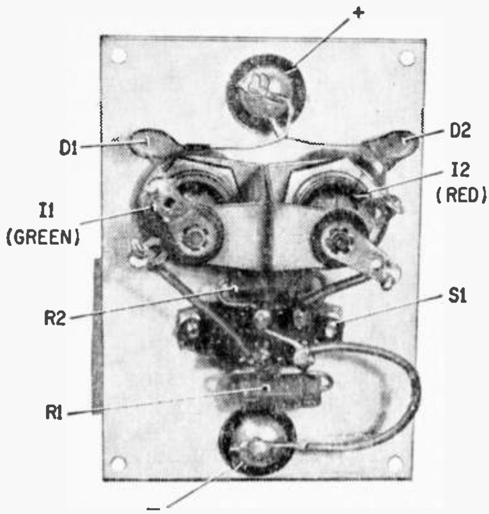
James A. Fred

Are you positive of your polarity? This handy little electronic gadget will indicate battery or charger polarity. Low in cost—easy to build. Why be without it?

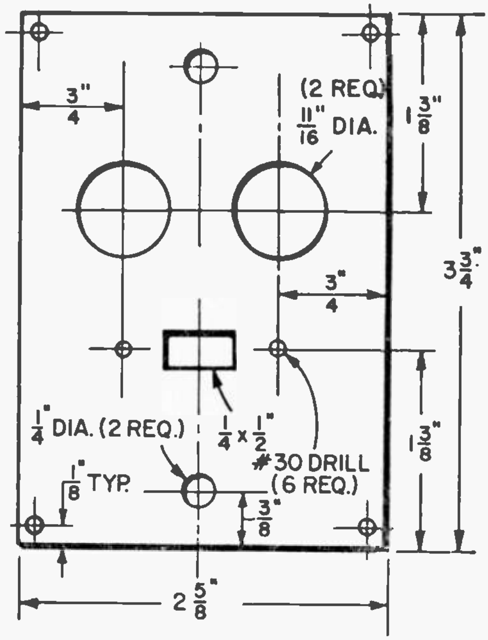
■ Several years ago most battery chargers made for use by the home auto mechanic, had red and green lights on their front panel. The green light was a combination power ON indicator and a proper polarity indicator. The red light was a wrong-polarity indicator. It would light up if the charger was connected to the battery backwards. The newer battery chargers shown do not have polarity indicators. Many of them do have an ammeter however, which will go violently off scale if the charger is connected backwards.

One of the oldest ways used to detect polarity is to use a potato. Just cut a potato in half; plunge a pair of wires into the cut surface. The area around the positive lead connected to the battery will turn green. A more modern way is to use a voltmeter. However most home style auto mechanics don't have a voltmeter.

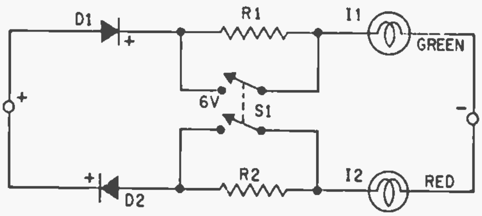
This little device that we built uses the property of a silicon rectifier of passing current in only one direction to indicate the polarity of a battery charger. Each rectifier is connected in series with a light bulb and when the plus side of the battery is connected to the positive terminal then the green light will light, but if the negative terminal of the battery is connected to the positive terminal then the red bulb will light indicating that the battery is connected backward. By using 6-volt bulbs and switching in a series resistor for a 12-volt battery, the device can be used on both 6- and 12-volt batteries or power supplies. *(Continued Overleaf)*



Large terminal screws are for convenience since current is limited by pilot lamps.



Complete circuit is mounted on this cover using lamp and switch lugs as tie points.



Circuit is simple. R1, R2 limit current through 6-volt lamps when used on 12-volts.

PARTS LIST FOR POLARITY INDICATOR

D1, D2—Silicon rectifier (Mallory 1N2090 or equiv.)
I1, I2—Pilot lamps (See text)
R1, R2—Resistors, 2-watt (See text)
S1—D.p.s.t. slide switch
1—molded black plastic case, 2 7/8" x 4" x 1-9/16" (Allied 87U895 or equiv.)
Misc.—Green pilot-light assembly; red pilot-light assembly, aluminum for case cover: wire; solder; terminal and mounting hardware; insulating washers; etc.
Estimated construction cost: $3.00
Estimated construction time: 2 hours

Start the Project. First collect all the parts on the list. Layout and drill the holes in the cover. The cover can be made of metal, wood, phenolic or other material of your choice. I used aluminum because it is easy to work with. The aluminum was etched in a strong solution of household lye until it had a uniform satin finish. A coat of clear spray was applied and then decals were applied. Another coat of clear spray finished the cover. When mounting the battery connecting bolts be sure and use insulating washers if your cover is made of metal. The polarity connections to the rectifiers are very important because this determines which light will light. You may use type 51 lamps with a 70-ohm, 2-watt resistor or type 47 lamps with a 56-ohm, 2-watt resistor for maximum brightness during 6-volt operation. If you will be using only 12-volt batteries (or can stand less brilliance during 6-volt operation) use a 12-volt lamp like the 428, 1446, 1487 or 1815. Then you can also eliminate the 6/12-volt switch and the two 2-watt resistors.

Making Tests. After you have wired and double checked the Polarity Indicator you are ready to test it. To test a battery or battery charger for polarity connect a wire from the plus wing nut on the tester to a post on the battery and connect a wire from the negative wing nut to the other post of the battery. (We are referring to the common type lead-acid automobile battery rather than a dry cell battery.) If the *green* indicator lights up you are connected properly, but if the red indicator glows you have the wires to the battery reversed. After determining the proper polarity of a battery terminal take some red fingernail polish and paint the top of the positive terminal post. ■

The Mighty Stereo Midgets

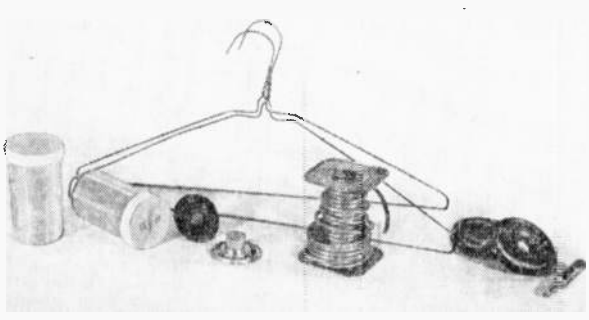
By Roy E. Nelson

**Listen undisturbed and in quiet!
No more distracting noise!
Neighbors can't complain about
window-rattling crescendos!
You won't upset your budget!**

■ Realism in the field of stereo listening has created the advent and subsequent sale of the stereo headset with some relief to the family if you like Mozart at 2:C0 A.M. These gadgets vary in price from $15.00 to $50.00 a pair and venture to guarantee your very presence in the concert hall.

Uniquely enough all the parts to build an excellent pair of these "realistic" listeners are right in the nearest neighborhood electronic parts house and at a bargain price. A pair of coat hangers, like your wife gets for free, and a quick visit to your neighborhood drug store will complete the parts list.

Mechanical Construction. The heart of this stereo headset is a pair of 2-inch speakers that are used for replacement in the small transistor radio sets. (My particular pair come from Electronic Distributors of Chicago at 99¢ each.) The impedance of these speakers varies from 8 to 30 ohms but most are the 8- or 10-ohm variety. The container and sound chamber for each ear is made from a plastic container primarily used by pharmaceutical houses for various and sundry drugs. (See photo.) The pair I utilized were 2 inches in diameter and 3¼ inches long. Ideally the size would be

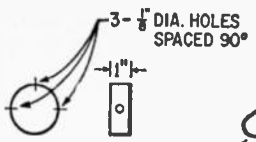


From this collection of odds and ends you can build a good looking pair of inexpensive stereo headphones that should give many hours of pleasure.

PARTS LIST

2—2-inch, 8-ohm speakers.
1—3-circuit phone plug
10-feet—3-wire cable, (Belden type 8443) (see text)
2—plastic containers, 2 inches in diameter, 1-inch (or greater) in height
Misc.—pair of earphone cushions, coat hangers, electrical tape, epoxy cement and Silastic or Dow-Corning RTV 732.
(Speakers, cable, phone plug and cushions available from Electronic Distributors Inc., 4900 Elston Ave., Chicago, Ill.

Estimated cost: $4
Construction time: 3 hours



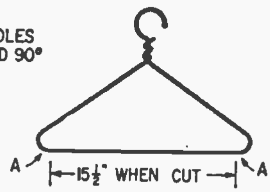


Fig. 2. (above left) Drill-hole spacing is indicated for plastic container rim.

Fig. 3. (above right) Straight portion of wire coathanger is used for headband.

Fig. 4. (below) Two pieces of coathanger wire are bent to form phones' headband.

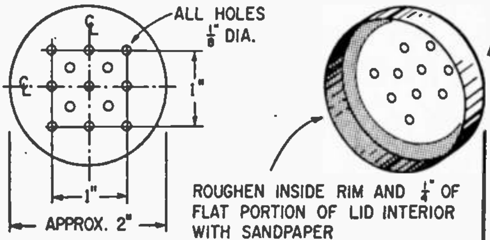
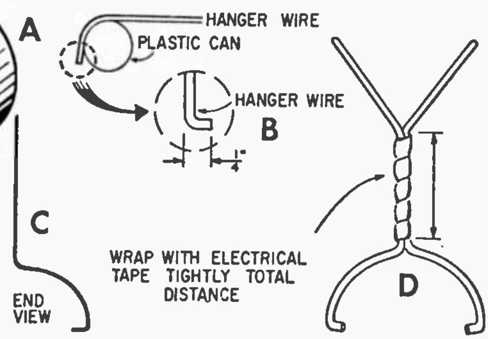


Fig. 1. First step is to layout the holes to be drilled in the round plastic box. Too-thin plastic vibrates with sounds—distortion.



2 inches in diameter by 1 inch in height. Unfortunately beggars (and authors) can't be choosers and since Harold, my druggist, handed me these two plastic cans as a gesture of good will, I will describe what has to be done to a 3¼ inch plastic can to make a 1 inch headphone container. It's very simple, cut 2¼ inches off the top leaving a 1 inch can with a solid bottom and a plastic lid.

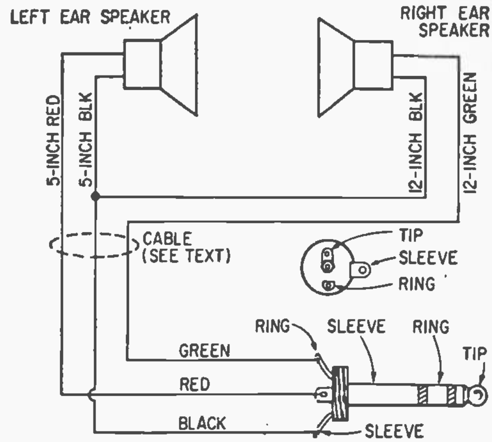
Mark a 1 inch square on each lid as shown in Fig. 1 and drill 13 holes with a ⅛ inch drill. Drill these holes carefully and without too much pressure on your drill as the plastic has a tendency to flow from the heat generated by drilling too fast. After drilling the holes remove any small bits of plastic that might adhere to the edges of these holes to prevent their touching the speaker diaphragm. With a piece of fine sandpaper roughen the surface of the inside edge of the plastic lid and a distance of about ¼ inch at the inside rim of this lid as shown in Fig. 1. This will create a bonding surface for the epoxy cement used to assemble the headset.

Prepare the epoxy cement by mixing the resin and hardener as instructed on the container. With a tooth-pick or some small stick, spread a thin layer of cement on the edge of the little speaker gasket. Be sure that no cement spills onto the diaphragm. If you have any excess remove it with your applicator and then carefully press the speaker into the plastic lid that has been prepared with holes and roughened edges. Repeat the above described operation with the other lid and speaker and set the assembly aside to dry overnight.

In each 1-inch plastic can, drill three holes in the sides as shown on Fig. 2 with an ⅛-inch drill. One of the holes will carry the leads from the speaker and the other two will carry the coat-hanger head band. Set these aside for later assembly.

Hang It. Many of today's modern coat hangers, as delivered by your neighborhood cleaner, come with a plastic-foam cover as a protection for your clothes. If you are lucky enough to find some in your closet, scrounge two of them and let your wife scream. (The next load from the cleaner will have new ones and she will be pacified.) Remove the foam rubber covers and set them aside to be used later. Cut the hangers

Fig. 5. Simple circuit is identical to that used in commercial stereo phones. Make sure plug and jack are mates before soldering wires to lugs. Black (common) lead must go to same position solder lug on both speakers for audio phasing.



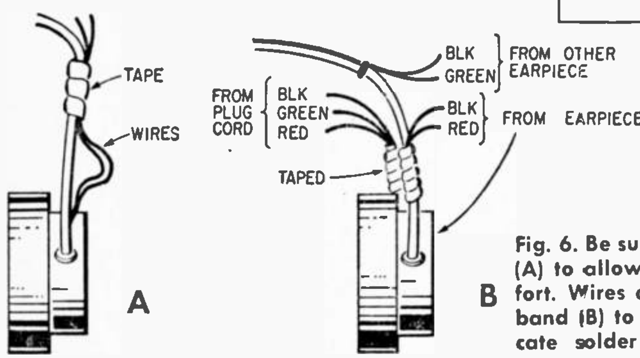


Fig. 6. Be sure to leave slack wire at phone (A) to allow for positioning for most comfort. Wires are securely attached to headband (B) to prevent pulling strain on delicate solder lugs, inside, to voice coils.

at the points designated as "A" on Fig. 3. Both of the pieces you make from these hangers should be identical so complete the operation I am about to describe on each hanger. Using the top part of the plastic can as a form, create a quarter turn around the form (Fig. 4A) at each end of the hanger. With a pair of long nose pliers, make a ¼-inch hook at each end of your turns like Fig. 4B. The next step requires using your head. With the quarter turns pointing forward and held in your hands, place the hanger over your head and center it. Now pull your hands down to your ears and form the hanger to fit your head. It will tend to spring away from the contour of your head but a little squeezing will fix this in a jiffy. (If your head is tender, try a towel over it when you make the second hanger.) When you get through, you should have two pieces of coat hanger that look like the two views in Fig. 4C— after you put the last bend in the hanger right where the curve and the straight portion meet. Each end of each piece should be the same.

Place the two pieces of coat hanger side by side, so the ends look like Fig. 4D, and wrap some plastic electrical tape around the two pieces for about 1½ inches above what is now a half turn with two inward-pointing hooks. Wrap the tape tightly and repeat the operation on the other end. Spread the two parallel hanger wires to distance of 2 inches at the center portion of your just manufactured headband. Now go to bed. The transducers (speakers to you) have only been drying for half an hour.

Electrical Connections and Final Assembly. The schematic is shown in Fig. 5. The ideal wire to use for the hookup of these midgets is a piece of Belden cable #8443. This cable has 3 22-gauge stranded conductors and is fairly flexible. Determine the length of headset cable you need and buy two feet more for the interconnections between the speakers. (I used 10 feet—a convenient length.) Cut about 17 inches from your piece of cable and remove the outer vinyl covering from this piece. The three wires are red, green and black. If the cement holding the speakers in place in the lids has hardened, cut the black wire in two pieces 12 and 5 inches. Cut the green wire to 12 inches in length and solder the 12-

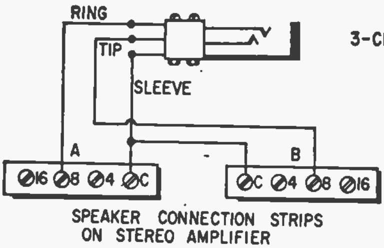


Fig. 7. Too much power from speaker output can quickly ruin these stereo headphones.

inch green and the 12-inch black wires to one of the speakers. Solder the 5-inch black wire to the other speaker and cut a 5-inch piece of red wire to match and solder it to the remaining terminal on the second speaker.

We are now ready to assemble the plastic cover caps to the speakers. Pass the red and black wire on one speaker through the middle hole in the cap—leaving the opposed holes to accept the headband. Repeat this process with the green and the black wire on the other speaker and cap. Seat the plastic cover in the plastic lid and place a small weight on the plastic cover with the lid down. Run a small bead of Dow-Corning RTV 732 Silicone Rubber around the plastic lid to create the bond and seal for the cover and lid. Repeat the operation on the other earpiece and set them aside to dry. The rubber takes about 24 hours to completely cure.

After the silicone rubber has cured, hook the headband into the earpiece with the green and black wire. Make a small loop in the two wires to allow for ear adjustment as shown in Fig. 6 and wrap a small piece of plastic tape over the previously taped portion of the headband to hold these wires in place. Now tape the two wires in three or four places to one of the two wires forming the headband and lead these wires over to the taped portion on the other end of the headband. Hook the other ear piece to the headband and leave a small loop in the red and black wire for adjustment and tape these two wires to the previously taped portion of the headband at this end.

Now prepare the remainder of your three wire cable by removing 1 inch of the outer insulation leaving the three insulated wires exposed. Tape this wire to the taped portion of the headband at the end where the red and black wire earpiece is attached. Follow the method shown in Fig. 6B. Splice the three black wires together, the two red and the two green. Solder the connections and tape each separately and then the entire assembly to the headband.

Prepare the other end of your three wire cable by removing 1 inch of the outer insulation. Disassemble the plug and slip the cover over the cable. Now solder the black wire to the sleeve, the red wire to the ring, and the green wire to the tip as shown in Fig. 5. Replace the cover on the plug and head for the stereo outfit in the living room. If it has a stereo headset jack plug your headset in and start out at low volume. The headset will stand about .2 watts of power and 200 milliwatts (.2 watts) at your ears will sound like you are at the conductor's podium in Hollywood Bowl.

If your stereo system does not have stereo headset connections you can wire in a jack as shown in Fig. 7. Use the 8-ohm connections for these phones.

Remember the plastic-foam we set aside when we dismantled the coat hangers—well take the two pieces and cover the "over the head" portion of the head band with this foam and hold in place with a little epoxy, RTV-732 or rubber cement. Oh yes . . . I bought a pair of earphone cushions for my ears as I use these earphones for hours and the plastic gets a little hard. They slip right over the plastic lids and friction holds them in place. Now pardon me while I make a Martini and have a date with Jane Morgan—stereo style. ■

Completed phones are neat and convenient although not as "pretty" as commercial units costing five times as much.

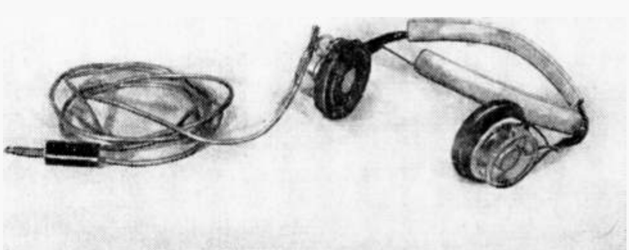


PHOTO-TROL

The Shutterbug's Variac

By
Herb Friedman
W2ZLF/KBI9457

The right balance of light and shadow is the secret of any great work of art; it's also the secret of excellent photography

■ We'll give you a guarantee: Use our *Photo-Trol* to balance the lighting for your home movies, family stills, or portraits, and your results can be as good as Hollywood or the local pro. If not, tear off the top of your local newsstand dealer and throw it into a mailbox.

Seriously, the secret to good pictures is in the lighting, and as any pro will tell you, good lighting can compensate for virtually any defect; it can even change a sow's ear into a silk purse (contrary to what they teach in school). But while the pros have almost unlimited lighting controls most amateurs are relegated, even by the so-called *lighting manuals,* to pushing a few photofloods around the room and hoping for the best.

But really fine lighting is obtained by balancing the lights, not by pushing them up, down and sideways. And right now, the only device available to the amateur photographer which can balance photo lights is our Photo-Trol, which can adjust photographic flood lights (or any other incandescent light for that matter) from a dim glow to full brilliance. In addition, since the Photo-Trol turns on the lights with reduced power, you can get up to six times the normal life from each set of floods.

Why Photo-Trol Is Better. While the Photo-Trol uses an SCR (silicon controlled rectifier) it is unlike the other so-called lighting controls which are really motor speed controls. Motor speed controls are half wave devices, they can only vary the lighting from zero to about 70 percent of maximum brilliance. To get full brilliance the motor control must have a separate switch which bypasses the control and applies full power to the lamps. Further, the adjustment range of the motor speed controls is very narrow and a very slight adjustment of the knob makes the light jump from minimum to maximum almost instantly; not to forget of course that motor controls cause the lamps to pulsate when set to very low light levels.

On the other hand the Photo-Trol uses a *full wave* SCR (called a Triac) which allows the light to be adjusted smoothly over the entire control range from a dim, barely discernible glow, to maximum brilliance, with no sudden switching jump from 70 percent to full brilliance.

The unit shown will handle two circuits, as most amateur photographers desire control over only two lights. However, you may place more than one light on each circuit or use a larger cabinet and build in three or

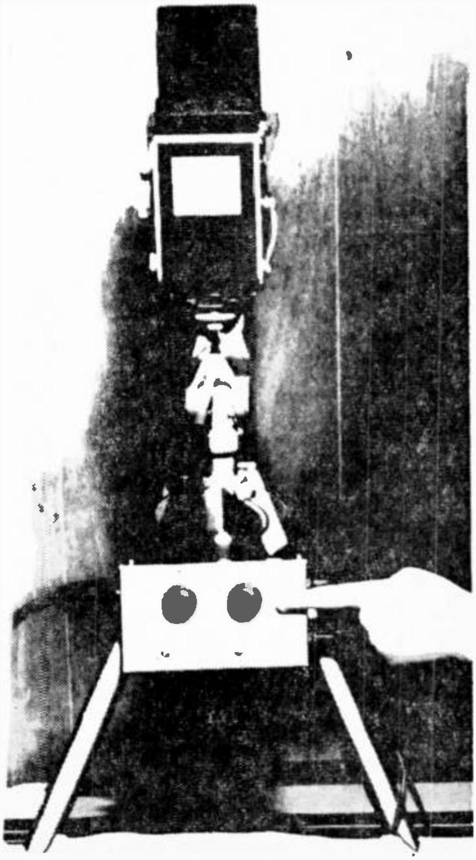
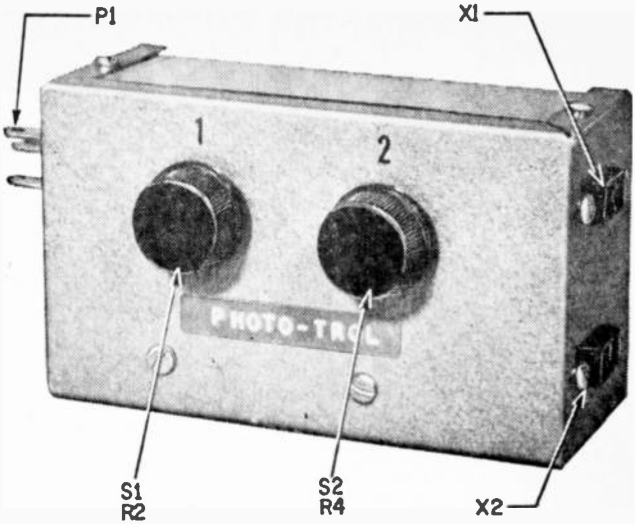
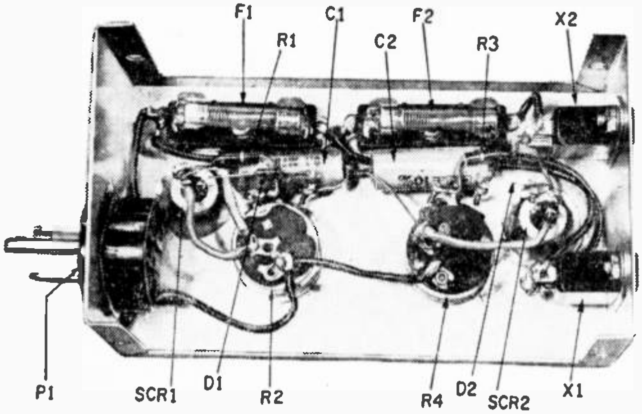
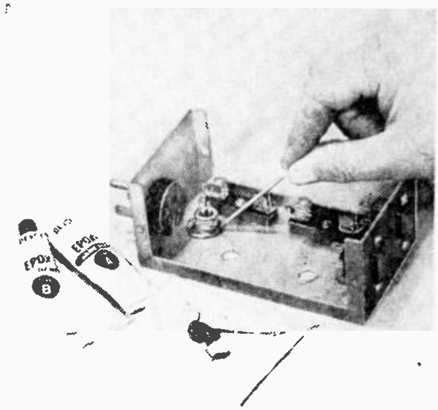


PHOTO-TROL



Potentiometers R2 and R4 contain integral switches S1 and S2. Rotate the pots until the switches click on; at this point, lamps will be about 50-percent brilliance. Then the pots can be rotated to give full brilliance or soft glow.



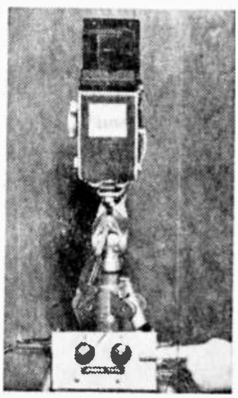


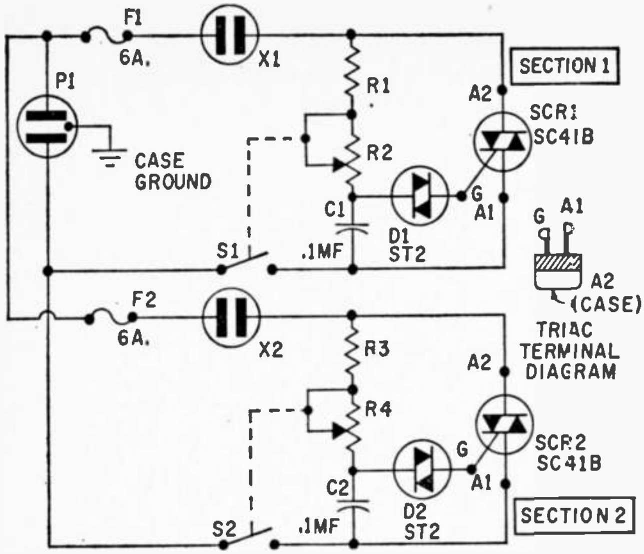
more circuits. With the components specified each circuit will carry a maximum of 6 amperes or 700 watts. Up to 1200 watts can be carried by each circuit if type SC46B Triacs are substituted for specified SC41Bs.

Construction. The Photo-Trol is built on the main section of an aluminum chassis box approximately 2⅛ x 3 x 5¼ inches. The specified SCR's do not have a mounting lug nor do they require a separate heat sink: they are epoxy cemented directly to the cabinet—the cabinet provides the heat sink. First, drill the cabinet for all the major components. Temporarily mount the potentiometers, fuse holders and sockets and then mark the positions for the SCR's; position the SCR's so they are not too close to other major components—then remove the components.

Mount the SCR's in the following manner. Place a very thin piece of tape such as cellophane tape or the plastic electrical tape on the cabinet—the tape should be no larger

As shown above left, the chassis box comfortably houses all components of the Photo-Trol. At the right, epoxy cement is being applied to SCR1; when cement hardens, mount major components. As shown below, the unit can be easily mounted right on your tripod.





Schematic diagram of the Photo-Trol shows the double circuit—section 1 and section 2—for control of two sets of lights. Each section is rated at 6 amperes or 700 watts. Details for increasing the power capacity are given in text. Use of plug P1 on the chassis box allows the box to be mounted on your tripod with no permanently attached external power cables to get in your way.

than the base of the SCR; it is only an insulator. Apply a liberal quantity of two-tube or hot epoxy cement to the SCR base and place the SCR over the tape. Using a toothpick, or similar item, pack epoxy all around the base of the SCR at the chassis junction. When the epoxy hardens the SCR will be insulated from and bonded to the cabinet—with the cabinet being the heat sink. Then mount the major components.

The SCR case itself is the second anode (A2) connection. Thoroughly clean a small section of the case, preferably with sandpaper, and using a soldering iron rated 100 watts or less, tin the SCR. If possible, use a very thin or low temperature solder. Make the connection fast; avoid applying heat for an extended period to the SCR. When installing D1 use a heat sink on the leads.

Fuses F1 and F2 should be rated no higher than the maximum SCR rating; 6 amps for the specified type (SC41B), 10 amps for the optional type (SC46B). Use standard 3AG fuses, not *slo-blow*. Miniature glass circuit breakers can be used if they're fast-acting.

The 3-prong power input, P1, is just a convenience, a power cord connected directly can be used. However, regardless of the power connection the leads should be #16 minimum, *not #18 zip cord*. Similarly, all leads connecting to the Triac's anode "cathode" (actually the first anode, A1) should be at least #16 or heavier.

PARTS LIST

- C1, C2—.1-mf., 200-VDC mylar paper capacitor (or equiv.)
- D1, D2—Diac type ST2 (GE)
- F1, F2—6-amp., 3AG-size fuse (See text)
- P1—AC 3-wire plug for retainer-ring mounting (Amphenol 61-M or equiv.)
- R1, R3—4,700-ohm, ½-watt resistor
- R2, R4—250,000-ohm linear potentiometer with s.p.d.t. switch
- S1, S2—S.p.d.t. switch, part of potentiometers R2, R4
- SCR1, SCR2—Triac Type SC41B, 6 amps., (GE) (See text)
- 1—Aluminum chassis box, 2⅛ x 3 x 5¼-inches (Bud 2106A or equiv.)
- Misc.—Fuse holders (2), epoxy cement, line cord, #16 wire, solder, hardware, etc.

Estimated cost: $18.00
Estimated construction time: 2 hours (not including epoxy curing time)

Using the Photo-Trol. Connect the power to P1 and the photofloods to X1 and X2. Rotate either R2 or R4 just past the point where the power switch clicks in. Keep advancing the control until the lamp suddenly goes on—the lamp-on point is at about 50 percent brilliance. Once the lamp is on R2 or R4 can be backed-off, reducing the brilliance to a *dull glow*, or *full-off;* or, the control can be advanced until the lamp is *full on*. In short, the controls have a "backlash" in that the lamp must go on first at about 50 percent brilliance before it can be dimmed to a glow.

There are no precautions necessary in the Photo-Trol's operation. The lamps can be controlled at light level or "snapped open" to full brilliance instantly. A *singing* sound from either the Triacs or lamps is normal (caused by the current pulses at reduced light level) and should not be a cause for concern. Now get out there, tiger, and snap away with the ol' Brownie like the Pros. ■

CQ WITH ANTIQUITY

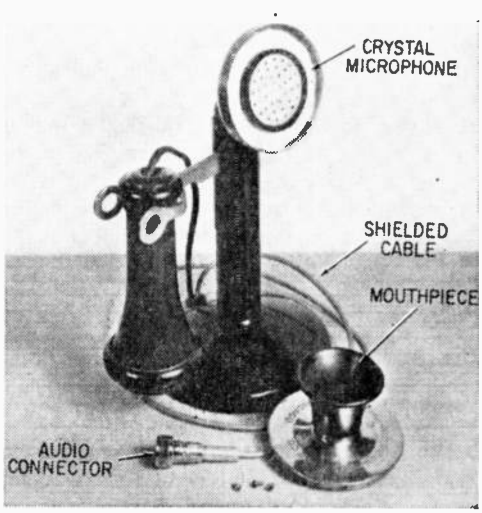
by Art Trauffer

Add a bit of Americana to your next amateur contact with a "candlestick" phone

■ The new has been added to the old in this novel desk stand mike for the ham shack or tape recordist. As shown in the photo, a desk stand telephone of yesteryear has had its old carbon transmitter replaced with a brand new crystal mike cartridge. If you don't have one of these old telephones around, they are still available at some second hand stores, antique dealers, auctions, or from the firms listed in the footnote below.

The face-plate and mouthpiece are removed from the transmitter housing by removing four small screws. Disconnect the two wire leads which go to the carbon element, and then remove the carbon element from the back of the face-plate. The old wire leads can either be clipped off or pulled down into the phone stand. The new crystal mike cartridge is mounted in a sponge rubber ring, as shown, but first connect a mike cable to the microphone cartridge and pass the cable down through the stand. Use rubber cement or Goodyear Pliobond to hold the microphone cartridge in the sponge rubber ring and the ring in the transmitter housing.

If desired, you can wire the receiver hook switch so that the mike is switched on when the receiver is lifted off the hook. You can even use the receiver as a low-impedance earphone for radio use. ■



Write to the following companies to obtain literature on what's available and prices: Lewins Antique Telephones, 5215 W. 77th Terr., Prairie Village, Kansas 66208. Telephone Company, Turtle Lake, Wisconsin; Continental Telephone Supply Co., 49 W. 46th St., New York 36, N. Y.; Telephone Engineering Co., Lincoln Bldg., Simpson, Pennsylvania; Telephone Repair & Supply Co., 1760 Lunt Ave., Rogers Park Station, Chicago 26, Ill.; Delta Electronics, Box 2262, Dallas 21, Texas.

Neon-Lamp Calculator

By Jack Brayton

Neon glow lamps provide the readout for this desk-top calculator that can be "programmed" to multiply, add and subtract.

5 + 12 − 21 × 32 =

■ Pure fun to build; pure fun to operate, that's the Neon-Lamp Calculator. Its magic-like lamps fascinate not only the builder but everybody else as well. And, if it's left about, somebody is bound to turn the rotary switches, then stare at the lamps which appear to "bounce" across the panel indicating the sums, differences or products of the switch-selected numbers.

The Neon-Lamp Calculator can add, subtract, or multiply any two numbers properly set on the switches. It's an exciting, visual aid for youngsters learning math tables or as a Science Fair project. But most of all it's just plain gadget-building fun.

How It Works. Before we analyze the circuit let's look at the basic addition, subtraction, and multiplication functions. It's here that the real secret of the Neon-Lamp Calculator lies hidden.

The table shows all possible problem combinations which can exist when any two numbers from 1 through 9 are added, subtracted, or multiplied. What the table doesn't show is the answers—these are dependent on the functions being performed. However, it's important to note that the 2 numbers which make-up the problem are identical for each function. To illustrate, the numbers 7 and 4 can be added, subtracted, or multiplied, but no matter what we do with them one 7 and one 4 input is

NEON-LAMP CALCULATOR

still required. It's only the *answers* which are different.

The next thing to notice about the table is that we've divided the inputs or number combinations into 3 groups. In the first group we have the combinations where the *first number is larger* than the second number. The second group lists the problems where *both numbers are identical.* And, in the third group the first number is *smaller.*

Of course, with addition or multiplication the answers to both the problems in the *first* and *third* groups are the same. *It doesn't matter which number comes first.* And, with subtraction, the larger number *always comes* first unless negative answers are desired. Therefore, if we don't want negative answers we can eliminate the third group entirely and specify that *the larger number has to come first.* Thus, if the problem reads 1 X 6 we would automatically change this to 6 X 1 before solving. And, it's obvious that some types of calculators could be greatly simplified by this arrangement because they would have to handle only a little over *half* of the input possibilities. This is true of the Neon-Lamp Calculator and that is why we've designed it so the *larger* number *has* to be on S1.

About The Circuit. In the schematic diagram the AC-line voltage is applied to the calculator circuitry through T1—an isolation transformer which provides approximately the same voltage at its secondary as is applied across its primary. This transformer eliminates the shock hazard which would be present if the line was connected directly.

The secondary voltage of T1 is, of course, present at the rotors of the switches (through S3 and R1). R1 limits the lamp current.

Looking at the circuit, we can see that the rotor of S1 connects to the horizontal and S2 to the vertical bus-wires. Thus, for *any* combination of switch settings one *horizontal* wire is connected to one side of T1 (through R1) and *one vertical* wire is connected to the other side. Thus, there's a 110-volt difference of potential *between* the two wires. And, *where they cross,* there's a neon lamp. This lamp, of course, lights. It's important to note that only *one lamp* is connected to the AC voltage for any switch setting.

A small filament transformer (6.3 volts, at .6 amp is more than enough) can be used to light up #47 pilot lamps if greater brilliance is needed for visual-aid displays. Replace R1 with a 7 to 10 ohm resistor to prolong the life of the pilot lamps if they are left burning for long periods or install a momentary-contact pushbutton. Connections can be soldered right to the lamp base—first solder the bottom bus wire to the shell then solder the top bus wire to the tip contact. You won't damage the lamps if you are careful and used tinned wire for all connections.

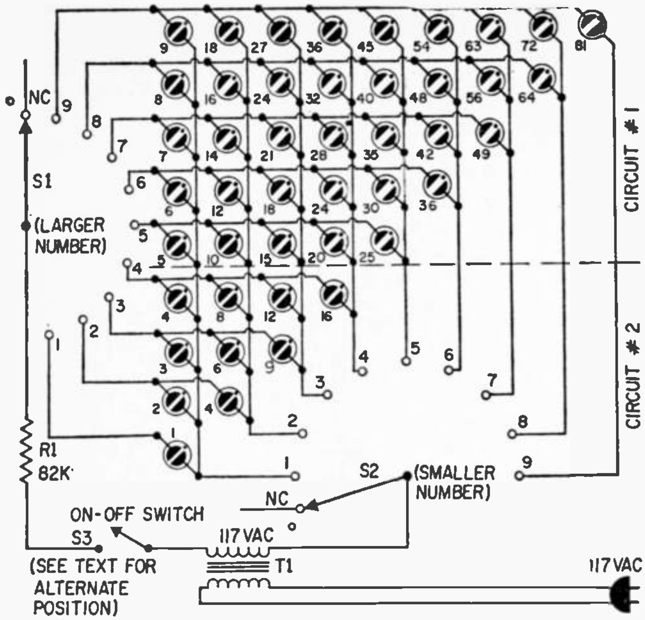
To illustrate, let's assume switch S1 is set at 7 and S2 at 4. Tracing the #4 (vertical) wire and the #7 (horizontal) wire to where they cross we find there's a neon lamp (marked with an asterisk (*) in the schematic). This lamp lights—it's the *only* lamp connected to *both* of these wires. Therefore, it's the only one which can fire. Of course, there are no lamps for settings where S1's number is *smaller* than that of S2. This would require 36 additional lamps and isn't necessary for the reasons stated earlier.

Since we now have a circuit which will light a different lamp for each input-problem combination all we have to do is mark the lamps with the proper answers. But since the answers for each of the functions (multiplication, addition, and subtraction) are different 3 sets of answers are required.

With the Neon-Lamp Calculator we accomplish this simply by using 3 interchangeable front panels—one for each function. The panels fit over the tips of the lamps and

Possible Problem Combinations

S1	S2	S1	S2	S1	S2	S1	S2
Group 1							
2	1	4	2	7	3	7	5
3	1	5	2	8	3	8	5
4	1	6	2	9	3	9	5
5	1	7	2	5	4	7	6
6	1	8	2	6	4	8	6
7	1	9	2	7	4	9	6
8	1	4	3	8	4	8	7
9	1	5	3	9	4	9	7
3	2	6	3	6	5	9	8
Group 2							
1	1	3	3	5	5	7	7
2	2	4	4	6	6	8	8
						9	9
Group 3							
1	2	2	4	3	7	5	7
1	3	2	5	3	8	5	8
1	4	2	6	3	9	5	9
1	5	2	7	4	5	6	7
1	6	2	8	4	6	6	8
1	7	2	9	4	7	6	9
1	8	3	4	4	8	7	8
1	9	3	5	4	9	7	9
2	3	3	6	5	6	8	9



Wiring of Calculator is quite simple. The ten lamps of Circuit #2 are physically fitted into the vacant triangle in the lower-right corner of Circuit #1. S3 can be replaced with a pushbutton or eliminated since the NC positions of S1 and S2 have the same effect. For a much brighter display use 6-volt pilot lamps—replace T1 with 6.3-volt filament transformer and eliminate R1. S3 should be a momentary contact pushbutton to give long life to pilot lamps. Of course the 6-volt lamps won't fit into the grommets so you'll either have to eliminate the grommets or use a much larger layout.

are supported by; but not attached to; the ¼-inch threaded spacers which act as mounting studs. The panels are held only by their weight and can be readily changed.

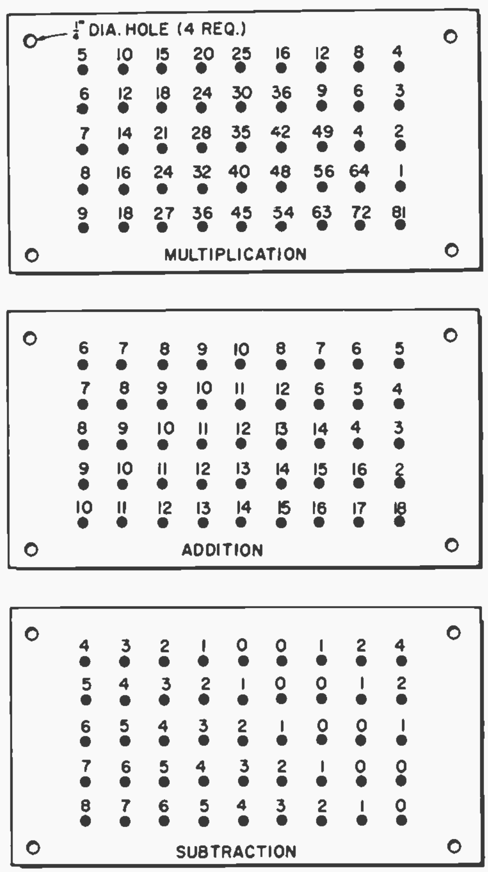
Although they are not separate circuits part of the schematic diagram is labled "Circuit #1" and part "Circuit #2". The reason for this is simply that the lamps do not fit on the panel in the triangle shape they form on the schematic. They are mounted in a square to conserve space. Therefore, physically, we've placed Circuit #2 in the corner of Circuit #1 where there are no lamps.

Parts. Most of the parts used in the Neon-Lamp Calculator can be obtained from any electronic supply house. However, the

PARTS LIST FOR NEON-LAMP CALCULATOR

- R1—82,000-ohms, 1-watt resistor
- S1, S2—12-position, single-deck, non-shorting rotary switch (Mallory 32112J or equiv.)
- S3—S.p.s.t. toggle switch
- T1—Power/Isolation transformer; 117-volt primary, 105-volt secondary (Lafayette 33 R 7502 or equiv.)
- 1—Aluminum cabinet (Bud AC1613 or equiv.)
- 2—Dial plates, 1-9 markings (Mallory 379 or equiv.)
- 45—Neon lamps, type NE-2
- Perforated circuit board, 3 21/32 by 6 ¾-inches, unclad (Lafayette 19 R 3606 or equiv.)
- Misc.—Flea clips; machine screws; nuts; washers; grommets (3/16 *inside diameter*); hookup wire; solder; etc.

Estimated cost: $14
Estimated construction time: 7 hours



Three identically-drilled front panels are numbered differently to give the correct answers for the three Calculator functions.

NEON-LAMP CALCULATOR

perforated board, flea clips, and isolation transformer are Lafayette items and can be obtained from them. The perforated board is a stock size (3²¹⁄₃₂ x 6¾ inches) and only one edge has to be cut. The three interchangeable panels can be made from aluminum, pressed board, phenolic, etc.

Construction. The first step in building a Neon-Lamp Calculator is laying out and cutting the perforated board. The holes at the line junctions are neon lamp centers.

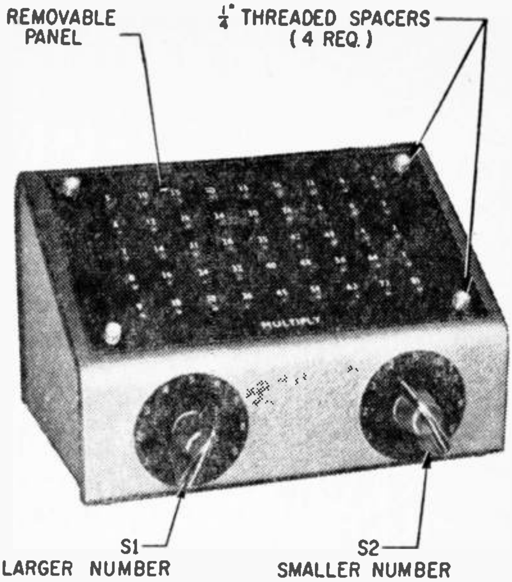
Now, cut the three interchangeable panels to an identical size. Then take a sheet of paper (same size) and tape it to the back of the board. Using a sharp pencil, mark *both* the mounting and lamp hole centers on the paper. Transfer the paper to the cabinet, square it, and center punch *all* of the holes. Then tape the paper to each of the panels but *mark only the 4 corner-mounting holes.* Make a scratch (in approximately the same location) on the *back* of each panel. Later, this mark will tell you which way they were drilled (the holes may match in one position but not in the other).

Drilling. The easiest way to make sure all of the lamp holes match is to drill the *initial* center holes at the same time. This can be accomplished in the following manner.

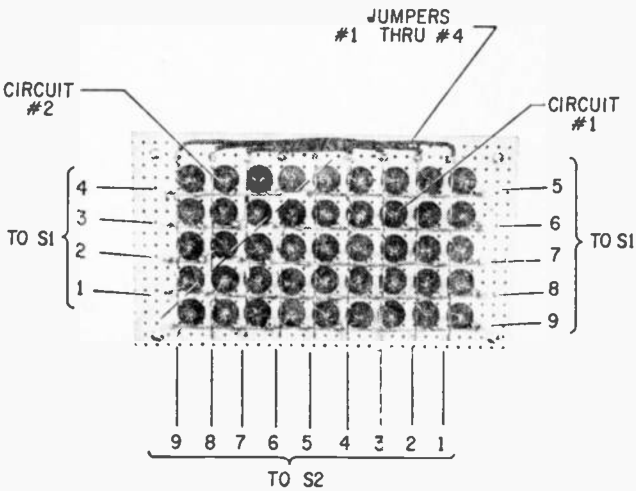
First—using a 9⁄64-inch (.1406) bit drill the 4 corner mounting holes in the perforated board; cabinet top; and each panel. *These should be drilled separately.* Next take a piece of scrap wood and cut it to about the same size as the panels. The 3 panels and circuit board are attached to the cabinet and the wood is used as backing. The perforated board should be on *top of the cabinet* with the markings facing out and the 3 panels should be *underneath* with their backs (marked earlier) facing *down.* 6-32 machine screws or wood screws in the mounting holes will hold the pieces firmly. Be certain the panel marks are in the *same* position and that the board holes *match* those center punched on the cabinet earlier, then drill the lamp holes using a *9⁄64-inch bit.*

Remove the 3 panels and replace the

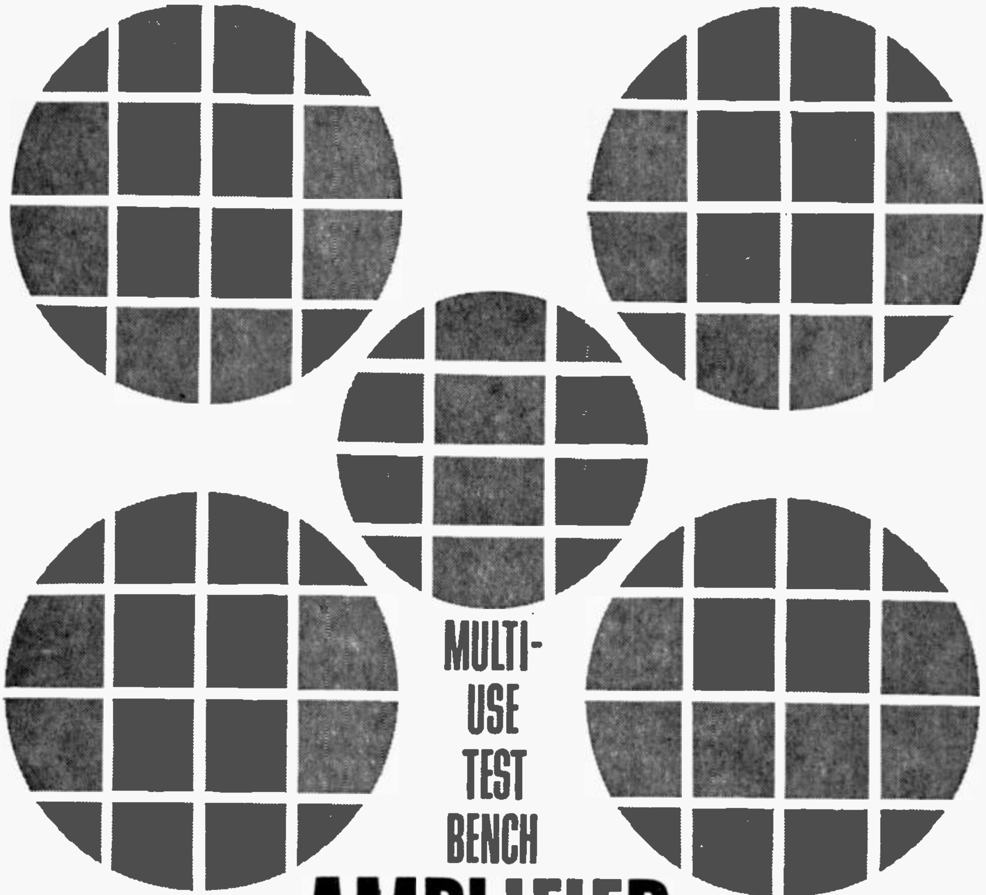
(Continued on page 127)



It's a simple matter to lift off the panel and drop a new one in place to subtract, add.



Phenolic perforated board layout shows jumpers used to connect Circuit #1 to the corresponding bus bars of Circuit #2. This layout condenses the circuit without making wiring difficult. Leads to selector-switch terminals are numbered for their knob and dial-plate position on front panel.



MULTI-USE TEST BENCH AMPLIFIER

by DAVID J GREEN, K3KNY

"Getting more than you bargained for" is usually a phrase that's used with tongue-in-cheek—but not when describing this unit!

■ A handy test bench amplifier should be exactly that—handy! Why not put an end to fooling around with temporary setups and build a multi-use unit that has some guts? A quick look at the schematic diagram for this construction project shows that it has quite a few features that expand and simplify your experimental work:

• An internal speaker is right there, built in and ready to use when you need it; or

• External jacks can be used for connecting earphones, or 4-, 8-, or 16-ohm external speakers.

• Pin jacks allow you to pick off your signal after the triode amplifier stage of V1 to determine the signal characteristics.

• A built-in neon indicator lets you monitor the peak level of your signal.

• Jacks are even provided for external B+ and filament voltage at a power sufficient to operate small experimental circuits.

All the jacks, switches and indicators for utilizing these features are accessible on the front panel and the top of the 4"x5"x6" aluminum enclosure used for the unit.

Circuit Operation. The signal input level is controlled by resistor R1 and then passed to the control grid of V1A through capacitor C1. Bias is provided by capacitor C2 and resistor R2. The auxiliary output jack, J3, for the oscilloscope connection, is provided through capacitor C3 to the plate of the triode section of V1A. The double section of the 6U8-A tube provides two stages of amplification in one envelope.

The signal is coupled to the pentode stage, V1B, through capacitor C4 after being developed across 270,000-ohm resistor R3. The bias for V1B is provided by C5 and R5. The peak-level neon indicator lamp, I1, is connected through capacitor C7 to the plate of the pentode section; similarly, the phone jack, J4, is connected through C8 to the plate.

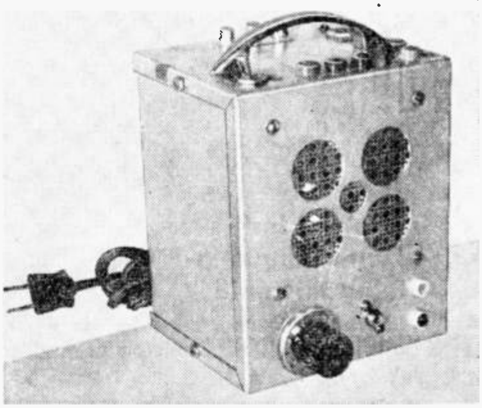
Output transformer T1 provides 16, 8, or 4-ohm outputs for the speaker jacks J5, J6, and J7. The internal speaker is connected to the 4-ohm jack and is cut in and out of the circuit by switch S1.

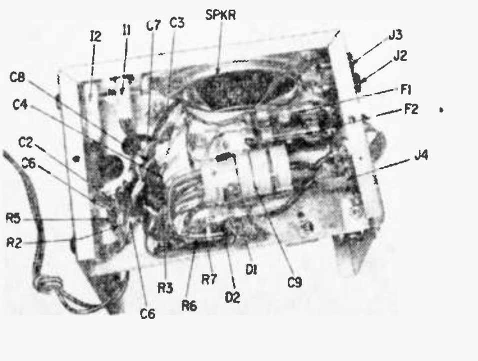
The power supply section of the amplifier is comprised of transformer T2, diode rectifier D1 and D2, and the RC filter circuit formed by C9A, C9B, and resistor R6. The B+ and 6.3 vac power supply voltages are connected through fuses F1 and F2 to the external pin jacks allowing the amplifier to be used as a power supply for low power applications.

The neon indicator lamp, I2, across the primary of power transformer, T2, indicates a power-on condition when S2 (located on potentiometer R1) is closed and applies power to the circuit.

Putting It Together. Begin construction of the bench amplifier by perforating the front of the aluminum chassis box for the speaker. Cut one large or several smaller holes and back up with a square of aluminum screening to protect the speaker. The next step is to form an inside chassis of sheet aluminum that is cut at one end to fit around

The completed amplifier is handsome as well as easy to use; and with its carrying handle, a cinch to transport. The side view (bottom) calls out the components on one side of the inside chassis as well as showing how the chassis is cut out to fit around the speaker. Radiator-type metal screening was used on the front panel to protect the speaker cone.





PARTS LIST

C1, C4, C8—.005 mf ceramic capacitors
C2, C5—5 mf, 15 WVDC electrolytic capacitors
C3, C6, C7—.01 mf ceramic capacitors
C9—20-20-20 mf triple-section, 150-volt electrolytic capacitor (Sprague TVA3440 or equiv.)
D1, D2—Diode rectifiers, 400 PIV, 450 ma (GE-504 or equiv.)
F1—1/16-amp, 250-volt fuse, type 3AG with fuse holder
F2, F3—½-amp, 250-volt fuse, type 3AG with fuse holder
I1, I2—"Tineon" indicator lamps, types 41N2317-6 and 36N-2311-6, respectively
J1, J5, J6, J7—phono jacks
J2, J3, J8, J9, J10—insulated tip jacks
J4—2-connector phone jack
R1—1,000,000-ohm potentiometer with s.p.s.t. switch (S2)
R2—5600-ohm, ½-watt resistor
R3—270,000-ohm, ½-watt resistor
R4—1,000,000-ohm, ½-watt resistor
R5—68-ohm, ½-watt resistor
R6, R7—1800-ohm, 2-watt resistors
S1—S.p.s.t. toggle switch
S2—S.p.s.t. switch (see R1)
T1—Universal output transformer (Knight 6-W-14-HFL or equiv.)
T2—Power transformer; Pri: 110-120 vac, 60 cps, Sec: 125 volts CT, @ 25 ma, and 6.3 vac @ 1 amp. (Knight 6-K-1 or equiv.)
V1—6U8-A vacuum tube with 9-pin miniature socket
1—4-ohm, 4-inch diameter speaker
1—4" x 5" x 6" aluminum chassis box (LMB CU-3007-A or equiv.)
1—3⅞" x 5⅞" aluminum sheet
Misc.—Line cord, grommets, angle brackets, dial knob, aluminum screening, carrying handle, rubber feet, panel marking, hookup wire, hardware, solder, etc.

Estimated cost: $15.00
Estimated construction time: 8 hours

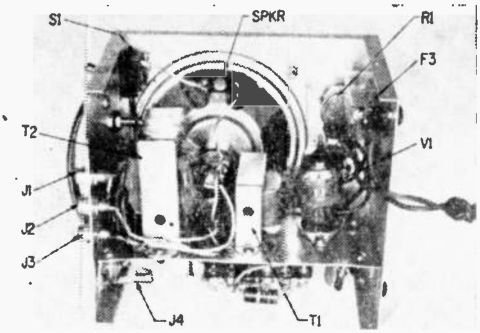
the speaker. Now begin mounting components on the chassis and front and top panels of the enclosure; check clearances as you work, and use photographs as a guide.

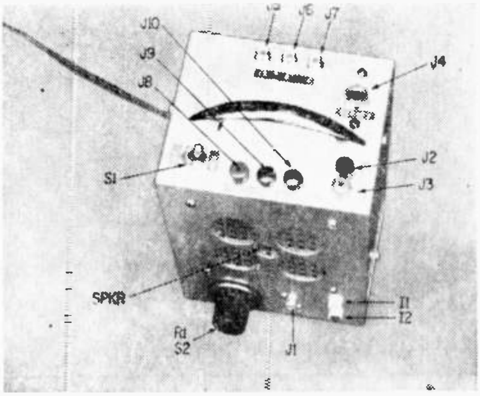
After wiring the unit, finish the outside by identifying the jacks and switches with suitable panel markings. Mount rubber feet on the bottom of the unit. Finally, provide ventilation by opening some holes in a neat pattern on the back or sides of the aluminum chassis box.

Putting It To Work. Allow the unit to warm up and connect an audio signal from, perhaps, a crystal set or phone output. Use the internal speaker first and then continue checking out your wiring by using external speakers and the headphone jack.

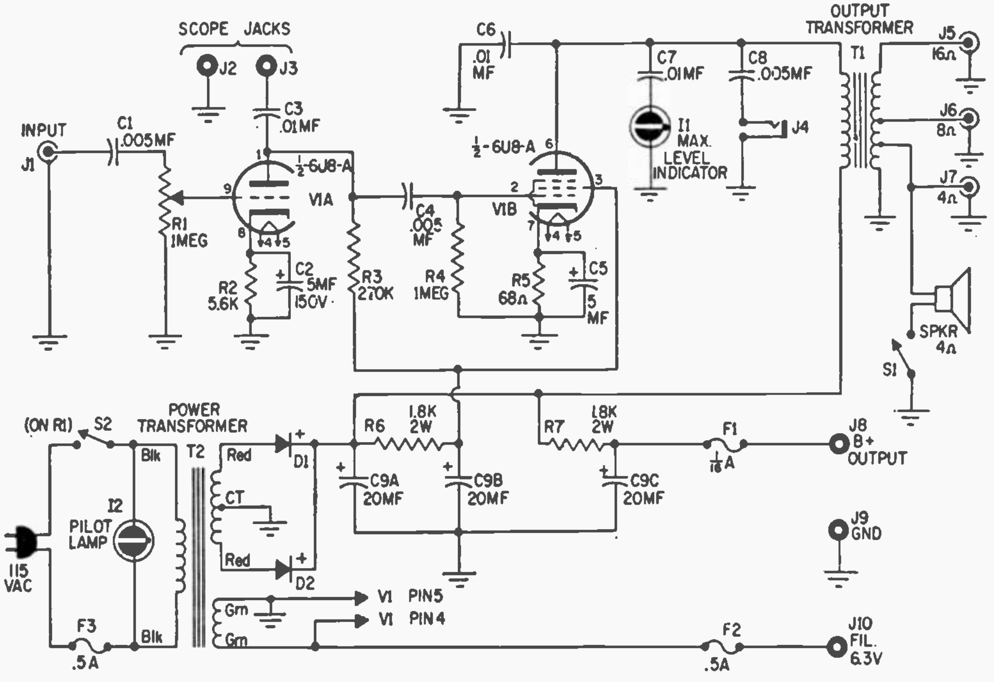
External power for circuits you are working on can be taken from the pin jacks while the unit is being used as an amplifier. The B+ is available at 120 volts at 15 wa. and the filament heater voltage at 6.3 vac at .5 amperes.

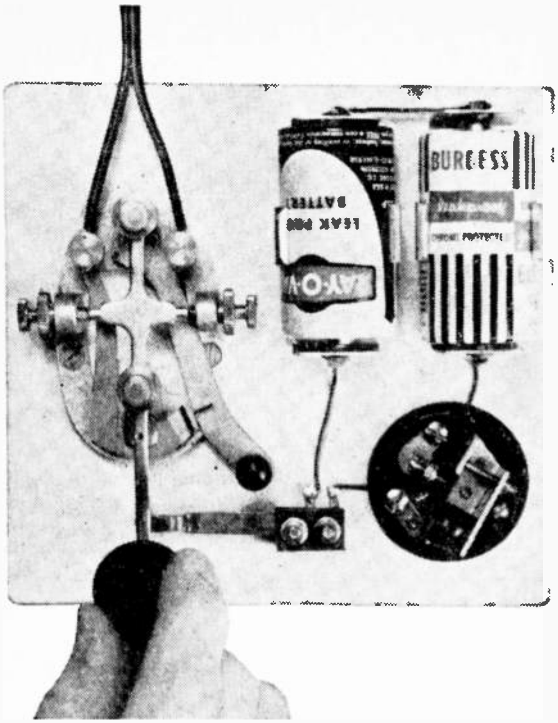
To use indicator lamp I1 to determine the peak level of an output signal, first disconnect any external speaker, then set the speaker switch S1 to off. Turning up the volume control R1 will increase the signal to I1 causing it to flash and giving you an indication of signal strength. By connecting an AC voltmeter to the phone jack J4, you can measure actual signal level and relate the intensity of I1 to actual voltage values. ■





This view of the inside chassis (top) shows the components on its other side. The view of the front and top panels (above) calls out the location of the jacks and controls.





SIMPLE CODE MONITOR

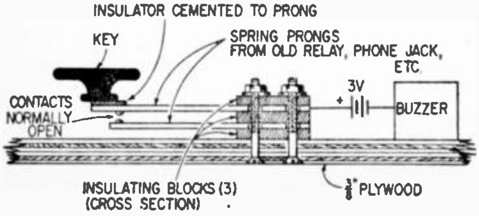
By Art Trauffer

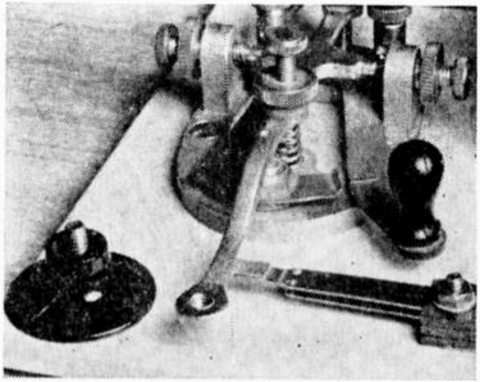
■ Most of us send better code when we can hear what we're sending. This code monitor, which is entirely independent of your receiver or transmitter and has no electrical connections to any of your equipment, is quickly rigged up using only three main components: first, a pair of prongs or reeds from an old phone jack, switch, or relay; secondly, a 3-volt supply (two D batteries); and, finally, a buzzer.

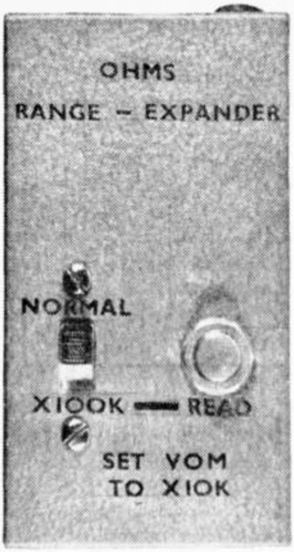
As shown in the photos and cross-section below, the monitor is actuated by the lever of your regular transmitter key. While the regular key operates your transmitter, it also closes the spring prongs of the old relay, activating the buzzer.

Monitor Mounting. Your transmitter key, monitor spring contacts, buzzer and battery are all mounted on a convenient surface; as shown here, they were mounted on a 6-inch square piece of ⅜-inch plywood. Prongs are mounted under the lever of your key close to the knob. A small piece of insulating material is cemented to the top spring prong to insulate it from the key. Adjust the monitor prongs so that they make contact just before the transmitter key contacts; then wire monitor in series and start sending! ■

The knob of the telegraph key at the right is removed to show how the key actuates the insulated top spring prong to make contact with the bottom prong, thereby completing buzzer circuit. Size of insulating blocks, below, is determined by height of the key.







ohms - range EXPANDER

by Thomas H. Charters

■ If you have tried to measure resistances larger than one megohm, you know that it is difficult with a VOM. The scale is crowded in this region and just the thickness of the meter needle represents a large difference in resistance. The Ohms-Range Expander gets around this problem by adding an extra-high resistance range to your meter making it possible to measure resistances ten times higher than you could before.

Most multimeters have this limitation; it is a compromise that most manufacturers make to eliminate a high-voltage battery. One of the exceptions to this is the line of multimeters made by Triplett which do have a high-resistance range (and a 30-volt battery.)

The Ohms-range Expander adds a *X100K* resistance range to many multimeters including the following: Simpson Models 260 and 270, Heathkit Model MM-1, Eico Models 555 and 565, Knight VOM kit #83U972MW.

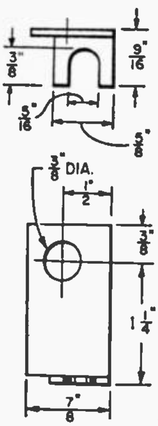
Operation is easy, it can be left connected to the multimeter without interfering with any of the multimeter's other functions, and it is line-operated, eliminating battery replacement.

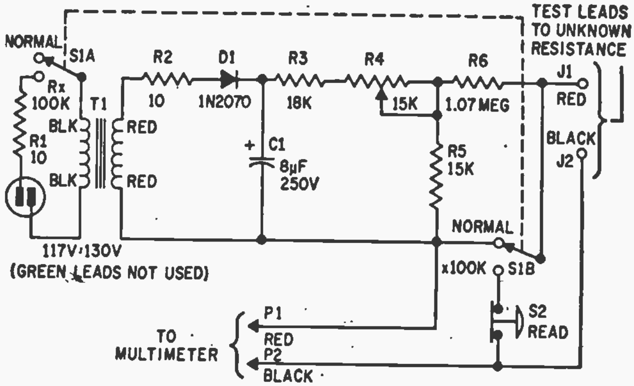
What Happens. The ohmmeter circuit used by several manufacturers for the *R X 10K* range is shown in the diagram. Before measuring the unknown resistance, the leads are shorted together (COM and +) and the potentiometer is adjusted for full-scale deflection (zero-ohms indication) on the meter. (This adjustment is necessary to take into account aging of the battery.) Then the test leads are connected across the unknown resistance and its value read from the meter scale. The calibrations on the scale are very unevenly spaced (non-linear) because the relationship between unknown resistance and meter current is nonlinear. The Ohms-Range Expander makes use of this same scale.

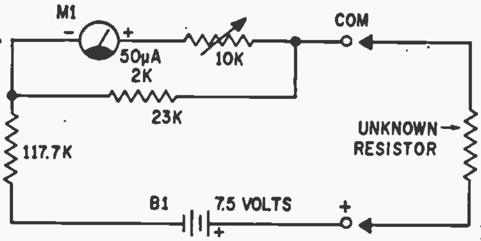
An important question to ask about designing this circuit is, "What value of unknown resistance will cause the meter needle to deflect to half-scale?" The answer is, "A value equal to the total resistance of the meter circuit, in this case 117.7K plus the parallel combination of 23K, 2K, and R3, or about 120K total." A glance at the multimeter shows that 120K is indeed the center-scale value. (Other VOM's may have different center-scale calibrations.) After all, this makes sense because when the leads were shorted, 50 microamps was flowing in the meter. Adding an unknown external resistance equal in value to the ohmmeter circuit's resistance should cut the current in half, giving a center-scale reading.

How It Works. Now we are set to see how the Ohms-Range Expander works. In order to have a *R X 100K* range we must have ten times as much resistance in the measuring circuit (so that the center-scale

Bracket (below) holds the calibrating potentiometer R15. Slot is fitted under one test lead jack.







For portable use transformer, rectifier and filter can be replaced with 67½-volt battery. Rewire S1A into battery circuit to prevent continuous current drain in *normal* position.

Basic VOM ohmmeter circuit uses 7.5-volt battery in high range.

PARTS LIST

C1—8-mf., 250-volt electrolytic capacitor
D1—1N2070 silicon rectifier (Texas Inst.) (400-prv, 5 ma or better)
J1—Red banana jack (E. F. Johnson series 108)
J2—Black banana jack (E. F. Johnson Series 108)
P1—Red banana plug (E. F. Johnson series 108)
P2—Black banana plug (E. F. Johnson series 108)
R1—10-ohm, ¼-watt, resistor
R2—10-ohm, ½-watt, resistor
R3—18,000-ohm, 1-watt resistor
R4—15,000-ohm, linear taper potentiometer
R5—15,000-ohm, 1-watt resistor
R6—1.07-megohm, ½-watt 1% precision resistor (IRC metal-film—Allied Radio 25Z018C)
S1—D.p.d.t. slide switch
S2—Pushbutton switch (Switchcraft type 102)
T1—Power transformer, 117-volt, primary; 130-volt, 20 ma secondary (Stancor 8415)
1—aluminum chassis box, 4 x 2¼ x 2¼-inches (Bud CU-2103A)
Misc.—Potentiometer mounting bracket (see text); line cord; rubber feet; strain relief; grommet; heat-shrinkable tubing; terminal strips (see text); spaghetti; mounting hardware; panel lettering; etc.
Estimated construction cost: $6.00
Estimated construction time: 4 hours

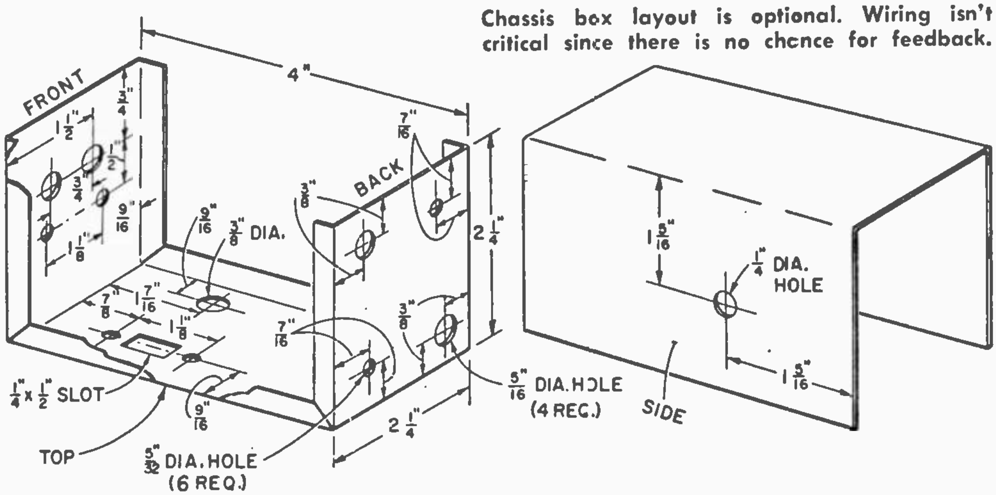
reading will be ten times higher. This also means that we must have ten times more voltage, too, because the meter coil still needs 50 microamps before it will deflect full scale for setting zero ohms.

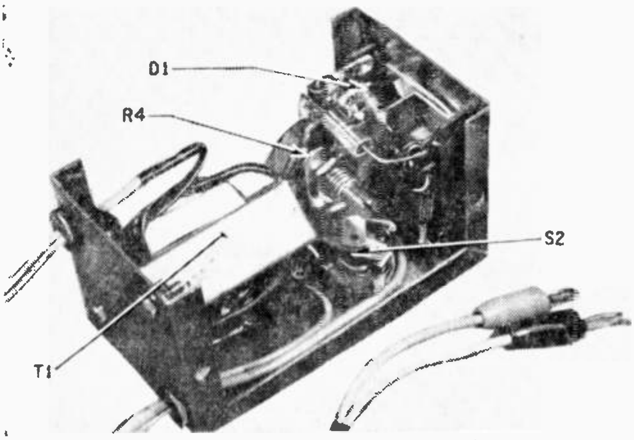
That's all there is to it. To get 10 x 7.5 volts, the Ohms-Range Expander supplies an additional 67.5 volts which added to the 7.5 volts gives 75 volts. To get 10 X 120K, the Ohms-Range Expander supplies 1.08 megohms which adds to the 120K to give 1.20 megohms. Now, the center-scale reading is 1.20 megohms.

The schematic diagram shows the complete circuit. Some extras have been added. Circuit parts T1, R2, D1, and C1 form a half-wave DC-voltage supply. Resistors R3 and R4 reduce the DC voltage to 67.5 volts across R5. R6 adds to the parallel combination of R3, R4, and R5 to give very nearly 1.08 megohms. R1 acts as a cheap fuse in case T1 should short-circuit. When switch S1 is in the *Normal* position, the Ohms-Range Expander is shut off and the meter leads are connected directly to the meter for normal operation. When S1 is in the *R X 100K* position, S2 shorts the multimeter terminals together so that *Zero Ohms* can be set with the multimeter *Ohms-Adjust* knob. After the unknown resistor is connected, the READ button (S2) is pushed which unshorts the meter giving a reading. The main purpose of S2 is to prevent electrical shorts—it keeps the 67.5 volts from appearing across the meter leads except when a measurement is being made.

Construction: If you want to use the chassis box specified in the parts list, the dimensions given in the drawings work well. The layout is very compact, however, and

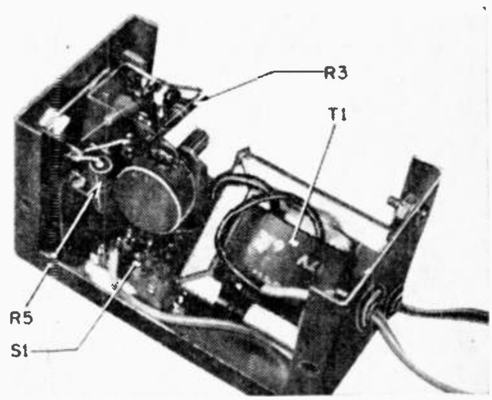
Chassis box layout is optional. Wiring isn't critical since there is no chance for feedback.





For some multimeters (VOM's) you'll need pin tips on the leads instead of the banana plugs shown here. Since some connections are quite close together it is best to use plastic sleeving (spaghetti) on the longer pigtail leads.

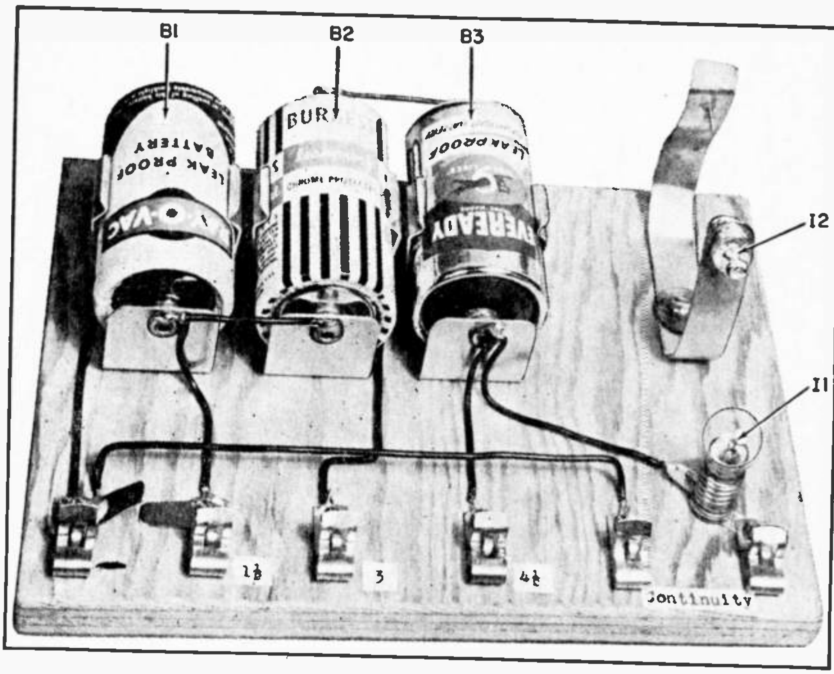
Only thing to watch out for is AC leakage between tie-strip terminals through a buildup of the rosin flux from the solder. This current leakage can add hum to your DC output.



the dimensions should be followed closely. The two terminal strips used (one with a mounting lug and two terminals to the right, the other with a mounting lug and two terminals to the left) were cut from larger strips. The leads to the meter were made from a length of lamp cord, slit three inches from one end, and prevented from separating further by a piece of heat-shrinkable tubing. With some volt-ohm-milliammeters you may have to reverse the connections to the red and black plugs and jacks from those shown in the diagram. To simplify switching these VOM's use reverse polarity to the test leads.

First Time Use. Plug the red and black plugs into the plus (VΩA) and common jacks of the multimeter. Set the multimeter to *R X 10K*. Set the Ohms-Range Expander to *Normal*. Adjust the multimeter *Ohms-Adjust* knob for a reading of zero ohms. Set the Expander to *X100K*. With a screwdriver, set R4 so that the multimeter again reads zero ohms (this adjusts the voltage to 67.5 volts and shouldn't have to be touched again unless the line voltage changes). Plug the meter leads into the Expander, connect a resistor, press the *Read* button, and read. ■

Workbench Weegee Board



By Art Trauffer

Your lab workbench may be equipped with everything in test equipment from an *A*nnunciation relay to a *Z*-angle meter, but do you have a Ouija board?

■ This innocent looking "Weegee" board is actually a low-voltage power supply for transistor experiments, a continuity checker, a bulb tester, an emergency flashlight, a cell tester, a code practice blinker, and anything else for which you can put it to use. (Incidentally, the correct spelling for "Weegee" is "Ouija", but how many people know how to pronounce it?)

Start With The Chassis. As shown in the photographs, the parts are mounted and wired on a ½-inch plywood board about 5 inches by 72 inches. The three D flashlight cells, B1, B2, and B3, can be mounted in Keystone battery holders, as shown, or simply soldered in series and strapped onto the board. The bulb tester is simply two strips of metal, brass, copper, or tin, about ¼-inch wide and ¾-inch long, soldered to the Fahnestock clips, as shown. The left-hand strip is bent up a little, as shown in the detail photograph.

The continuity tester is simply a miniature light bulb, I1, screw base type, mounted in a socket and wired in series with the 4½-volt power supply. One socket lug can be soldered directly to the right-hand Fahnestock clip, as shown.

The flashlight cell tester is simply a ½-inch by 6-inch springy metal band bent into a U, and screw-fastened onto the board. A 1.2-volt flashlight bulb, I2 is soldered into a hole near one end of the U, and a brass tack is soldered near the other end. Make the U from any springy metal that's easy to solder. Bend the U so it can be spread or compressed to accommodate any flashlight cell from penlite to D size. All the circuits are shown in the schematic diagram.

It's important to note that, since we are dealing with low voltage, it is advisable that all connections be soldered, where possible.

Some Uses. For transistor experiments, or other low voltage experiments, the four left-hand Fahnestock clips will give you 4½ volts in 1½-volt steps.

Any flashlight bulb, or radio dial bulb, can be tested as shown. Even a No. 47 radio dial bulb will glow faintly if the filament is not open. Series strung Christmas tree bulbs can be tested by twisting them into the bulb socket and shorting the *continuity* clips.

Fuses, low-resistance coils, etc., can be continuity-tested by connecting a pair of test prods to the *continuity* clips. Variable capacitors can be tested for shorts: I1 will light if the plates in the capacitor are shorted.

Connect a telegraph transmitting key to the *continuity* clips and you have a "blinker" code practice set.

Connect a wire jumper across the *continuity* clips and you have an emergency flashlight.

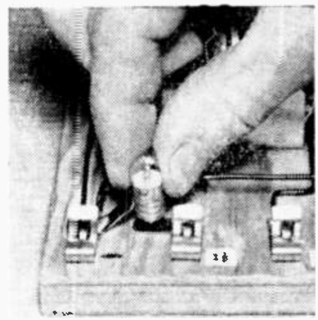
Any flashlight cell, from penlite to "D", can be tested as shown. I2 lights brightly if the cell is in good shape, but glows dimly, or fades out, if the cell is weak.

We will leave it to you to continue listing other uses for this board. ■

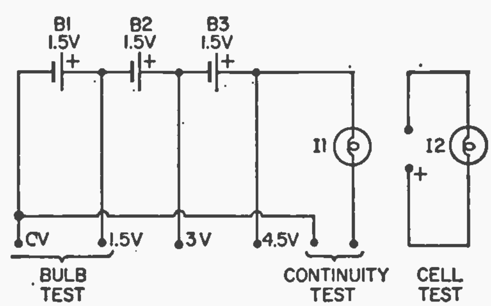
PARTS LIST

B1, B2, B3—D size flashlight cells
I1—4.9-volt, screw-base miniature lamp (GE 407 or equiv.)
I2—1.2-volt, screw-base miniature lamp (GE 112 or equiv.)
3—Battery holders (Keystone No. 175 or equiv.)
1—Miniature screw socket for I1 (Leecraft 5-06 or equiv.)
6—¾" x 5/16" Fahnestock clips (Mueller No. 10 or equiv.)
Misc.—Scrap metal for cell and bulb testers; plywood for baseboard, nominally 5" x 7" x ½"; round head wood screws; hookup wire; brass tack; washers; solder; etc.

Estimated cost: $2.00
Estimated construction time: 1 hour



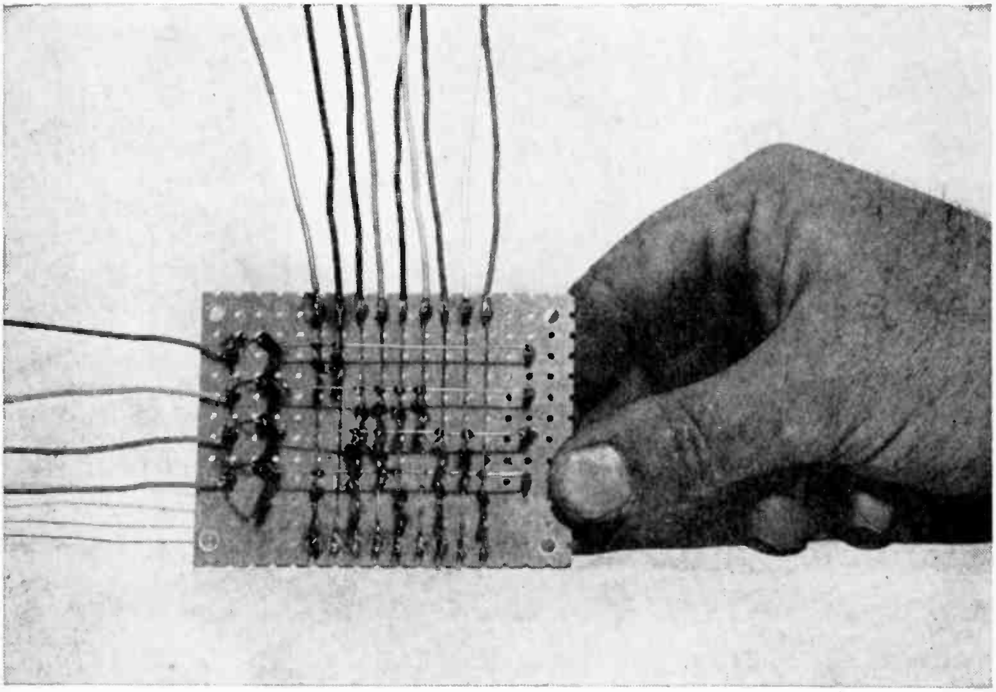
Bulb is quickly tested using the test prongs attached to the first two Fahnestock clips. The 1.5 volts is enough to check for an open filament. Flashlight cells are checked in a flash in the fabricated bulb holder and strip. Brightly lighted or dimly lit bulb indicates strength.



Simplicity of the Weegee Board schematic diagram belies its tremendous usefulness in giving you a quick answer to your "good or bad?" electrical questions in the shop.

MATRIX CIRCUITS

by Jack Brayton
& Herb Friedman



A simple rectangular array of semiconductor diodes plus some switches and lamps can be assembled by you to convert decimal numbers to binary digits

■ When we were in grade school we learned to perform simple arithmetical problems using the decimal number system—mainly because we have *ten* fingers. But computers can't understand the decimal number system. They understand only their own language: the binary number system and for good reason—they have only *two* fingers (*on* and *off*). As a result everything fed into a computer must be translated from *decimal* to *binary* before any calculations can take place.

The electronic circuit which does the translating is called a *matrix*. In spite of the function it performs it's neither large nor complicated. In fact—it's simple to build and easy to understand. The parts used are inexpensive and readily available. Even its many diodes aren't expensive because they're offered in ten-for-a-dollar lots in many parts supply catalogs.

To help you learn all about the matrix, we have prepared three experiments that can be easily assembled from low-cost parts. Just in case you would like to make a simple demonstrator for the class room or Science Fair project, the first experiment is followed by complete plans for a simple, low-cost decimal-binary demonstrator.

Experiment 1. A basic matrix circuit that can be breadboarded is shown in Fig. 1. The one and zero of the binary system is represented by lighted and unlighted lamps, respectively. Its input consists of normally-open button switches numbered 1 through 9.

If we wanted the number 7 converted to binary we would simply press the number 7 switch, S7. With the switch closed the positive voltage of the battery is applied to the *anodes* of 3 diodes, D10, D11, D12, and 3 circuits are activated. *Each* of the activated circuits is a series circuit consisting of a diode, a resistor (R3, R2, R1), and a lamp (I4, I2, I1). Each circuit has 9 volts across it.

Since a diode conducts whenever its anode is positive with respect to its cathode the three diodes, D10, D11, D12, conduct. Current flows through the diode, the resistor, and the lamp of each circuit. As a result the lamps light. In this case lights numbered 1, 2, and 4 on the front panel would be lighted and lamp 8 remains unlit.

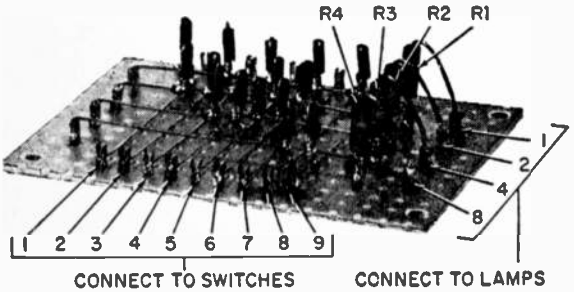
A lighted lamp represents a one while an unlighted lamp represents a zero. Thus, we can see that the output reads 0111. This, of course, is the binary number for 7. It means that the number 7 is composed of *zero* eights, *one* four, *one* two, and *one* one. So all the observer has to do is add up the numbers associated with the illuminated lamps to learn whether or not the matrix converted the decimal number to the correct binary number.

Optional Design Note. 68-ohm resistors can replace the diodes in Fig. 1 which are marked with an asterisk (*). Their input switches go to only one output and the isolation provided by the diode isn't needed. However, if the inputs were connected directly to the outputs (without the resistor) the current through the lamp would be too high.

Why and Why Not. Now is a good time as any to discover for yourself why the other lamps do not light. Starting from the positive terminal of battery, B1, try to work your way through the depressed #7 switch, S7 to lamp I8. Remember, you cannot pass through a diode unless you travel in the same direction as the arrowhead in its symbol. Try every possible path and you will discover you just can't get to lamp I8. Hence, when S7 is depressed, I8 will never light.

PARTS LIST FOR EXPERIMENT 1

B1—9-volt battery (Eveready 216 or equiv.) (See text)
D1 through D15—1N34, 1N34A or equivalent (Two packages of Lafayette 19G6001 diodes or equiv.)
I1, I2, I4, I8—#49 pilot lamps (GE)
R1, R2, R3, R4—68-ohm, ½-watt resistor
R5, R6, R7, R8—68-ohm, ½-watt resistor (Optional—used in place of diodes D1, D2, D5, D13. See text)
S1 through S9—Single-pole, normally-open pushbutton switch (Lafayette 99G6218 or equiv.)
4—Bayonet sockets for #49 lamps (Leecraft type 7-11 or equiv.)



Bare copper leads suspended between flea clips serve as busses to form the matrix.

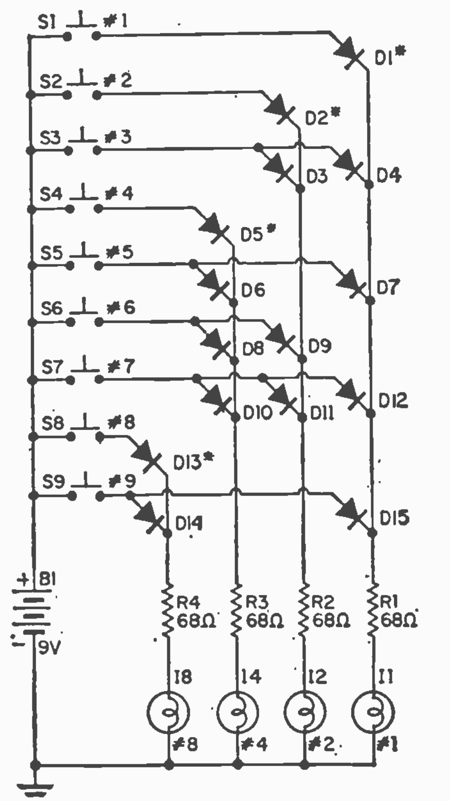


Fig. 1. Schematic diagram for an easy-to-build four digit, decimal-to-binary demonstrator.

This is true for the other switches, too. The table below lists the lamps which should light when a selected switch is depressed. Using the circuit tracing technique described in the preceding paragraph, select a few numbers and find out for yourself whether the table is correct or not. *(Editor's note: the table is correct. If you differ—you're wrong.)*

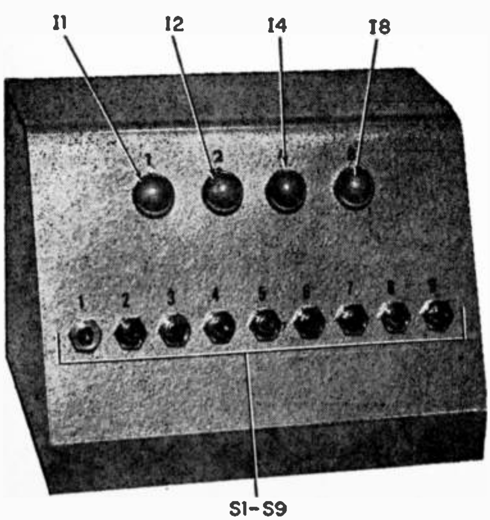
Switch/Lamp/Number Relationships

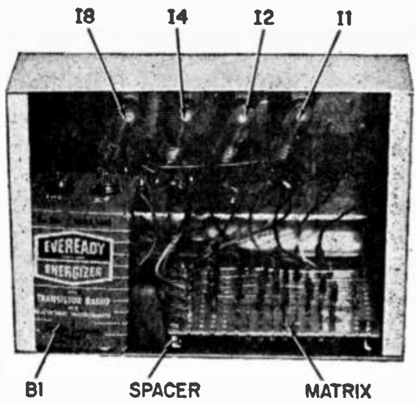
Depress Switch	Lamps That Will Light I1	I2	L4	I8	Numbered Lamps Add Up To (*)
S1	●				1
S2		●			2
S3	●	●			3
S4			●		4
S5	●		●		5
S6		●	●		6
S7	●	●	●		7
S8				●	8
S9	●			●	9

** When no lamps are lit, they add up to zero—hence, no switch is needed for the number 0.*

Experiment 2. Fig. 2 shows another matrix circuit. Excluding its output it works exactly like the first shown in Fig. 1. In this new circuit a one is indicated by positive voltage while a zero is indicated by no voltage. When an input switch is closed positive voltage is applied to the proper diodes. When the diodes conduct they have a very low resistance compared with the 10,000-ohm loading resistors. Since we measure the voltage at the top of the resistors almost the entire positive 1.5 volts of battery B1 can be measured whenever a diode conducts.

Diodes D1, D2, D5 and D13 in Fig. 2

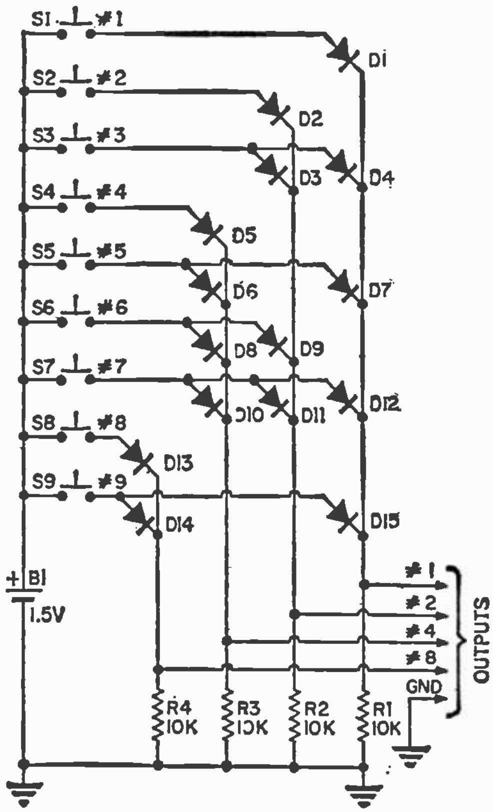




Rear view of the demonstrator shows location of lamps, switches, battery and matrix.

Photo at lower-left corner of page shows location of front panel lamps and switches on the demonstrator. Exact parts location is not critical—lamp jewels are all red.

Fig. 2. Basically the same as Fig. 1, the circuit below provides positive voltage output on binary busses in place of lamps.



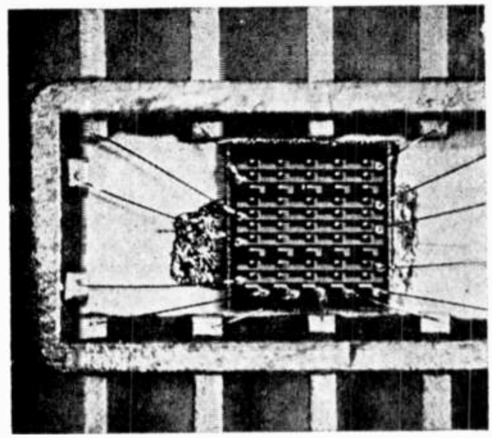
can be eliminated (shorted out) and their inputs connected directly to the outputs because neither the diode's isolation or resistance is needed in this circuit.

Experiment 3. The last circuit which we'll experiment with is a matrix whose output signal is *positive* voltage and no output is negative voltage. This circuit is shown in Fig. 3.

The basic diode arrangement is still the same. However, the output circuit operates differently. Whenever a diode is forward biased (S1 in Fig. 3 is depressed) we have a circuit equivalent to the one shown in Fig. 4.

Since batteries B1 and B2 are in series their voltages add. Thus, we have 3 volts across a series circuit consisting of the conducting diode and the resistor. Using the *current-flowing-from-plus-to-minus* theory, current flows from the positive terminal of B1 through D1 and R1 then through B2 and back to B1's negative terminal. The diode drops only a few one hundredths of a volt because its forward resistance compared with R1 is very small. This means that the 10,000-ohm resistor, R1, drops almost the entire 3 volts. Now then, the voltage seen at the output is the sum of the positive 3-volt drop on R1 and the negative 1.5-volt voltage rise in B2—therefore the output signal is the algebraic sum of the two, 1.5 volts *positive*.

(Continued on page 126)



Microminiature matrix circuit designed for computer application—enlarged ten times.

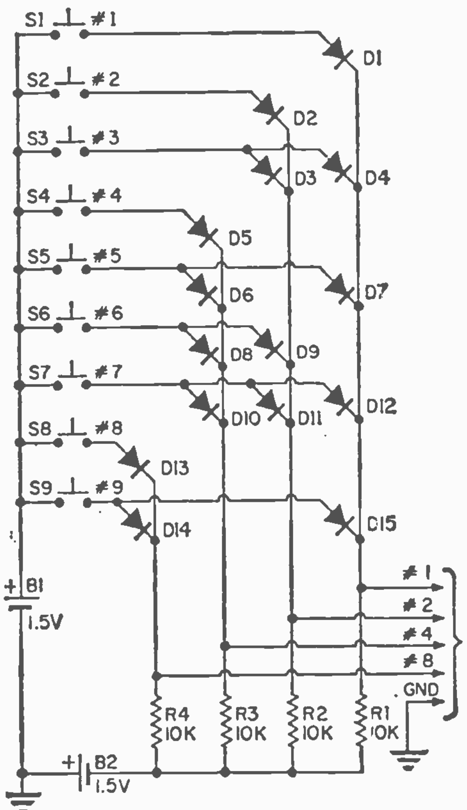


Fig. 3. Diagram of a matrix circuit capable of positive (on) and negative (off) signals.

PARTS LIST FOR EXPERIMENTS 2 & 3
B1, B2—1.5 volt (D cell or equiv.). B2 used in Experiment 3 only
D1 through D15—Same as Experiment 1
I1, I2, I4, I8—Same as Experiment 1
R1, R2, R3, R4—10,000-ohm, ½-watt resistor
S1 through S9—Same as Experiment 1
4—Bayonet sockets. Same as Experiment 1

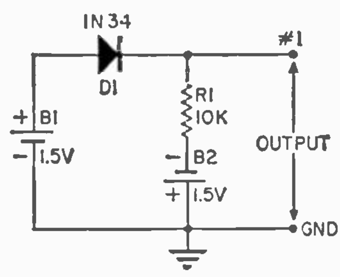


Fig. 4. Equivalent circuit for on signal.

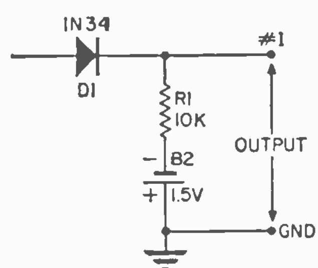


Fig. 5. Equivalent circuit for off signal.

THE OSCILLOBRATOR

The Oscillobrator is of interest mainly to people who have oscilloscopes, or to people who hope to buy one but whose budget will allow only the economy model . . . or to experimenters who don't even own a scope but simply can't resist a construction project.

Those in all three categories are probably aware that without a voltage calibrator an oscilloscope functions strictly as an observational device. With one, the oscilloscope becomes a highly sophisticated voltage measuring instrument.

The shortcomings of the ordinary voltmeter are readily apparent. It performs very successfully on D.C. voltages, or on 60-cycle sine waves. But it is useless at audio or radio frequencies, or on square waves, or on pulsating DC, in fact, on any non-sinusoidal waveform. It is in these applications that calibrated oscilloscope really earns its keep.

A Bargain Project. The careful shopper can buy all new parts for the Oscillobrator for less than ten dollars. Voltage calibrator kits now on the market cost anywhere from half again to twice as much. Not only has this circuit sacrificed nothing to achieve economy, but it can actually boast of features not found in its commercial counterparts.

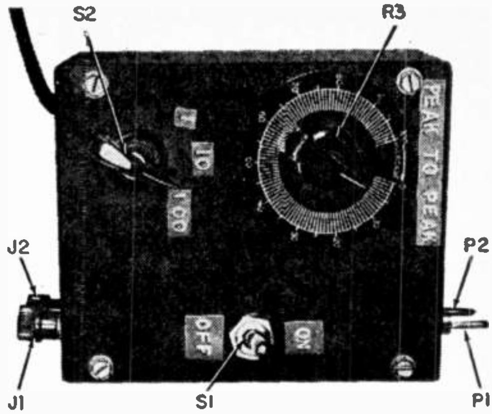
For instance, it requires no warmup time. Flip on the switch when you are ready to take the measurement and flip it off when you are through. There is no standby current consumption, nor any overheating and ventilation problem. If you are so inclined, you can substitute a spring-loaded momentary contact switch for S1 so that it will turn itself off when released.

Another highly desirable characteristic is that constant *zeroing* or recalibration is not required. After you make the initial adjustment you need give it no further attention unless you change the voltage regulator tube or some other component.

Perhaps the outstanding feature is the convenience and availability that can be built into the instrument. It is designed to plug directly into the vertical input terminals of the oscilloscope. The test leads can be plugged into the Oscillobrator and left there

To calibrate your oscilloscope to indicate voltage just take a dash of a few dollars to home-brew this circuit

By William J. Millard



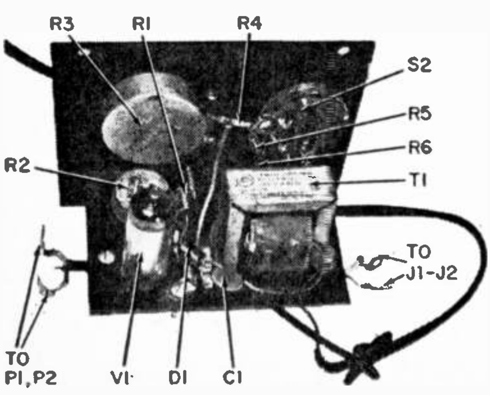
Plugs P1 and P2 are placed at a level to meet vertical input terminals of the scope.

permanently because, in the off position, switch S1 provides a direct path between the input and the output terminals.

How It Works. Voltage regulator tube V1 is the heart of the calibrator. It fires when the pulse from the rectifier reaches 115 volts and immediately draws enough current through resistor R1 to reduce the voltage and hold it at a steady 105 volts. When the amplitude of the positive pulse drops below that point, the regulator tube cuts off. The resultant waveform, as it appears on the oscilloscope, is shown in the drawing. The peak at the left side represents the initial surge to 115 volts that fires the regulator tube. The horizontal bars at the top and bottom represent a voltage differential of 105 volts.

When the oscilloscope sweep frequency is higher than 60 cycles, which is normally the case, the calibrator output appears as a set of parallel bars. The vertical components of the waveform occur so rapidly that they practically disappear, leaving the two horizontal bars representing the calibrating voltage. Normal line-voltage variations have a negligible effect on the VR tube output, thus providing an excellent comparison standard.

Voltage Divider Network. The calibration voltage is controlled by potentiometer R3 and the divider network consisting of resistors R4, R5, and R6. The use of a wirewound potentiometer for R3 is an absolute must. The linearity of a carbon potentiometer, even with the so-called *linear taper*, is too poor for reasonably accurate calibration. Resistors R4, R5, and R6 should be low-tolerance resistors, 5% or less. If you have a good supply of resistors in your junk box and an accurate ohmmeter of adequate range, you can build up a divider to



All components except the input and output jacks and plugs are mounted on subchassis.

PARTS LIST

C1—.01-mf., 600-volt ceramic capacitor
D1—Silicon rectifier, 400PIV, 750ma (GE 1N539, Lafayette Radio 19G5001 or equiv.)
J1, J2—Red and black banana jacks
M1—AC voltmeter (for calibration only)
P1, P2—Red and black plugs to match oscilloscope input jacks
R1—4700-ohm, 2-watt, 10% resistor
R2—5,000- to 50,000-ohm, ½-watt, linear taper potentiometer
R3—20,000-ohm, ½-watt, linear taper wire-wound potentiometer
R4—470,000-ohm, ½-watt, 5% resistor
R5—47,000-ohm, ½-watt, 5% resistor
R6—5100-ohm, ½-watt, 5% resistor
R7—Low resistance potentiometer (for calibration only)
S1—D.p.d.t. toggle switch
S2—Single gang, 3-position rotary switch
T1—Power transformer, 125vdc @ 15ma (Allied Electronics 61G410 or Lafayette 33G3405)
V1—OB2 voltage regulator tube
1—4" x 5" x 3" utility cabinet (Bud C-1794 or equiv.)
Misc.—7-pin miniature socket, solder lugs, terminal strip, line cord and plug, dial and switch plates, indicator knobs, panel markings, hardware, wire, solder, etc.

Estimated cost $7.00
Estimated construction time: 6 hours

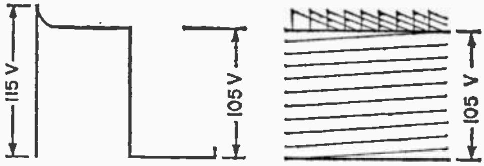
even closer tolerance—it's all up to you.

Construction Hints. The configuration of the control panel of your oscilloscope determines to a large extent the physical layout and the type of cabinet you choose for your version of the Oscillobrator. If you wish to plug directly into your scope, you'll want to use as small a cabinet as possible. Be sure to locate plugs P1 and P2 so that the calibrator doesn't cover the oscilloscope controls. Switch S1 and the input and output terminals J1-J2 and P1-P2, respectively, should be in a direct line and isolated as much as possible to avoid losses and interaction with the calibrator circuits.

Note that calibrating potentiometer R2 is mounted on the subpanel with screwdriver access through a hole drilled in the side of the cabinet. R2 can be a surplus potentiometer from your junkbox and can range from 5K to 50K ohms resistance. If it has no slot, cut one in the shaft with a hacksaw. Once it has been adjusted it requires no further attention and the inside mounting prevents accidental misalignment.

Potentiometer dial plates with 0-100 divisions are available from most parts supply houses. The ideal method for the most precise among us would be to make your own dial so as to conform to the potentiometer being used, because even the wirewound variety is not perfectly linear. However, some non-linearity ordinarily poses no problem for most applications. Besides, the dial plate is dressier and costs about a quarter.

Once the front panel with the subchassis is attached to the cabinet, quarters are a



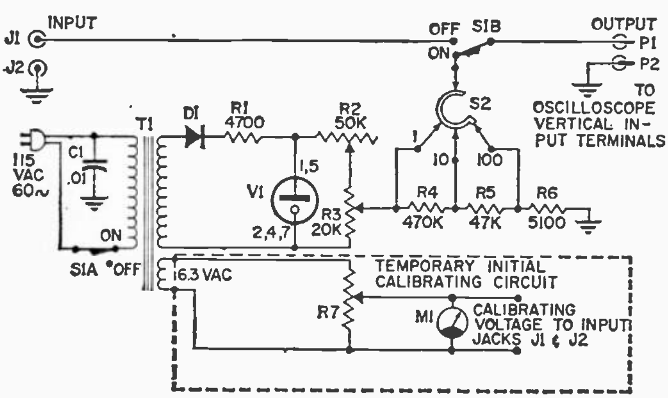
Single V1 pulse at left; but resulting two bars at right represent calibrating voltage.

little too close for easy access. Therefore, after the chassis wiring is complete, prepare two lengths of shielded wire slightly longer than necessary to reach from S1 to the input jacks and output plugs. Solder them to the appropriate lugs on S1. Then with the front panel partially in place but still with enough space to work in, solder the loose ends of the shielded wire to the input and output connectors on the cabinet. Both the input and the output positive terminals, J1 and P1, respectively, must be insulated from the cabinet. The negative terminals, J2 and P2, may be mounted directly.

Calibration. Calibration is simple. You will need an AC voltmeter, a source of alternating current, and another potentiometer. You can use another transformer to hook up the calibration circuit shown in the schematic diagram, or, which is more convenient, run a couple of leads from the unused 6.3-volt winding of transformer T1 to potentiometer R7. Leave the voltmeter M1 connected during the calibration process so as to prevent any fluctuation caused by the loading imposed on the circuit by the

(Continued on page 124)

Schematic diagram of the Oscillobrator shows the OFF position feature of passing the signal directly to the oscilloscope. Note the advantageous use of 6.3vac T1 leads, otherwise unused, for a calibration source (see table).



VOLTAGE COMPARISON

RMS	Peak-to-Peak
.354	1
.707	2
1.07	3
1.41	4
1.77	5
2.12	6
2.47	7
2.83	8
3.18	9
3.54	10
7.07	20
11.61	30
14.14	40
17.67	50
21.21	60
24.75	70
28.28	80
31.82	90
35.35	100

COVER STORY
PART 1

Build a 6 meter Solid-State Transmitter

by Edward A. Morris
WA2VLU

A simple circuit—easy to build and to operate as a portable, mobile or emergency Ham station. Ideal for the Novice as a first station or as an extra rig for any Ham. Mate it with the 6-meter receiver following these pages and you'll have a walkie-talkie!

HERE is one QRP* 6-meter transmitter that does not *sound* QRP! This potent handful uses a total of 7 semiconductors—6 transistors and one diode, to generate one of the cleanest signals you will hear on 6-meters. The RF section operates at a DC power input level of 250 milliwatts. Clean, crisp, 100% modulation is the result of high level collector modulation. The modulator itself uses two transistors to drive the class B push-pull modulating stage. A push-to-talk ceramic microphone and internal relay switching add to the convenience and operating utility of this little rig. The transmitters output network will provide a good match for antennas whose impedance is 30 to 75 ohms.

There's More. Other features include a spot switch, internal antenna transfer and receiver mute terminals operated by the push-to-talk relay. A built in relative RF output meter makes tune up a snap, and also provides an indication of

Continued Overleaf

*QRP: Decrease power; followed by question mark (QRP?), must I decrease power? As used in text above, "Reduced power" 6-meter transmitter.

battery strength. Operating power is derived from ten inexpensive AA-size penlight cells.

Modular type construction allows even a beginner to tackle this rig with confidence. Low in cost, it will fit a beginners modest budget. Total cost is under $35.00—and that's using all new, quality components throughout. Later on we'll tell you how to reduce this cost almost in half with just a few modifications. More about that later.

Completed unit shows compactness that is possible by using modular construction.

Go Walkie-Talkie. The transmitter described here was built as part of an all solid state 6-meter amateur station. The companion receiver was physically designed to match the transmitter. The receiver, built in the same size case, can be bolted to the right side of the transmitter to form a complete 6-meter station.

Of course nothing forces you to mount the rigs side-by-side. You can connect them bottom-to-bottom or top-to-bottom if the place you want to put them won't take something that is only ten inches long. Just remember to position the decals and meter (tuning dials, too) so they are easy to read. The transmitter section would be better on the bottom—that mike cable you know.

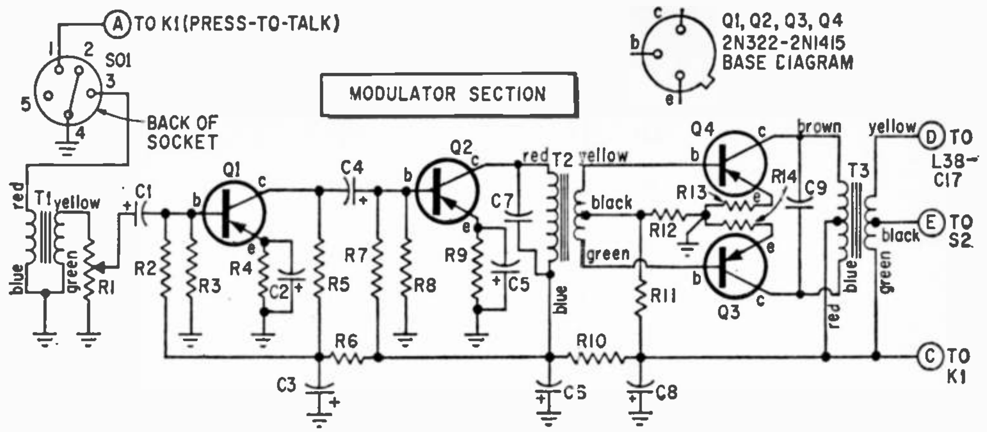
How it works. Let's first describe the action of the audio modulator, and then the RF section. Later on, how they work together.

Audio signals generated by the ceramic microphone are coupled into the primary of transformer T1, which matches the high microphone impedance to the low input impedance of transistor Q1. Variable resistor R1 serves as the modulation control. Audio from the secondary of T1, is coupled into the base of Q1 by capacitor C1. The bias on Q1 is preset by resistors R2 and R3. This stage is stabilized by resistor R4, which is by-passed by capacitor C2. Resistor R5 is the collector load for transistor Q1.

The audio voltage developed across R5 is coupled into the base of transistor Q2. The operation of this stage is identical to the first with the exception that a transformer, T2,

Parts List for 6-meter Solid-state Transmitter

B1-B10—1.5 volt AA cells (See text)
C1, C4—10-mf., 12-WVDC miniature electrolytic capacitor, (Lafayette 99R6082 or equiv.)
C2, C3, C5—50-mf., 12-WVDC miniature electrolytic capacitor (Lafayette 99R6085 or equiv.)
C6, C8—10-mf., 15-WVDC miniature electrolytic capacitor (Lafayette 99R6049 or equiv.)
C7—.005-mf., 75-WVDC miniature ceramic capacitor (Lafayette 99R6062 or equiv.)
C9—.05-mf., 75-WVDC miniature ceramic capacitor (Lafayette 99R6068 or equiv.)
C10—100-mmf., 500-WVDC ceramic capacitor
C11, C14—.01-mf., 75 WVDC miniature ceramic
C15, C19—capacitor (Lafayette 99R6063 or equiv.)
C12—20-mmf., 500-WVDC ceramic capacitor
C13, C17—68-mmf., 500-WVDC ceramic capacitor
C16—15-mmf., 500-WVDC ceramic capacitor
C18—10-mmf., 500-WVDC ceramic capacitor
D1—1N64 crystal diode
J1, J3, J4—phono jack, single hole mounting
J2—RF Connector, type SO-239
K1—3 p.d.t. miniature relay (Potter and Brumfield KM14D, 12-VDC coil. See text)
L1—4 3/4 turns No. 26 wire close wound on 3/8 o.d. ferrite tuned coil form
L2—1 1/4 turns No. 26 wire, wound around top of L1
L3—5 3/4 turns No. 26 wire close wound on 3/8 o.d. ferrite tuned coil form
M1—0-1 ma. miniature meter (Lafayette 99R5052)
Q1, Q2—2N322 transistor (Motorola)
Q3, Q4—2N1415 transistor (GE)
Q5, Q6—2N2512 transistor (Amperex) (order from Newark Electronics Corp., 223 West Madison St., Chicago, Ill. 60606. Part No. 22F2634 @ $1.60 each)
R1—5,000-ohm miniature potentiometer (Lafayette 99R6143)
R2—100,000-ohms
R3—15,000-ohms
R4—1,200-ohms



Modulator is only an audio amplifier. The main difference is in T3 secondary winding.

and not a resistor, is the collector load.

The output of transformer T2 drives the output stage, which is operated class B push-pull. The secondary of T2 is center tapped. As one transistor amplifies one half of the input signal, while the second transistor amplifies the other half.

Resistors R11 and R12 form a voltage divider which places a slight forward bias on transistors Q3 and Q4 to reduce cross-over distortion. Stabilization of transistors Q3 and Q4 is accomplished by resistors R13 and R14 which are in series with the emitter leads. The amplified output appears in the secondary of transformer T3.

Now that we have discussed the operation of the modulator, let's turn to the RF section.

The RF carrier is generated by transistor Q5, which operates as a crystal controlled overtone oscillator. The bias on Q5 is set by resistors R15 and R16. Capacitor C10 bypasses resistor R15. The resonant circuit formed by capacitors C12, C13 and coil L1 is resonant at the crystal frequency. Capacitors C12 and C13 also form a voltage divider —the crystal (XTAL) being placed in the feedback path which starts and sustains oscillation.

Transistor Q6, which is the final amplifier, operates class B. Radio frequency energy at the crystal frequency is coupled into the base of Q6 by the secondary of coil L1, that is coil L2. The turns ratio of L1/L2 is arranged to match the low input impedance of Q6.

A small amount of bias is placed on Q6

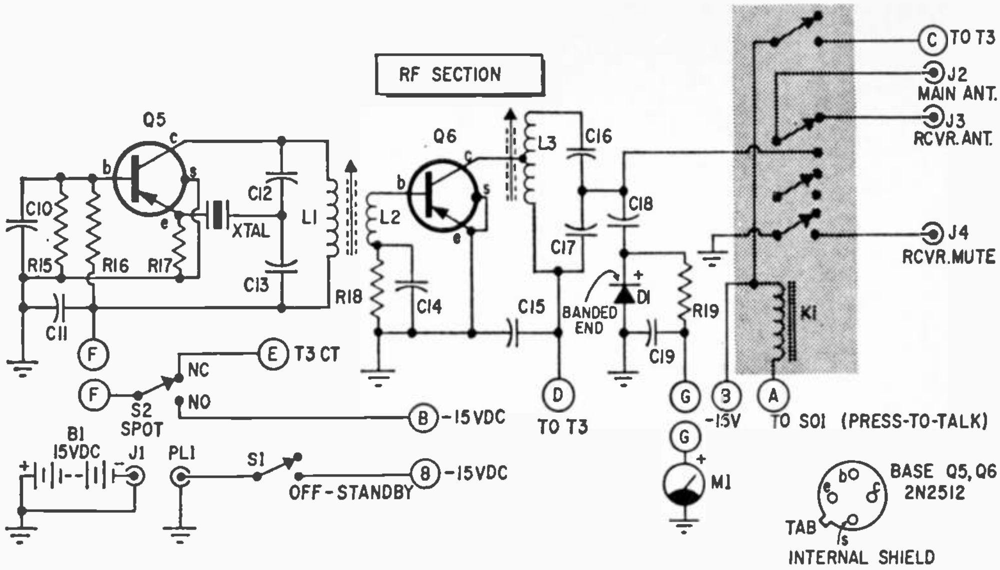
R5, 15—4,700-ohms
R6, 9—470-ohms
R7—220,000-ohms
R8—10,000-ohms
R10—220-ohms
R11—2,700-ohms
R12—47-ohms
R13, 15—10-ohms
R16—27,000-ohms
R17—100-ohms
R18—68-ohms
R19—330-ohms
PL1—Phono jack, RCA type
SO1—5-pin chassis connector (Amphenol PCG-5)
S1—S.p.s.t. toggle switch
S2—S.p.d.t. push-button switch
T1—Miniature audio transformer; 100,000-ohm primary, 2,000-ohm secondary (Lafayette 99R6125)
T2—Miniature audio transformer; 10,000-ohm primary, 2,000-ohm C.T. secondary (Lafayette 99R6126)
T3—Miniature audio transformer; 500-ohm C.T. primary, 500-ohm C.T. secondary (Lafayette 33R8553)

Note: all fixed value resistors are ½-watt, ±10%

XTAL—6-meter (50.1 to 54 mc.) 5th. overtone crystal
1—Push-to-talk microphone (Lafayette 44R0116)
1—Heat sink for Q6 (Thermalloy type 2211B)
1—Minibox, 5x4x3 inch (See text)
2—⅜ inch o.d. ferrite tuned coil form (Lafayette 99R6000 or 6001 or 6002)
Misc.—Nuts, bolts, solder, hook-up wire, ¼ o.d.-⅛ inch id plastic tube, perforated board, flea clips, eyelets, rubber feet, battery holders, etc.

Parts List—Bracket Handle

2—3x¾x⅛ inch aluminum
1—10⅜x¾x⅛ inch aluminum
2—¾x? inch length of aluminum 90° angle stock
Misc.—Nuts, bolts, epoxy, microphone hang-up bracket, (supplied with microphone)



The usual high-frequency wiring techniques must be used when wiring this section of unit.

by resistor R18 and capacitor C14, which generate signal developed bias. The collector of Q6 is tapped down on L3 to obtain a better impedance match and maximum power output. Capacitors C16 and C17 form a capacitive voltage divider which matches the resonant-frequency impedance of the tank circuit to that of the antenna. A small portion of the output energy is sampled via capacitor C18. This energy is rectified by diode D1. This DC voltage is applied to the meter to provide a visual indication of RF power output.

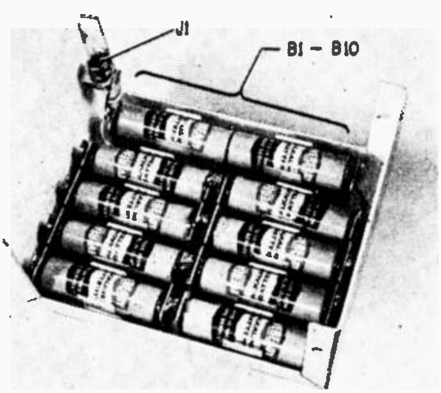
Team Work. Now that we have explained the operation of the modulator and RF sections separately, we'll show how they work together.

When the push-to-talk switch on the microphone is depressed, relay K1 is energized. A pair of contacts on the relay are closed and power is applied to the transmitter at point C. Notice that current flowing to the RF section must first pass through the secondary of the modulation transformer, T3. When you speak into the microphone, the audio modulation voltage appears in series with the DC voltage. This audio modulation voltage adds and subtracts from the DC voltage according to the input signal. Thus the current to the RF section is modulated by the input audio signal, and the carrier is modulated.

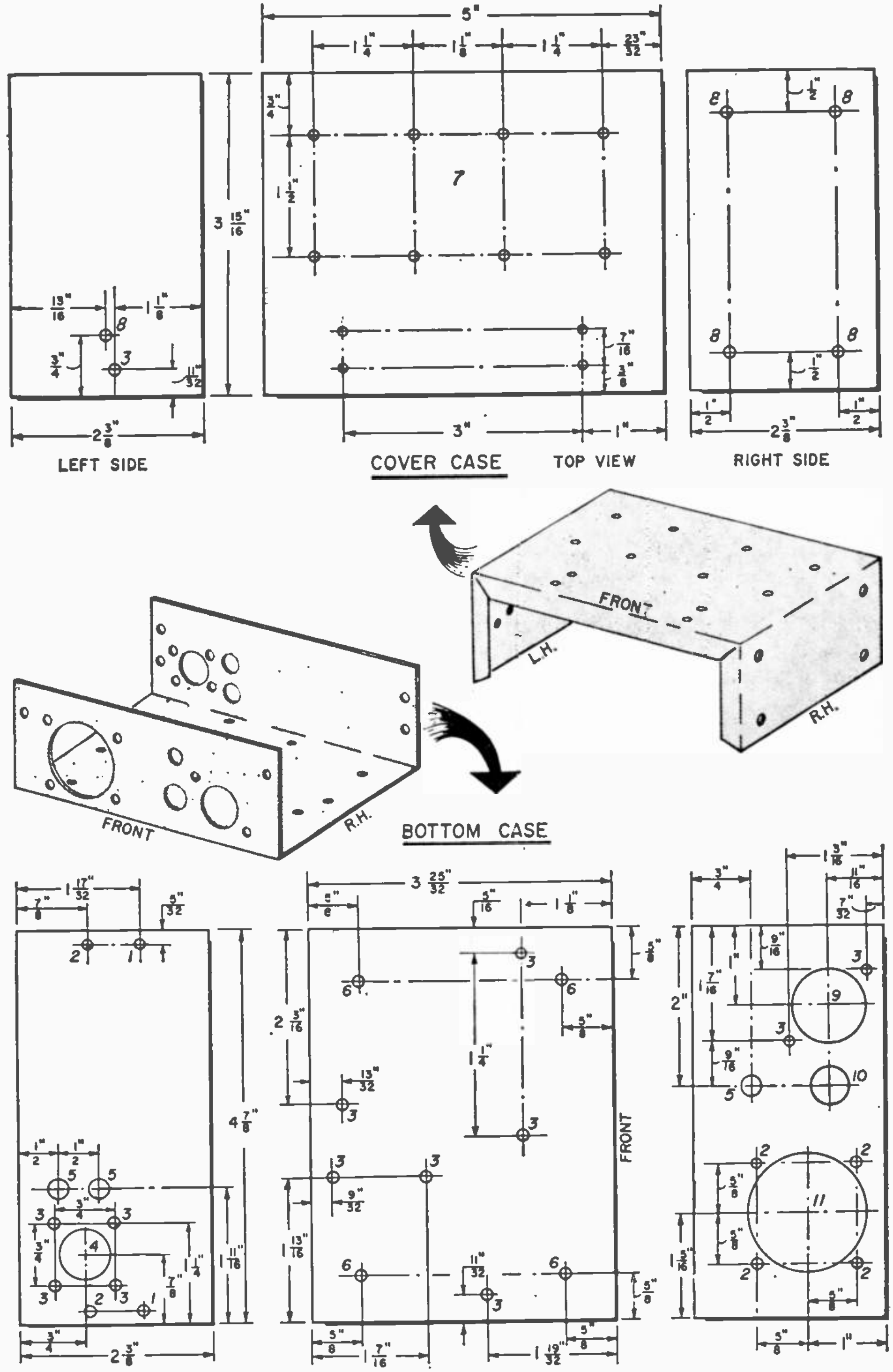
Mechanical Construction. The transmitter is built into a standard 5x4x3 inch aluminum chassis cut down to 5x4x2⅜ inches. To modify the case, the bottom ⅝ inch from each half of the box is cut off. It's a simple job with a hacksaw or a hand nibbler. Dress any rough edges with a file.

Lay out the spots to be drilled in the case with a square. Center punch each spot to be drilled before drilling. The larger holes can be formed by first drilling a small hole and using a reamer to enlarge it to the proper size. The holes for meter M1 and socket SO1 are most easily made with a Greenlee chassis or knock-out punch.

After all the mechanical work on the case has been completed, the case is prepared for painting. Wash the case to remove any dirt or grease which might prevent the paint from adhering to the case properly. The case can



Batteries mounted in cover provide the 15-volts DC. Keep contacts clean and secure.



Notes on Chassis Box Preparation

1. Original hole in case.
2. 3/32" diameter hole.
3. Hole for #4 screw.
4. 5/8" diameter hole.
5. 1/4" diameter hole.
6. Hole for #6 screw.
7. All holes in case cover top are for #4 screws.
8. Holes for #8 screws.
9. 7/8" diameter hole.
10. 1/2" diameter hole.
11. 1 1/2" diameter hole.

then be painted using a good quality spray paint following the paint manufacturer's directions.

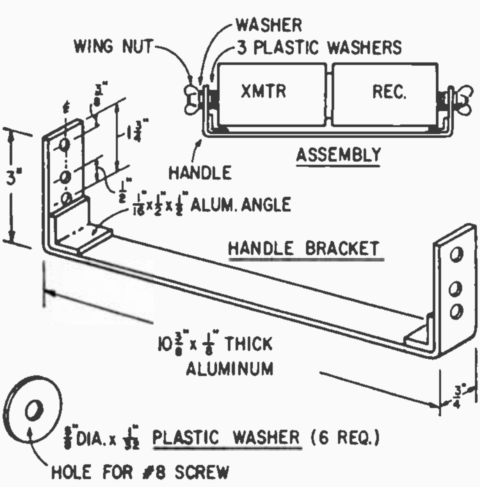
Suitable decals may then be applied to give the transmitter a professional, finished appearance. Apply several light coats of a clear spray paint to protect both the paint job and the decals.

The mounting bracket (see drawings) is assembled using ¾x⅛ inch aluminum stock cut to the dimensions given. The corner brackets, made from aluminum angle stock, were *epoxied* to the side pieces. The reader may prefer to use conventional hardware. The microphone bracket, which comes with the microphone, is mounted using 6-32 hardware.

Electrical Construction — Modulator. The modulator is built on a 1 15/16x2 13/16 inch piece of perforated board. The general parts layout can be seen in the photographs. Most of the components are mounted upright in order to conserve space. Although the layout is not critical, due to the compact construction of the modulator, the reader would do well to follow the layout presented. Modulator Location Table gives the exact location of all capacitors and resistors on the perforated board. The placement of transistors Q1 through Q4 and transformers can be determined from the photographs.

After the modulator is wired, recheck it for possible errors. After you've assured yourself that the wiring is correct, proceed to test the modulator.

Testing Modulator Section. Insert the transistors. Temporarily connect a 470-ohm,



Handle is used as bracket to mount rig under dashboard or for tabletop tilting.

½-watt resistor from point C to D. Connect a VOM set to read AC volts across the 470-ohm resistor. Connect a microphone to the input. Apply negative (–) 15 volts to point C, and positive (+) 15 volts to a ground point. Set the modulation control R1 so that the meter reads 7 to 7.5 volts rms when speaking into the microphone in a slightly louder than normal voice. The modulator is now set to modulate the transmitter 80 to 100%.

If a VOM is not available, a medium impedance (500 to 2,000 ohms) headset can be used to check that the modulator is operating.

Electrical Construction—RF Section. The RF transmitter section is built on a piece of copper clad perforated board to simplify construction. Areas of the copper are stripped from the board to provide insulated areas for flea clips, coils, etc. Remember that at VHF frequencies, all leads should be as short as possible to ensure proper operation.

Coils L1, L2, and L3 are wound on miniature ⅜-inch o.d. coil forms. The coil forms specified are replacement parts for popular CB walkie talkies, and are easy to obtain. Strip off the original winding and rewind the coils as given in the Parts List. A drop of wax or Duco cement will keep the turns from coming loose. Be sure that the tap on coil L3 does not short to an adjacent turn.

Complete the wiring as shown in the schematic diagram. Recheck your work for possible errors.

Testing RF Section. After the RF board has been checked over, test it as follows.

Plug in transistors Q5 and Q6. As transistor Q6 is operated close to its maximum power rating, be sure to use the heat sink specified in the parts list. Plug a 6-meter (50.1 to 54 mc.) 5th overtone crystal into the crystal socket. Using jumper leads, connect terminals F, D, and C together. Connect the positive terminal of meter M1 to terminal G, and the negative terminal to ground. Temporarily solder a 47-ohm, ½-watt resistor from the junction of capacitors C16 and C17 to ground. Use short leads. Connect negative (–) 15 volts to terminal B, and positive (+) 15 volts to ground. When terminal A is momentarily contacted to ground, relay R1 should pull in and meter M1 should deflect up scale. Tune coils L1 and L3 for maximum on meter M1. A meter indication of 0.6 to 0.9 will indicate that the RF section is operating correctly.

Final Testing and Alignment. Assuming no wiring errors have been made during the final assembly, the transmitter should require only minor adjustments to tune it up for peak output and 100% modulation.

Connect a 50-ohm dummy load to J2. If you don't already have one, you can make one up quite easily. Insert a 50-ohm (47-ohms will also do), ½-watt resistor into a PL-259 connector, pass one lead through the center conductor and solder. The remaining lead is soldered to the shell of the connector.

Plug in the battery pack, and the microphone to the unit. Switch S1 to the stand-by position. When you depress the push-to-talk button, on the microphone, meter M1 should deflect up scale, indicating that there is output. If it does not, recheck the wiring.

Key the push-to-talk switch, and without speaking into the microphone, peak coils L1 and L3 for maximum reading on meter M1. A reading of 0.6 to 0.9 is about right. With the dummy load still connected, listen to the transmitter with a receiver tuned to the transmitter's frequency. Adjust the modulation control, variable resistor R1, for best modulation when speaking in a slightly louder than normal voice. The modulation control should not be advanced *too high,* however, or the transmitter may overmodulate on peaks.

On the Air. Operating this rig is a breeze. Once the necessary tune-up adjustments have been made, you can forget them. This is one rig you don't have to shout into to be heard —the modulator has plenty of reserve power.

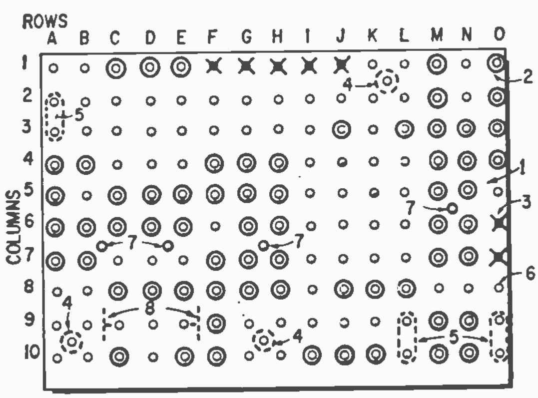
Batteries are replaced when the indicated

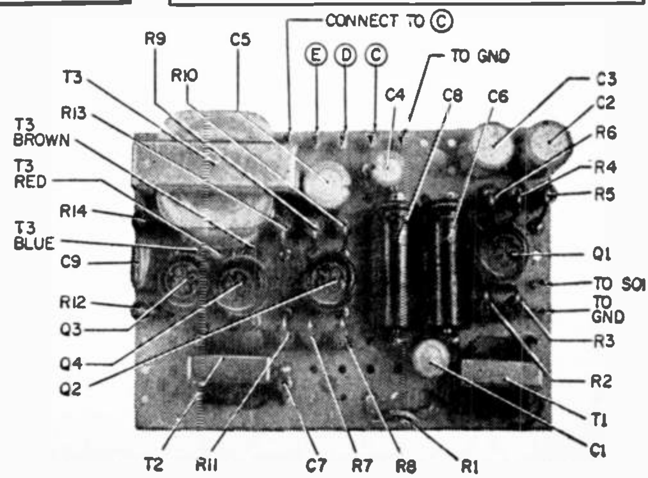
Modulator section contains the greater number of electronic components. Table at right indicates resistor and capacitor positions on perforated board below. The completed modulator is at bottom right.

Modulator Location Table

Resistor	Location	
R1	I 10, J10, K10	
R2	M6, M7*	
R3	N6, N7*	
R4	N3*, N4	
R5	O3*, O4	
R6	M3*, M4	*indicates which hole the upright resistor rests on.
R7	G7, G8*	
R8	H7, H8*	
R9	G4*, G5	
R10	H4*, H5	
R11	F7, F8*	
R12	A7*, B7	
R13	F4*, F5	
R14	A4*, B4	

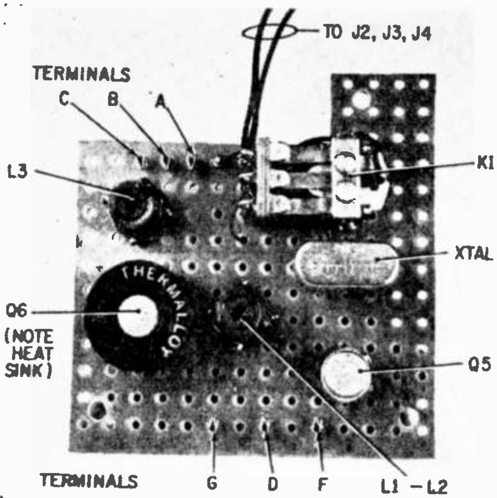
Capacitor	Location	
C1	K8, K9*	
C2	O1*, O2	
C3	M1*, M2	
C4	I1*, J2	*indicates position of positive (+) terminal, if polarized.
C5	G3, H3*	
C6	L3*, L8	
C7	F9, F10	
C8	J3*, J8	
C9	A5, A6	

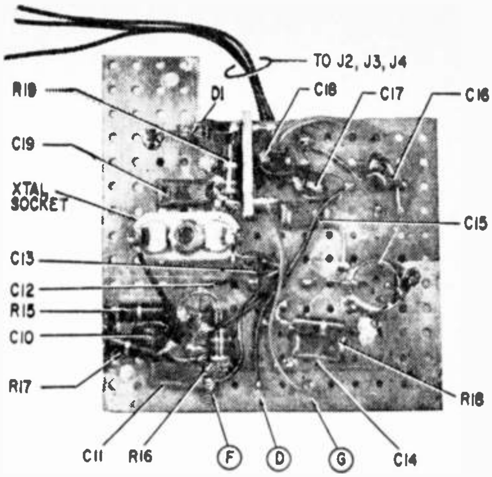




Notes on Modulator Perf-Board

1. Component side of board is shown. All interconnections are on other side.
2. Eyelet in hole is indicated with heavy circle.
3. Flea clip locations are (X).
4. Dotted circle indicates a hole drilled for #4 screw.
5. Dotted circular loop around two holes indicates cutout for transformer mounting.
6. Unmarked holes not used.
7. Small dark circles not in line with perf-board holes are drilled 1/16" diameter.
8. Slots cut for T2 mounting.





Top view of RF section (above) and the bottom view (below) have fewer components to squeeze into available space. Point-to-point wiring is used in RF stage to keep all lead lengths as short as possible thus keeping all stray capacitances lower.

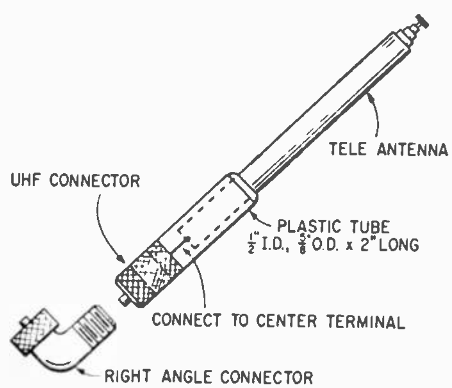
RF power output on meter M1 drops. You'll get more for your money if you use the premium alkaline cells. These cells do cost more initially, but will last far longer than ordinary cells, and actually reduce the operating cost-per-hour.

With a low power rig such as this, a good antenna is a must. A simple whip antenna suitable for portable operation can be assembled using a replacement type telescoping antenna joined to a PL-259 connector.

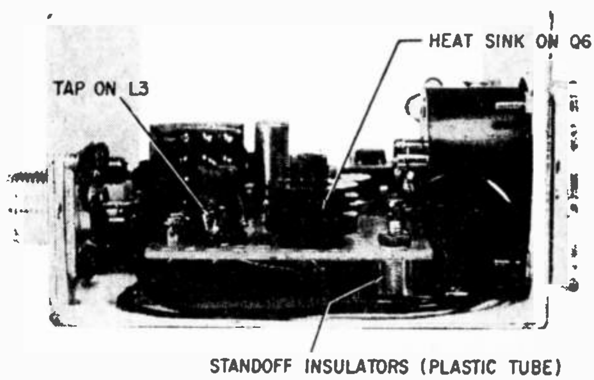
For best results when used as part of a fixed station, a better antenna should be used. A properly cut half-wave dipole will give good results if it's mounted high and is in a good location. A beam-type antenna would be your best bet.

Ranges of 30 to 50 miles are typical, and can be expected when the rig is used with a beam type antenna. A lot depends on the height and location of the antenna. Naturally, if you live on top of a 1500-foot hill, your results are likely to be a lot better than the fellow who lives *between* two 1500-foot hills! Skip contacts 600 to 1500 miles distant are possible during the summer months. For additional antenna information, the reader is referred to The Radio Amateur's Handbook published by the ARRL.

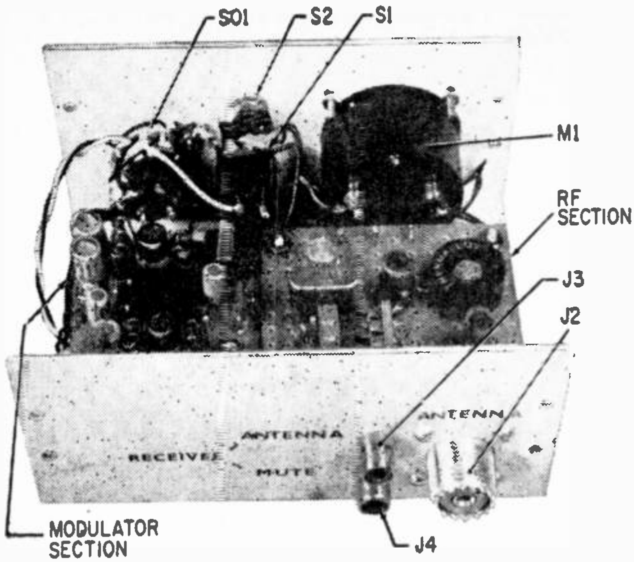
Warning. When operating this or any



Adjust telescoping antenna around basic 54-inch length for maximum signal radiation. Don't remove antenna with power on.



Side view of transmitter shows there is lots of room between top of components on circuit board and top of chassis box.

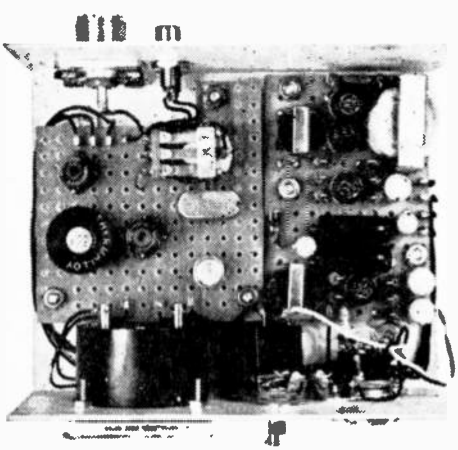


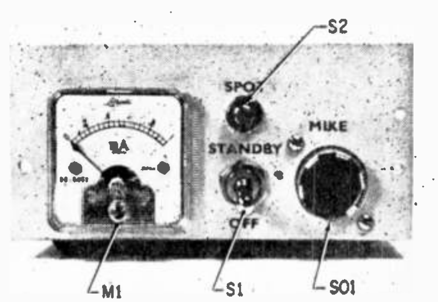
Rear-panel view and a partial view of the innards (right) shows back-of-front-panel wiring. Antenna jack J3 is for interconnecting the whip antenna (in J2) to matching 6-meter receiver (see text). When testing transmitter a dummy load or antenna must be connected to J2 or transistor Q6 will be damaged. Q6 will also be damaged if the heat sink is not in place to absorb heat generated in semiconductor-wafer junction.

other transistorized transmitter, *NEVER key the transmitter without a suitable load being attached to the output!* To do so will most likely cause instantaneous damage to the RF output transistor. You have been warned.

Some Modifications. Earlier we mentioned that the cost of building this transmitter could be cut substantially by making a few modifications. If the reader is willing to forego the operating convenience of push-to-talk capability, Relay K1 can be replaced with an ordinary 3-position, double-throw slide switch. A standard microphone can be used in place of the push-to-talk microphone specified in the parts list. If you feel that you can do without the relative power output meter, and use a field strength meter to tune the rig up with, meter M1 and its associated components (C18, C19, D1, R19) may be dispensed with. Several dollars can be saved by shopping for the 6-meter crystal on the surplus market. A basic version of this transmitter can be built, using all *new* parts, for as little as $18.00—quite easy on the wallet.

Special mention must be made of the fact that the transmitter described in this article may be legally operated by those persons holding a valid Technician, or higher class, amateur license. Penalties for violating the law are quite stiff. ■





Panel of transmitter is not crowded but SO1 could be replaced by a smaller, more delicate miniature connector. Top view, left, shows placement of modulator board and RF section. You could make everything on one board but it is easier to handle as individual sections when doing wiring.

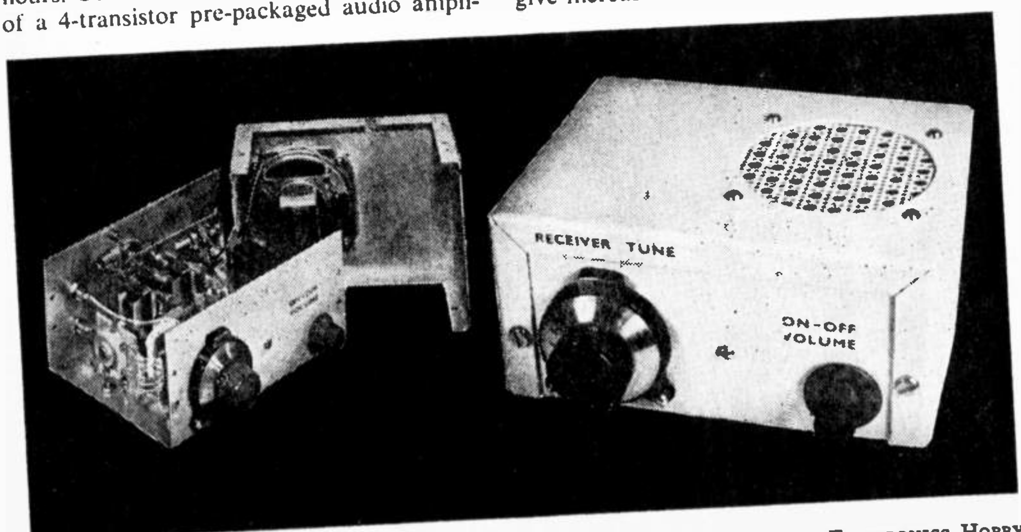
COVER STORY
PART 2

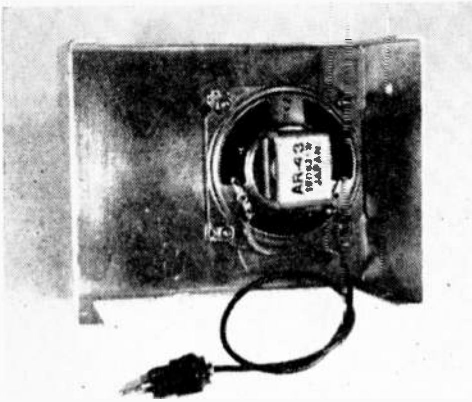
Build a 6 meter Solid-State Receiver

by Edward A. Morris
WA2VLU

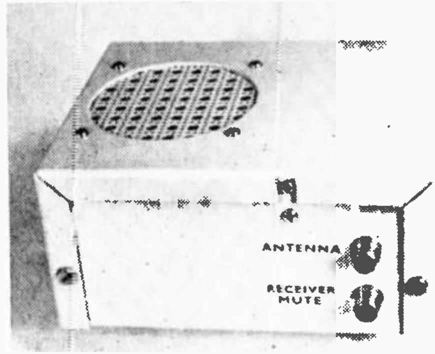
Second half of a 6-meter station is an easy project—ideal "first station" or field-day rig.

■ Here is a solid-state, 6-meter, amateur receiver that's just great for beginners! Its super-regenerative detector provides for good over-all sensitivity and excellent noise limiting properties. Low in cost, you can build it for less than $18.00, and that's using all new parts too! Easy to build, a Novice could do the job in less than five hours. Construction is aided through the use of a 4-transistor pre-packaged audio amplifier, whose cost you couldn't beat if you built it yourself. The receiver is entirely self contained, except for an antenna. Power for the receiver is provided for by one 8.4 volt mercury battery, which can be expected to last for more than 25 hours when used with this receiver. For extended service in emergencies and on field days D-cells will give much longer operation. Penlight cells will give increased service too.





Inside of cover of receiver case only has the small (2½-inch) speaker and a length of single-conductor shielded wire terminated in plug (P3) that mates with J3. You can add a phone jack too.



Rear of receiver case shows location of antenna jack (J1) and receiver muting jack (J2). If flat-head screws are used it will not be necessary to notch lip of cover to clear round-head screws used by author to attach the L-bracket for mounting J3.

If you use a miniature speaker, or earphones instead, you'll have enough room for the extra-size battery pack. Better stick to conventional cells—you'll be able to get replacements easier.

How It Works. The receiver detector uses a single transistor, Q1, in a super-regenerative configuration. Signals picked up by the antenna are fed into the emitter of transistor Q1 through capacitor C1. Feedback in the detector occurs between the collector and the emitter of transistor Q1 via capacitor C2. Capacitor C7 together with coil L1 and tuning capacitor C8 resonate the receiver at the desired frequency.

The operating bias on transistor Q1 is set by resistors R2 and R3, which form a voltage divider network. The detector is stabilized by resistor R1, and is by-passed by capacitor C3. The quench frequency is largely determined by the value of capacitor C5, and in this case is well above audibility—about 25 kilocycles.

Resistor R5 and capacitor C6 decouple the detector from the audio amplifier. An 8.4 volt mercury battery, B1, is employed as the sole source of power for the receiver. Electrolytic capacitor C4 bypasses degenerative audio components. Audio is coupled to the prepackaged amplifier from the detector by way of transformer T1, a 10,000-ohm to 2,000-ohm interstage unit.

Capacitors C9 and C10 along with resistor R5 form a filter which prevents the quench frequency signal from being coupled into, and overloading, the amplifier.

Audio signals across the volume control, R6, which also serves the on-off control, are coupled into the input of the pre-packaged amplifier. This amplifier is prewired and contains all the components necessary to perform its job. The output of the amplifier is fed into the speaker.

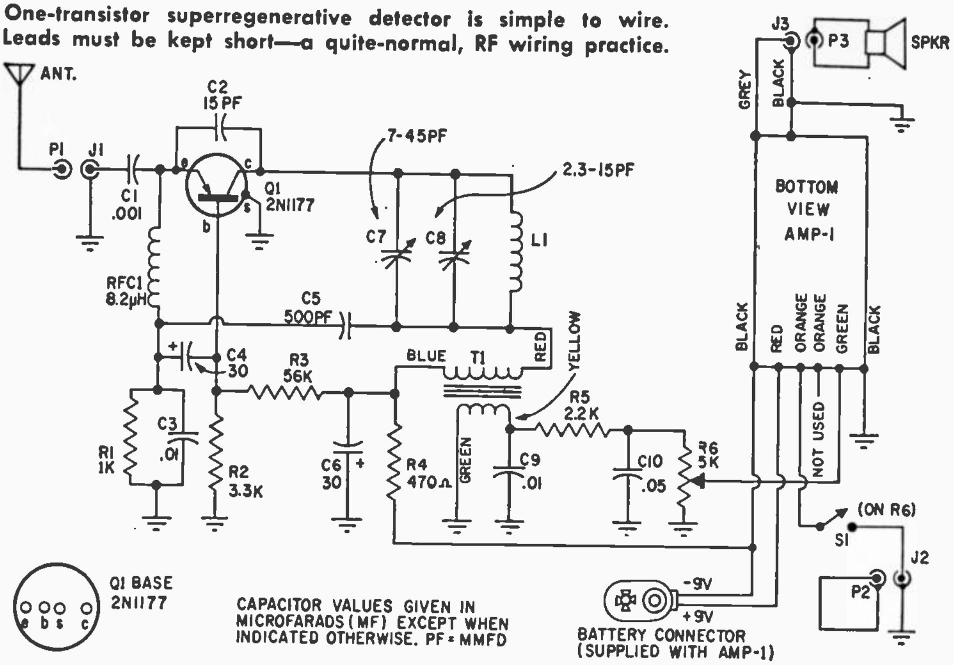
Notice that jack J2 is wired in series with the on-off switch S1. When the receiver is used by itself, a shorting plug, P2, is inserted into jack J2. When the receiver is used in conjunction with a transmitter, J2 connects to the mute terminals in the transmitter, through a cable terminated at the receiver and with an RCA plug. This turns the receiver off when the transmitter is keyed, preventing feedback and possible damage to the receiver.

Mechanical Construction. The case for the receiver is cut down from a standard 5x4x3-inch aluminum chassis box. The bottom ⅝ inch from each half of the box is cut off to obtain a box measuring 5x4x2⅜ inches when closed. The job can be done with a hacksaw in a few minutes; although a hand nibbler tool is certainly more convenient to use if you have access to one. Be sure to dress any rough edges with a file.

Lay out all holes to be drilled in the case with a T-square or carpenter's square. Center punch the spots where holes are called for before drilling. The hole for the speaker can be cut using a nibbler, or alternately, with a circle cutter.

If you do not plan to use the receiver with the companion transmitter, you need not drill the holes in the right and left hand sides of the case cover.

One-transistor superregenerative detector is simple to wire. Leads must be kept short—a quite-normal, RF wiring practice.



PARTS LIST

AMP—Miniature 4-transistor amplifier (Lafayette Radio 99R9042 or equiv.)
B1—9-volt mercury battery (Mallory TR-126 or equiv.)
C1—.001-mfd., 75-WVDC miniature ceramic capacitor (Lafayette 99R6060 or equiv.)
C2—15-pf., 500-WVDC dipped silvered mica capacitor (Elemeco type DM-10 or equiv.)
C3,9—.01-mfd., 75-WVDC miniature ceramic capacitor (Lafayette 99R6063 or equiv.)
C4,6—30-mfd., 12-WVDC miniature electrolytic capacitor (Lafayette 99R6084 or equiv.)
C5—500-pf., 500-WVDC dipped silvered mica capacitor (Elemenco type DM-10 or equiv.)
C7—7-45-pf. trimmer capacitor (Centralab type 822-BN or equiv.)
C8—2.3-15-pf. miniature variable capacitor (Hammerlund type MAPC-15B or equiv.)
C10—.05-mfd., 75-WVDC miniature ceramic capacitor (Lafayette 99R6068 or equiv.)
J1, J2, J3—RCA type jack, single hole mounting (Lafayette 99R6234 or equiv.)
L1—3 turns B&W miniductor #3002 (3 turns #16 wire spaced to ¼ inch.)
P1, P2, P3—RCA type phono plug
Q1—2N1177 transistor (RCA)
R1—1,000-ohm, ½-watt resistor
R2—3,300-ohm, ½-watt resistor
R3—56,000-ohm (See text)
R4—470-ohm, ½-watt resistor
R5—2,200-ohm, ½-watt resistor
R6—5,000-ohm miniature potentiometer, with s.p.d.t. switch (Lafayette 32R7363 or equiv.)
RFC1—8.2uh. RF choke (Miller type RFC-50, or equiv.)
S1—S.p.d.t. switch, attached to potentiometer R6.
SPKR—8-ohm voice coil, 2½-inch square speaker (Lafayette 99R6097 or equiv.)
T1—Miniature audio transformer: 10,000-ohm primary, 2,000-ohm, center-tapped secondary (Lafayette 99R6125 or equiv.)
1—Vernier dial mechanism, 36mm diameter (Lafayette 99R6031)
1—Aluminum chassis box, 5x4x3-in. (See text)
Misc.—Nuts, bolts, hook-up wire, transistor socket, knob, spray paint, decals, flea clips, eyelets, ¼-i.d., ⅜-o.d. plastic tube, ¼-o.d. plastic tube, etc.

Estimated cost: $18
Estimated construction time: 6 hours

The necessary mounting brackets are, for the most part, cut from 1/16-inch hard aluminum sheet stock. Note that the shaft of tuning capacitor C8 is not grounded, and should not be allowed to contact the chassis at any point.

The battery clip for B1 is the center clip from a single "AA" size cell. The clip is easily removed drilling out two retaining rivets. The speaker grill from a piece of perforated do-it-yourself aluminum.

After all necessary mechanical work on the case has been completed, the case can then be prepared for painting. First wash it down to remove any surface dirt or grease, then rub it down with a fine grade of steel wool. Several light coats of spray paint can then be applied according to the manufacturers directions on the can. Take care to allow for sufficient time for each coat to dry before applying the next. If you warm the cabinet slightly the paint will dry much faster than with air drying. Just make sure you don't make it too hot or the paint will blister. A temperature of about 150°F is more than enough.

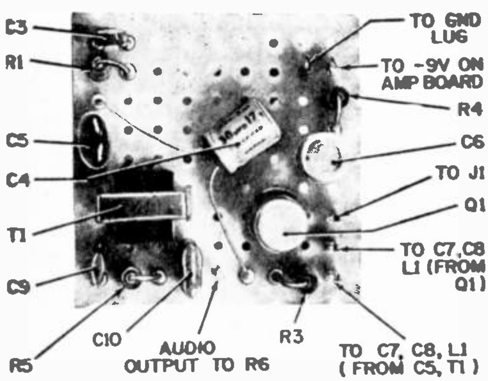
Decals or transfer lettering may then be applied according to the manufacturers directions. Suitable decals are both inexpensive and easy to apply. They lend a professional appearance to the finished receiver, and are well worth the small amount of extra effort to purchase and apply. Several coats of a clear spray plastic is then applied to protect both the paint job and the decals.

Electrical Construction. The superregenerative detector is built on a 1⅞x1⅞-inch piece of perforated board. Parts lay-out is clearly visible in the photographs. For best results, try to follow the lay-out as presented. Keep in mind that at 50 megacycles leads should be kept as short as is possible. The only components associated with the detector which are not mounted on the perforated board are capacitors C7, C8, and coil L1. Hollow eyelets inserted in the proper holes serve as lead anchors and terminals for individual components. Flea clips are also used as terminal points, as can be seen in the photographs.

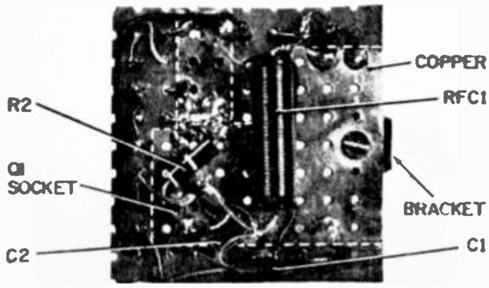
If you carefully examine the photo of the detector board's underside, you will note a copper-clad surface on a portion of the perforated board. This copper surface serves as a ground return circuit quite handy and eliminates many unnecessary leads. There's no need to etch off the undesired copper. Just deep scribe along the borders of the wanted copper, then pry up and pull free the unwanted copper. Exact dimensions are not critical. Just be *dang* sure the copper surface does not short against circuit parts and terminals that are not to be grounded.

Although the author chose to use a transistor socket to mount transistor Q1, you can, if you wish, solder transistor Q1 directly into the circuit. If you choose to solder Q1 directly into the cicuit, use a low wattage, well tinned soldering iron. Complete the soldering operation as quickly as possible. Be sure to use a heat sink on each lead when soldering to prevent possible damage to the transistor.

After the detector board has been wired according to the schematic diagram, recheck your work for any possible errors and accidental shorts. Pay special attention to the polarity of the electrolytic capacitors and to the wiring of transistor Q1's socket.



Top view of perforated board shows most components. Better anchor C4 to board.

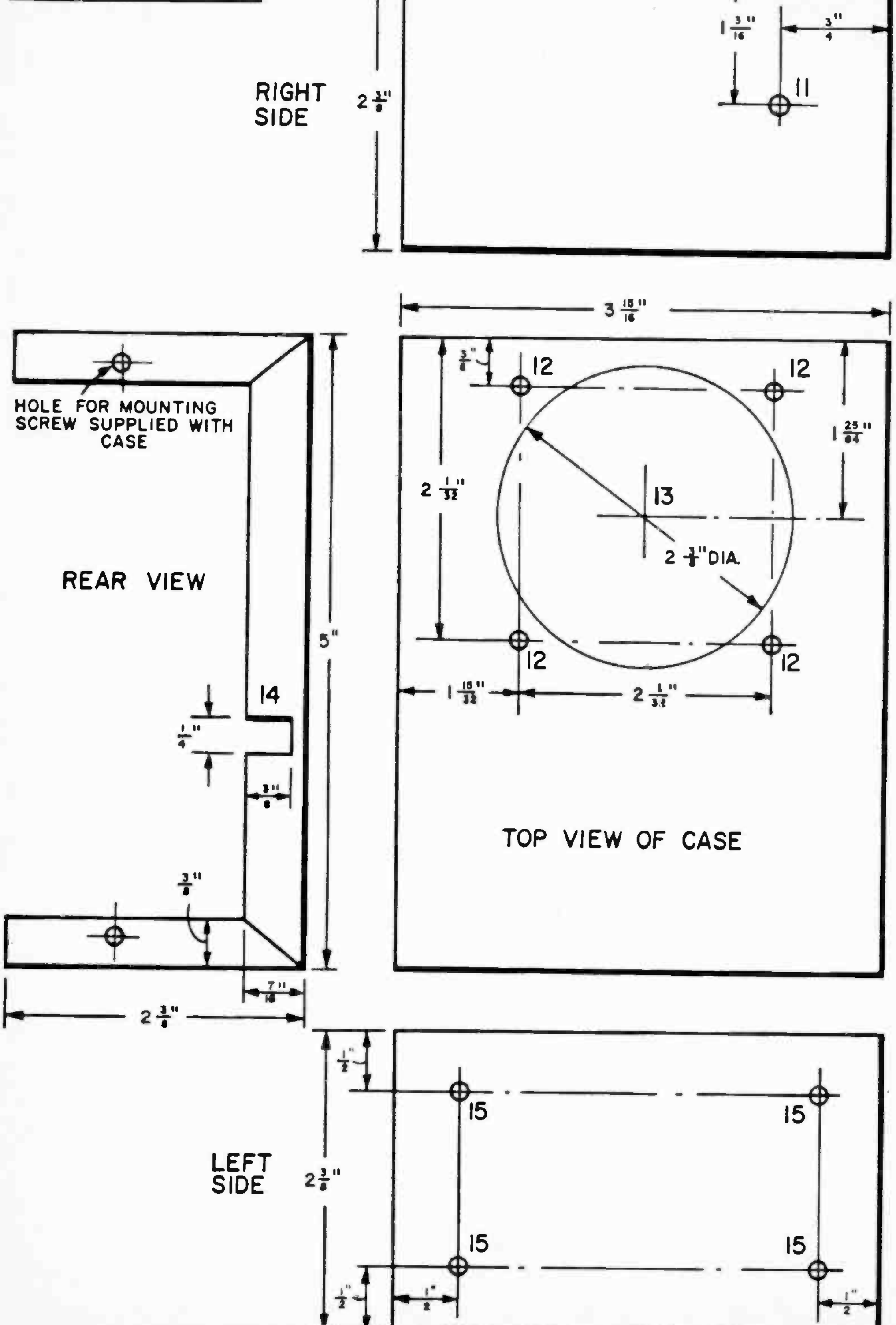


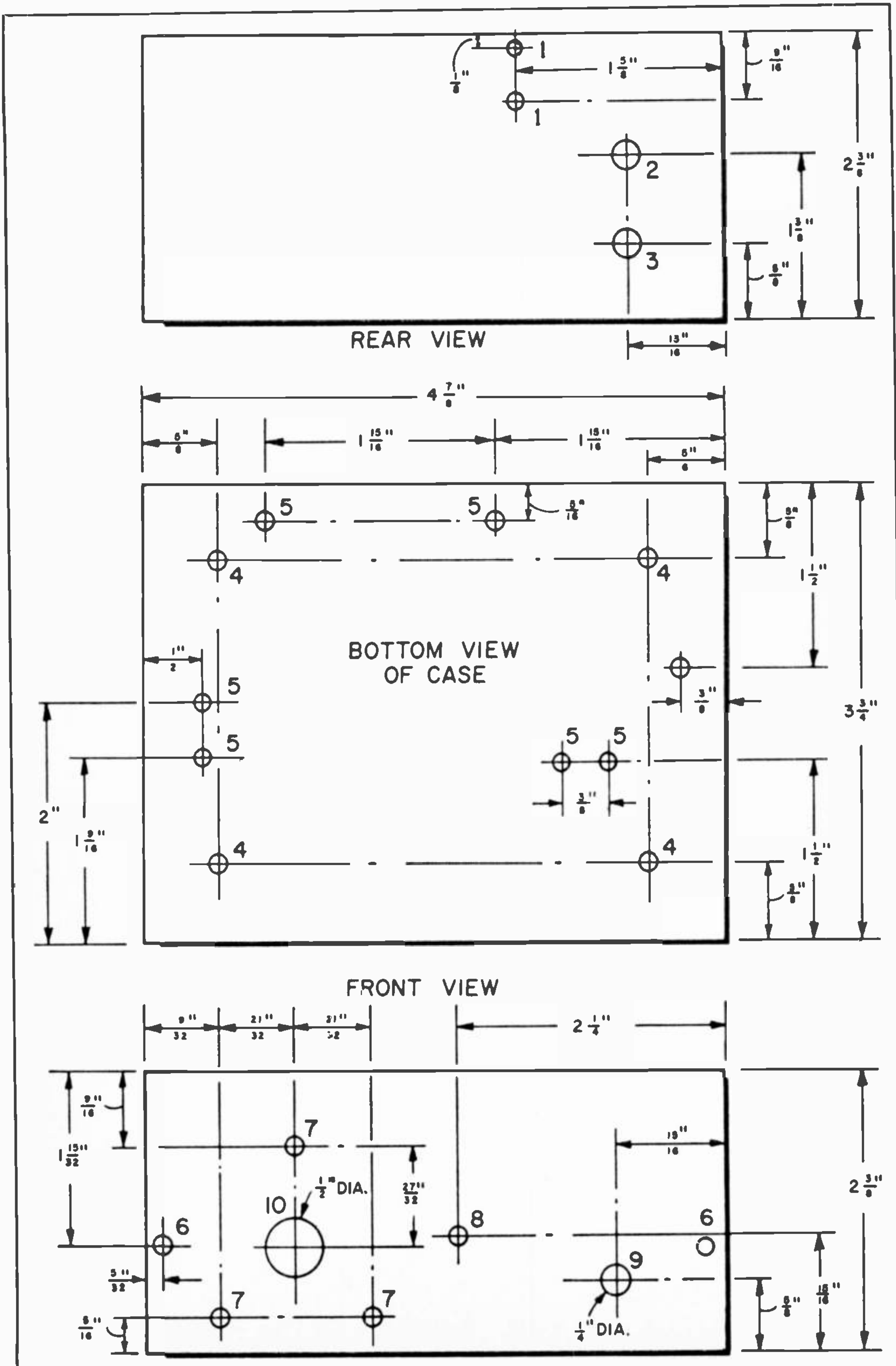
Foil covered area on phenolic board (inside dotted lines) acts as RF shielding.

NOTES ON CHASSIS DETAIL DRAWINGS ON FOLLOWING PAGES 118 AND 119

1. *Holes for #4 screws.*
2. *¼" dia. hole for J1.*
3. *¼" dia. hole for J2.*
4. *Holes for #8 screws.*
5. *Holes for #4 screws.*
6. *3/32" hole for selftapping screw.*
7. *Holes for #4 screws to mount vernier.*
8. *Holes for #4 screws to mount circuit board.*
9. *¼" dia. hole to mount R6.*
10. *½" dia. hole for Vernier shaft.*
11. *Hole for #8 screw to mount handle.*
12. *Holes for #4 screws to mount SPKR.*
13. *13/16" hole for SPKR opening.*
14. *Slot to cleor screw head.*
15. *Holes for #8 screws to mount receiver and tronsmitter together.*

6-METER RECEIVER




REAR VIEW
BOTTOM VIEW
OF CASE
FRONT VIEW
1 5/8"
9/16"
2 3/8"
1 3/8"
5/8"
13/16"
4 7/8"
1 15/16"
1 1/2"
3 3/4"
2"
1 9/16"
9/32"
21/32"
2 1/4"
1 15/32"
27/32"
1/2" DIA.
1/4" DIA.
5/32"
5/16"

Final Assembly. Capacitor C7 and L1 are mounted on a piece of perforated board as shown. Next mount tuning capacitor C8, it's insulated shaft, and the vernier dial mechanism. Check to make sure that capacitor C8's shaft does not contact ground at any point. The receiver will not operate if any part of capacitor C8 contacts the case.

Jacks J1, J2, and J3 along with the on-off/volume control R6 are mounted next. The audio amplier is mounted using two brackets as shown in the photographs. Mount the super-regenerative detecting board in the position indicated together with the other jacks, brackets, and clips.

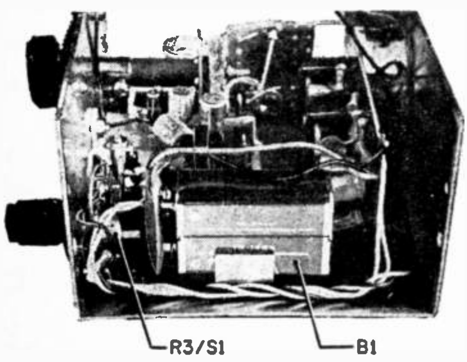
After you complete the wiring of the receiver, carefully re-check your work again for possible errors.

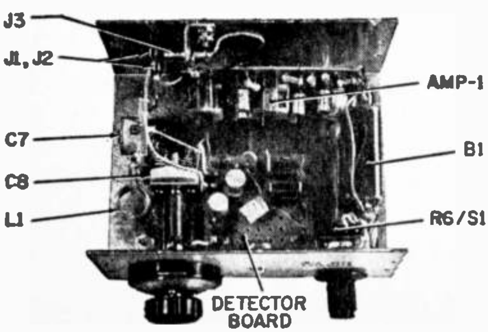
Testing and Alignment. After you've assured yourself that the receiver is wired correctly as is shown in the schematic diagram, proceed with testing the unit.

Set capacitor C7 to approximately it's mid capacity position. Adjust the vernier dial mechanism so as to read zero with the tuning capacitor C8 set to maximum capacity. Lock the vernier dial in this position. Insert a shorting plug, P2, into jack J2. Plug in the speaker, and battery B1. Plug some sort of 6-meter antenna into jack J1—a 55 inch piece of wire will suffice for testing. Turn the on-off/volume control to the on position. You should immediately hear a rushing noise, whose volume can be controlled by the volume control R6. If you can't obtain this rushing noise, recheck your work.

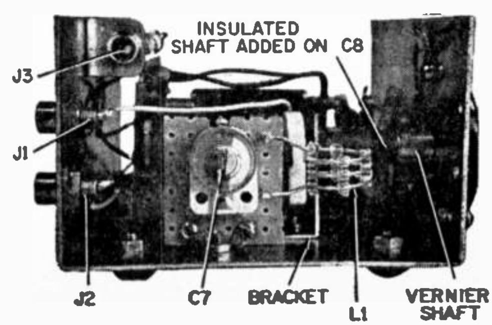
To align the receiver it's necessary to couple the output of a signal generator or a grid dip meter to 50 megacycles to jack J1. If your using a signal generator, simply connect the generators output leads to J1. In the case of a grid dip meter, connect a short antenna (10–15 inches) to jack J1. If your grid dip meter accepts crystals, use a 6-meter rock for alignment purposes. Enough signal will be coupled into the receiver by the antenna. Turn the receiver on. Adjust capacitor C7 so that the 50 megacycle energy appearing at jack J1 is detected by the receiver when the receiver vernier tuning dial is set to approximately "1". This completes the alignment of the receiver. The receiver will now tune the 6-meter band from the numeral "1" on the vernier dial upwards. Several crystal checks will give you an idea of your band spread.

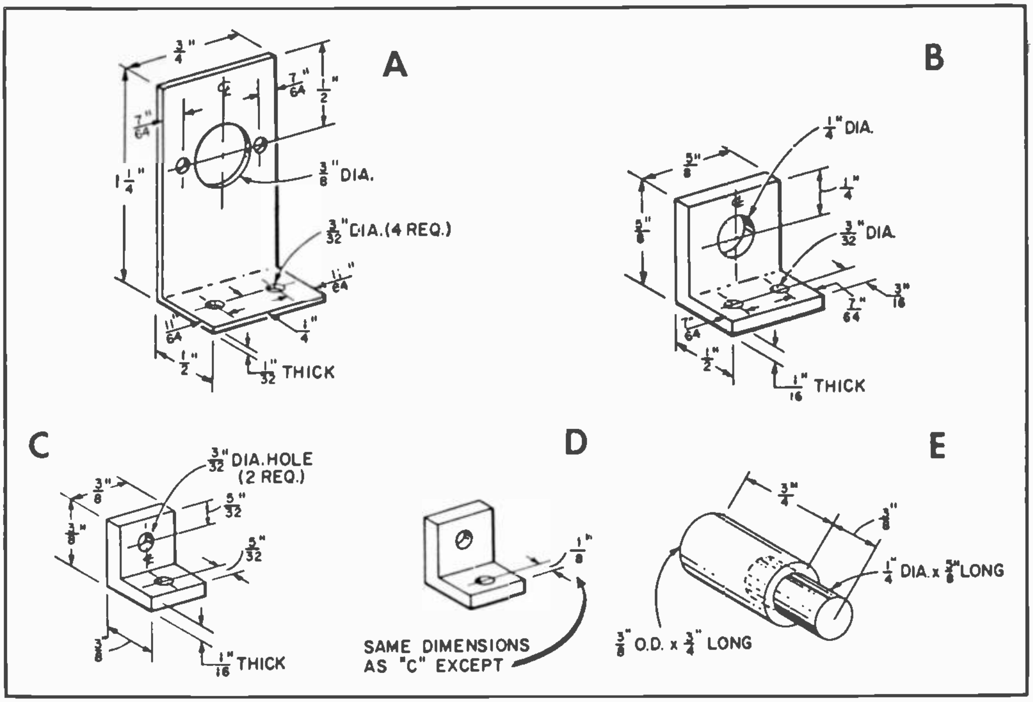
Due to variations between transistors, the optimum value for resistor R3, and the component parts used, the sensitivity of the receiver may vary from unit to unit. This is especially true when transistors of a different type are substituted for transistor Q1. A 56,000-ohm resistor proved best for the authors model. Typical values for R3 may range from 27,000 ohms to 100,000 ohms. The reader can determine the optimum value for his unit by connecting a 15,000-ohm resistor in series with a 100,000-ohm potentiometer, and wiring it into the circuit in place of resistor R3. The optimum value can then be easily determined by tuning to a weak





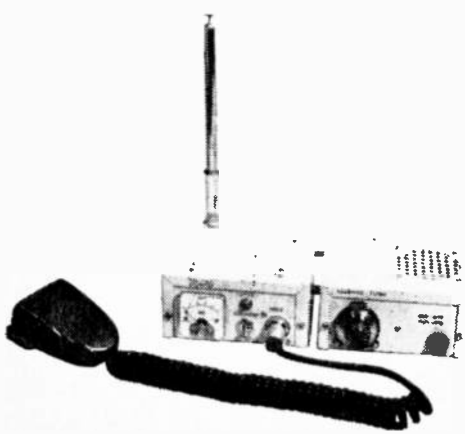
Top and end views of the completed receiver. When used for mobile operation all components must be securely mounted to prevent lead breakage from the bouncing and vibration of car. Internal battery can be replaced with a Zener regulator for 12-volt use.





The L-bracket detailed in A is to mount the tuning capacitor (C8). Large hole (3/8-in.) passes tuning shaft—small holes are for the mounting screws. Jack J3 mounts on bracket B; use 2-56 flat-head machine screws in 3/32 or #42 drill hole (or tap for 4-40). Brackets C and D are identical except for bottom hole which is positioned to make edge of phenolic board flush with back of bracket—bottom hole (of C) mates with existing perforation in the phenolic board. Shaft extension for C8 is made from a piece of 1/4-in. i.d. phenolic tubing and a piece of phenolic rod. Although they make a tight fit it is best to epoxy them together (and to the shaft) to prevent any slippage. Use care when cementing tubing to C8's shaft.

station, and varying the value of the potentiometer and noting the results.



Spacers are used between the receiver and transmitter units to allow the covers to fit evenly over protruding screw heads—use flat-headed screws to eliminate spacers.

As a Transceiver. Transmitter and receiver units are easily connected together and handle or mounting bracket bridges the units Units can be mounted side-by-side or one on top of the other without affecting the operation or utility.

Operation. Operating this receiver is as simple as "eating apple pie." The functions of the two controls are self-explanatory. As you tune in a station, with control C8, the rushing background noise will disappear. As the desired signal decreases in strength, the rushing background noise may not disappear entirely, and tuning may become somewhat critical. The inherent characteristics of the super-regenerative detector account for the excellent built-in AVC and noise limiting properties of this receiver. But don't take our word for it, build this 6-meter rig yourself. Get away from your ham appliance-buying trends and return to the fun *Hamdom* has given over the years. ■

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100	101	102	103	104	105	106	107	108	109	110	111	112

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The Oscillobrator

Continued from page 104

voltmeter, as well as to warn you of any serious fluctuations in line voltage.

The step-by-step calibration procedure is as follows:

1. Turn the range switch S2 to 10, Switch S1 to OFF, and set R3 to 100 on the dial.

2. Adjust the AC voltage to as close to 3.54 volts as possible using potentiometer. This corresponds to 10 volts peak-to-peak.

3. With 3.54 volts rms applied to the Oscillobrator input jacks J1 and J2, adjust the vertical gain of your scope so that the sinewave is at some conveniently measured height on the faceplate markings.

4. Turn switch S1 to the ON position, and adjust the screwdriver control on R2 so that the two horizontal bars are the same height as the sinewave in step 3.

5. Using R7 and M1, adjust the input voltage as near to 1.75 volts as you can. This corresponds to a peak-to-peak voltage of 5 volts.

6. Turn switch S1 to the ON position and adjust the vertical gain of the scope so that the sinewave once more is at some conveniently measured height.

7. Turn switch S1 to the ON position and adjust R3 until the squarewave is the same height as the sinewave in step 6.

8. If the indicator knob on R3 is not pointing to 50 on the dial, carefully loosen the setscrew and move the knob until it does. Before tightening the screw, check that the scope's image is still the same height.

The Oscillobrator is now adjusted for 10 volts peak-to-peak at the maximum dial reading, for 5 volts at midpoint, and for 0 volts at the minimum dial setting. As is the case with most measuring instruments, accuracy is greatest at midrange.

In the event you wish to check the calibration further against some additional voltages, or if you want to calibrate at a different range than 0 to 10, use the accompanying table of various peak-to-peak voltages and their rms equivalents. You will find some variations not only due to the difficulty in reading fractional voltages on the voltmeter, but also to imperfect linearity of the wirewound potentiometer.

If these variations are objectionable, then you have no alternative but to prepare and calibrate your own dial. However, some discrepancy can usually be tolerated as long as the peak-to-peak amplitude of any given waveform will measure the same in a month or a year as it does now.

Using the Oscillobrator. By the time you have completed the calibration process, you will have become a skilled operator. Since it is strictly a comparison process, you will find it useful to choose one particular set of markings on the scope grid and always adjust the vertical gain so that the signal to be measured is of that amplitude.

At first you may wish to adjust the vertical position control so that the calibrating lines occur at the same points as the peaks of the waveform being measured. The slight offset is the result of the firing pulse mentioned earlier. As you gain familiarity, however, even this adjustment will become unnecessary. ■

VHF Extender

Continued from page 23

ANY OTHER COILS. Then reconnect resistor R4, put on the bottom plate, and you're ready to enjoy the VHF Extender.

Switching Bands. To change to another frequency band, should you tire of your first choice, replace the crystal with one of proper frequency (see coil tables) and retune the VHF Extender as described above. If the move in frequency is not very far, you may not need to change the coils. However, if the frequency change is more than half a dozen megacycles or so, you will probably have to replace L1, L2, L5, and possibly L4.

To change from low-band to high-band operation, you must either add D1 and L4.

Don't be alarmed at the thought of using the VHF Extender and a standard shortwave receiver to listen to the FM signals of most commercial VHF communications gear. The VHF gear must now use restricted bandwidth for its transmissions, and as a result you can get very clean copy from the FM signal with an AM receiver simply by tuning a trifle to one side of the signal itself.

Going Mobile. And the VHF Extender can be used with auto radios, too, by using the "BC-Band" component values in the coil tables and supplying 150 volts DC from an external supply. ■

Ham Radio Handicaps

by John Demchuck

"He can have all the amateur equipment he built himself."

"Those curlers of yours detuned my final last night!"

"You say your lifetime linear amplifier went dead, eh?"

"Why can't you stop for a drink on the way home like other men?"

Matrix Circuits

Continued from page 101

When diode D1 isn't conducting we have a circuit equivalent to the one shown in Fig. 5.

It can be seen that when the input switch is open the diode is out of the circuit. If a VTVM is connected across the output it measures the battery's negative 1.5 volts; through R1. Resistor R1 drops almost no voltage because its resistance is small compared with the VTVM's.

Again, diodes D1, D2, D5 and D13 can be eliminated (shorted out) and their inputs connected directly to the outputs because neither the diodes' isolation or resistance is needed in this circuit.

Matrix Demonstrator. While you can always throw a matrix together on a breadboard just to get the hang of things, it takes just a little extra finesse and a sloping panel cabinet to turn out a classy matrix demonstrator suitable for class discussions, science fairs, or just plain fun for the family's junior members. The unit assembled in this article is made from the schematic diagram in Fig. 1.

The heart of the unit is the matrix which is built on a 2$\frac{7}{16}$ x 3$\frac{3}{8}$ inch section of perforated board (Lafayette 19G3601). This is a stock size so you won't have any cutting problems. The matrix grid is formed by stretching #22 solid hook-up wire between flea clips (Lafayette 19G3301) at each end of the board. Place a row of nine clips at two opposite sides and connect matching clips together. Stretch the wire as tight as possible laying it flat against the board; wrap the wire around the base of the flea clip. Then mount four clips at the two remaining sides spacing them *two holes apart*; the extra space is needed to avoid jamming the diodes together. Stretch the connecting wires across the top of the clips so you form a grid with nine leads on the bottom and four leads on the top. Make certain the top leads do not sag into the bottom leads.

Any cheap diode of the 1N34 type can be used. The specified type are subminiature and extra-easy to connect. Connect them as shown in the photographs—on end. The cathode is indicated by a color band. If the diode has several bands only one will be on the end—ignore the other bands. Cut the anode lead (the one without a color band) to ½ inch and form a small hook. Snag the hook around one of the nine bottom leads and solder. Do not use a soldering gun, or an iron in excess of 75 watts—the heat will destroy the diodes (there isn't room to use a heat sink). Make the connection fast and with a minimum amount of solder.

Fold down the remaining cathode lead and connect it to the appropriate top lead. Again, solder quickly. If possible, use a different color wire for each input and output connection to avoid a wiring error during final assembly.

The Panel Sub-Assembly. The panel must be completed and pre-wired on the cabinet (sloping panel utility box, Premier ASPC 1202) before the matrix is installed. S1 through S9 are normally-open miniature push button switches; use the least expensive type. For a *professional appearance*, suitable for display, use standard red panel pilot lamp assemblies. For reduced costs, the lamps can be mounted in a ½-inch rubber grommet with the connecting leads soldered directly to the lamps. Wire both the switch and lamp common leads and the battery terminals before installing the matrix.

Insulating the Matrix. The matrix is mounted on the cabinet's bottom plate. Since the flea clips extend through the board the assembly must be raised to prevent the clips from shorting to the cabinet. Place a ¼-inch spacer or fiber washers under the board at the four mounting corners.

Number the appropriate panel lamps—1, 2, 4, and 8. Number the switches in the appropriate order 1 through 9. Connect the 9-volt clip-on battery (Burgess M6), depress any switch and the total of the illuminated lamps should equal the switch number. For example, if 7 is depressed the 4, 2, and 1 lamps (representing 4 + 2 + 1 = 7) should light. Check all switches in a similar manner. If a switch produces an incorrect total either a diode is installed with reversed polarity, a diode is defective, or there is a wiring error.

You are now armed with some solid theory and practical knowledge on the subject of "the matrix." Don't hesitate to put it to full use the next time one of your chums pipes up with big words like *EDP-electronic data processing* or *computer language*. Just pipe in with, "Well let me tell you about *matrix circuits*. They work this way. . . ." You will be solidifying your acquired knowledge and passing some of it on to your buddy at the same time. ■

Neon-Lamp Calculator

Continued from page 88

wood backing. Then enlarge the circuit board and cabinet top holes to ¼ inch. The panel mounting holes are also drilled to ¼ inch. *Do not enlarge the 4 mounting holes in the perforated board or cabinet.*

Drilling is complete on the cabinet *top* and panels. But the circuit board lamp holes have to be enlarged to 5⁄16 inch. And, since bits of this size tend to tear the phenolic, it's best if a *reamer* is used instead of a drill.

Finally, the cabinet front and back holes are laid out and drilled.

Lamp Subassembly. The neon lamps are held in place by rubber grommets—installing these grommets is the first step. The grommets have a 3⁄16-inch *inside diameter* and mount in 5⁄16-inch holes.

After the grommets are in place insert the flea clips to support the ends of the bus-wires. Note that the #9 horizontal wire has a flea clip tie in the center. Next cut and solder the bus-wires. The horizontal wires are laid against the board and are soldered to the bottom of the flea clips. The *vertical* wires are soldered to the *top* of the flea clips and their ends are bent and shoved down the center of the clips. The two sets of wires should not touch. Care should be used at the junction of Circuit #1 and #2 to be sure the wires are properly placed.

Next put the ⅝-inch, 6-32 machine screws in the mounting holes (heads on same side as the bus-wires) and thread on two, ¼-inch spacers on *each* machine screw. A #6 washer goes between the two spacers. Later, the second spacer and washer are removed and used on the top of the cabinet to hold the board in place but this allows us to use the panels as a guide for installing the lamps.

Install one lamp at a time and solder it into the circuit. One wire connects to the nearest vertical bus-wire and the other to the nearest horizontal wire. After each lamp is installed, place a panel over the spacers and check the lamp's height. The tip of the lamp should be through the 9⁄64-inch lamp holes and flush with the top of the panel. After the wiring is complete, remove the second spacer and washer from each mounting bolt and install the board in the cabinet.

Rotary Switches. Although the rotary switches specified have 12 positions only 9 switch positions are used. And, since there are no stops, any 9 consecutive positions will work. The terminal in the *center* is the *rotor*.

Nothing is preventing the builder from using all 12 positions of the switches to go as high as 12 times 12 etc.—The Editors

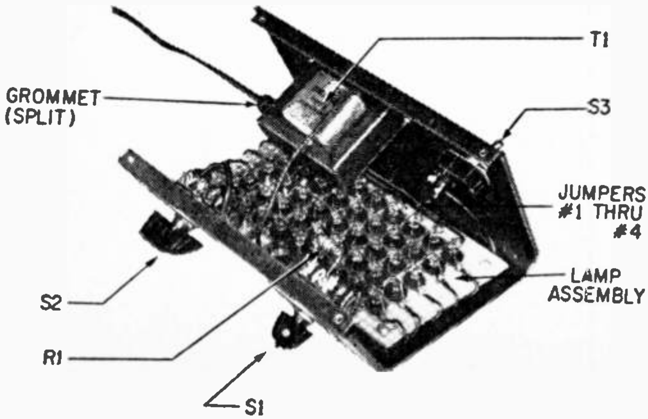
Looking at the back of the switch, count *counterclockwise* when connecting the wires. Connect one wire to each of the 9 positions used. (Cut-off the shafts at the first notch *before* fastening the switches in the cabinet.) To position the knobs check for circuit continuity and set them accordingly. Mount the remaining parts in the cabinet as shown in the drawings and photos.

Final Wiring. The final wiring consists of merely connecting the switch wires to the proper board terminals. The isolation transformer, R1, and S3 are wired according to the schematic diagram. Note that the #10 position on S1 is used as a tie point for R1.

The last step is marking the three panels which are used for the different functions.

To check the unit run through the problem combinations shown in *the first two* groups in the table and check the answers.

The Neon-Lamp Calculator is finished but the fun hasn't even started! ■



Completely wired unit is ready to be "buttoned up" after final check has been made. Grommet is split to go onto ready-wired linecord of T1. Put a knot in linecord to give some strain relief to the connections on T1. Cord protecting grommet fits in slot in edge of side of cabinet's bottom plate.

Build the Aero-Bander

Continued from page 56

way into the plug. Form a safety loop out of the tip of the antenna.

Testing and Tuning Up. Set the radio to be used with the converter to a clear spot at about 1600 kc. Place the plastic window on the converter as near as possible to the antenna coil in the radio. Turn on both the radio and the converter. Tune coil L3 in and out slowly, at some point a rushing noise should be heard from the radio. Tune L3 for maximum noise. Set tuning control capacitor C7, to maximum capacity. Couple the output of a signal generator, or a grid-dip meter, set to 115 mc. to the antenna. Tune the range adjustment control, capacitor C6, until the output of the signal generator is heard from the radio. The converter will now tune from 115 mc. to 127 mc. The range adjustment control, capacitor C6, can be set so that tuning control, capacitor C7, will tune any 12 mc. band from 95 mc. to 135 mc.

If difficulty is experienced obtaining the rushing noise described, which indicates that the oscillator is working, recheck the wiring, and the polarity of B1. If you still can't get the circuit to operate, couple a grid-dip meter set to operate as a wave meter, to coil L4. If you don't get a reading by tuning over the oscillator frequency, move the tap on L4 up, a turn at a time until you do. This indicates that the circuit is working. With some transistors it may be necessary to connect the tap on L4 to within a turn or two of the top of the coil.

A Modification. Although the Aero-Bander was designed to cover the aeronautical bands only, it can be modified to receive the two-meter ham band. Accomplished this by removing one turn from L2 and L4.

Operation. When you have the converter working properly, you will be able to tune in any 12 mc. segment of the aeronautical band. The author chose to set his to receive the 115 mc. to 127 mc. portion of the band, where the most interesting local stations were heard. In operation the antenna tuning control, capacitor C2, should be peaked for maximum signal, or in the absence of a signal for maximum noise. As this control is quite sharp, keep it peaked as you tune. The weaker the station being received, the more critical the tuning will be. Keep in mind that the Aero-Bander was not meant for long range use, but for use nearby or at airports. ■

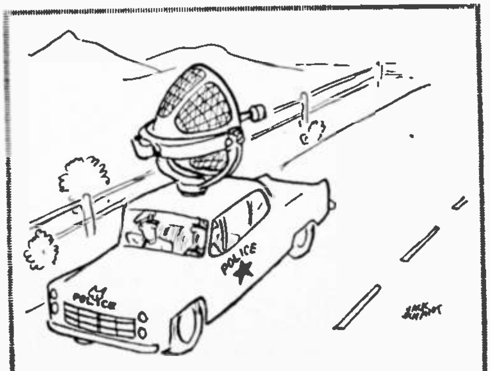
A Go-Go Stereo Compact

Continued from page 50

nel down and turn the right channel volume control up. If both channels make a loud scratchy sound you're in business. Place a stereo record on the turntable for a check of sound. Turn each channel volume up and down and then balance them out. The left channel speaker should be around six or eight feet from the main unit. Check the speaker reproduction for any mounting vibrations. You will note, for comfortable volumn, turn down both balance controls.

Checking For Trouble. If the left channel is working and there is no volume on the right channel, place the blade of a screw driver on the right crystal cartridge terminal. If there is still no hum or volume, check the terminals on the scratch-filter switch and balance control. Check and see if B+ voltage is going to the right channel. The left channel can be checked the same way if it does not work. If there is a hum at the crystal terminals and no volume, the right side of the crystal cartridge is bad.

A dead phono motor may be caused by improper hookup. Check over the wiring and voltage dropping resistor. Place a speed disc on the turntable and check for correct speed. A dirty or worn idler wheel will cause slow or erratic speeds. Clean off the turntable rim and brush on liquid rosin. ■



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100 kc. Calibrator

Continued from page 37

normal service) there's no need to use battery clips, the power leads can be soldered directly to B1's terminals.

Note that no power switch is shown. For maximum convenience the power switch should be on the front of the receiver. If your receiver has an RF gain control simply replace the existing control with a similar value having a push-pull switch and connect the calibrator's power leads to the switch. To turn-on the calibrator it's then only necessary to pull out the switch—regardless of the RF gain control setting. If your receiver doesn't have an RF gain control mount a SPST miniature switch on the front panel for convenience.

If you're only interested in 100 kc. markers to 15 mc. or so it's not necessary to connect the calibrator to the receiver. If it is positioned within three or four inches of the antenna input lead, radiation will provide sufficient signal. If you need markers to 30 mc. connect a short length of wire to the free end of C3 and wrap the other end around the antenna input lead—a direct connection to the antenna terminal(s) of the receiver is not required.

Adjusting the Calibrator. Run in L1's slug as far as possible (full clockwise). Set the receiver to a low frequency, say 600 kc., and slowly back out L1's slug a turn at a time. At each turn slowly rock the receiver's tuning back and forth with the BFO (beat frequency oscillator) on. When the calibrator kicks-in you'll hear the beat note. (Note that it is possible for the calibrator to be operative with the slug full in.) Then adjust L1's slug for the maximum S-meter reading attainable.

Turn the calibrator off and tune in WWV at any of its frequencies—depending on the time of day WWV will be received at 5, 10, 15, 20 or 25 mc. Turn the calibrator on and adjust its frequency by adjusting C1 for *zero-beat* with WWV. If the calibrator's output is so strong it jams WWV, turn the calibrator off, turn the receiver's BFO on and adjust the BFO for zero-beat with WWV. Without changing the BFO's setting, turn-on the calibrator and adjust C1 till the calibrator's signal is zero-beat with the BFO. Effectively, since WWV and the calibrator are zero-beat to the BFO they are zero-beat to each other.

It is possible that the ambient heat inside the receiver cabinet will cause the calibrator's frequency to shift very slightly. If this occurs, heat up receiver for 15 minutes.

Troubleshooting hints. The normal *total current* supplied by the battery is about 5 ma. If the current is in excess of 7 ma., or very high, check that Q1 is a PNP transistor and the battery is installed with the correct polarity. If L1 just seems to be approaching resonance with the slug all the way in (full clockwise) and you cannot obtain a definite "peak," parallel C2 with a 150 mmfd. capacitor. ■

Audio Compressor

Continued from page 46

mary and a 1,000-ohm secondary, such as the Lafayette 99 R 6034.

When the compressor is to be used with a transmitter which normally uses a low-impedance microphone, replace C6 with a 2-mf electrolytic capacitor.

Operation. With the OUTPUT control (R8) and the COMPRESSION control (R11) fully counterclockwise, advance the output control until the modulation reaches 100% on *peaks*. Next advance the compression control until the modulation drops to about 60%. Now bring up the output control. Repeat this process until optimum results are obtained. If you don't have access to a modulation meter, peak the compressor by adjusting it while listening to your signal.

As this compressor provides a substantial amount of audio gain, along with voice compression, the output may have to be reduced to prevent overmodulation with some transmitters. This can be accomplished quite simply by removing capacitor C3 from the circuit. Without a bypass capacitor across R3 the gain of transistor Q1 is reduced because of degeneration (negative feedback) in the emitter circuit. If audio output is still too high readjust modulator or remove capacitor C5.

When properly used, voice compression can make the difference to a Ham, between making or not making a contact with that rare DX station. Do not, however, be misled into thinking that if a moderate amount of compression is good, that a greater amount of compression is better—it's not. If the COMPRESSION control is set too high serious distortion will occur. ■

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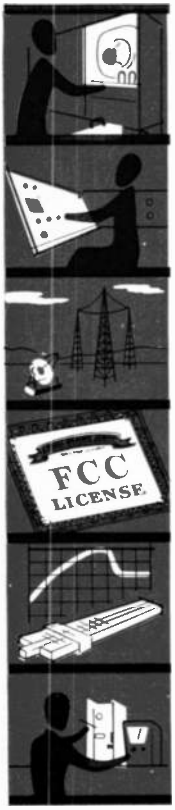

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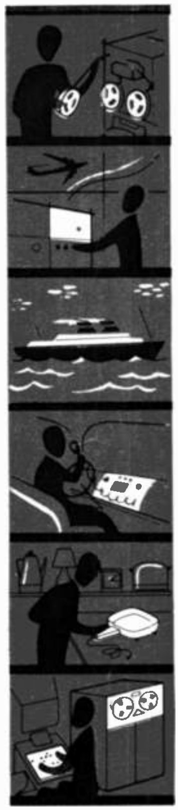

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