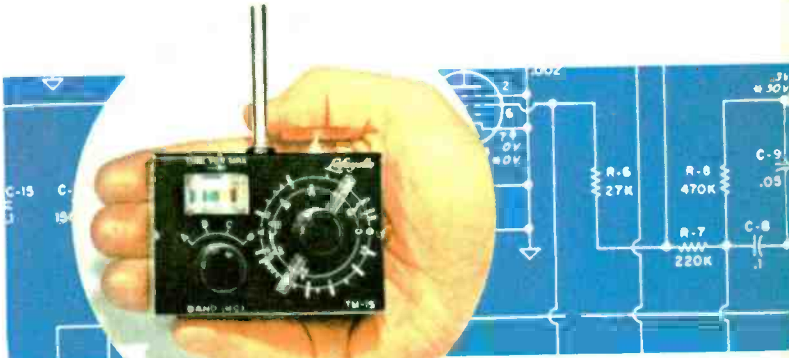
Electronics Ideas

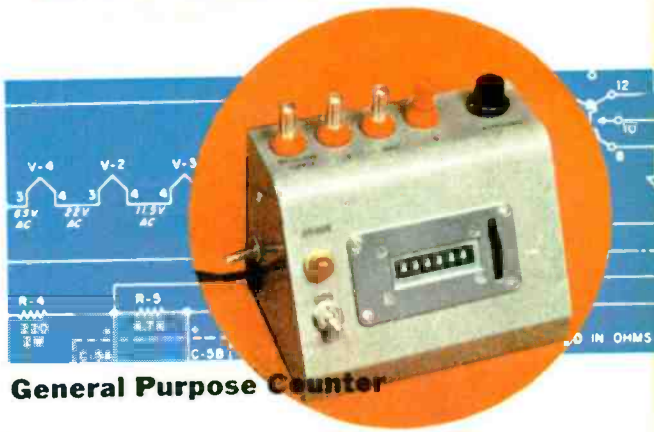
535 A FAWCETT BOOK

By the Editors of ELECTRONICS ILLUSTRATED

- Stereo Mike Mixer
- Negative Ion Generator
- Ultrasonic Cleaner
- Electronic Fish Lure
- Build a Panic Button
- Printed Circuit Pocket Radio
- Transistorized FM Booster
- CB Through Your Car Speaker
- Perforated Chassis Boards
- Basic Transistor Circuits



Field Strength Meter



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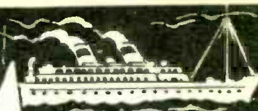

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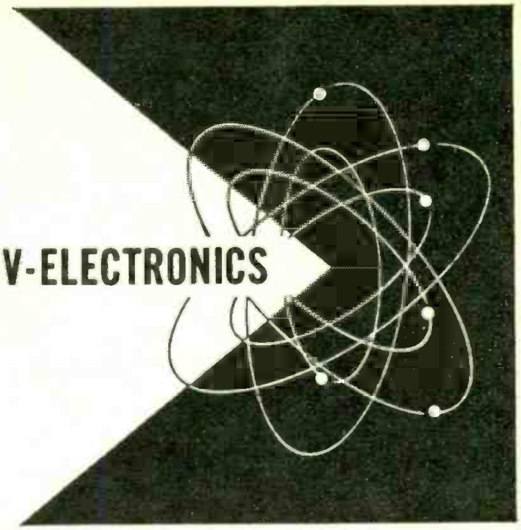
ELECTRONICS IDEAS

By the Editors of ELECTRONICS ILLUSTRATED



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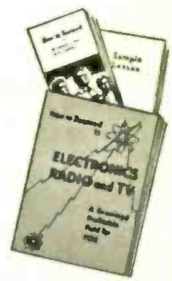

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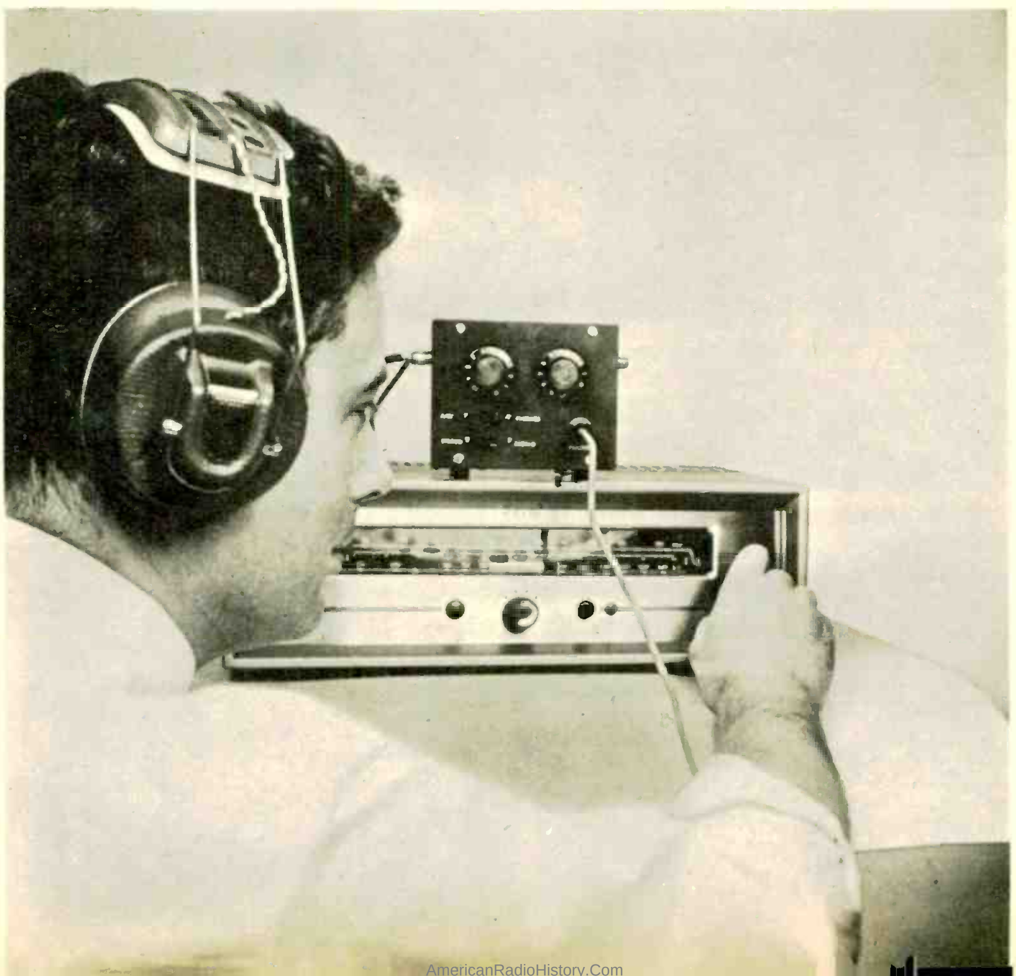
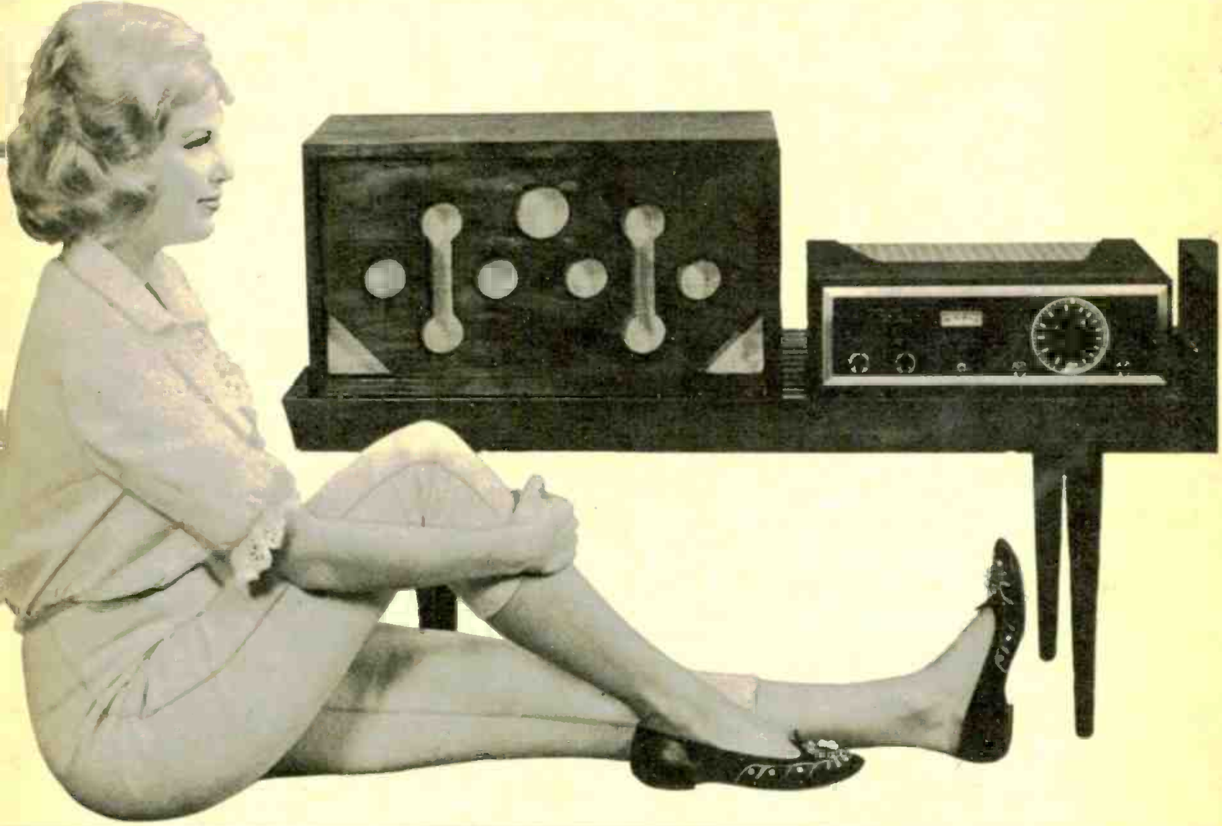


THE DUOFLEX

Complete plans for a bookshelf hi-fi speaker system that you can build for under $15.

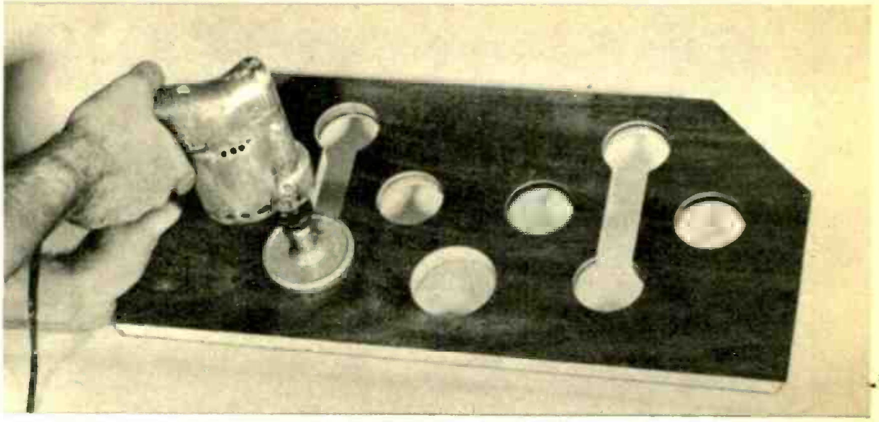
By Larry Klein



THE sound quality of the Duoflex speaker system belies its simple construction and modest cost. A striking cabinet design enables the speaker to fit harmoniously into the decor of any living room or den—either as a solo unit or a stereo pair. And its small size means the Duoflex can sit conveniently on a bookshelf, which is not the case with many units bearing the bookshelf label.

Though the acoustic design of the Duoflex is complex, only the components, some basic woodworking tools and a few hours of your spare time are required to duplicate the superb results achieved by our prototype. Any extended-range 8-inch speakers with a free-air resonance around 65 cps will produce good results in the system; however, the specific speakers installed in the prototype (see Parts List), gave excellent results at a cost of

A rotary saw hole-cutter—or similar tool—is used to make the front panel cutout sections.

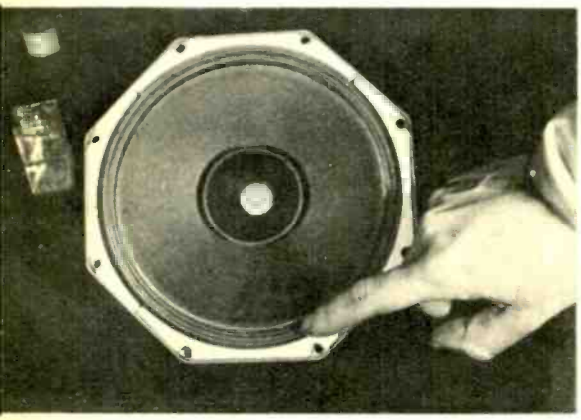


only $9 a pair. This leaves you some $6 for lumber and miscellaneous items in order to bring in the basic system for $15.

If you want to add an extra shimmer to the highs, you can install a tweeter. They are available as cheaply as $2. We chose an excellent miniature unit that sells for $3.60 (see Parts List). The crossover network—capacitor and hand-wound coil—will run you less than $1. Warning: don't use a standard crossover as it will not match the speaker impedances.

The Duoflex may be wired for 16 ohms by connecting the two 8-inch speakers in series. However, the 4-ohm connection is preferred because of the improved electrical damping obtained from parallel connection.

Before installing the speakers, rub your finger vigorously around the speaker cones' corrugated rim.



Constructing the cabinet is a simple job. The exploded view of the cabinet is self-explanatory. Only a few notes are required. You can use ¾" plywood or Novoply and finish as desired, but the dimensions must not be varied from those shown. All joints should be secured with *both* glue and screws to make them as rigid and airtight as possible (the back panel is an exception, being held in place with wood screws only). If you go in for fancy woodworking, you can make miter rather than butt joints. The bottom of the baffle board and back panel are secured with screws brought up through the bottom.

The speakers, before installation, require a simple treatment to lower their resonance. As sold, they have a free-air resonance of about 75 cps. You can bring this down substantially by running your finger around the outer edge suspension of the cone (see photo). Use moderate pressure, but avoid tearing the cone. Two minutes of rubbing will reduce the resonance to around 65 cps, providing improved bass response.

The grille cloth may be any acoustically transparent material mounted with tacks or staples. After the grille cloth is in place, use ½" or ¾" wood screws to mount the speakers, taking care to center over the baffle cutouts.

The tweeter may not be required by your ear since the 8-inch speakers specified have a fairly extended treble response and produce a nicely balanced sound in the Duoflex cabinet. If you don't add a tweeter, you naturally omit

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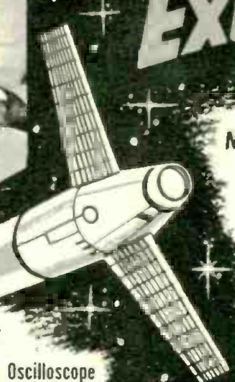

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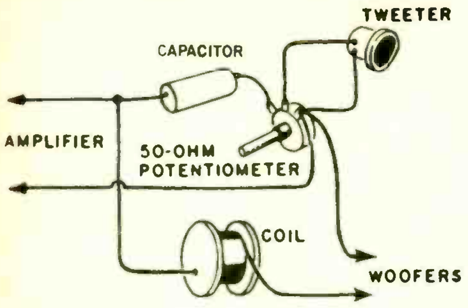


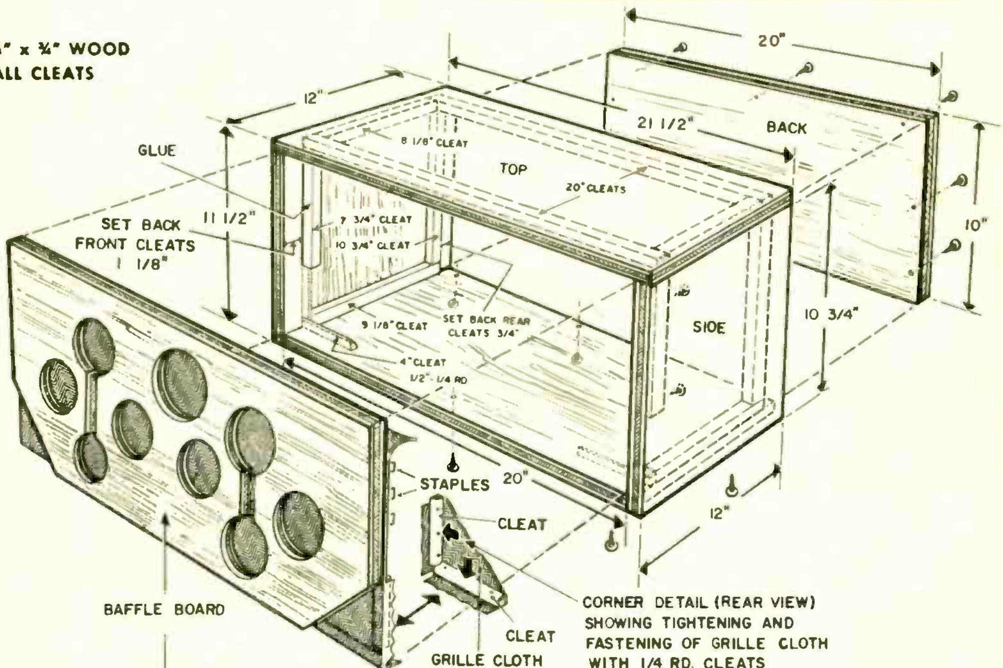
Full L-C crossover with tweeter control is wired as above. The woofers are connected in parallel.

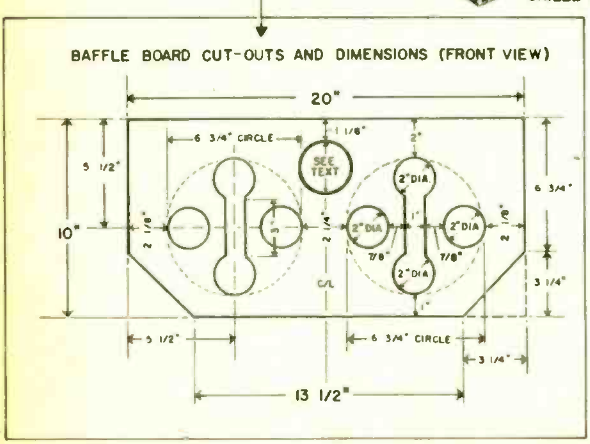
PARTS LIST

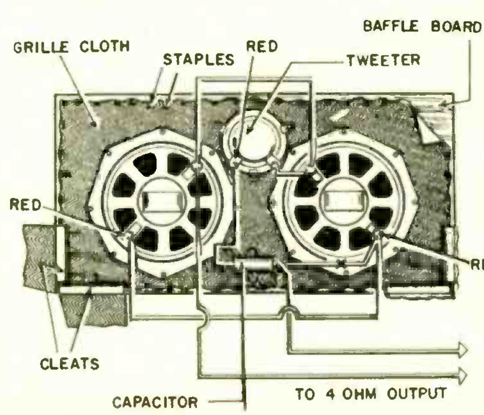
Lumber—Approx. 10 square feet of ¾" plywood or Novoply. Finish as desired
Speakers—Two 8" Norelco speakers (AD-3800) available from Olson Electronics, Stock #S-278 (2 for $9)
Optional—2" tweeter (Olson, S-345; $3.60); 4 mf non-polarized capacitor (Olson, C-958; 39¢); Coil, if used, ¼ lb. spool of #18 enameled solid copper wire. Use any 1- to 25-watt amplifier

The wiring diagram below shows the speakers and a tweeter wired with a capacitor only. If a coil is added, insert it at the point marked X between the capacitor and the right-hand speaker. The size of the tweeter cutout depends upon the tweeter that is selected. The suggested tweeter (see above) takes a 1¾" diameter hole. If a tweeter is not used, do not cut the tweeter mounting hole shown in the front panel cutout plans.

USE ¼" x ¾" WOOD FOR ALL CLEATS







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Max D. Reece, 4222 Fremont Ave. N., Seattle 3, Wash.	1st	20
Robert Benns, 3802 Military Rd. N.W., Washington, D.C.	1st	12
Jon M. Martin, 7913 Sausalito Ave., Canoga Park, Calif.	1st	24
Kline H. Mengle, 401 Granville Dr., Silver Spring, Md.	1st	24
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The author's prototype had front panel removable. Here the cabinet is being lined with a layer of glass wool.

the tweeter opening in the front panel. However, if you do like extended highs almost any type and impedance tweeter may be used. Horn types and 4-ohm tweeters may require an attenuator, such as the 50-ohm pot shown in the diagram. If the control action is too abrupt, try a 25-ohm pot instead. The recommended tweeter does not need a potentiometer.

A sealed-back tweeter may be mounted inside the cabinet, using the manufacturer's recommended opening, but a tweeter with the rear of the cone exposed should go on top of, or alongside the speaker cabinet to avoid interaction with the 8-inchers.

The crossover should be about 5 kc, even though the tweeter manufacturer may recommend a lower figure. A single non-polarized paper or oil capacitor hooked up as shown in the cabinet diagram provides a high-pass filter. This means that only highs are allowed to pass through to the tweeter, while the 8-inch speakers get both the highs and lows. A 4-ohm tweeter requires an 8 or 10 mf capacitor, an 8-ohm tweeter a 4 mf capacitor. A 16-ohm tweeter uses a 2 mf capacitor.

A full inductance-capacitance crossover provides improved performance in the mid-frequencies. The L-C crossover not only keeps the lows out of the tweeter but in addition prevents the highs from reaching the 8-inchers. The capacitor values for the L-C crossover are the same as given above and depend on tweeter impedance.

The .13 millihenry coil which is connected in series with the woofers is made by tightly winding about 100 turns of #18 enameled wire on a 1½" length of 1" wooden dowel. The end pieces of the coil form are made of 2" discs of Masonite or any other flat nonmetallic material. You can cut out the discs with the same hole cutter used for the cabinet's baffle openings. Do not screw or nail on the disc end pieces; use glue.

After the speakers are wired, it's a good idea to check their phasing. Do this by connecting a flashlight battery across the speaker leads. Both cones should move either in or out at the moment of contact. If the cones move in opposite directions, switch the leads going to one of the speakers.

The coil may be held in place by looping a length of tape around its middle and stapling the tape to the cabinet wall. After the speakers are mounted, line the inside of the enclosure and the back panel with a 1-inch layer of glass wool (fiberglass). Ordinary lamp cord is fed through a ¼" hole drilled in the back panel for connection to the 4-ohm taps on your amplifier. •

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and needs help to get rid of it . . .

The Panic Button

By Fred Maynard, Motorola, Inc.

SAY YOU'RE the hard-pressed Madison Avenue type. You worry about everything . . . about the winter house, the summer house, the three cars, the two boats, the wife, the kids, the girl friends. Sweat pops out on your brow, your grey flannels get greyer. What do you do next?

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The original version of the Panic Button was an electronic siren hardly as big as a giant-size Miltown box. With an ingenious transistor circuit, a homemade coil and a handful of standard parts, it produces the piercing wail of a true siren. As a novelty, it attracts attention everywhere—if that's your life's aim.

However, the Panic Button also has a serious side. The fact that its circuit does produce a true siren wail makes it applicable for police, Civil Defense and other emergency duties. On a police car it can be combined with a small PA system to form a dual-purpose unit. Its output is sufficient to drive an efficient PA horn large enough to alert a whole area. And the Panic Button's cost is a fraction of the selling price of an air siren.

Construction

You may build the button in any box large enough to contain the parts. You can see some of the versions in the lead photos. The author's model is built in a 3¼" x 2⅛" x 1⅝" Minibox.

Inductor L1 can be wound in a few minutes. The core is a ¼" diameter 2"

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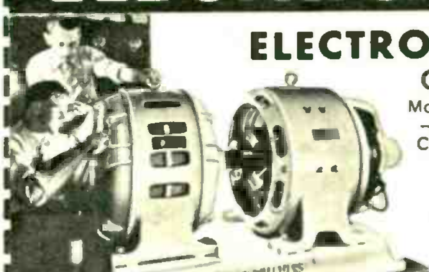

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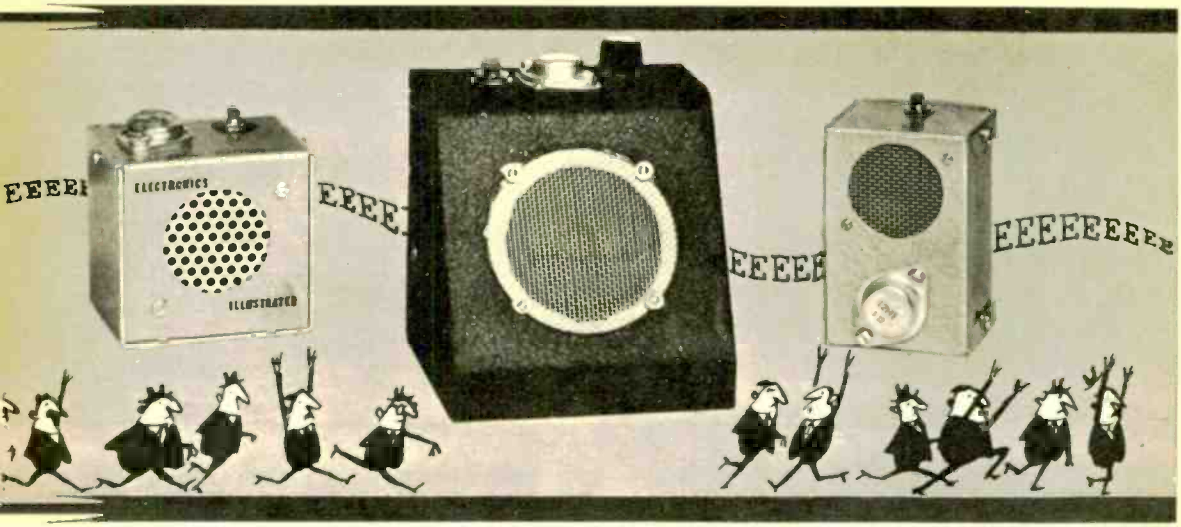

long iron stove bolt with two nuts. Screw one nut about 1½" from the head end. Next, cover the bolt with a layer or two of plastic electrical tape to protect the wire from the sharp threads. The coil should be scramble-wound between the nut and the head of the bolt keeping an even distribution of wire over the winding area. The turns should be kept fairly tight since loose turns may result in "ragged" sound.

Start at the nut end of the bolt and wind about 150 turns of No. 28 cotton or nyclad insulated wire. Bring out a 2" loop in the wire (for the center tap) and then continue to wind 150 more turns in the same direction. Wrap the coil with a layer of tape and mount it on a bracket or directly to the cabinet with the spare nut. The 2" loop tap goes to the negative battery terminal.

Circuit Operation

The oscillator comprises C1, Q1, L1, R1, and R2 in a conventional Hartley oscillator with inductive collector to base feedback. The Hartley oscillator alone, however, would produce a sine wave and would sound more like a whistle than a siren. The siren effect is achieved by choosing the proper values of C1, R1, and R2 which establish a quench frequency determined by their time constant. The quenching frequency is highly sensitive to the voltage at the junction of R1 and C2, rising to a high frequency as the voltage increases.

The charging voltage at the junction of R1 and C2 is dependent on the time constant of R3/C2. In other words, R3 controls the rate at which the frequency of the tone rises. When SW1 is closed, the voltage across C2 starts to rise and continues to do so, as long as SW1 remains closed, causing the sound to rise in frequency. Eventually equilibrium is reached and the pitch remains constant. When SW1 is released, C2 discharges through R1 and R2, the voltage at the junction of R1 and C2 falls, and

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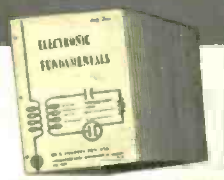

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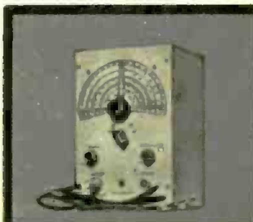

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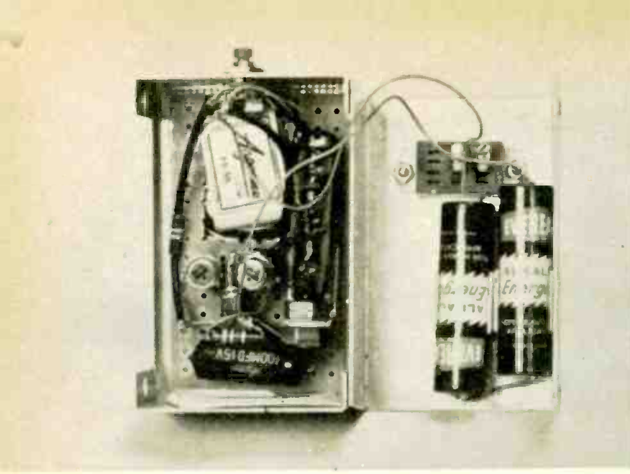


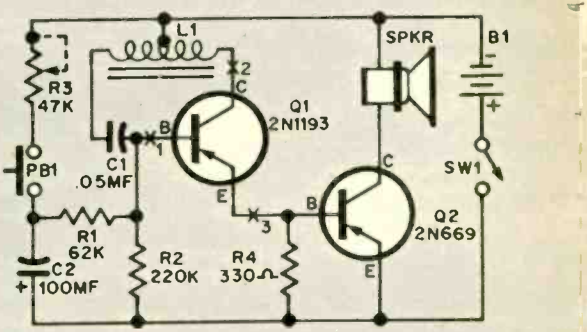
Inside view of one of the more compact versions of the Panic Button. Components are mounted on a perforated board with a cutout for the loudspeaker. Arrangement not critical.

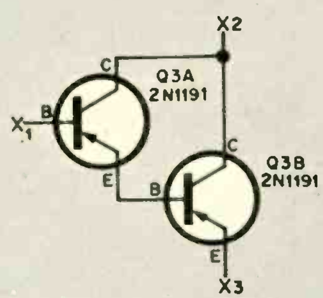
the frequency of the sound lowers gradually. The rate of rise and decay can be varied by changing the value of R3 or C2. The pitch of the tone can be changed by using a different value for C1. Both the speed at which the sound rises in frequency and the upper limit of its frequency are dependent on the battery voltage. You can experiment with different part values to achieve the most desirable effect with the battery selected.

Almost any audio transistor will produce oscillation in this quenching circuit. However, the dynamic range of the siren tone will be greater if a high-gain transistor such as a 2N1193 is used. An even greater dynamic range can be produced by using two low-gain transistors, such as 2N1191s, in place of Q1, in the Darlington amplifier configuration shown in the schematic. However, this may require further changes in the values of R1, R2, and C1.

The oscillator output is emitter-follower coupled to the base of Q2. For best results, the impedance of the speaker voice coil should be in the range of 45 to 100 ohms. Ten-ohm speakers work well but deliver less audio power, somewhat thinner quality sound, and cause a much higher current drain on battery B1. B1 can be from 3-9 volts; greater volume and a higher pitch is attained with a higher voltage.

If a three-transistor circuit is built and a 10-ohm voice coil speaker is used, it will be necessary to power the Button with at least size D flashlight cells. If only penlight cells can fit in the housing, it is necessary to use Alkaline Energizer cells, such as Eveready E91, to supply





PARTS LIST

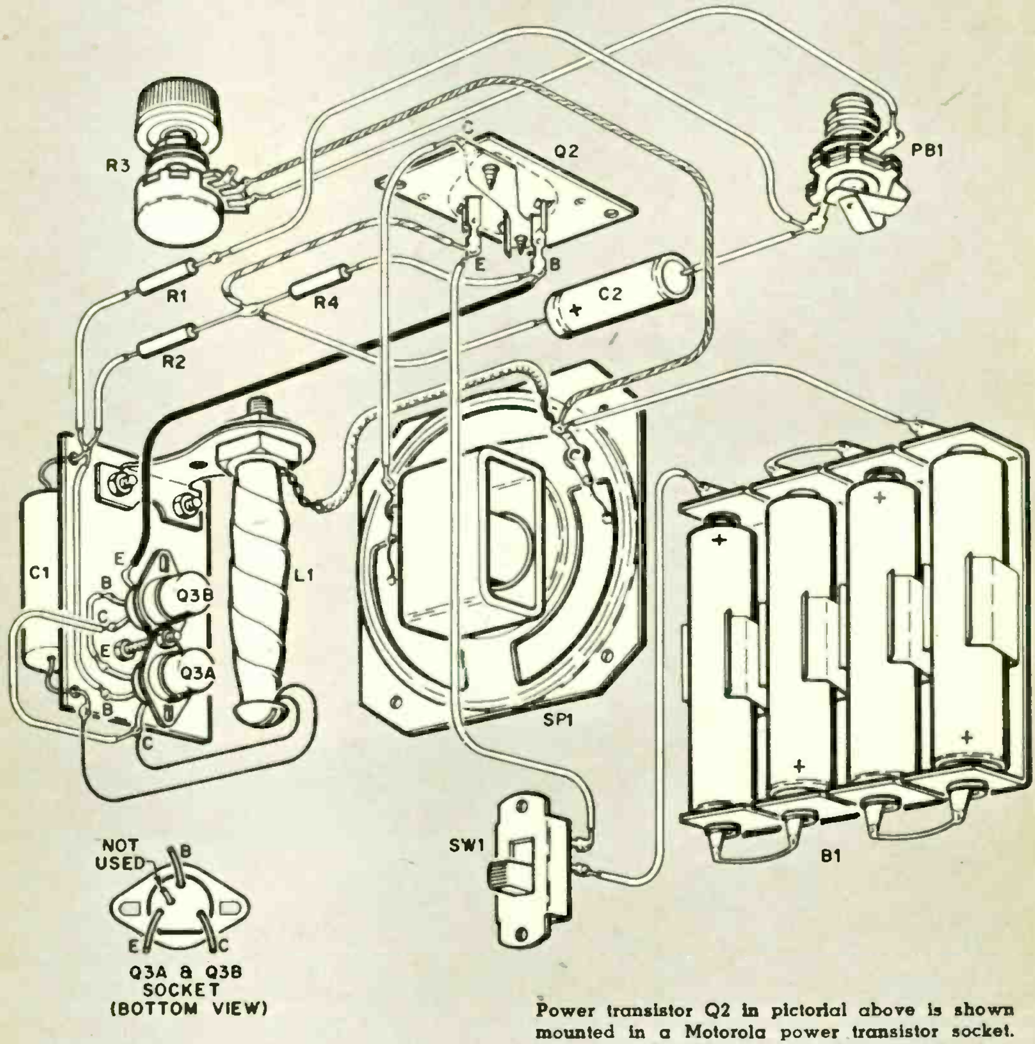
Resistors: ½ watt, 10%
R1—62,000 ohms
R2—220,000 ohms
R3—47,000 ohms (see text)
R4—330 ohms
Capacitors
C1—.05 mf, 100 volt or higher paper or ceramic
C2—100 mf, 15 volt electrolytic
PB1—SPST push button switch
SW1—SPST slide switch
Q1—2N1193 transistor (Motorola)
Q2—2N669, 2N554 or 2N176 power transistor (Motorola)
Q3A, Q3B—2N1191 transistors
L1—Special coil (see text)
Spkr—100-ohm miniature speaker (Quam 22A06Z100) Available from Allied Radio and other distributors
B1—3 volt to 8 volt (see text)

For greater dynamic range transistors Q3A,B may be used instead of Q1. The two-transistor d.-c. circuit is inserted at the numbered points.

the necessary current. Since the standby current (SW1 closed, PB1 open) of the 3-transistor, 10-ohm voice coil speaker circuit is over 300 ma, SW2 should be turned off when the siren is not in use.

An ideal housing for a king size Panic Button is a $5.95 intercom sub-station sold by McGee Radio Co., 1901-07 McGee St., Kansas City 8, Mo. The catalog number is M-45. The sub-station contains a 4" speaker and an output transformer with a 45-ohm primary. In addition, it includes a small chassis and a spring-loaded DPST switch that can be used for PB1.

When Q2 is connected to the primary of the transformer, its load is 45 ohms instead of 10 ohms; a much better match. Also, the battery drain will be lower. The chassis as supplied will easily accommodate all the Panic Button's components. •



Power transistor Q2 in pictorial above is shown mounted in a Motorola power transistor socket. Home wound coil L1 is installed on small bracket.

printed circuit

POCKET RADIO

Combination regen and reflex circuit soup up simple two-transistor receiver.

THE POCKET RADIO receiver would win almost any construction project popularity poll. But the hobbyist contemplating the construction of one has a problem. What circuit should he use? Superheterodynes work well but are expensive, complex and require alignment. On the other hand, a one- or two-transistor receiver may require 10 to 20 feet of antenna to pull in anything.

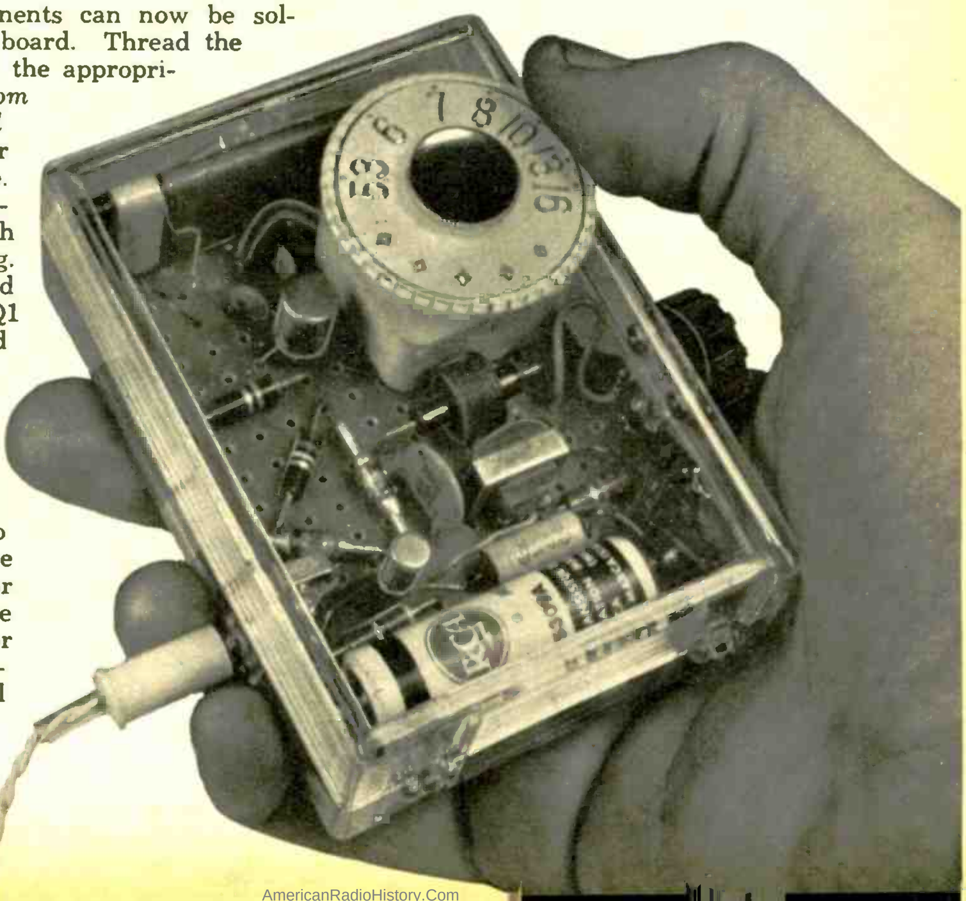
Here, then, is a little receiver that resolves the dilemma. Using two inexpensive transistors and a handful of other components, all major stations in an area can be received without an external antenna. The completed receiver fits into a small plastic case and all components (with the exception of control R3 and phone jack J1) are mounted on an etched circuit board.

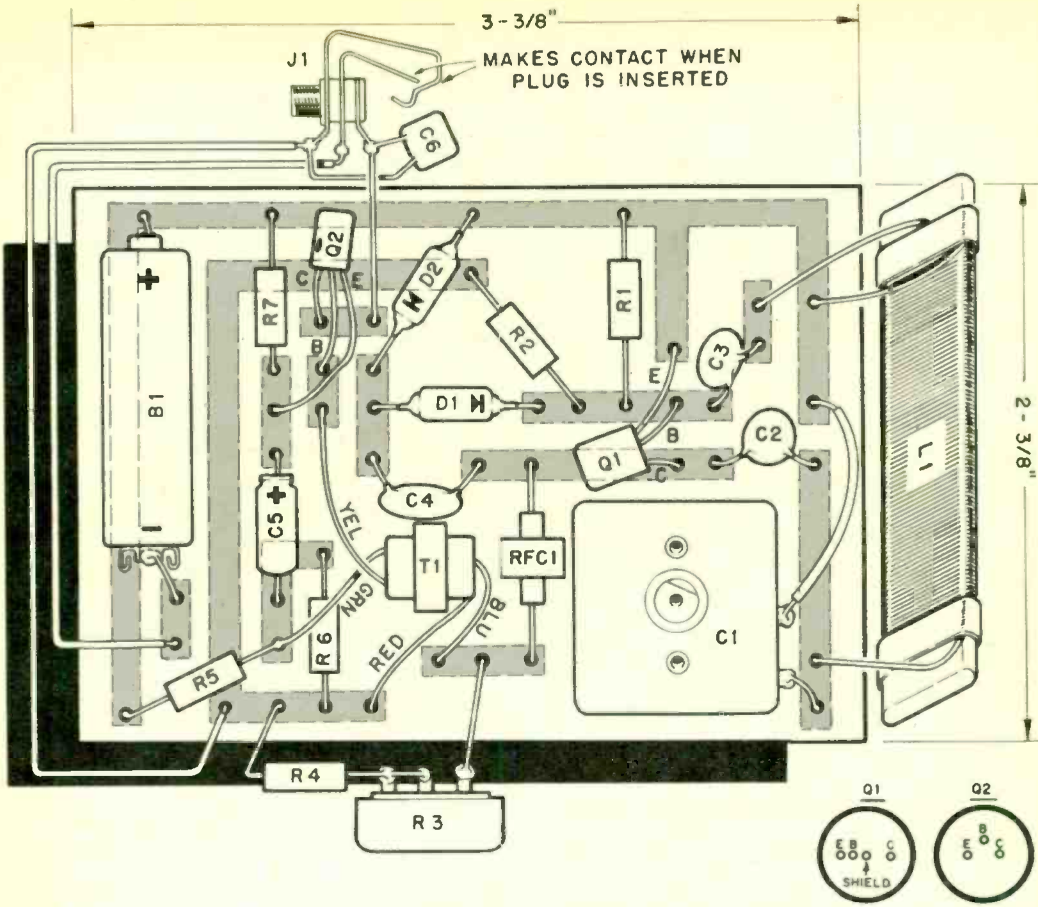
The etched circuit board is made first. Following the instructions in the preceding article and using the full-size template as a guide, lay out the circuit with 1/8" tape resist on the foil side of the board.

After etching the board, two small slots are cut for the mounting lugs of transformer T1. Push T1's lugs through the slots and bend them over tightly against the chassis. Tuning capacitor C1 is fixed to the board with Duco cement.

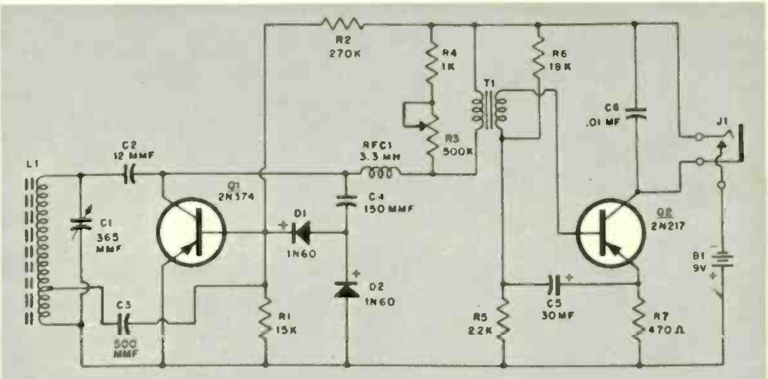
The components can now be soldered to the board. Thread the leads through the appropriate holes *from the non foil side* and solder to the foil side. Clip off the excess lead length after soldering. The shield lead on transistor Q1 is not used and and should be cut short. This completes the wiring of the circuit board.

Drill two holes in the plastic case for J1 and the shaft of C1. For the type of volume control (R3) shown,





In pictorial above, the foil side of the board is shown in an X-ray view. All components are mounted on the non-foil side of the board. Standard components are used throughout circuit.

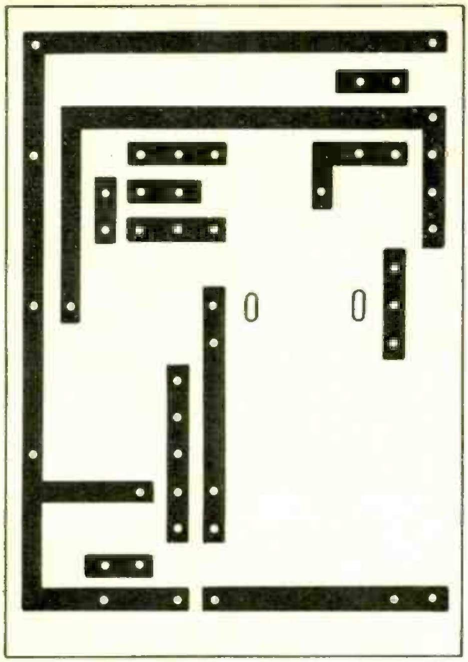


PARTS LIST

Resistors: ½ watt, 10%
R1—15,000 ohms
R2—270,000 ohms
R3—500,000 ohm miniature volume control—any type
R4—1,000 ohms
R5—2,200 ohms
R6—18,000 ohms
R7—470 ohms

Capacitors: Low voltage disc ceramic, unless otherwise noted
C1—10-365 mmf miniature variable capacitor plus tuning dial (Lafayette MS-274 and KN-24)
C2—12 mmf
C3—500 mmf
C4—150 mmf
C5—30 mf @ 6-volt, miniature electrolytic
C6—.01 mf

T1—Transformer, 100,000 ohms to 1,000 ohms (Lafayette TR-97 or equiv.)
RFC1—3.3 millihenry choke (National R-40)
L1—flat transistor antenna coil (Lafayette MS-330)
Q1—2N374 transistor
Q2—2N217 transistor
D1, D2—1N60 diodes
B1—9-volt battery (RCA VS309A or equiv.)
Misc.—Earphone, 7,000 ohm (Lafayette MS-260) Other less expensive 3,000-ohm earphones may be used with some loss of sensitivity; plastic case, 3⅜"x2⅜"x1" (Lafayette MS-159 or equiv.); perforated copper-clad board, resist, etc.



Full-size template for laying down the tape resist is shown at right. Only those holes which take the component's leads are shown. Note that the resist tape goes over, not between, each row of holes.

two outside holes for the mounting bolts and one center hole must be drilled. The control is positioned on the top half of the case so its three lugs protrude over the cover edge. A small groove is filed to clear the control lugs.

If the type of control shown is not available to you in the 500,000-ohm size, any miniature pot of the correct resistance value may be substituted for the one shown. If the standard type of potentiometer is used, it may have to be located in a position other than that shown in the pictorial.

Rather than use a pot with a switch for turning on the radio, it was decided that the old trick of modifying the earphone jack as a switch would be employed. Battery life is conserved since a glance at the jack tells you if the set has been accidentally left on. Bend the center contact of J1 as shown in the pictorial so it will connect the battery when a phone plug is inserted.

Place the circuit board in the bottom half of the case. Connect R4 to volume control R3 and solder the appropriate wires from the circuit board to J1, R3 and R4. Close the case and attach the tuning dial to the shaft of C1. To turn on the receiver, simply plug in the earphone.

If the receiver whistles as you tune across the band, try using a smaller capacitance value for C2.

How it works. A combination of regenerative and reflex operation is the secret of this receiver's sensitivity and selectivity. The RF signal is picked up by ferrite antenna L1 and fed through C3 to the base of Q1, where it is amplified. The RF signal now appears at Q1's collector and is fed back into L1 (via C2) for further (regenerative) amplification. The souped-up RF signal is next fed from Q1's collector via C4 to detector diodes D1 and D2 (hooked up in a voltage-doubler circuit). The audio output of the diodes is reapplied to the base of Q1 (from the cathode of D1) and Q1 now functions also as an audio amplifier. From Q1 the amplified audio signal is coupled by T1 to output transistor Q2 for final amplification, and then fed to the earphone from the collector element of Q2. •

You can build your own underground wireless communications system with the . . .

TERRAQUAPHONE

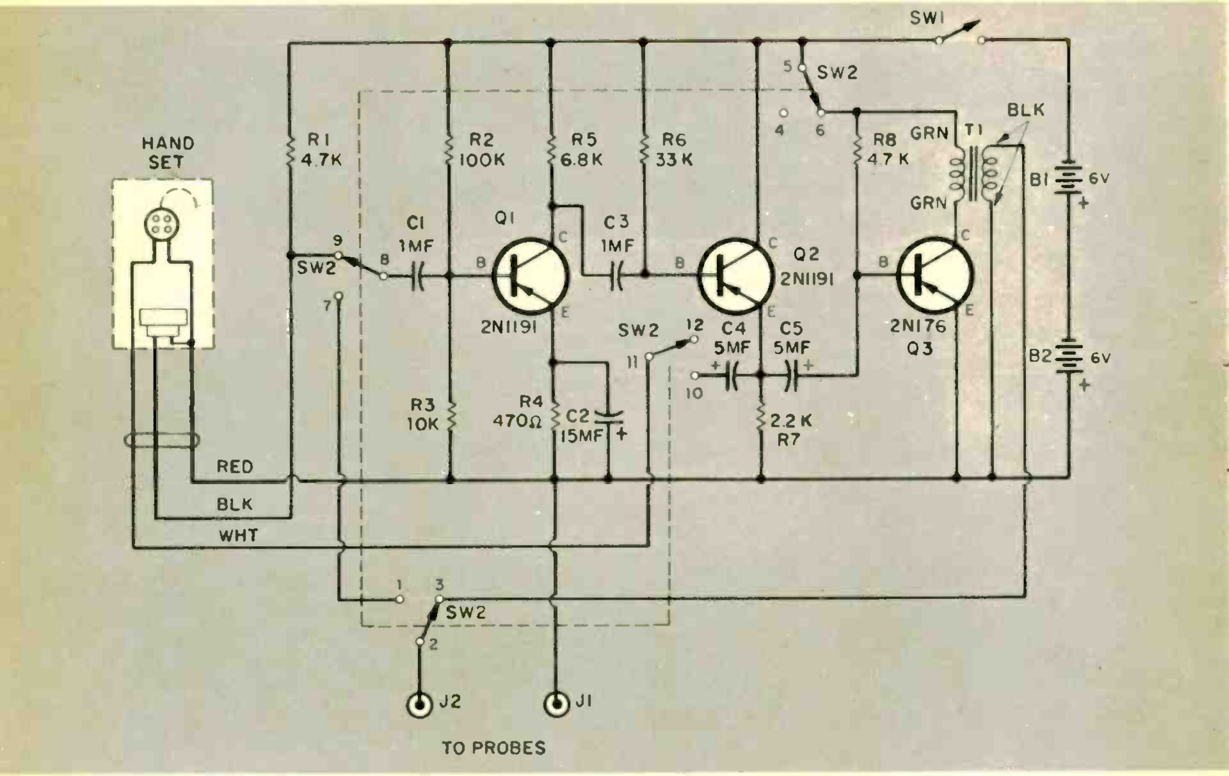
By Fred Maynard
Motorola Semiconductor Products

HUNTERS, campers, anglers, and other outdoor types may possess closets full of expensive equipment; but there is one item they're all likely to lack. That is a means of communication when in the field.

Unless a sportsman is also a ham or a Citizens Band licensee, he is cut off from the world when his hunting party splits or his fishing party spreads out. Whether he wants to tell his companions, "Hey come on over; they're biting here," or wants to summon help, he has no way to transmit his message.

The Terraquaphone answers this need for communications in the field. It also has other applications as an emergency signaling device, and hobbyists will find it an interesting experimental apparatus.

As the name Terraquaphone (earth-water phone) im-



Transistor amplifier is heart of Terraquaphone. Talk-Receive switch (SW2) is shown in Talk (depressed) position. In Receive position, power transistor Q3 is switched out and current drain is only 10 ma.

PARTS LIST

This list includes all components necessary for one Terraquaphone station. For two stations double the quantities.

Resistors: ½ watt, 10%
R1,R8—4700 ohms
R2—100,000 ohms
R3—10,000 ohms
R4—470 ohms
R5—6800 ohms
R6—33,000 ohms
R7—2200 ohms

Capacitors: 15 volt or higher rating
C1,C3—1 mf, paper or disc ceramic
C2—15 mf, electrolytic
C4,C5—5 mf, electrolytic
T1—Any 6.3V filament transformer (used as output transformer)
SW1—SPST toggle switch
SW2—4-pole, 2-position spring return lever switch (Centralab No. 1457)
B1,B2—Two 6V lantern batteries in series, 8 size D flashlight cells, or car storage battery
J1,J2—Insulated banana jacks
Q1,Q2—2N1191 or 2N650
Q3—2N176 or 2N669
Probes—2 each of the following ½"x18" copper, steel or aluminum rods—pointed. Flexible wire, banana plugs, battery clamps
Sockets—2 standard transistor sockets, 1 Motorola M-15 mounting kit
See-Zak Chassis Parts 4-R38 sides, 2-P88 panels by Rimak, 10929 Vanowen St., N. Hollywood, Calif.
Handset—includes carbon microphone and 35-100 ohm dynamic earphone. May be purchased as separate items. Handset available from Olson Electronics, stock No. PH-37 @ $2.35 post paid

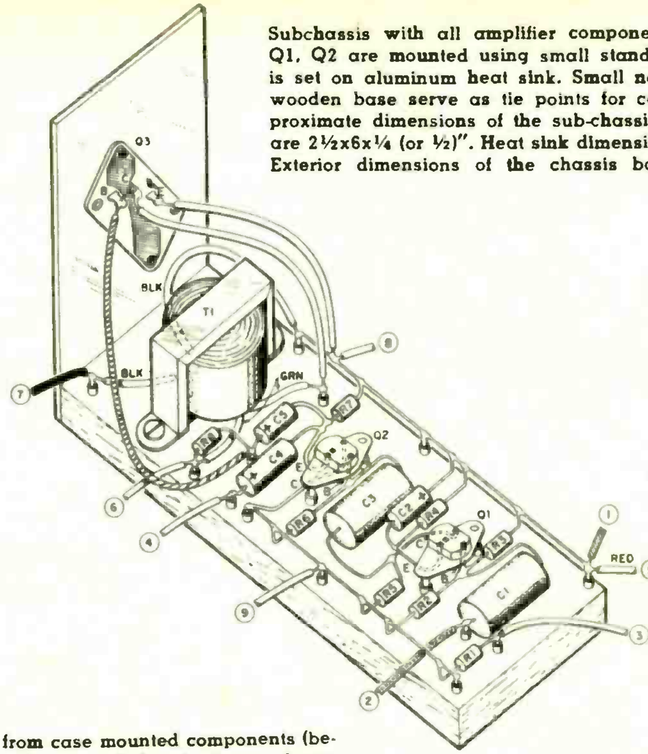
plies, the instrument transmits voice communications through earth or water. It is an underground wireless telephone or "radio."

An Old Idea

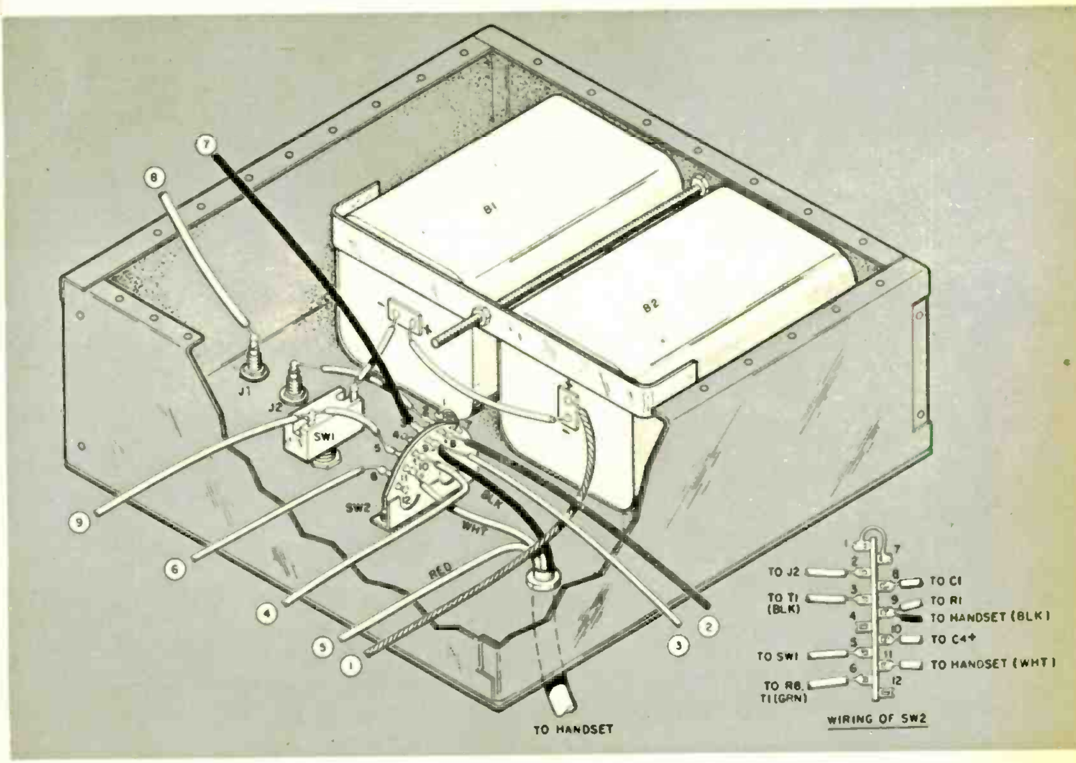
The idea of communicating via earth currents can be traced back to the year 1885 when an American, Nathan B. Stubblefield, achieved wireless communication using telephone equipment and ground stakes. Many now credit Stubblefield with the invention of radio, but what he actually invented probably was the underground wireless telephone.

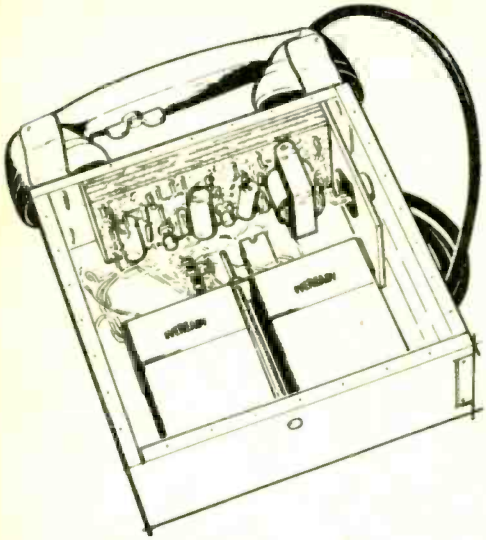
There's a considerable difference between underground radio and underground wireless telephone although the terms often are used interchangeably. In underground radio, an RF signal is radiated into the earth. A portion of it reaches the surface and is propagated

Subchassis with all amplifier components. Sockets of Q1, Q2 are mounted using small standoffs. Q3 socket is set on aluminum heat sink. Small nails driven into wooden base serve as tie points for components. Approximate dimensions of the sub-chassis wooden base are 2½x6x¼ (or ½)". Heat sink dimensions are 2½x4". Exterior dimensions of the chassis box are 8x8x3".



Numbered leads from case mounted components (below) connect to leads from subchassis shown above.





Subchassis is fitted in cabinet as above. Avoid shorting out the wiring, components or tie points.

along the interface between earth and air. A range of more than 100 miles is possible if sufficient power is applied.

Audio Transmission

Underground wireless telephone is something else again. No RF is employed. Instead, *audio* signals are pumped into the earth and travel through soil and water in all directions. The earth then becomes a giant *sheet resistance* and conducts the audio signal just as would a sheet of metal foil (although offering much more resistance). Receiving probes put down almost anywhere in this sheet pick up the signal.

The Terraquaphone's range depends on many variables. They include the homogenity of land or water in terms of resistance, moisture content (a Terraquaphone test in Arizona where the soil is quite dry achieved only 600 feet), absence of rocks (insulators), and the amount of dissolved salts in a body of water.

The Secret is Spacing

Since the sheet resistance concept is probably new to most readers, a word of explanation is in order. The two probes stuck into the ground will measure a certain resistance between them, as we mentioned before. The total resistance is actually composed of the resistance directly between the two probes shunted by an infinite number of other resistances, growing larger and larger as the resistance paths between the probes become more circuitous. Since the signal fed into the earth is developed across these resistances, it is necessary to place the pickup probes so they include as much signal path between them as possible. In general, the two sets of probes should be parallel to each other. The spacing of each pair is determined by the distance between the two Terraquaphones. The farther apart they are, the greater the range. Other things being equal, usable two-way communications usually is possible over a distance 30 to 50 times the probe spacing. A spacing of 30 feet then would mean a 1,500-foot range.

If probe spacing, sheet resistivity and orientation remain the same, signal strength diminishes as the square of the distance. Thus, doubling the distance between two Terraquaphones cuts signal strength to one-fourth its original level.

Since it is impossible to know exactly what sort of conductivity there is in any specific area, a certain amount of experimentation is required to achieve optimum results.

For a boat installation, the Terraquaphone's probes should be mounted on the bow and stern of the craft. Two boats wishing to communicate should be parallel to each other, with beam facing beam. •

STEREO FM SIGNALLER

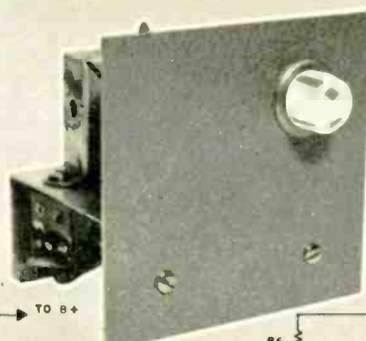
Spotlight those elusive stereo broadcasts with an easy-to-build signaller that works with any tuner or multiplex adaptor. We also present plans for adding filters and a cabinet to your stereo FM adaptor.

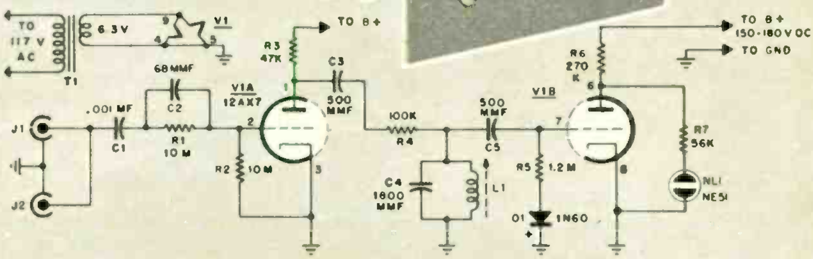
By Harry Kolbe

THE QUESTION, "Are you *sure* you're getting stereo?" is answered automatically if you have an adaptor or tuner that signals when stereo is received. For those whose equipment does not include such a useful function, here are plans for a universal add-on stereo signaller.

Signaller may be built as a separate unit on a small chassis (as shown) or, if there is room, can be put into an existing tuner

Fig. 1—One-tube signaller may be constructed on a small chassis with panel as shown or built into an existing multiplex adaptor. B-plus voltage is taken from either the tuner or adaptor. Filament voltage is supplied by transformer.



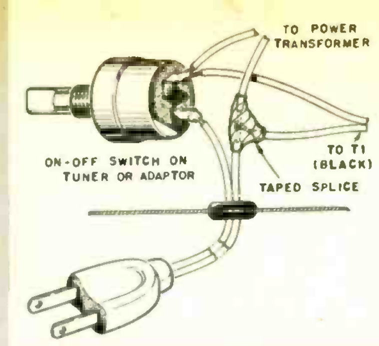


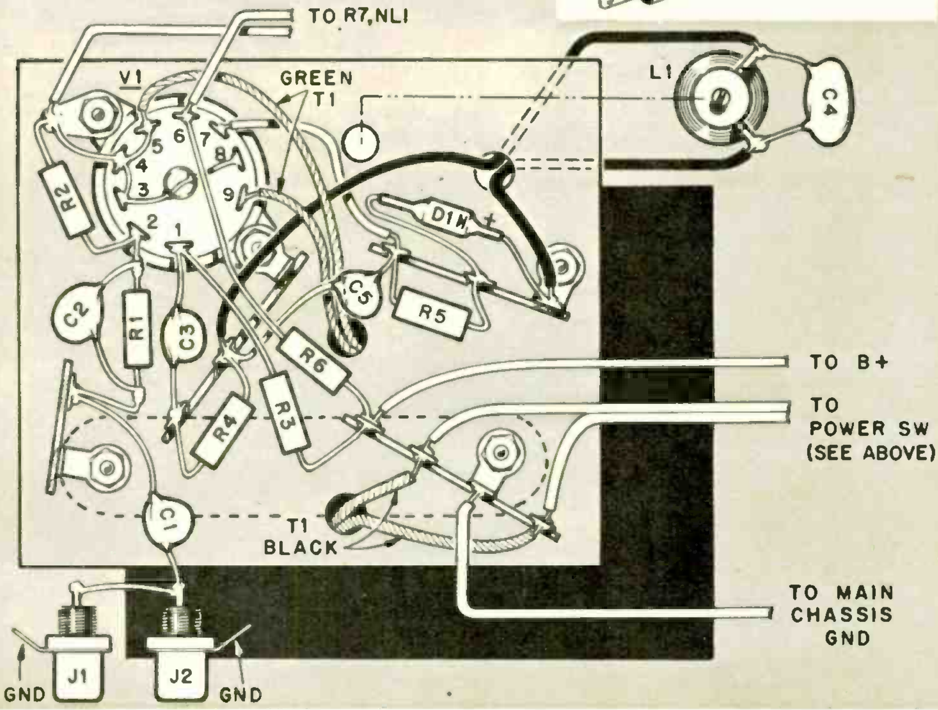
R1,R2—10 megohms, ½ watt, 10%
R3—47,000 ohms " "
R4—100,000 ohms " "
R5—1.2 megohms " "
R6—270,000 ohms " "
R7—56,000 ohms " "
C1—.001 mf, 600v., disc capacitor
C2—68 mmf " " "
C3,C5—500 mmf, " " "
C4—1,800 mmf, 600v., disc capacitor
V1—12AX7 or ECC83 tube
D1—1N60 crystal diode
T1—Filament transformer 6.3 v. @ 1 amp.
NL1—NE51 neon lamp in pilot lamp assembly with clear jewel
L1 is a 15-60 mh TV width control (Miller 6319). The required inductance is 4-50 mhs

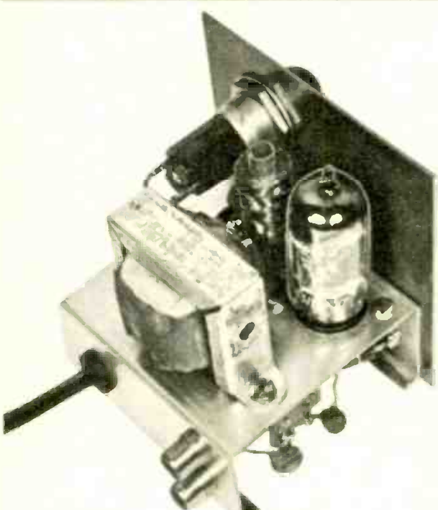
or adaptor. If you have built a stereo adaptor on a printed circuit board there may be room to build the signaller on the same chassis.

Power for signaller is tapped either from the FM tuner or adaptor: 150 to 180 volts of B-plus are necessary (keep the B-voltage down to 160, no higher than 180. If you exceed 180 volts signaller will stay on constantly). 117 volts AC is tapped off after the tuner on/switch to feed filament transformer T1.

Fig. 2—Signaller is shown on a flat surface rather than built in a chassis to permit its construction directly into an FM tuner or your multiplex adaptor. Coil L1 mounts in the hole to the right of the tube socket. Transformer T1 mounts in dotted line area on opposite side of chassis.







Completed signaller, less B-plus supply. Coil L1 is mounted between pilot lamp assembly and V1.

The signaller uses separate filament transformer because the added filament drain on the tuner supply might overload its power transformer. The tuner's B-plus supply will not be overloaded since signaller requires only 1.5-2 ma.

The two input jacks (J1, J2) on signaller are wired in parallel. A low-capacity shielded cable connects J1 to the tuner's multiplex jack; J2 is connected to the multiplex adaptor input. If signaller is built directly on the chassis of a tuner or an adaptor, the jacks may be eliminated and the signaller connected directly to the appropriate points both for signal and B-plus voltage.

Component layout is not critical; however, some care must be taken in the location of coil L1 if signaller is built in an existing unit. Keep L1 away from audio circuitry which may pick up the amplified 19-kc pilot signal.

The only slightly tricky step in construction is the modification of L1, a standard TV width control. L1's coil form is about a half-inch too long for our purposes and must be shortened.

Taking care not to damage the winding, pull the mounting clip off the coil form. The tuning slug will come off with it. Apply small amounts of cement solvent to the fiber collar that holds the two terminal lugs. Be careful not to get solvent on the coil windings. The cement holding the collar soon will soften enough to allow the collar to be moved. Slide the collar along the coil form to within 1/8" of the coil and re-cement. Cut off about 1/2" of the section now exposed. Re-insert the slug assembly and push the mounting clip back on the form. L1 is now mounted by pushing it through the 5/16" hole until the mounting clip clicks firmly in place.

Adjustment of signaller: After the four power connections are made (see pictorial), a shielded cable is connected between J1 on the signaller and the tuner's multiplex jack. Turn on the tuner and tune in a station that you are sure is broadcasting stereo. Now adjust the slug of L1 until the neon indicator goes on.

The circuit relies on the 19-kc signal that always accompanies a stereo broadcast to fire neon bulb NL1. The signal from the tuner's multiplex jack is fed through a high-pass filter consisting of C1, C2 and R1. This filter attenuates audio frequencies below 19 kc. V1A, which has a high input impedance to avoid loading down the tuner detector, amplifies frequencies of 19 kc and up.

V1B is so biased that it is normally drawing enough current to keep the voltage at its plate slightly below the voltage necessary to fire or sustain neon indicator NL1 (60 v.). When the 19-kc signal appears at the grid of V1B it is rectified by D1, which puts a relatively high negative potential on the grid. The high negative grid voltage cuts off V1B and the plate voltage rises high enough (70 v.-110 v.) to fire NL1. Flickering of the bulb while tuning should be ignored. •

FILTERS AND CABINET

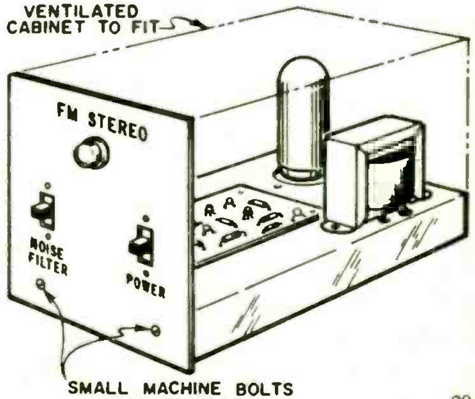
for your Stereo FM Adaptor

For that cooler, cleaner stereo—add a filter to your multiplex adaptor.

Although a number of commercial adaptors do not include filter circuits, our tests have indicated that they are almost mandatory. Let's look at the reasons. All MX adaptors operate with a high-level 38-kc internal signal. In some units, the 38-kc signal is the amplified and doubled pilot carrier broadcast by the FM station. In other adaptors, the 38 kc is generated by an oscillator synchronized by the FM station's pilot carrier.

Within the adaptor the 38-kc level may be as high as 30 or 40 volts and despite de-emphasis, an appreciable 38-kc signal may appear at the output in addition to the stereo signal. Although the 38-kc signal can't be heard, amplifiers and tweeters can respond to it. It could overload the amplifier or even burn out a tweeter's voice coil. And when tape-recording stereo broadcasts, the output of the adaptor or its harmonics could

Fig. 3—Cabinet for your MX adaptor and signaller may be constructed to suit requirements of user. A suggested cabinet for the printed-circuit version of the adaptor would have a metal front panel 1/2" wider than the chassis. The cabinet would be built of 1/4" plywood bolted to the chassis sides. The cabinet sides should be about 1" higher than the tallest component used in the adaptor.



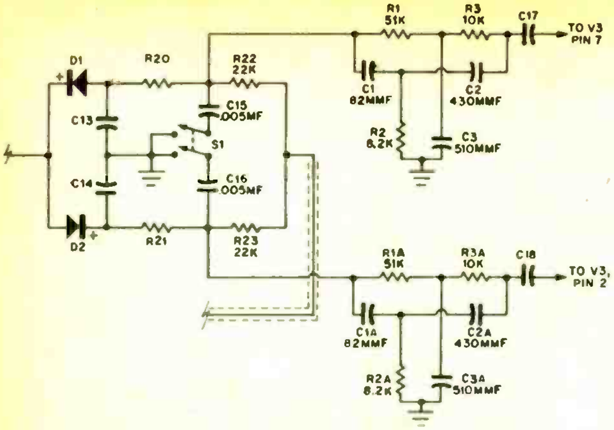


Fig. 4—Part of original MX adaptor schematic showing changes. The new components required are listed below.

NEW COMPONENTS

Resistors: ½ watt, 5%
R1,R1A—51,000 ohms
R2,R2A—8,200 ohms
R3,R3A —10,000 ohms
R20,R21 R22,R23—22,000 ohms
Capacitors
C1,C1A—82 mmf, 5% silver mica
C2,C2A—430 mmf, 5% " "
C3,C3A—510 mmf, 5% " "
C15,C16—.005 mf @ 200v. tubular or disc
S1—DPST toggle or slide switch
Misc.—5-lug terminal strips with center lug grounded

beat with the recorder's internal bias oscillator and cause beat notes or birdies.

Several filter systems were tried and for our purposes, the best design turned out to be a modified twin-T filter. This filter not only incorporates a null over the 38-kc region but also provides deemphasis. Not as critical or expensive to build as other types, the two filters (one for each channel) may be constructed using 5% tolerance resistors and capacitors.

Since the stereo FM broadcasts have an inherently lower signal-to-noise ratio than mono, a switchable high-frequency noise filter has also been added to the adaptor. In a weak signal area, a restricted high-frequency response may be less objectionable than noise. The noise filter consists of two capacitors, C15 and C16 (one for each channel), which when switched in by S1 provide a high-frequency roll-off starting at 5 kc.

Construction steps are as follows:

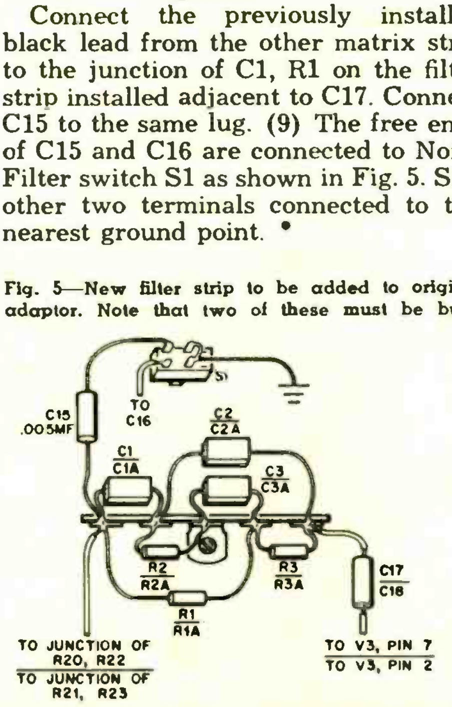
(1) Mount Noise Filter switch S1 on chassis apron on the side of output jacks J2, J3 opposite power switch SW1.

Important: Before unsoldering any connections, use a heat sink to protect diodes D1 and D2 against heat damage.

(2) Remove the original C15 and C16 capacitors (.001 mf) from the circuit and discard. (3) Disconnect the leads of C17, C18 to matrix terminal strips. Now a 4" length of black hook-up wire is connected to the lug in place of C17. A 4" length of red hook-up wire is connected in place of C18. (Leave the other lead of each capacitor connected to its respective tube socket pin.) (4) Remove the original 1% resistors R21, R22, R23, R24 from the matrix terminal strips and discard. Substitute the new values of R21, R22, R23, R24 (see Parts List and Fig. 4). Capacitors C13 and C14 remain unchanged. (5) Assemble the components (except C15, C16, C17, C18) on the two 5-lug filter strips as shown in Fig. 5. Note that the center lug of each strip is grounded. (6) Mount the two filter terminal strips with 6-32 hardware. One strip (we will call it A) is installed approximately under C19; the other is installed approximately where C17 is located. (7) Now wire in the two strips as per Fig. 5. Connect the free end of C18 to the filter strip A located under C19. Connect C17 to the other strip. (8) Connect the previously installed red lead from one matrix strip to the A filter strip where C18 and R1A meet. At this same lug connect one lead of the new capacitor C16.

Connect the previously installed black lead from the other matrix strip to the junction of C1, R1 on the filter strip installed adjacent to C17. Connect C15 to the same lug. (9) The free ends of C15 and C16 are connected to Noise Filter switch S1 as shown in Fig. 5. S1's other two terminals connected to the nearest ground point. •

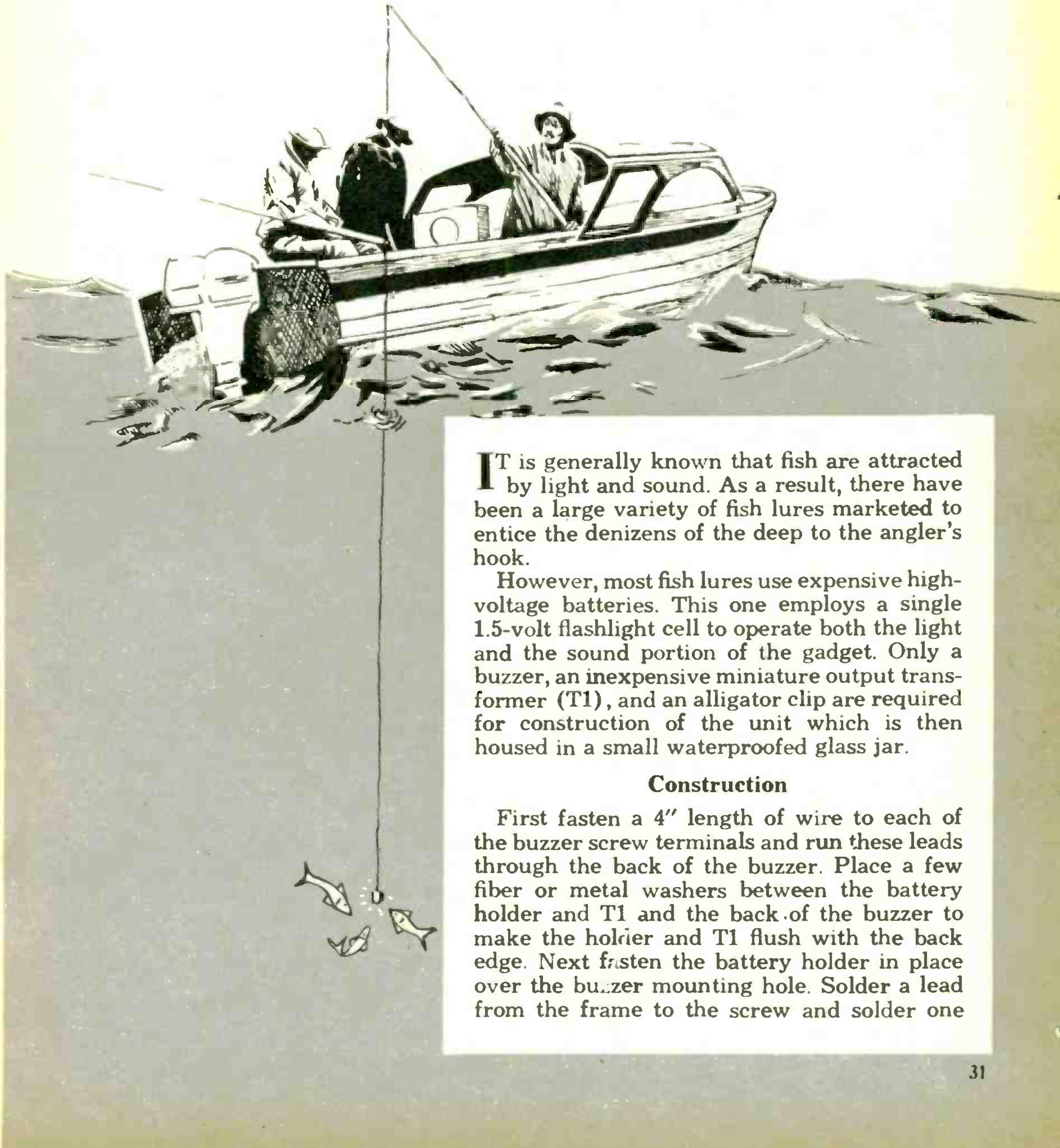
Fig. 5—New filter strip to be added to original adaptor. Note that two of these must be built.



Electronic Fish Lure

A fisherman's dream come true. Have fun, Sons of Izaak Walton.

By Forrest H. Frantz, Sr.

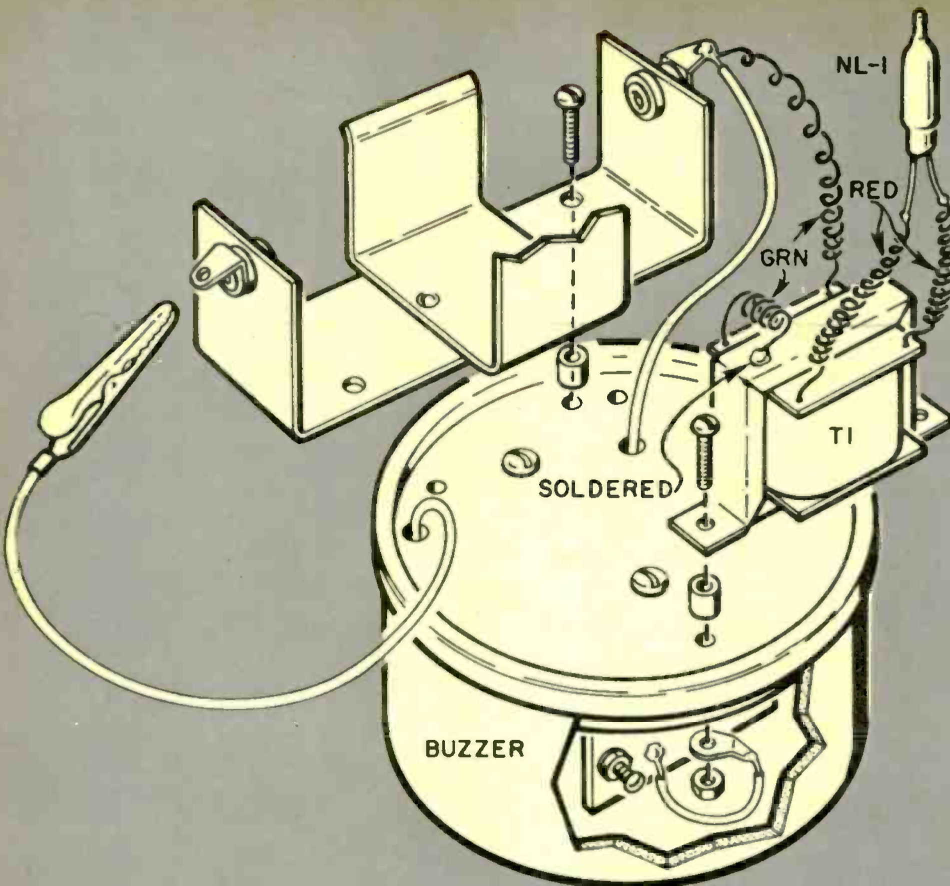


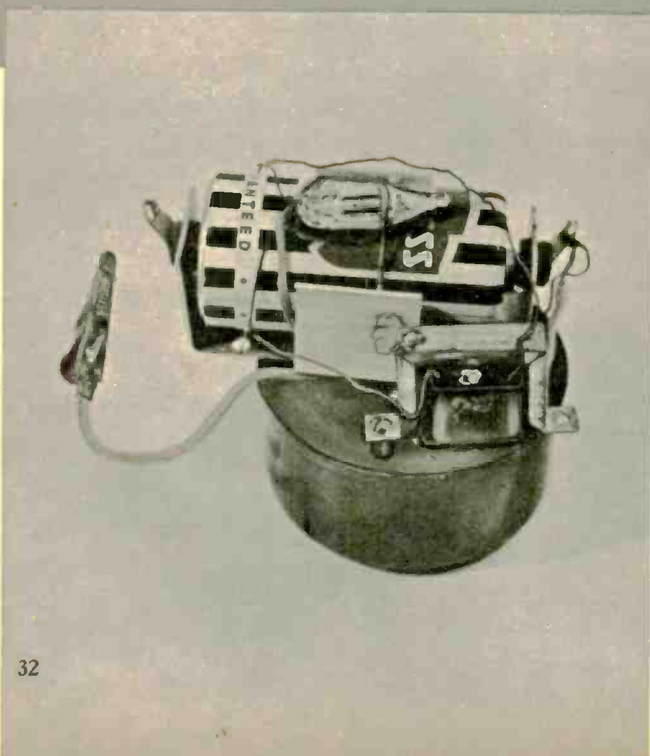
IT is generally known that fish are attracted by light and sound. As a result, there have been a large variety of fish lures marketed to entice the denizens of the deep to the angler's hook.

However, most fish lures use expensive high-voltage batteries. This one employs a single 1.5-volt flashlight cell to operate both the light and the sound portion of the gadget. Only a buzzer, an inexpensive miniature output transformer (T1), and an alligator clip are required for construction of the unit which is then housed in a small waterproofed glass jar.

Construction

First fasten a 4" length of wire to each of the buzzer screw terminals and run these leads through the back of the buzzer. Place a few fiber or metal washers between the battery holder and T1 and the back of the buzzer to make the holder and T1 flush with the back edge. Next fasten the battery holder in place over the buzzer mounting hole. Solder a lead from the frame to the screw and solder one





Place washers under transformer and battery holder for flush mount against edge of buzzer. Alligator clip connected to lug on battery holder starts unit.

of T1's green secondary leads to its frame. Solder the other green secondary lead and the lead from the buzzer coil terminal to the positive battery holder terminal. Solder the clip to the other buzzer lead which should be long enough to permit clipping to the negative battery terminal. Connect the red primary leads of T1 to the neon lamp. Fasten the neon lamp to the battery with a rubber band and place the battery in the holder.

If the buzzer sounds too loudly, you can weaken its signal by inserting a small value resistor at the point marked "X" in the schematic.

Operation

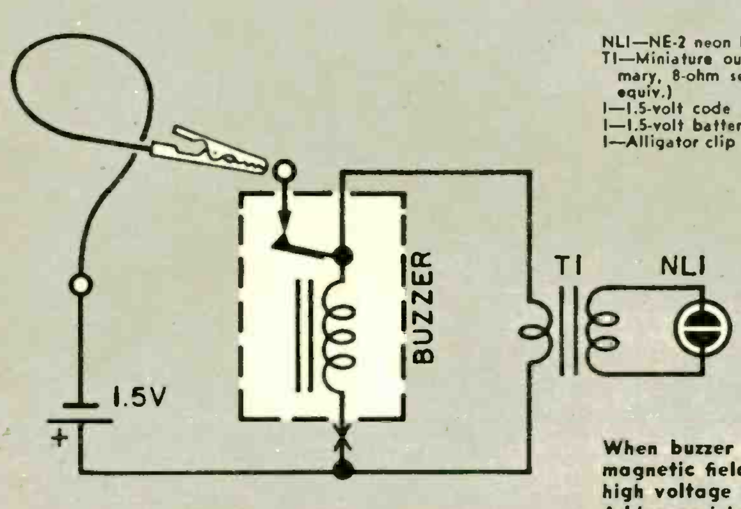
To operate the lure, all you need do is connect the clip to the negative battery terminal and adjust the buzzer contact screw for a clear *high frequency* note. This adjustment may be somewhat critical and you may have to repeat it several times. Install the buzzer in the jar, fasten the lid, and lower the lure into the water on a line. If necessary, add weight to the jar, and use cellophane tape to hold the components and the weights in place.

A hook made of No. 14 copper wire may be soldered to the jar lid for attaching the line. Since a glass jar is used, it's a good idea to provide a similar hook on the inside of the jar lid to permit tying a string to the battery holder. Then, if the jar is broken by accident when the lure is submerged, the contents will not be lost. If through some accident the jar does break, the electronic components should be dried by placing in the sun or an oven. If immersed in salt water, rinse in fresh water before drying.

This lure provides continuous sound and light. Those anglers who prefer periodic or intermittent sound and light can add an external remote on-off switch for operation from the boat. Leads will have to be added and brought out through waterproofed insulated terminals in the lid and given several coats of spar varnish. You could also install a mercury switch between the clip and buzzer and position it so the lure is normally on. Attach a string to the jar to tilt the unit to switch it off.

How It Operates

The pulsating direct current that appears across the buzzer terminals is stepped up by the primary of T1. The high AC voltage across the secondary of T1 energizes the neon lamp. T1 connected in reverse steps up the voltage to almost 100 volts, sufficient to light the neon bulb. •



PARTS LIST

NL1—NE-2 neon lamp
T1—Miniature output transformer; 2,000 ohm primary, 8-ohm secondary (Lafayette TR-93 or equiv.)
1—1.5-volt code practice buzzer
1—1.5-volt battery and matching holder
1—Alligator clip

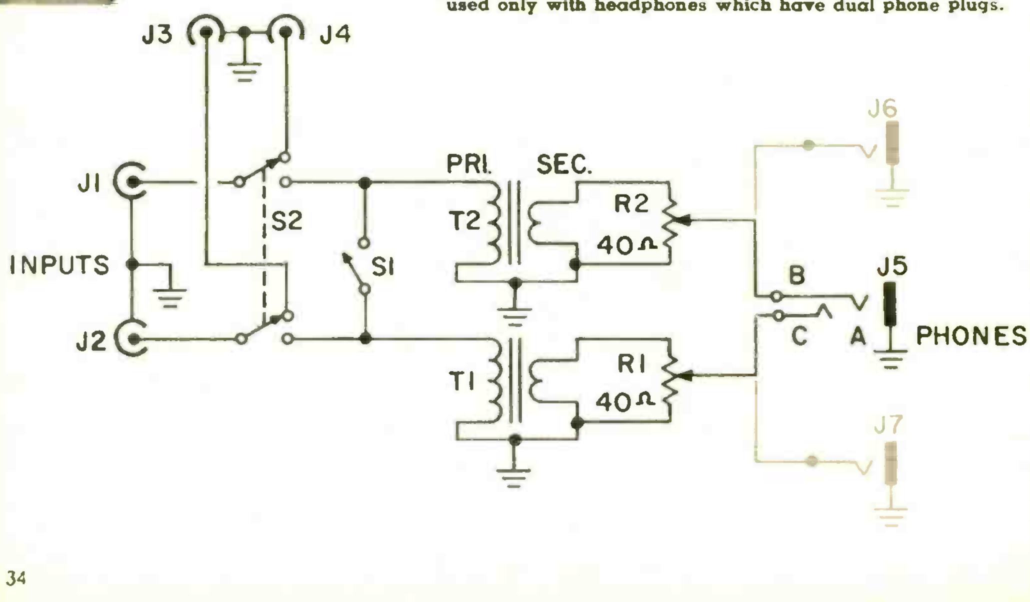
When buzzer contacts open, collapsing magnetic field in primary of T1 induces high voltage in secondary to light NL1. Add a resistor at X to weaken buzzer.

STEREO HEADPHONE ADAPTOR

Don't waste watts! Here's an inexpensive device that allows you to connect any of the new low-impedance headphones directly to the output jacks of your stereo preamp or AM-FM stereo tuner!

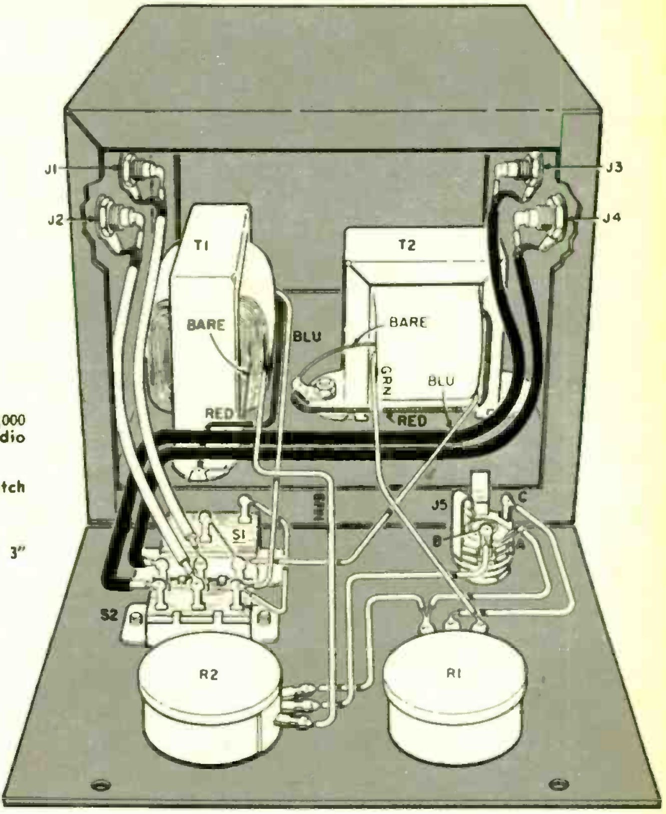
By Harry Kolbe

Schematic of complete adaptor. Optional jacks J6, J7 are used only with headphones which have dual phone plugs.



PARTS LIST

R1,R2—40-ohm wirewound potentiometer
T1,T2—output transformer—Primary: 7,000-10,000 ohms, Secondary: 3-8 ohms (Lafayette Radio TR-69 or the equiv.)
J1-4—single-hole mounting phono jack
J5—3-conductor, open circuit phone jack (to match headphone plug)
S1—SPST slide or toggle switch
S2—DPDT slide or toggle switch
1—aluminum utility cabinet approx. 4" x 5" x 3"
J6,J7—See text



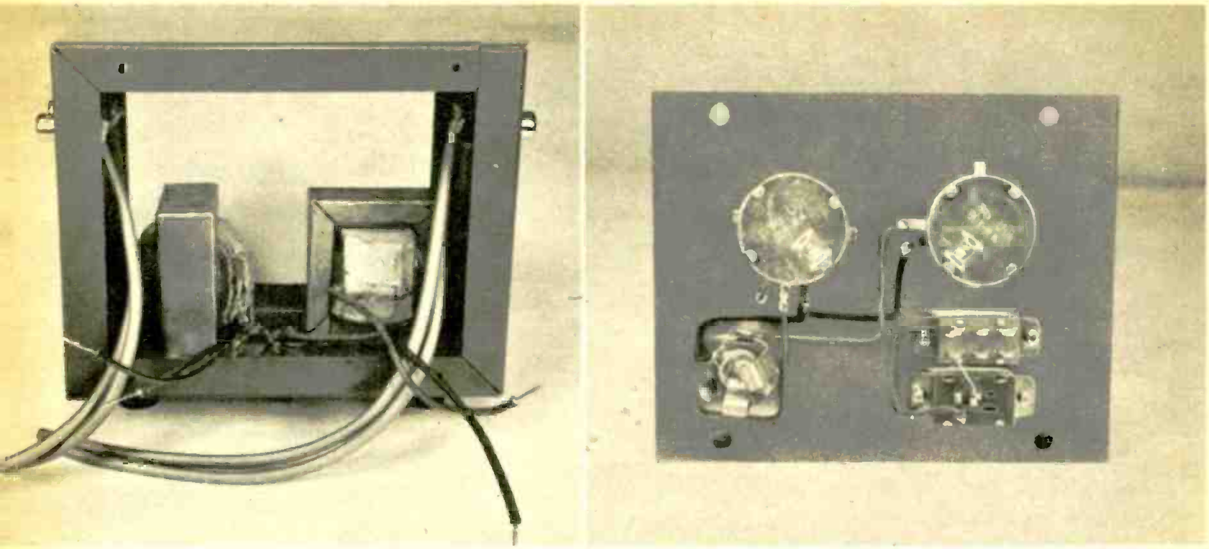
Unit with its front panel dropped to show the internal wiring. Transformers are installed toward rear and in position shown.

ALTHOUGH the new 8-ohm stereo headphones are ideal for solo hi-fi listening, they present problems. In the first place, it's a nuisance to have to disconnect the speaker leads from the amplifiers and replace them with the headphone leads. And secondly, it seems wasteful to use two high-powered amplifiers to drive a pair of headphones which require only a fraction of a watt for ear-splitting volume.

This impedance-matching switch box solves both these problems in one fell swoop. A *Phones-Amp.* switch (S2) provides instant choice of phone or speaker listening, and the impedance matching feature permits the direct connection of 8-ohm headphones to the preamp or tuner instead of to the amplifier's 8-ohm output terminals.

The box contains two output transformers, T1 and T2, which serve as the impedance matching devices. The units specified in the parts list can be purchased for only 39c each. Potentiometers R1 and R2 across the secondaries of T1 and T2 are large enough not to load down the headphones and yet allow compete control over the level of the signal fed to each ear.

Phones-Amp. switch S2 receives the stereo signals from the preamp or tuner via J1 and J2. In the *Phones* position, S2 feeds the signals to the primaries of T1 and T2, while in the *Amp.* position, the signal is routed directly to the inputs of the amplifiers via J3 and J4. For



Adaptor is constructed in two separate assemblies, front panel and cabinet, which are later interconnected.

standard mono reception, *Stereo-Mono* switch, S1 parallels J1 and J2 so a signal appearing at either jack is fed to both earphones.

Construction

The wiring and assembling of the adaptor box is evident from the pictorial. For ease of construction, the front panel on which the two switches, pots and J5 are mounted should be assembled and wired first. The cabinet containing the two transformers and the four phono jacks is then assembled. Note that the jacks are the new single-hole mounting type that do not have a fiber mounting plate. The shielded wires have their shield leads connected to the ground lugs of the jacks and their hot leads connected normally. No ground connection is made to the shielding at the end of the leads connected to S2. Make sure that you allow enough shielded lead to enable the front panel to lie flat as shown in the pictorial.

Transformers (T1, T2) are mounted at right angles to each other and as far to the rear of the case as possible to allow sufficient clearance for the front panel components. A ground lug is installed under a mounting tab of each transformer and the red and bare leads are soldered to the lugs. (Some transformers may have *two* bare secondary leads instead of one bare and one green lead.) Make sure to scrape the enamel off the bare lead before soldering or a bad joint may result.

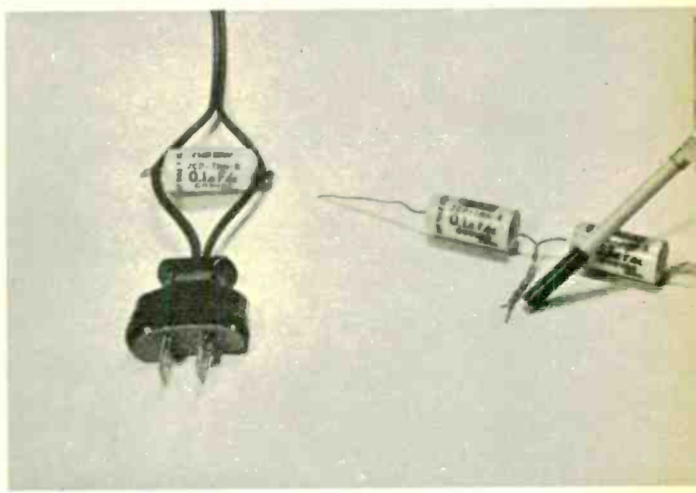
When FM stereo multiplex programs start coming through, the headphone adaptor will work equally well connected to the outputs of your multiplex adaptor. Most MX adaptor units have cathode-follower outputs and hence can drive the headphones through the adaptor box. •

TRY THESE

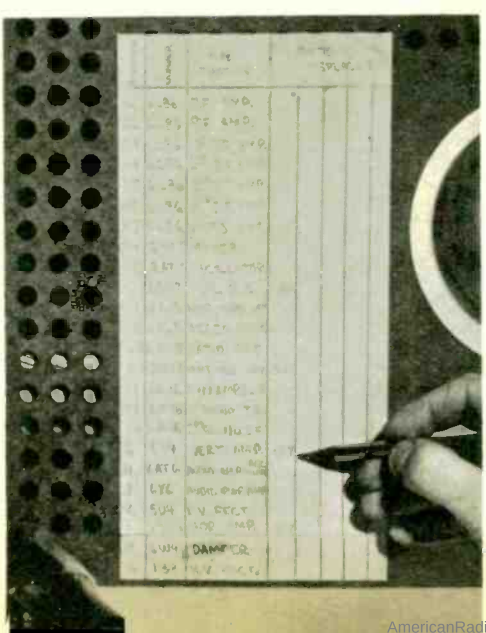
Can-Opener Knob Puller

To help loosen a tight radio, TV, or hi-fi push-on knob, a puncture-type can opener makes an ideal tool. The opener is bent at just the right angle and its wide tip won't cause damage to either the push-on knob to be removed or the unit's cabinet.

Interference Reducer



You can kill most radio noise from appliances with a .1 mf, 600-volt capacitor. Connect it across the line inside the appliance, if possible, or mount in a small metal or plastic box. Tougher cases may require two capacitors with the outside leads connected across the line and their center leads twisted together and grounded to a water pipe.



Tube Maintenance Record

A chart of all the tubes in your TV, their function and replacement date pasted to the back of the set will help in predicting the life in each tube. Mark down the location of each of the tubes also.

An Experimental NEGATIVE ION Generator

Here's an inexpensive home-built device that duplicates costly commercial units

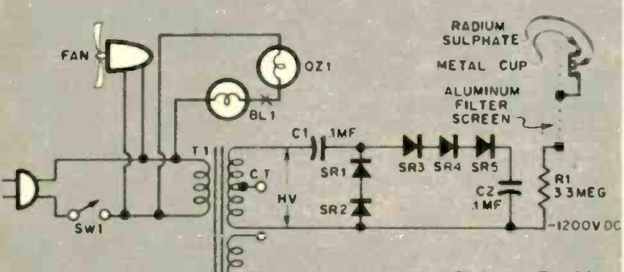
By George Gordon

BY ALL odds, the most-talked about new electronic device now on the market is the negative-ion generator. How well these invisible particles do the jobs claimed for them is open to some question (still in basic research), but the fact remains that a great many negative ion generators are being sold for $75 to $100 and more.

We therefore present the Negative Ion Generator as an experimental apparatus. It is an interesting project to build and its method of operation can make an engrossing study. Cost can be held to less than $20.

This generator also includes an optional ozone lamp (OZ1) which may be switched on (with SW2) for short periods to rid the air of unpleasant odors. It should not be turned on continuously because high concentrations of ozone can be harmful.

All components of the generator are standard including the radioactive element, which actually is an anti-static "jewel" normally used to keep records dust-free. The radioactive ionizing element is a tiny bit of radium sulphate set in a metal cup. It emits about 90,000 alpha particles (or electrons) a second and has a half-life of more than 1,500 years. It is quite



Voltage Doubler

PARTS LIST (Continued)

R1—3.3 meg. ½ watt resistor

Ozone lamp—4 watt G4S11 (Available from Lafayette Radio and elsewhere)

Aluminum Filter—E-Z Kleen manufactured by Research Products Corp. (Available at hardware and air conditioning supply stores)

1—Ionizing Jewel Audiotex Atomic Stat Elem. By Audiotex Mfg. Co., 400 S. Wyman, Rockford, Ill.

1—Fan and motor

1—12" speaker baffle

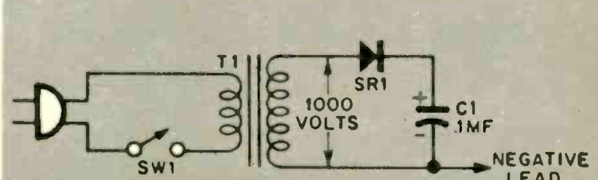
PARTS LIST

T1—Power transformer, 475 to 525 volt center-tapped high voltage secondary (center tap unused), or 1000 volt secondary for half-wave hookup

C1—.1 mf 1000 volt tubular capacitor

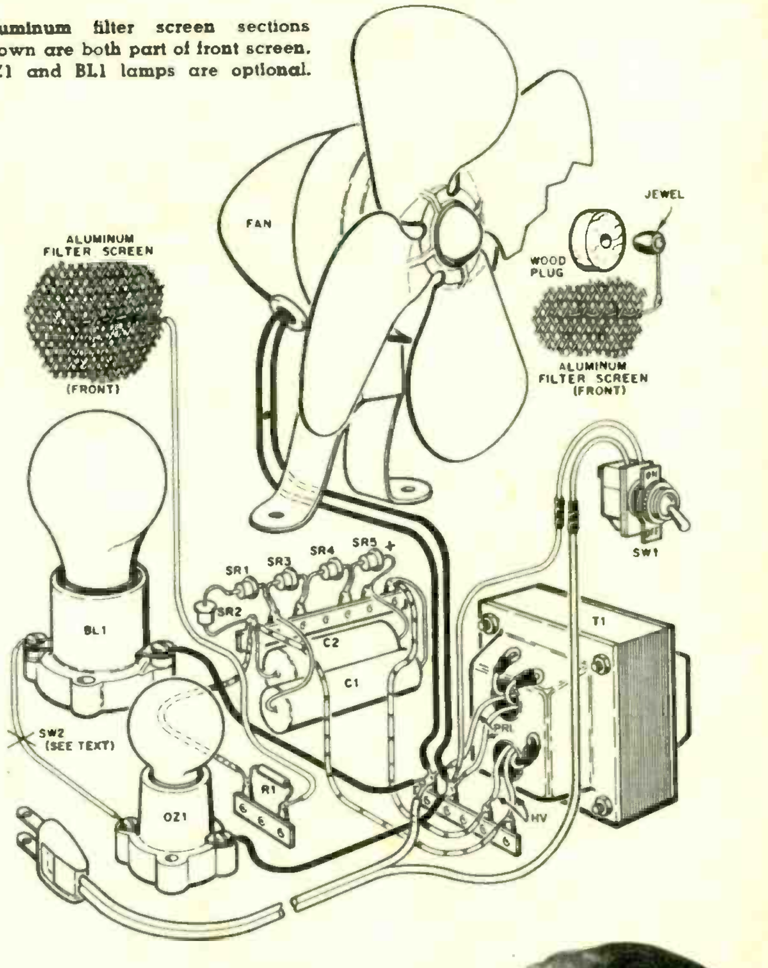
C2—.1 mf 1600 volt tubular capacitor (You may substitute two .05 mf @ 1600 volt capacitators connected in parallel for C1 and C2)

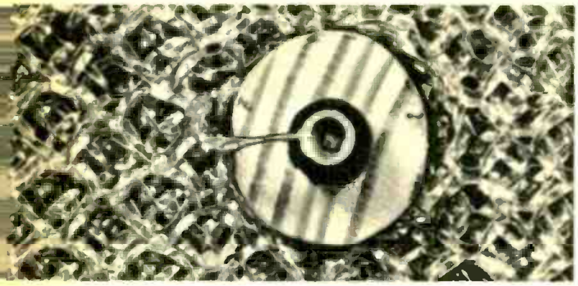
SR1-SR5—Silicon rectifier, 200 ma, 400 volt peak inverse voltage. (Available for 50¢ each at Tab. 111 Liberty St., New York, N. Y.) (SR1 must have a PIV rating of at least 1500 volts. Current rating of 1 ma or higher is adequate)



Half Wave

Aluminum filter screen sections shown are both part of front screen. OZ1 and BL1 lamps are optional.





Ionizing jewel is glued in a ¼" hole drilled in a 1" block of wood glued to unit's front panel.

harmless unless it's swallowed or held close to the nose for a long period. The electrons emitted by the element join molecules or atoms of oxygen (oxygen usually exists in molecular form in nature). Since each electron carries a negative charge, it upsets the balance of the neutral molecule and transforms the whole mass into a negative ion.

The generator propels these ions out into the room with a 1,200-volt negative charge on the metal cup and aluminum filter screen. Air set in motion by the fan also helps circulate the ions around a room. Keep the enclosure at least a foot away from any wall to insure an adequate air flow through the rear of the cabinet.

The particular filter screen specified for the front and rear of the enclosure is a new product designed as an air conditioner filter replacement and the manufacturer claims that it effectively removes dust, pollen, etc., from air passing through it. Resistor (R1) isolates the screen from the power supply and eliminates all possibility of shock.

Construction

The voltage doubler circuit shown uses the full high voltage secondary winding of an ordinary power transformer to deliver 1,200 volts DC. If you have or can purchase cheaply, a surplus transformer with a 1,000-volt secondary, you can use a high-voltage diode in a simpler half-wave rectifier circuit. Be sure to tape up the ends of unused center taps and filament windings.

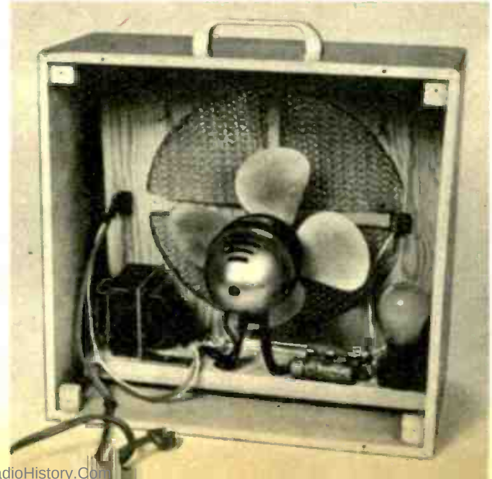
The silicon rectifiers employed in this unit sell for about 50¢ each. Their peak inverse voltage rating is only 400 volts, however. Since a 1,200-volt silicon rectifier costs about $2.50, the cheaper ones were used in series for economy reasons.

The ionizing jewel is mounted by drilling a ¼-inch hole in a 1" block of wood, gluing the jewel in the hole and then the block to the front panel.

The smaller the fan, the smaller the enclosure you will need, of course. In this case, speaker baffle for 12" speakers was used because it combines a compact attractive appearance with relatively low cost. If the fan is small enough, a 10-inch baffle will do.

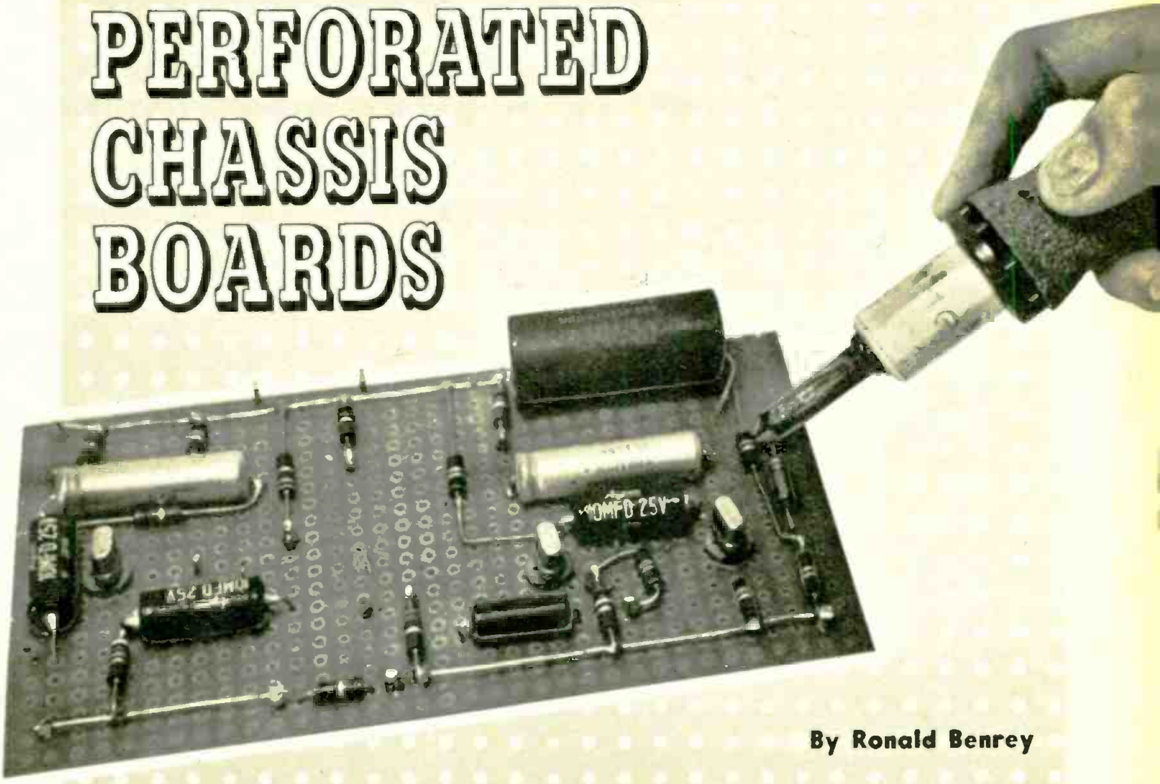
Make certain that you solder a lead from the *negative* side of the power supply to the ionizing jewel. Using the positive side will simply attract the negative ions and ground them. Solder the lead to the metal cup containing the radioactive element with a hot iron and work quickly! The solder will take hold better if you first scrape the metal at the point to be soldered to obtain a shiny surface.

The front filter connected to the negative DC potential serves as a charged screen to repel any negative ions that may wander back toward the enclosure. The amount of aluminum filter needed will vary from 1½ to 2 square feet depending on enclosure size. Since you can't solder to the aluminum, thread the bare end of the negative lead through the screen. Do the same with the lead to the jewel. A 40 watt incandescent lamp must be used in series with the ozone lamp to provide adequate ballast. CAUTION: *Do not expose yourself to or look at the direct rays of the ozone lamp.* •



getting the most out of

PERFORATED CHASSIS BOARDS



By Ronald Benrey

RAPID GROWTH in popularity of transistors and the miniaturization techniques that came with them have created a demand for a suitable chassis system. Although printed-circuit board is widely used in industry, among experimenters, the perforated chassis board is by far the most popular method of mounting components. Unfortunately, the hobbyist doesn't always use the boards wisely; in fact a large number of unsuccessful projects can be traced to their misuse.

Small components can be secured to perforated chassis boards by miniature nuts and bolts, clamps, etc., or by the leads of the parts themselves. The latter method is possible because of the light weight of most miniature components. Interconnections are made using push-in terminal lugs (flea clips) as junction and solder points. Thanks to the great number of adjacent holes, a lug pattern can easily be made to suit any circuit, and by simply removing the clips, the same chassis board can be re-used many times. A variety of clip types are available for temporary connections and experimental work.

Sizes and Shapes

Boards can be easily shaped to suit a particular application. You can save money by buying large boards and cutting off sections for individual projects. A fine-toothed coping or jeweler's saw, using light pressure to prevent splitting will serve nicely. Cut along a row of holes whenever possible. Airplane-type tin snips also can be used to cut the boards. With a little practice you can learn to break the board (over a desk edge) along the row of holes desired.

The best way to make large holes is to enlarge one of the small holes with a drill, then widen this pilot hole with a tapered reamer. Chassis punches can be used on high-quality phenolic board but in general it's best to *ream* large holes, not punch them. Odd shapes are easily cut with a nibbling tool such as the inexpensive Adel type shown.

Perforated boards are not very strong and tend to crack under strain. Consequently, they should not be used to support heavy components such as standard-sized transformers. Lack of mechanical rigidity also makes them unsuitable for high-frequency equipment requiring a non-flexible chassis.

Heat-producing components should not be mounted too close to the heat-sensitive phenolic material. However, as most transistor build-it articles describe low-frequency devices using lightweight and cool-running components, the above disadvantages are unimportant to the home experimenter.

Miniaturized vs Open Construction

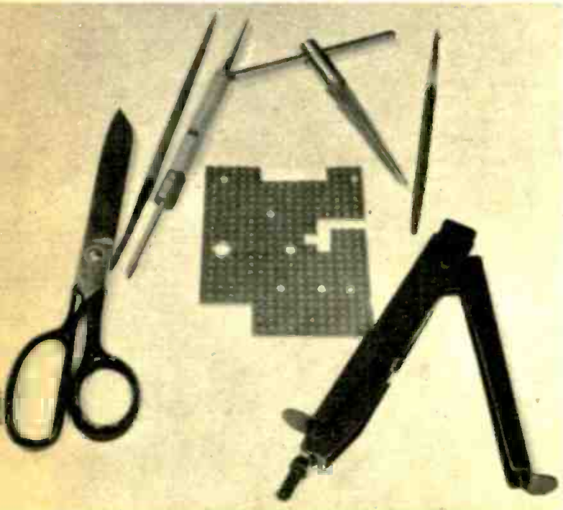
There are two basic approaches to using the perforated chassis board.

Maximum miniaturization implies the use of the smallest possible board, miniature and subminiature components, tight layout and elimination of such "luxuries" as transistor sockets, insulation and comfortable working space. And unless you're really skilled, damage to components during soldering and mistakes in component polarity run wild. You'll find that troubleshooting a miniaturized circuit is often more difficult than building it. Component prices go sky-high as size decreases. Unless a device cries for miniaturization, stick to the open construction technique.

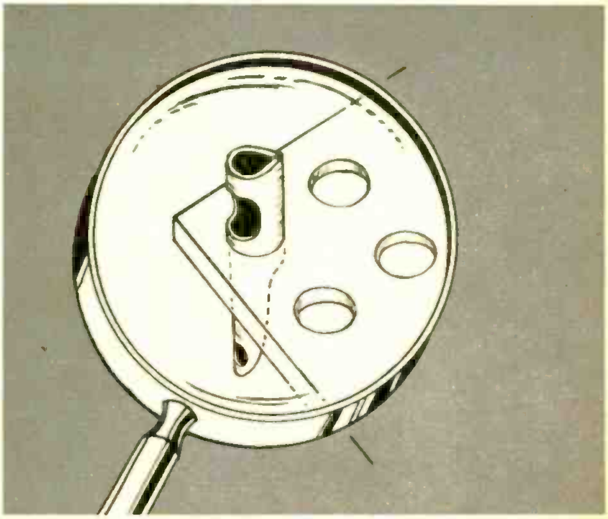
The correct approach is shown in the photos. Note the use of buss bars at the top and bottom edges and the squared-off components and leads of the transistorized preamp. Although there are about 30 major components in a fairly small area, everything is out in the open, and there is no doubt about polarity—and no danger of a short circuit. In addition, all the components are mounted so their values may be read.

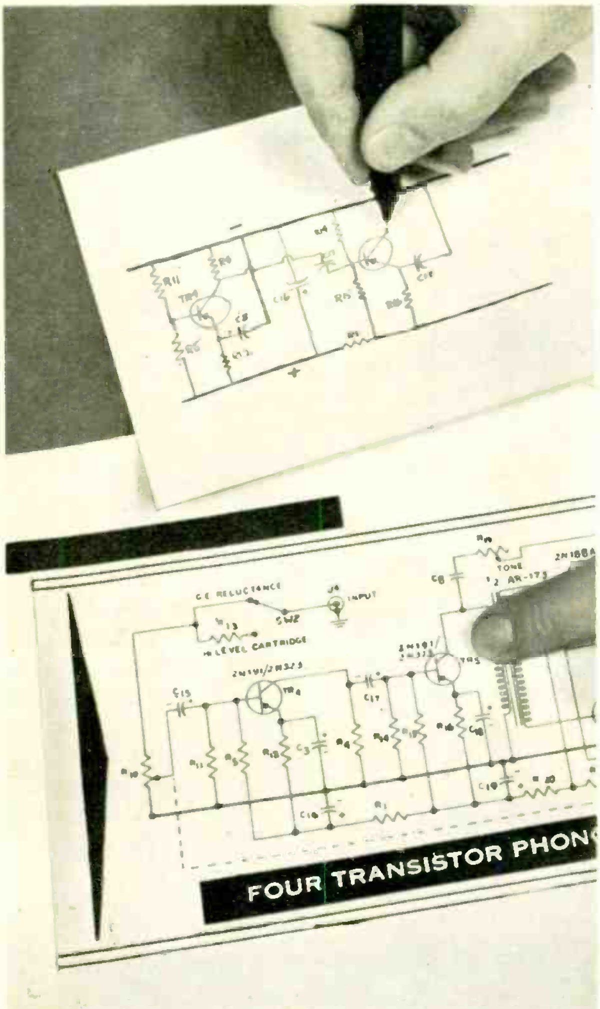
Since it is easier to do it right the first time it doesn't make sense to build a rat's nest instead of an electronics proj-

A few simple tools will suffice for cutting out even the most complicated shape chassis board.



Several types of small push-in terminal lugs are designed for use with perforated chassis boards.





It frequently pays to redraw a schematic to adapt it to the perforated board construction technique.

ect. First of all, have all components in front of you before you begin. The components themselves can serve as templates and you can experiment to determine most efficient placement and the locations for the lugs.

If working from a construction article, you can assume that the author tried several chassis arrangements before he selected the final layout. When working from a schematic diagram, it might be helpful to redraw the schematic (if it isn't already in that form), as is shown above. Otherwise, simply duplicate the diagram on the chassis board, placing the components in the same relative positions as they appear on the diagram. While some concessions must be made for bulky parts, this method usually works well.

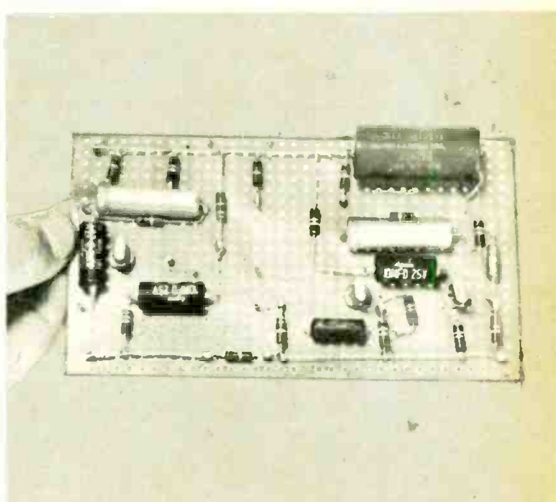
The actual wiring depends a great deal on the type of device being built. Amplifiers, for example, should have short, direct connections to eliminate stray pickup. High-voltage power supplies, on the other hand, demand wide spacing and careful isolation to avoid arcing and leakage.

Pay attention to the author's comments such as: "keep the input and output well separated" or "mount this component in an upright position."

Flea clips, as mentioned before, serve nicely as terminal points, and provide secure hitching posts for component leads. Use color-coded wire, making each separate circuit a different color. This makes it easier to keep track of the individual sections and cuts down on the chance of a wiring error.

This discussion can be summed up in two words: planning and neatness. Keep them in mind when working with perforated chassis boards and you will have at your disposal a versatile chassis system perfect for a multitude of applications. •

A completed project. All the components are accessible and their values can be read at a glance.



Commercial Killer

The luxury of sponsor-free radio can be yours for less than three bucks. Could be used for TV too!

By Virgil L. Parker

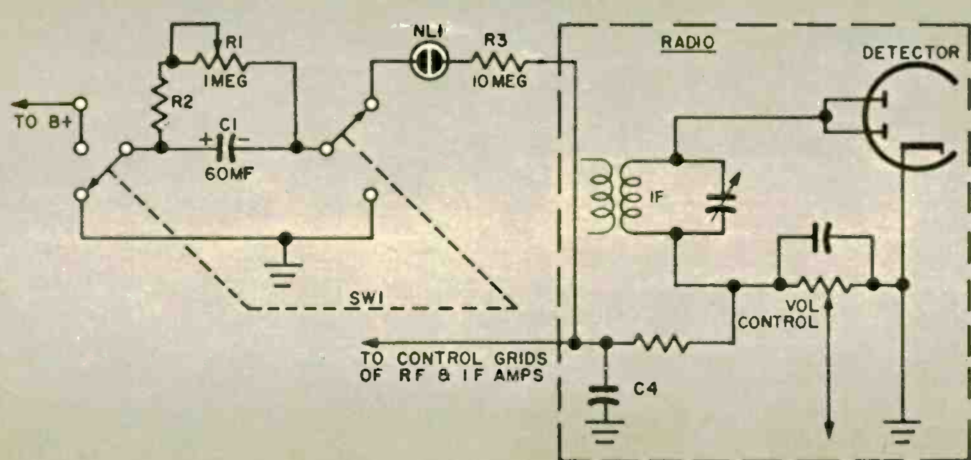
HERE'S good news for people who are plagued by radio commercials. This novel commercial killer was designed primarily for the car radio (though it can be used with any receiver) to eliminate frantic grabs at the volume or tuning knob when an advertiser gets overbearing.

By the push of a button the radio is silenced for a fixed length of time, at the end of which it comes back on automatically. A minimum of parts are required as use is made of the radio's AVC (automatic volume control) circuit as the suppression point.

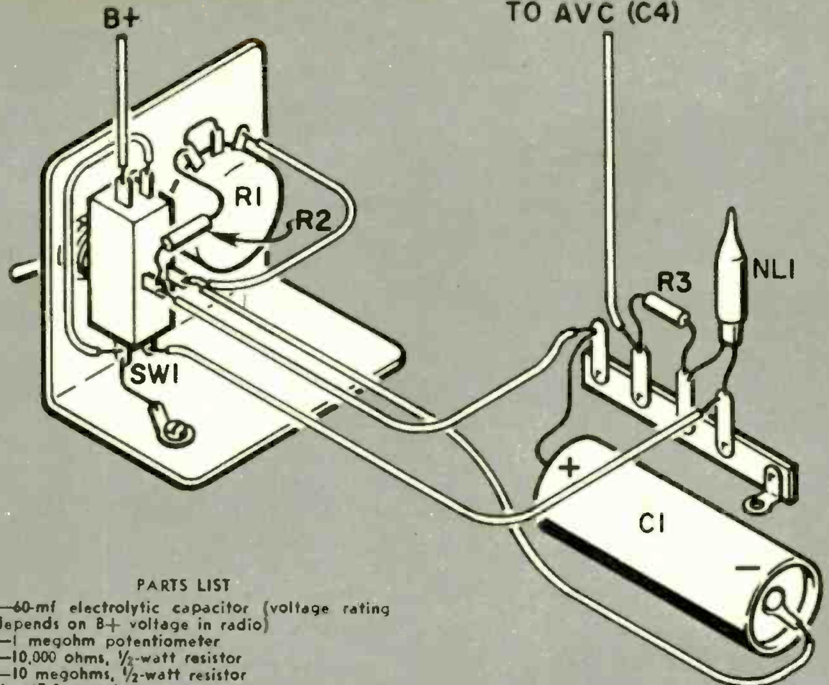
Theory

All radios have an AVC circuit which controls the negative bias on the RF and IF amplifiers. If this bias is made sufficiently

Killer output goes to the AVC line in radio. Refer to the volume control to locate C4. It's at other side of a 2 or 3 megohm resistor and is about .05 mf.



Parts arrangement for car-radio installation. For TV, the output could bias the audio stages.



PARTS LIST

C1—60-mf electrolytic capacitor (voltage rating depends on B+ voltage in radio)
R1—1 megohm potentiometer
R2—10,000 ohms, ½-watt resistor
R3—10 megohms, ½-watt resistor
NL1—NE-2 neon lamp
SW1—DPDT momentary push-button switch or spring-return toggle switch
Misc.—Solder lug terminal strip, knob mounting plate, hdwe., etc.

large, the tubes will be driven to cutoff and the receiver will be silenced. When SW1 (DPDT spring-return pushbutton switch) is depressed, C1 is charged to B+ potential. When SW1 is released, the positive terminal of C1 is grounded and the negative terminal is connected to the AVC line. Thus the application of a high negative voltage to the AVC line silences the radio.

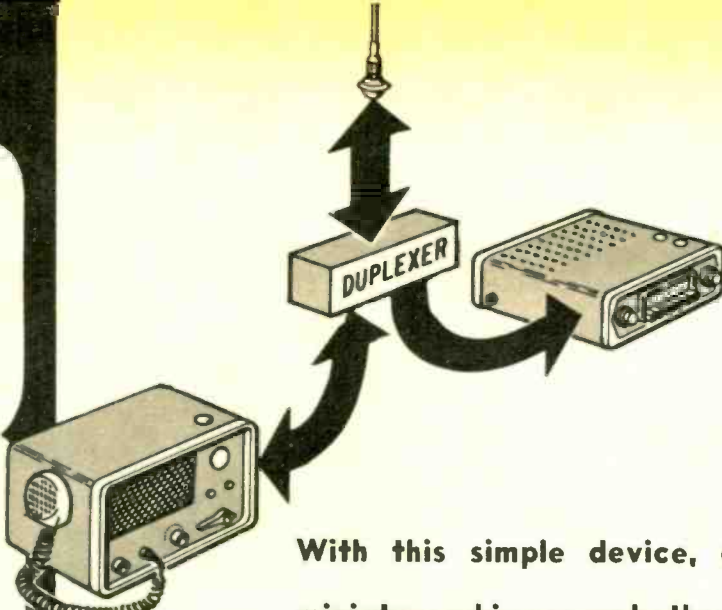
The parts listed worked well with a 200-volt B+ supply and permitted adjustment of the dead time from a few seconds to one minute. If longer time is desired, or if the Commercial Killer is to be used with AC-DC receivers with lower B+ voltage, R1 or R2 should be made larger to lengthen the discharge time of C1. R2, a current limiting resistor, prevents damage to R1 when R1 is adjusted to minimum resistance. Neon bulb NL1 acts as a switch to open the circuit abruptly when the voltage drops below its ionizing potential. This removes the high negative bias from the AVC line instantly and prevents distortion which would occur if the tubes were biased near cut-off. There are several points in the AVC circuit that the commercial killer could be tied to, however the high side of C4 (in a typical radio) was found to operate best. This capacitor is usually a .05 mf and can be located easily. For testing, SW1 should be held for five seconds to insure that C1 is fully charged.

Construction

Construction is simple. The terminal strip supporting the electrolytic capacitor, resistor and neon bulb can be mounted on the outside of a car radio. The time control potentiometer and switch can be installed on a mounting plate under the dash. In any other receiver the parts should be mounted in vacant space inside the cabinet.

The parts listed are those used by the author, however most values are not critical, can be found in the junk box. •

CB



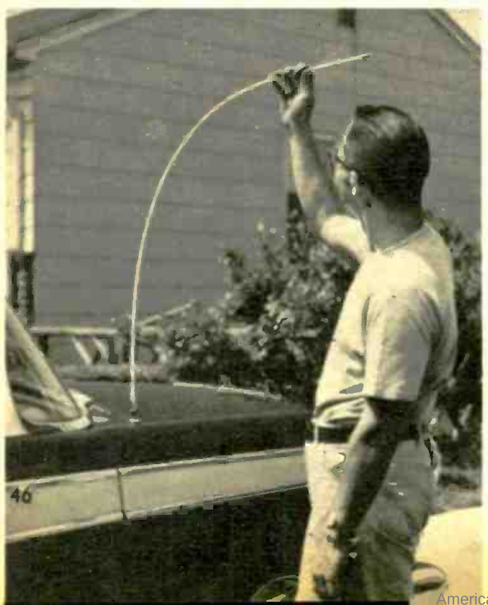
With this simple device, one miniature whip serves both your CB transceiver and car broadcast radio—without switching!

ANTENNA DUPLEXER

By Herb Friedman, 2W6045

THE CONTINUOUSLY loaded whip (we used Antenna Specialists M-52) is so short—5 feet less than a regular CB whip—that it can be cowl-mounted and actually replaces your existing auto antenna. Besides being a convenience at your home garage door, the loaded whip answers the needs of trucks, taxis, salesmen, servicemen and others who must go under many low overheads.

Fiberglass whip is no longer than standard auto radio antenna and serves both BC and CB sets.



Before installation is completed, the Duplexer is tuned with an SWR meter or with other technique.

Mounting the loaded whip is easy because you usually can use the hole left by your broadcast-radio antenna. No extra drilling is required. And this position on the cowl leaves the M-52's radiating area in the clear.

The connecting cable comes wired with connectors at both ends, so a wrench is the only tool usually required for mounting the antenna.

The Antenna Duplexer actually is an isolating network which prevents signals transmitted by the CB rig from entering the regular broadcast radio's circuitry and causing damage. As a matter of fact, with this setup you can transmit on the Citizens Band and simultaneously monitor Conelrad signals (or perhaps listen to rock 'n' roll) on your BC radio. Naturally, the whip and Duplexer are able to serve both receivers at once, and without signal loss or interaction.

Construction is simple and the total cost of the Duplexer should be about $4.

Coaxial antenna jack J1 mates with the PL-259 plug supplied with the M-52 antenna. Plug PL2 fits the antenna jack of your transceiver and PL1 plugs into the auto radio's antenna jack.

Each connecting cable from the Duplexer is made from RG-58A/U and should be about 24" long before trimming.

Choke L1 may not be available from all parts distributors. If necessary you can substitute the L1A/C1A combination for L1/C1 with equal results.

Adjustment is made with an insulated alignment tool. Close C1 fully, and then back off the screw three-quarters of a turn. (C1's correct setting will occur at about one-half turn.) Temporarily connect the M-52 antenna *directly* to the transceiver and tune the transmitter for maximum power output.

Several methods may now be used to tune the Duplexer; if you have a grid dip oscillator, the Duplexer can be adjusted before it is installed. Using a *short* length of bare wire, short out jack J1 to the nearest ground point. Also solder a short jumper between points X and Y in the pictorial. With the GDO set to 27.1 mc adjust C1 for resonance; remove the shorting wires and install the Duplexer in the antenna feedline.

The preferred method of tuning uses a standing wave ratio meter which permits you to peak the Duplexer for use on your favorite channel. Install the SWR meter between the CB transceiver and the Duplexer. Adjust C1 for minimum SWR. The SWR meter technique will insure a negligible power loss in the Duplexer.

Regardless of which method of adjustment you use, retune the transmitter after adjusting C1. Transmitter tune-up and adjustment of C1 should be performed at least three times to insure maximum efficiency.

Finally, plug PL1 into the auto radio's antenna jack. In all probability, the BC radio signal will be low. Tune in a weak station at about 1400 kc and peak the radio's antenna trimmer (this is always an external adjustment, usually near the antenna jack) for maximum signal.

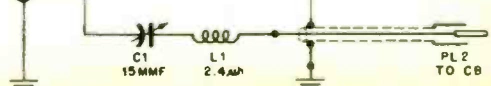
The Duplexer's Theory of operation is quite simple. The L1, C1 combination is series resonant at 27 mc and therefore presents a low-impedance path between antenna jack J1 and the CB transceiver via PL2. L2, on the other hand, appears as a high impedance to a 27 mc signal and prevents the signal from reaching the auto radio.

At broadcast frequencies, L2 appears as a low impedance and passes the BC signal into the radio. C1 appears as a high impedance to the BC signal, thereby preventing the transceiver input coil from short-circuiting the BC signal. •

PARTS LIST

C1—1.5-15 mmf trimmer capacitor
L1—2.4 microhenry RF choke (Miller 4528 or equiv.)
or
L1A—1.8 microhenry RF choke (Ohmite Z-144—see text)
C1A—2-30 mmf trimmer capacitor (see text)
L2—22 microhenry choke (National R25-22 or equiv.)
J1—SO-239 coaxial jack to fit ant. lead
PL1—Plug to fit auto radio
PL2—Plug to fit transceiver
Coaxial cable—4' of RG-58A/U
Cabinet—Aluminum, approx. 4"x2⅛"x1⅝"
Terminal strips and rubber grommets

Six components make up the total parts list of the Duplexer. PL2 matches the CB antenna jack.

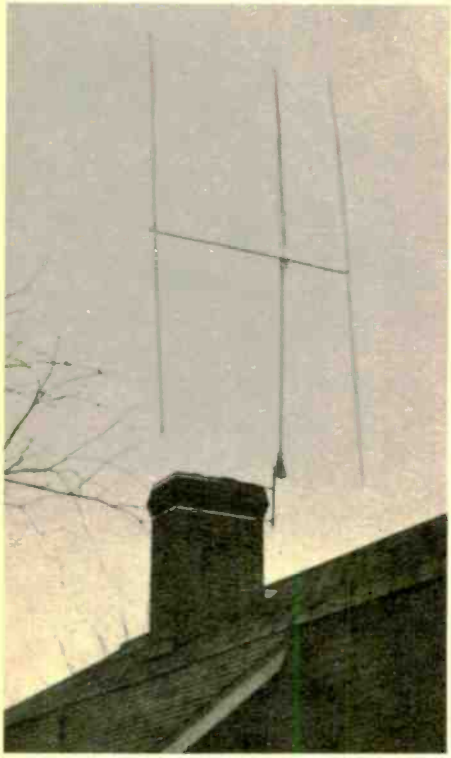


HOW TO BUILD

- **Directional Beam**
- **Ground Plane**
- **Coaxial**
- **Cubical Quad**

by Charles Tepfer, 2W4223

CB ANTENNAS



THERE ARE two basic approaches to Citizens Band base station antenna design. One aims at concentrating every watt possible in a narrow radiation pattern. The other is willing to sacrifice some gain in favor of omnidirectionality. But, no matter what your needs are, you can save a pile of dough and multiply your effective radiated power with one of the antennas described below. Once you have the materials, any of the four designs shown will take only a few evenings of work with hacksaw, drill and plane.

Since antennas really are tuned circuits, the size of their elements are relatively critical. These antenna designs use no element-shortening (and power-losing) loading coils, which makes them easier to build and more efficient. Strong-but-light stock aluminum tubing and rods are used wherever possible.

DIRECTIONAL BEAM

The most efficient base antenna you can build is a directional beam. There are many types but all are multi-element, with two or more sets of arms in the same plane. One element (the *driven* one) is the active transmitter and receiver. The others are parasitic and shape and direct the radiation pattern of the antenna into a beam. The more elements, the sharper the beam. Like a searchlight, beam antennas have high radiation (and pickup) in front and little to the sides and rear. Relative to the standard half-wave dipole, the gain of the beam is 3 to 5 db for the simpler jobs to 10 db or more for rigs with more than five elements.

This beam is a full-size, three-element unit. The *driven* element is a nine-foot half-wave coaxial radiator. The other elements are a *director* (16′ 10″), shorter than and in front of the driven element, and a longer (18′ 6″) *reflector* behind it. The elements are mounted vertically to produce vertically polarized signals, matching the polarization of mobile whips and base station antennas of the ground-plane and other non-directional types (most CB antennas fall in these categories).

The coaxial vertical radiating element is constructed first. The solid rod top portion (see Fig. 1, point A) is 9′ of 3/8″ Reynolds do-it-yourself aluminum listed by them as Item 3A. Since Item 3A comes in 8′ lengths, you must add 12″, plus 4″ for the part of the rod that projects into the nose plug—a total of 16″—to its length. Make a 4″ sleeve of 1/2″ thinwall aluminum tubing and slip this over the joint to hold the two sections together. Fasten it to both sections by drilling 3/32″ holes through rod and sleeve and inserting 3/4″ nails, flattening both ends. For a tight fit, wrap a couple of layers of aluminum foil

Author's directional beam before installation. Size may be judged by comparison with the windows.

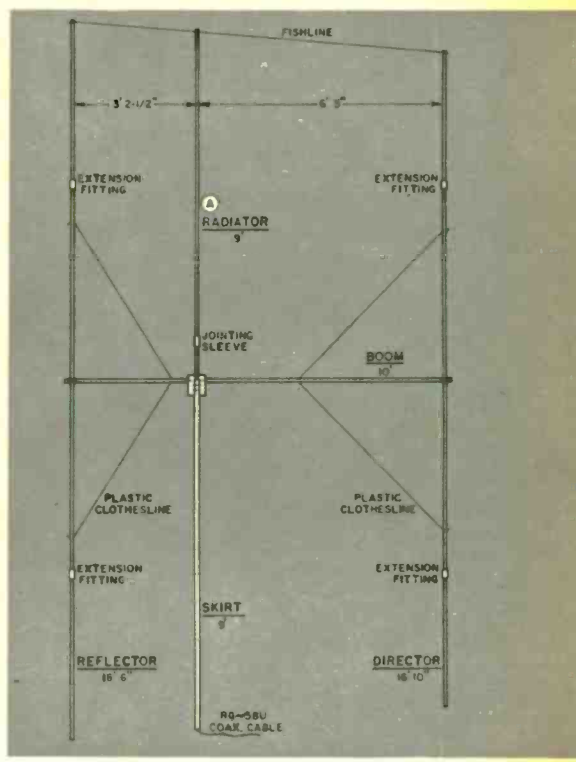


Fig. 1. Diagram showing length and spacing of beam's elements. See text and pictorial for details.

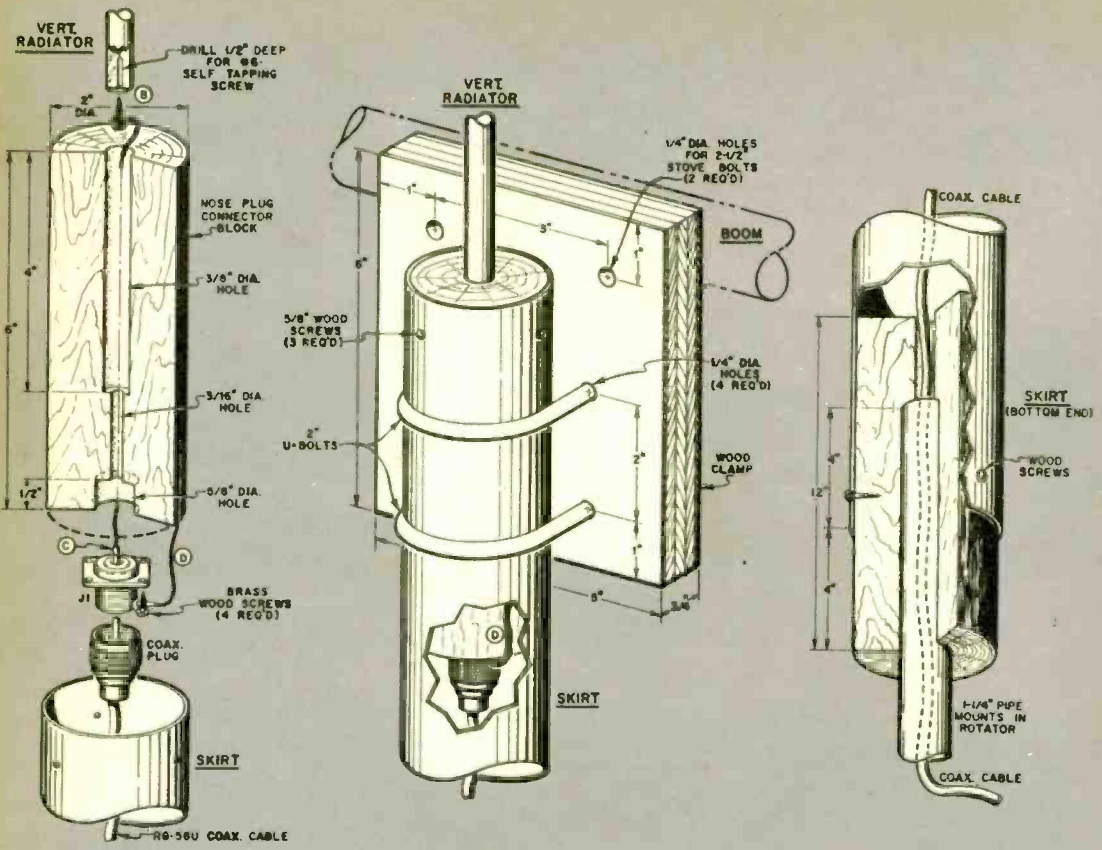
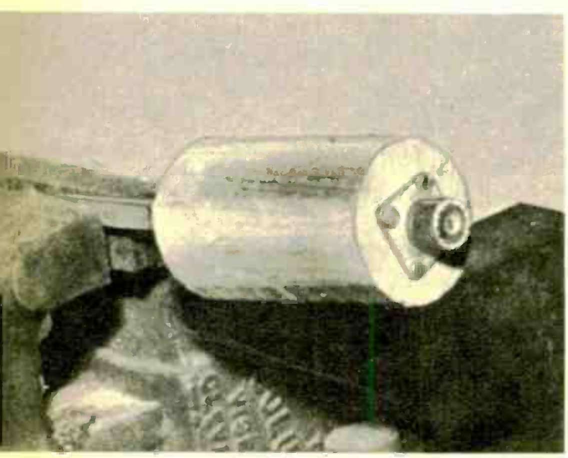


Fig. 2. Construction details of directional beam antenna showing the installation of the two skirt plugs.



Wooden plug to be installed in the top of the skirt. Note mounting of the coaxial connector.

around the rod ends before inserting them in the sleeve.

Using a 1/8" drill, make a half-inch deep hole (Fig. 2, point B) in the bottom end of the rod. A 1/2" #6 self-tapping sheetmetal screw is threaded into the hole. This screw will be used later.

The 2" inside-diameter EMT thinwall aluminum tubing for the skirt comes in 10' lengths, so a foot must be cut off. The top and bottom skirt plugs are trimmed from 4" x 4" scrap wood or other insulator that will make a snug fit. Follow Fig. 2 for drilling and dimensions, then give the plugs two coats of spar varnish for waterproofing. Connect a 7" length of stranded hookup wire to the screw previously placed in the bottom end of the radiator rod (Fig. 2-B). Thread this wire through the plug, slide the vertical radiator into the top end of the plug and use epoxy cement to hold it in place. Then cut the wire short and solder it to the center terminal (Fig. 2-C) of coax socket J1. Use small brass wood screws to mount J1 to the bottom of the plug, fitting it into the ⅝" well. Connect a 5½" length of bare stranded wire to one of J1's mounting screws (Fig. 2-D). Install the bottom skirt plug as shown in Fig. 2. Before installing the top (nose) plug and male coax connector, run the coax cable through the rotator mounting pipe, the just-installed bottom plug and the skirt. Then solder the connector on the cable and plug this connector into J1 and tighten it securely. Next, fit the top plug into the top of the skirt dressing the bare wire between the side of the plug and the wall of the tubing as in Fig. 2-D. Fasten the plug with three ⅝" wood screws through ⅛" holes drilled in the skirt as in Fig. 2. Use vinyl tape liberally around the top of the nose plug for waterproofing.

The *director* and *reflector* are made from 10' lengths of ½" EMT thinwall aluminum tubing. For the *director*, use extension fittings and add a 3' 5" piece of ½" tubing to each end of a 10' length. For the *reflector*, add a 4' 3" piece to each end of a 10' section.

The boom is a 10' length of 1¼" EMT tubing. Drill ¼" holes through ends of the boom to accept the U-bolt clamps for the *reflector, director* and the wood clamp plate for the driven element as shown.

Make the wood clamp plate of ¾" exterior grade plywood and drill the holes as in Fig. 2. Give the wood plate two coats of spar varnish for waterproofing. Mount the reflector and director on the same side of the boom as the driven element for best balance.

After the antenna is assembled, drill $\frac{3}{16}$" holes in the director and reflector and ¼" holes in the boom to accept the plastic clothesline struts. (Avoid changing antenna element spacing with these struts since it is critical.) Also drill ⅛" holes near the top of the *vertical* rod, the *reflector* and *director*, and thread 20-pound test monofilament nylon fishline through these holes (making a knot at each element) to reduce element vibration and changes in spacing. Use spaghetti tubing through the holes to keep the nylon line from chafing.

Standard TV antenna hardware with 2" U-bolts may be used for mounting. When buying the rotator, make sure to get one which can accommodate the 1¼" pipe. I used the standard Channel Master automatic TV rotator with built-in 2" U-bolts.

Attach the rotator to the mast first. Then mount a stub mast on your chimney, a tripod, etc. Use a good length (3 feet or so) of sturdy cast iron pipe for the mast and no guying will be needed. Remember that the highest point on the antenna must be not more than 20 feet above an existing structure. The antenna is 18 feet. Therefore, the mast can only go 2 feet above the chimney or whatever it is mounted on.

And there you have it—a high-gain vertical beam antenna guaranteed to give your signals the long reach you want.

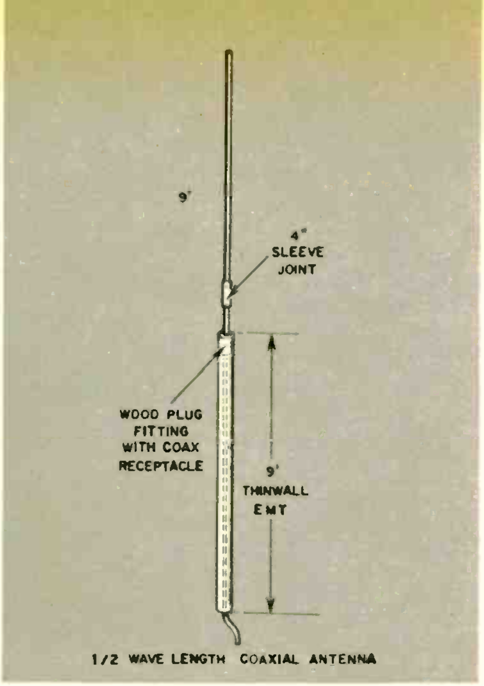
PARTS LIST: CB BEAM

10 feet—2" EMT Thinwall aluminum tubing
40 feet—½" EMT Thinwall aluminum tubing
10 feet—1¼" EMT Thinwall aluminum tubing
4—extension fittings for ½" EMT thinwall tubing
Available at any large electrical supply house
8 feet—⅜" solid aluminum rod (Reynolds "Do-it-yourself" aluminum Item 3A)
4 feet—⅜" solid aluminum rod (Reynolds "Do-it-yourself" aluminum Item 3)
1—coaxial cable socket receptacle (Amphenol 83-1R)
1—coaxial cable plug (Amphenol 83-1SP)
1—coaxial cable plug adapter for RG 58U (Amphenol 83-168)
Length of RG 58U cable from antenna to CB rig
1—set of heavy duty TV antenna chimney mounts (or other suitable mounting hardware)
2—1" U-bolt assemblies
2—2½" U-bolt assemblies (2" U-bolts may be used)
20 feet—plastic clothesline
20 feet—20 lb. test (or higher) monofilm nylon fishline
18 inches—iron pipe, 1¼" OD (for bottom plug of skirt)
Total cost of parts: about $20

THE COAXIAL

The half-wave coaxial antenna consists of a quarter-wave vertical element above and in line with another quarter-wave vertical tube which encloses the transmission line. The center conductor of the transmission line is connected, via a coax connector and socket, to the top rod; the shield of the transmission line is connected to the bottom tube (skirt). The latter prevents the transmission line from radiating, keeping the radiation of the antenna close to the earth for maximum effectiveness.

The construction of this antenna is the same as for the driven element of the 3-element beam except the bottom plug may be omitted. This is an omnidirectional antenna and requires no rotator for wide coverage.

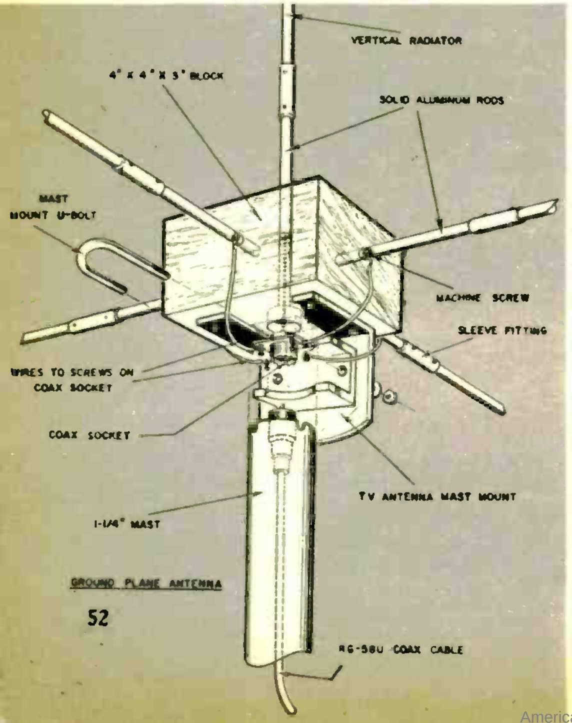


1/2 WAVE LENGTH COAXIAL ANTENNA

THE GROUND PLANE

This popular omnidirectional antenna requires comparatively little room. The four horizontal equal-length rods furnish an immediate ground for the vertical radiator and keep the radiation pattern close to the ground.

The wood block which serves as the base for the elements is a short length of 4 x 4-inch stock. Drill 3/8" holes, 1½" deep on the top and four sides, to hold the driven element and radials; drill a 5/8" well on the bottom for the coax socket. Drill a 3/16" tunnel between the well and the hole on the top for the wire from the vertical radiator to the inside terminal of the coax socket.



GROUND PLANE ANTENNA

Use a right-angle mast mount that has the central portion cut out (one is available for 34¢ from Allied Radio, type 8800-U). Fit the coax socket through this cutout onto the well on the bottom of the block and fasten with wood screws. Connect an insulated wire from each radial to the screws holding the socket to the block. Notch the top of the skirt as shown to allow these wires to pass through.

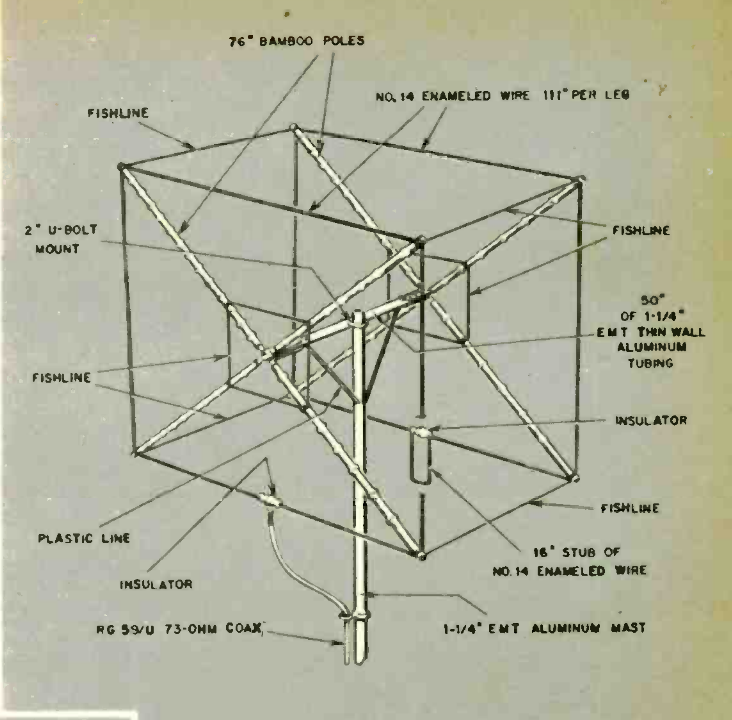
The vertical radiator and horizontal radials are made from 3/8" solid aluminum rod 9′ long. Since such rod normally is supplied in 8′ sections, sleeve fittings will be required to lengthen the rods. Fit them as described in the Directional Beam construction.

In building any of these antennas, closely follow the dimensions given. Do *not* use metal parts where the plans specify use of wood or other insulator. Use spar varnish on all wood and spray all exposed connections and terminals with acrylic protective spray.

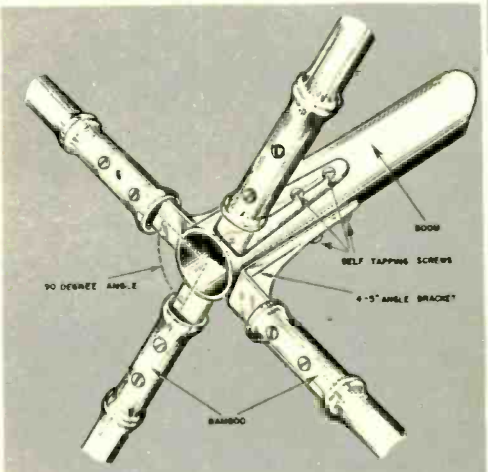
THE CUBICAL QUAD

This unusual-looking antenna acts like a full-wave two-element directional beam with the front loop as the driven element and the rear loop as the reflector. The optimum spacing between the front and the rear loops for highest gain is about 80 inches on the 11-meter band, but 50 inches is a reasonable compromise giving a gain of about 5 db.

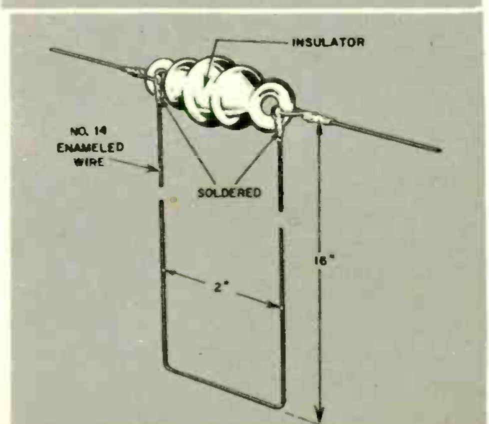
The C-Q requires a rotator to work mobile rigs, but its beam is not as sharp as the first antenna described. Since part of each element is vertical and part horizontal, the C-Q is polarized horizontally *and* vertically.



QUAD ANTENNA FOR CB



DETAIL OF JUNCTION OF BAMBOO POLES AND BOOM



DETAIL OF STUB

Bamboo poles are used to support the loops because the wires must be insulated from the boom and mast, and bamboo is both light and strong. Ordinary fishing poles (without splits) will do, but they must be of equal length. Use a 20-pound test fishline to keep the arms from vibrating and changing the loop spacing.

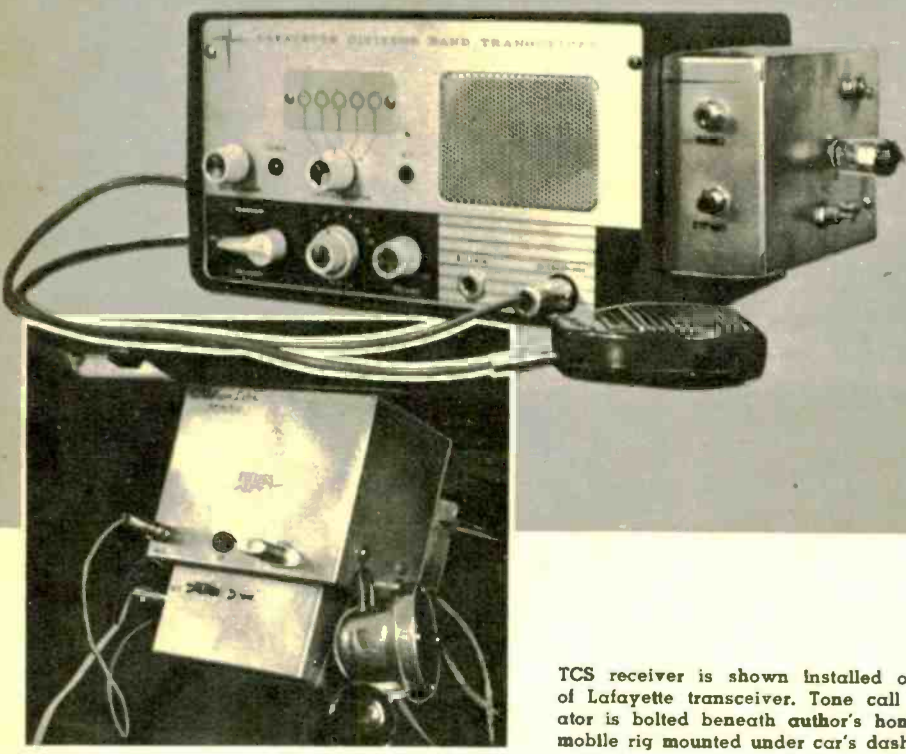
Use 1¼" EMT thinwall aluminum tubing for the mast and boom. Standard 5" angle brackets (with bolts through the rod and brackets) hold each bamboo rod to the boom. Each rod must be 90 degrees from the adjacent rods. If the bracket will not fit into the end of the bamboo rod, bolt it to the outside of the rod. In either case, wrap picture wire around both the rod and bracket for extra strength. Spray the wire with a rust arrester.

Each vertical and horizontal section of the loop must be equal in length, so don't pull the poles together while wiring the antenna.

The "stub" is used to tune the reflector to 27 mc. About 75 feet of No. 14 enameled or Formvar wire will be needed for the loops. •

CB'ers! Build this

TONE CALL/SQUELCH



TCS receiver is shown installed on side of Lafayette transceiver. Tone call generator is bolted beneath author's home-built mobile rig mounted under car's dashboard.

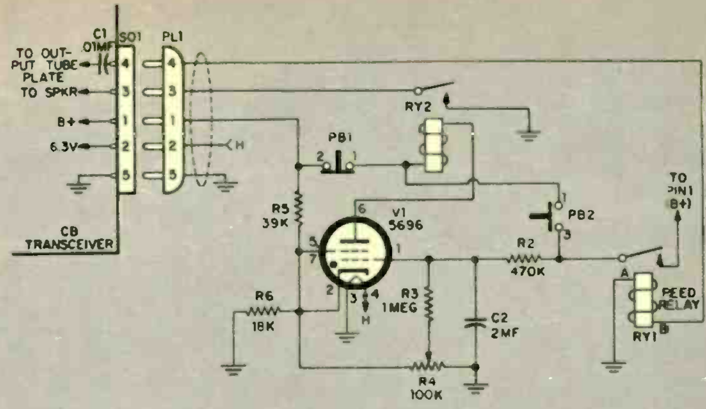
By Morris Goodman, 2W1855

MOST CITIZENS Band squelch circuits don't really do what you would like them to. Sure, you can adjust the squelch to kill background hash, but your rig still faithfully delivers every call coming through on your channel. And nothing can be more annoying than to have to listen to the chatter cluttering up the channels when all you want is one short message from your man in the field.

This Tone Call Squelch adaptor solves the above problem simply and inexpensively. With our TCS there's absolute silence when your CB unit is switched to standby: another station switches on your set only when its operator wants to call you specifically. And you don't have to mutilate your equipment since the TCS's two units are built on separate chassis and mounted externally.

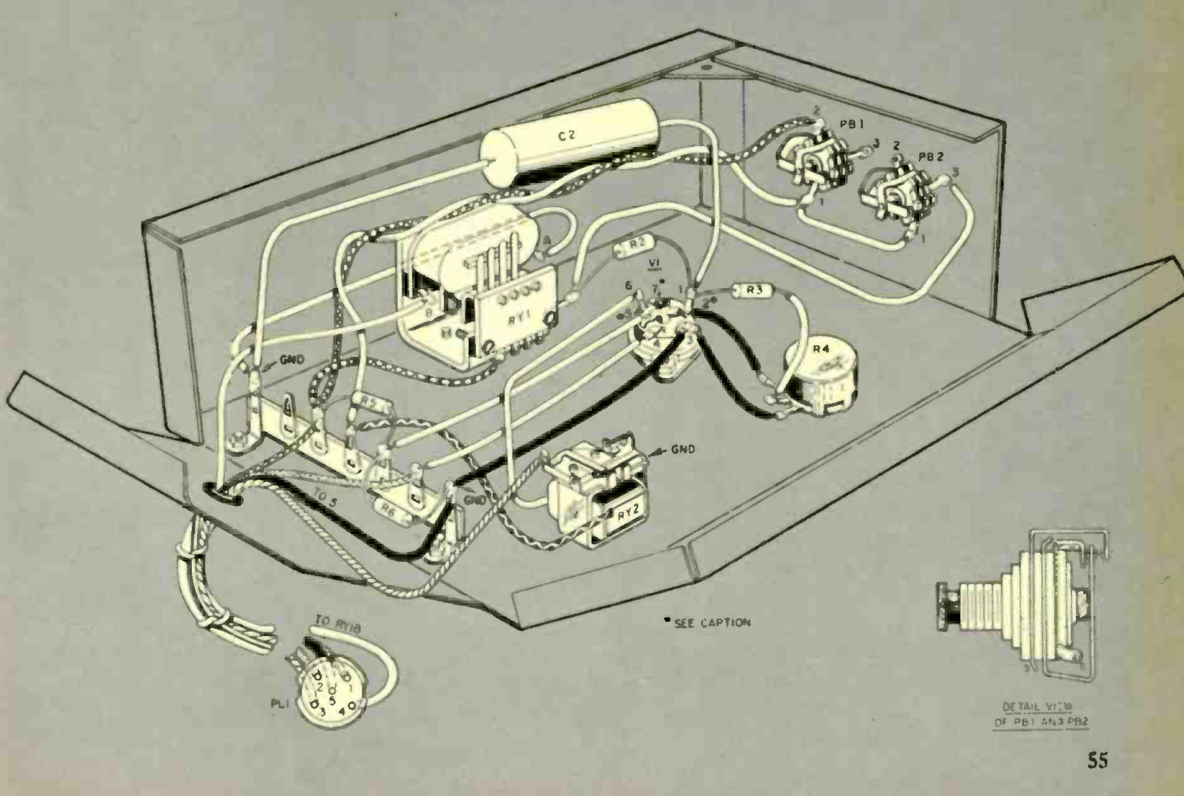
With the TCS system the base-station receiver is left in the *receive* position with the noise limiter and squelch controls set normally with one exception. One speaker lead is opened and its circuit is completed through a relay in the TCS unit. When the remote station wants to call you he presses (for about five seconds) a button on his TCS call unit. This transmits a tone at a specific

FIG. 1
Schematic of TSC receiver is shown at right. In pictorial of unit below, V1's socket pins 2, 5, and 7 are soldered to socket's center post, but not grounded. RY1 is insulated from the chassis with fiber washers. Detailed view of PB1 and PB2 is drawn to show electrical action rather than the mechanical relation of the contacts. PL1 and SO1 are numbered in the schematics and pictorials as per the manufacturer's numbers stamped on the units.



RECEIVER PARTS LIST

Resistors: ½ watt, 10% unless otherwise specified
R1—47 ohms, 20% (see CB output stage schematic)
R2—470,000 ohms
R3—1 megohm
R4—100,000 ohm potentiometer, linear taper (firing time adjustment)
R5—39,000 ohms
R6—18,000 ohms
R —33,000 ohms or value needed for 135 v. at SO1, pin 1
C1—.01 mf, 400 volts capacitor (see CB output stage schematic)
C2—2 mf, 200 volt paper or oil capacitor
PB1—SPDT push button (connected as normally-closed SPST)
PB2—SPDT push button (connected as normally-open SPST)
RY1—Resonant reed relay. Any frequency in the 200 to 425 cycle range. Available from Gyro Electronics Co., 36 Walker St., New York 13, N. Y. for $8.95 postpaid. Gyro will supply a TCS kit for $24.95 postpaid less battery and mic. plugs
RY2—SPST or SPDT relay, 8,000 to 10,000 ohm coil
V1—5696 or 2D21 thyratron tube
SO1, PL1—5-pin miniature plug and socket
Misc.—7-pin miniature socket, 2"x4"x6" aluminum chassis, rubber grommets, screws, wire



frequency which closes your TCS speaker circuit relay. Once the speaker is activated it is not necessary to transmit the tone again during subsequent transmissions because the circuit is self-locking.

Then you operate your station normally, with the noise limiter and the squelch circuits working as before. After you have cleared your message, you simply press reset button PB1 and the TCS is on standby again. To call from your station, you press bypass button PB2, which closes speaker relay RY2, and then proceed as usual.

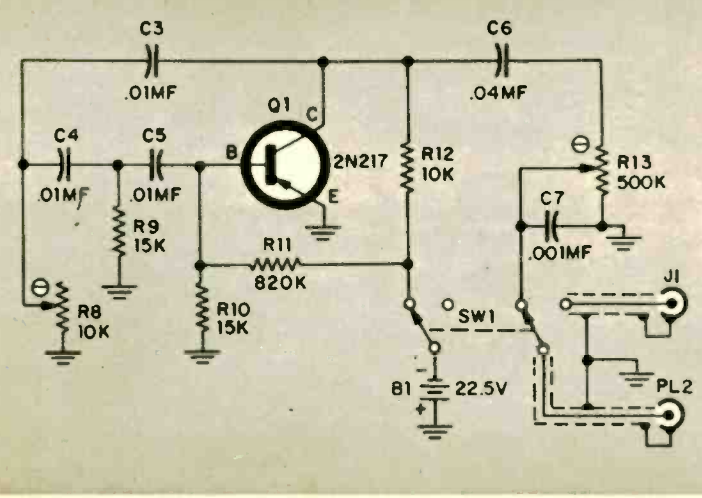
The heart of the TCS system is a tone-selective device called a resonant reed relay. This relay uses a thin steel reed as an audio-frequency-sensitive armature which responds to only one frequency: its resonant frequency. A frequency as little as ten cycles away from resonance will not operate the reed.

Receiver operation can be understood by referring to Fig. 1. When the unit is set for *standby,* thyratron tube V1 is held non-conducting by the negative voltage (with respect to the cathode) on grid 1. Relay RY2 in V1's plate circuit, therefore, is open and the speaker disconnected. When the actuating tone is transmitted by a calling station it is picked up by the receiver and is passed on to RY1 by C1 connected to the plate of the CB unit's output tube. The tone voltage causes the reed of RY1 to vibrate, which connects a positive voltage to the grid of V1. When the negative cut-off voltage is overcome, RY2 closes and completes the speaker circuit. Since V1 remains conductive even though its grid goes negative again, RY2 remains closed. To reset RY2, V1's plate voltage is momentarily interrupted by depressing PB1.

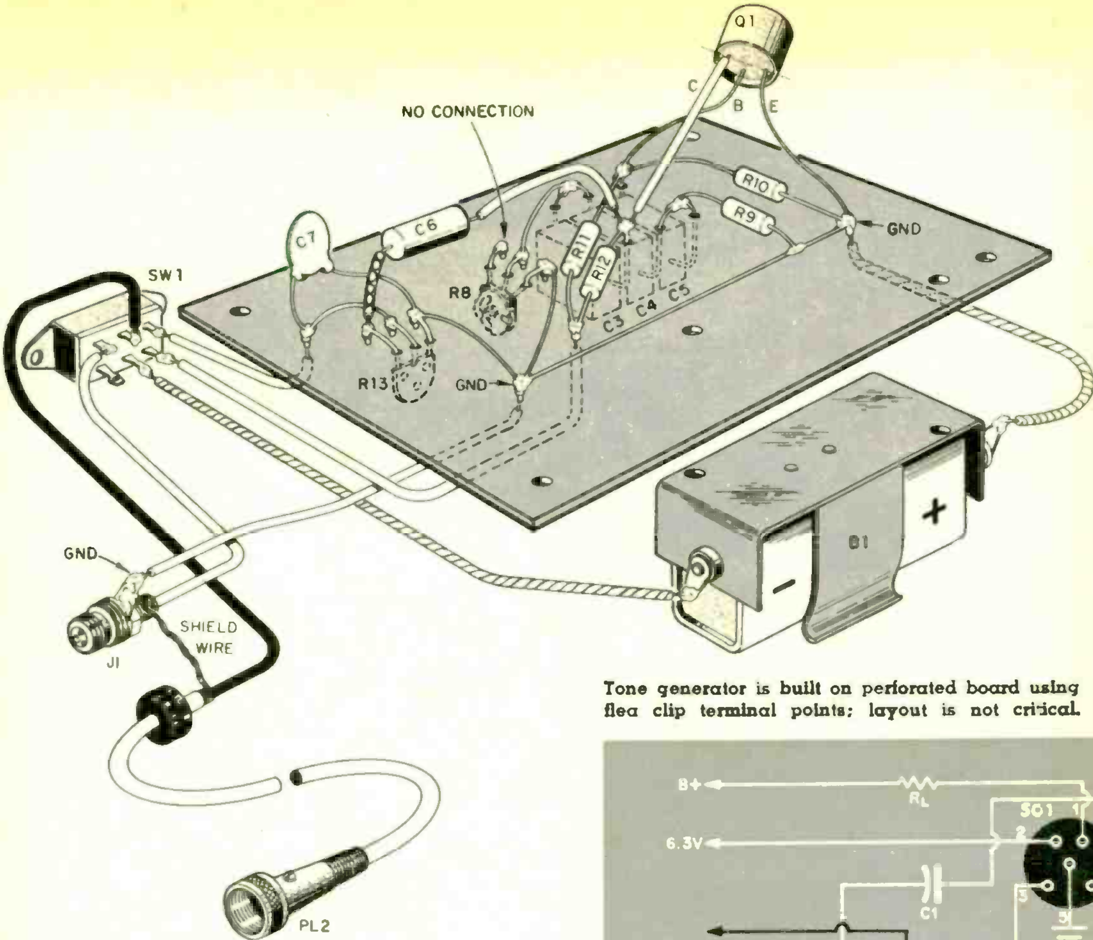
When the base station wants to initiate a call, PB2 is depressed. This momentarily connects a positive voltage to the thyratron grid and turns on the speaker. Because the reed responds intermittently to speech frequencies, a long time constant (C2, R2) is added

TONE GENERATOR PARTS LIST

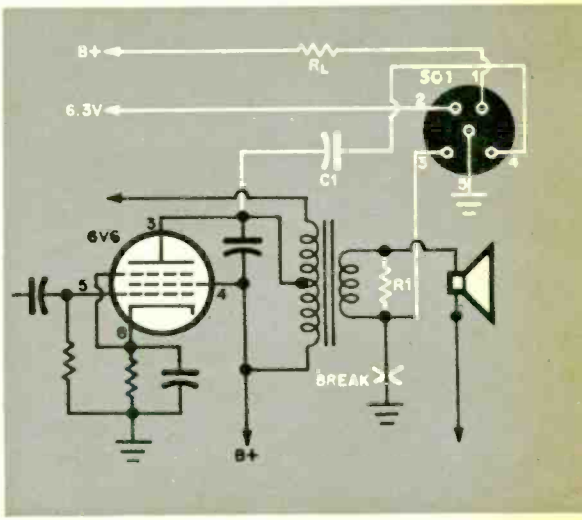
Resistors: ½ watt, 10%
R8—10,000 or 20,000 ohm linear calibration type or miniature potentiometer (tone adjustment)
R9,R10—15,000 ohms
R11—820,000 ohms
R12—10,000 ohms
R13—500,000 ohm calibration type or miniature potentiometer (output level adjustment)
Capacitors: 50 volts or above
C3,C4,C5—.01 mf mica* capacitor
C6—.04 mf paper or disc
C7—.001 mf paper or disc
Q1—2N217 transistor or equivalent
SW1—DPDT slide switch
PL2—Plug to match mike jack on transceiver
J1—Jack to match microphone plug
B1—22.5 volt battery (Burgess U-15 or equiv.) and holder
3"x5" perforated chassis board
Aluminum box to house subassembly
*May be necessary to change these values to reach the resonant frequency of RY1. Increasing the value of the capacitors will lower the frequency of the tone output and vice versa. The values given produce a frequency of about 375 cycles.



Schematic of transistor tone generator shows simplicity of the design. Phase-shift oscillator provides a stable sine-wave tone signal.



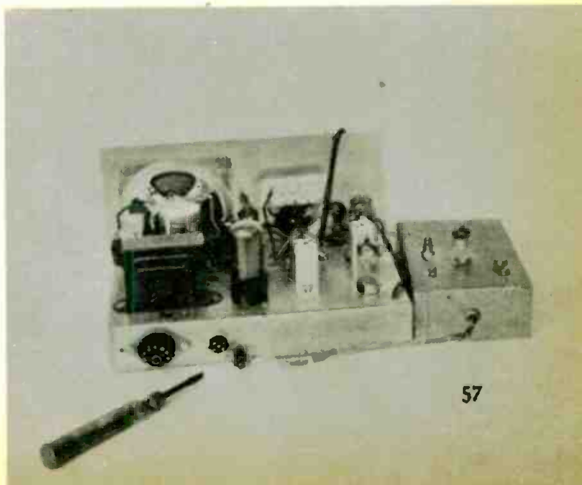
Tone generator is built on perforated board using flea clip terminal points; layout is not critical.



Wiring added to CB output stage is in white. Resistor R_L is selected to provide about 135 volts B+.

to the thyratron grid circuit. This prevents the short speech bursts from overcoming the negative cut-off voltage and makes it necessary for the tone to be transmitted about five seconds before the TCS operates. This time requirement can be adjusted by potentiometer R4, which varies the negative voltage on the grid of V1. The less the voltage difference between the grid and the cathode, the shorter the time required to activate the TCS.

Construction is quite simple. RY1 is



Five-prong socket SO1 is shown installed on the rear apron of a Lafayette Model-15 CB transceiver.

insulated from the chassis with rubber grommets because the reed contacts are electrically connected to the relay frame. With the speaker disconnected during standby, the output transformer primary of the CB receiver can develop voltage high enough to arc over, so a 47-ohm resistor (R1) is connected across its secondary to prevent this.

The TCS chassis is secured to the base station receiver cabinet with sheet metal screws and is mounted so that its controls are accessible.

The tone generator that supplies the triggering signal for the reed relay must be stable. And because it is self-contained, the tone generator can be incorporated in any CB unit simply by fitting its output cable with a plug to match the mike jack on your transceiver and plugging your mike into the tone generator's input. Mica capacitors are recommended for the circuit because of their better thermal stability. The DPDT *microphone/tone* switch (SW1), when in the *tone* position, turns on the tone generator and connects it to the transmitter microphone input. In the *microphone* position, SW1 turns off the generator and reconnects the microphone to the transmitter. Since the tone generator is used intermittently, its battery should last for its shelf life.

In order to avoid the tone overmodulating the transmitter, the 500,000-ohm pot (R13) adjusts the output voltage of the tone signal to the same relative value as that of the microphone. There is sufficient signal available from the generator to drive a carbon microphone input circuit also. The tone signal is a fairly pure sine wave, free from sideband splatter.

Another potentiometer, R8, adjusts the tone frequency to the resonant frequency of reed relay RY1. These controls are mounted inside the box because, once set, no further adjustment should be required. Several inexpensive PNP transistors were tried as Q1 in the generator and all gave good results.

The tone generator is installed beneath the mobile transmitter (the author's home-built rig is shown in the photos) so that switch SW1 is easily accessible. A short length of shielded audio cable is run to the original microphone input plug and a duplicate microphone receptacle is mounted in the tone-generator box and the microphone is connected to it. If your transmitter is a type with the microphone cable wired in, it's a good idea to install jacks and plugs.

Aligning the TCS:

• Connect the squelch unit to the receiver and turn it on. Depress *reset* button PB1. RY2 should open, silencing the receiver. Check the voltages at V1. With the tube non-conducting (RY2 open), the plate voltage (pin 6) should be somewhere near +135 volts. The grid voltage (pin 1) should be adjustable (with R4) from 0-30 volts positive (as measured from grid to ground with a VTVM).

• If RY2 does not remain open, increase the negative voltage on the grid of V1 (as measured to the cathode, pin 2) with control R4 until it does.

• Depress *bypass* button PB2 and RY2 will close, turning on the speaker. Turn up the volume of the receiver about three-quarters and tune in some strong signals. While these noises and signals are coming in, depress *reset* PB1 and the speaker should cut out. Now see whether the strong signals cause V1 to fire. If they do, increase the cut-off voltage with R4 as above.

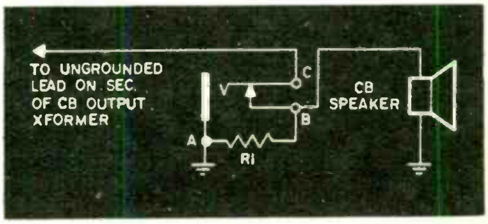
• Have your partner set up the remote unit within sight and transmit a tone signal to you. Have him adjust the frequency pot (R8) in the tone unit until the resonant frequency of RY1 is found. This is indicated by the widest swing of the reed. R4 usually will not need resetting after these adjustments are made. A tone signal of about five seconds duration for firing the TCS has been found to give the most satisfactory results.

• With the remote station at a distance, have him adjust the tone input level potentiometer R13 so that the transmitted signal does not overmodulate the transmitter.

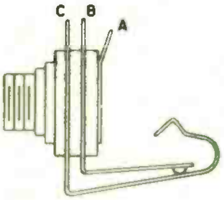
Be sure to leave the volume of the receiver turned up reasonably high during standby, since the audio amplifier of the receiver supplies the signal to the reed relay. Those of you who question the legality of the system are referred to 19.32 of "Rules and Regulations." •

AN EARPHONE
for your transceiver

UNLIKE communications receivers, most CB transceivers do not have an earphone jack. This is regrettable considering the QRM on the band. Think of the convenience of being able to monitor CB without disturbing family or friends and being able to read a signal over the background noise in your immediate environment. High quality miniature earphones are available from a number of distributors and some even include a miniature matching jack. The jack is so small that you will have no trouble finding an open area close to the speaker on your rig's panel in which to mount it. If connected as shown in the diagram, plugging in the earphone will automatically disconnect the speaker.

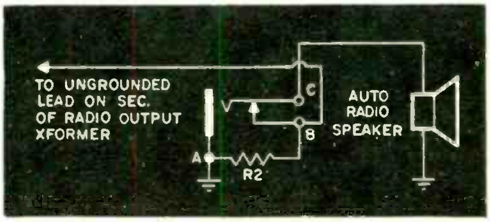


You can use any impedance earphone (8 ohms to 100,000 ohms), but with an earphone other than the 8-ohm type it's a good idea to install a 47-ohm, 1-watt resistor (R1) as shown to prevent damage to the unloaded output transformer.



The volume heard in the earphone will be controlled by the transceiver's gain control. However, because of the efficiency of these earphones you will need a lot less gain when substituting for the speaker. Never have the gain turned up high when plugging in the earphone as you may damage the earphone—or your ear. •

CB Thru Your Car Speaker



WITH THE same jack installation shown above on your CB rig and the hook-up at left added to your auto radio speaker you can feed the output of your CB transceiver directly into your car radio's speaker. Simply connect the two jacks by a jumper wire with a standard miniature phone plug on both ends. The wires need not be shielded and may be of any convenient length. The greater fidelity and sensitivity of your auto radio speaker will be of decided advantage in helping those hard-to-hear mobile messages get through. Normal operation of the auto radio is restored when the plug is removed.

Both the adaptions shown assume that one side of the speaker voice coil of your auto radio and transceiver is grounded. The jacks themselves have their A terminals grounded because they are mounted to the panels without insulating washers.

The car radio need not be switched on when you're using its speaker for the CB transceiver. Since the output transformer of the auto radio will be unloaded if set is accidentally switched on, R2 (about 47-ohms) will prevent damage. •

for CB'ers and Hams

A SAFE MOBILE MIKE

For messages on the move and safety, too . . . build this under-$5 boom microphone.

By F. David Herman

IF you have to transmit while traveling, this boom microphone adds some safety to a not-so-good procedure.

First of all, you drive with both hands on the wheel. The microphone remains a fixed distance from your mouth, regardless of which way you look, and you have a special push-to-talk switchbox at your fingertips. With the specified switch, the transmitter can be either locked in the ON position or a spring return can be used for a quick break.

Construction. The microphone boom assembly is built of scrounged components: a ladies headband hair clip, a couple of pieces of scrap plastic, nine inches of 3/16" copper tubing and a hard plastic screw-on bottle cap.

A half-inch from one end of the hair clip drill a 6-32 hole (#28 drill). Drill another 6-32 hole through the two plastic pieces as shown. Clamp the two pieces together and drill a 3/16" hole angled through the pair for the copper tubing. The block serves as a swivel to permit adjustment of the microphone position.

About 6½" from one end, bend the copper tubing in an arc. Make certain you do not crimp the tubing because the microphone cable must be able to pass through it.

If you have one of the modern, small, ceramic microphones, you can remove the element for use in the boom. Or you can purchase a small replacement element.

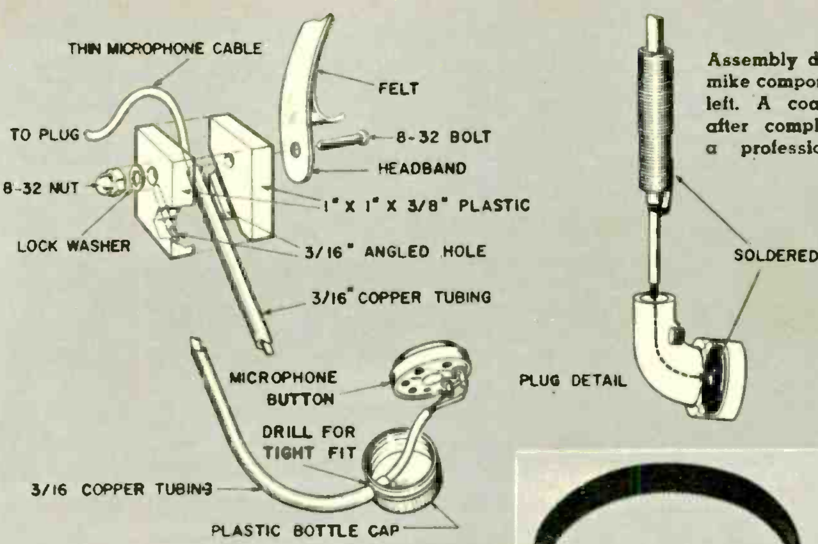
Drill a 3/16-inch hole in the side of the bottle cap which serves as a base for the microphone element. Drill slowly to avoid shattering the cap. The parts are then fitted together with epoxy cement.

Attach the boom to the headband with a 6-32 screw, lockwasher and either an acorn or thumbnut.

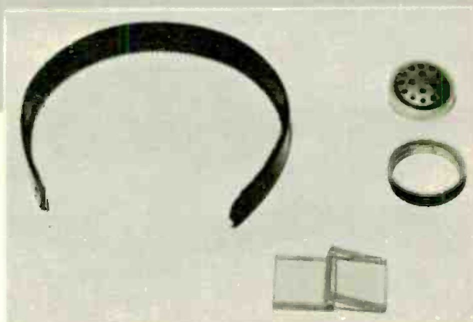
Pass an eight-foot length of extra thin microphone cable through the tubing

PARTS LIST

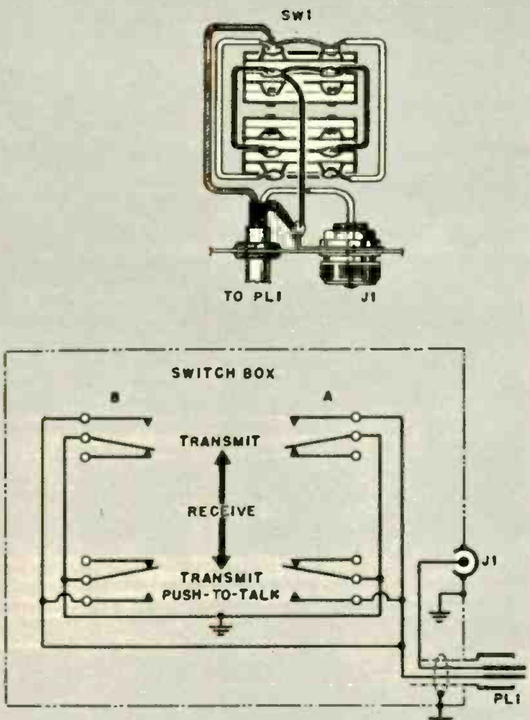
SW1—Switch, 4PDT three-position spring-return (Lafayette SW-68)
PL1—Plug to match transmitter input jack
PL2—Microphone connector (Amphenol 75MC1FA)
J1—Jack to fit PL2 (Amphenol 75PC1M)
Minibox, 3¼"x2⅛"x1⅝"
8 feet thin microphone cable (Alpha type 1702, 0.125 OD)
Microphone Cartridge available from Custom Electronics, 2929 Fulton St., Bklyn, N. Y., $3.50 postpaid
Misc. hardware—See text and pictorials



Assembly details of the boom mike components are shown at left. A coat of spray paint after completion gives mike a professional appearance.



Raw material of the boom assembly includes a woman's hair clip, a couple of pieces of plastic, a microphone cartridge and a plastic bottle cap.

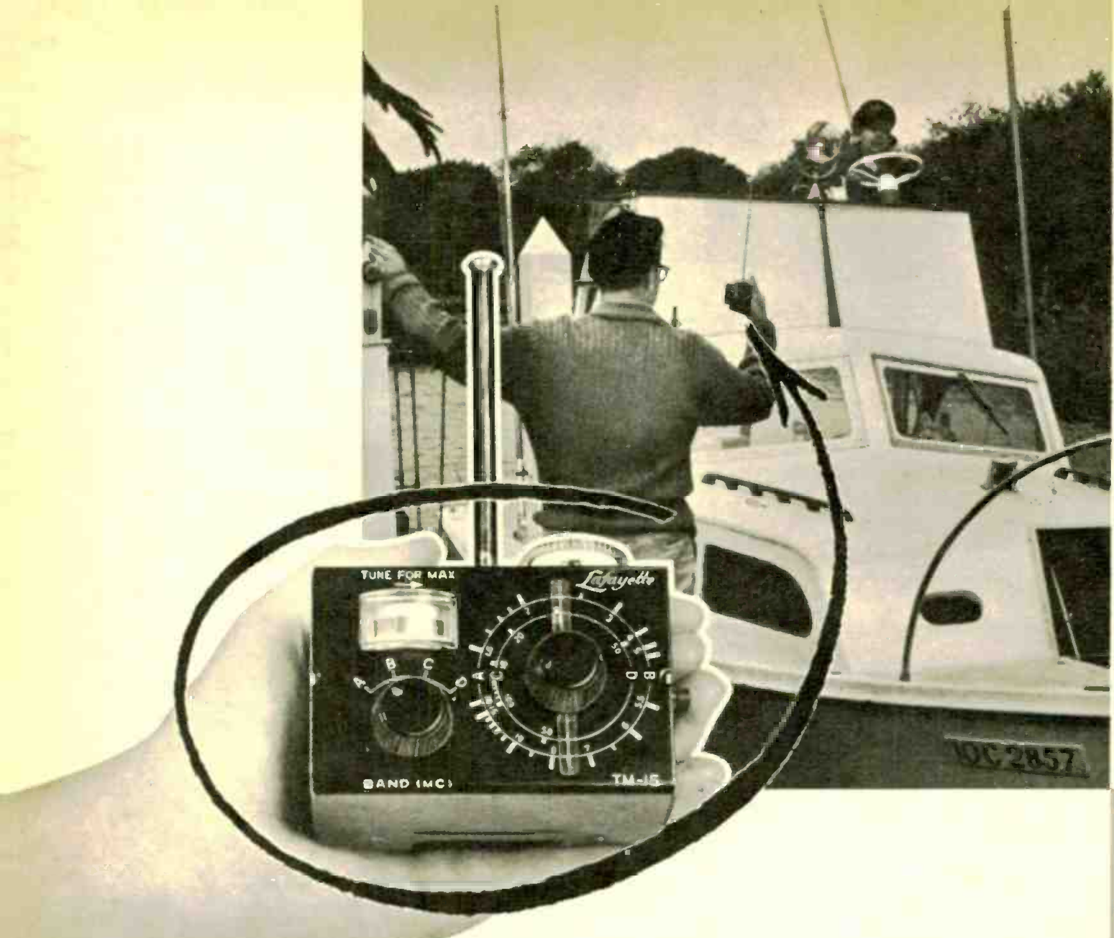


Wiring of S1 as viewed from rear. Section B of switch may be used for other circuits.

and cap. The microphone element is set in the cap with plastic cement. Connect microphone connector PL2 to the free end of the cable and the boom is completed. For greater comfort, the headband can be lined with a strip of felt.

The Switchbox. Push-to-talk switch SW1 mounts in a Minibox which has a large rubber suction cup (available from auto supply stores) attached to its cover. For the usual three-wire control circuits, wire SW1 as shown. For four-wire or special control circuits, section B (shown in parallel with section A) can be used separately.

Operation. Put on the boom and adjust the headband to a comfortable position. Adjust the swivel so the microphone is about one inch under your lips and tighten the swivel nut. With the microphone in this position you talk across it, avoiding sharp pops and hisses. It is also out of the line of vision. •



transistorized

Field Strength Meter

For checking the output of your amateur or CB transmitter

By Harvey Pollack

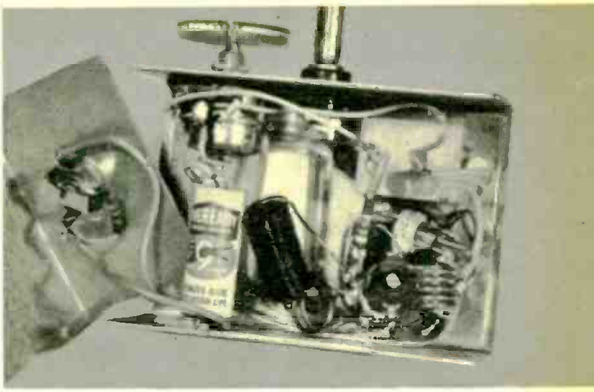
BY ADDING an inexpensive transistor and a few other components, you can soup-up the Lafayette TM-15 FS meter to a super-sensitive instrument capable of reading frequency and field strengths at great distances from the transmitting antenna of your ham rig, CB transmitter, or remote-control antenna.

Meter indication is proportional to the signal strength of the RF field and the calibrated tuning scale indicates the signal frequency within ±10%.

A transistor amplifier connected in a bridge configuration permits adjusting for zero-signal leakage current of the transistor. To avoid overloading the meter during bridge balance adjustment, miniature pushbutton PB1 puts a 5000-ohm resistor (R3) in series with the meter. When released, the button cuts out R3 providing maximum meter sensitivity. The finished instrument is so sensitive that it gave a 10% scale indication on a 3-watt mobile Citizen's Band transceiver located about 1½ city blocks away! (An unmodified TM-15 had to be brought about 10 feet from the transmitting antenna before any deflection was observed.) This high sensitivity is quite an advantage, for if reliable tuning of beam antennas is to be realized, a meter must be at least 20 beam elements away—further if possible. In fact, *any* kind of antenna adjustment should be made with the indicator as far away as space and sensitivity permit.

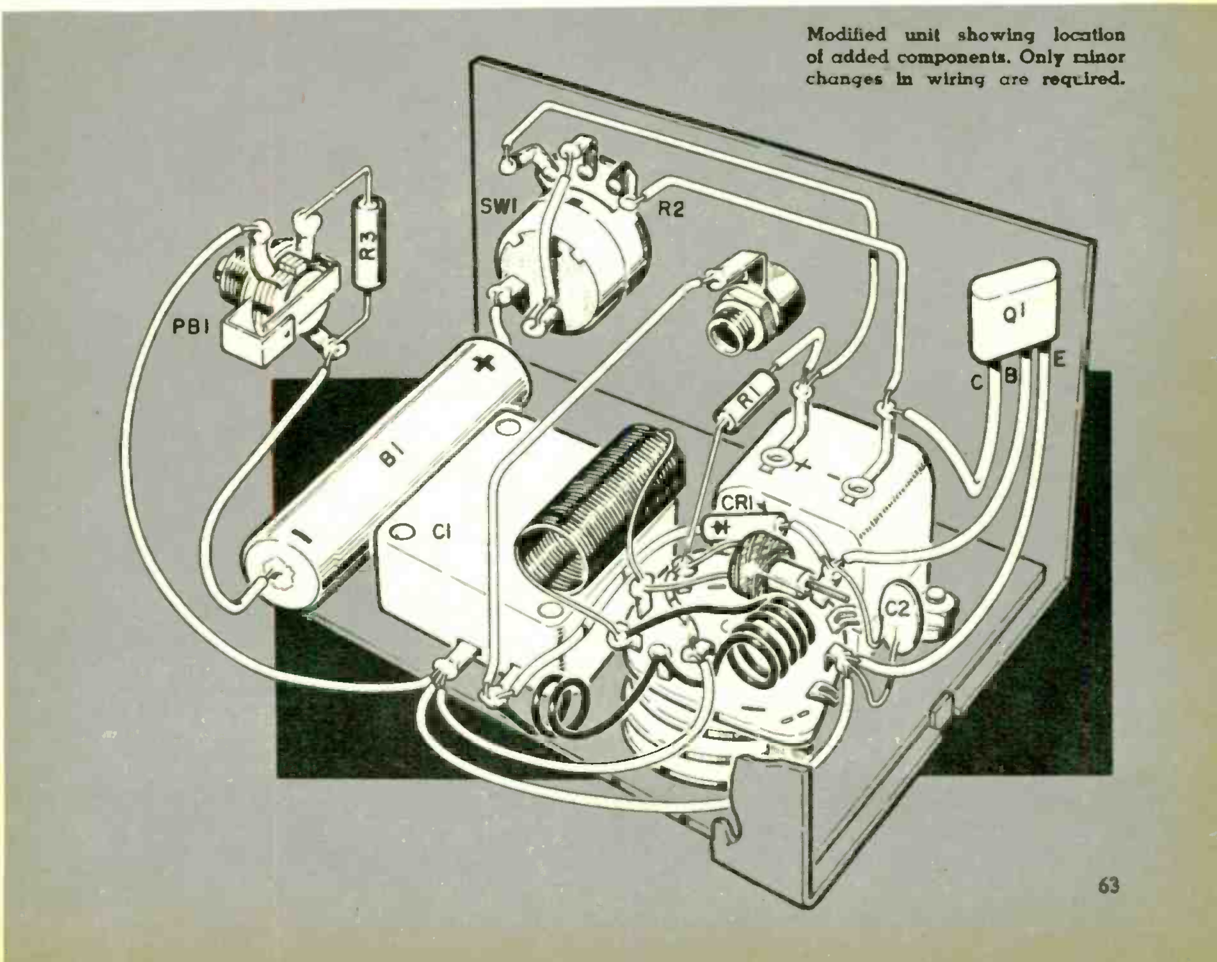
Construction

There is more than enough room inside the tiny case to install the additional parts. Note that the band switch is a two-pole, four-position type and that only one of the two poles and four of the possible eight circuit lugs are used. The unused terminals can be put to work as tie-points. The base lead of the 2N213 transistor goes to one lug, and the emitter goes to another. B1 should be a No. 904 or similar size cell as the AA size cell is too large to be fitted in

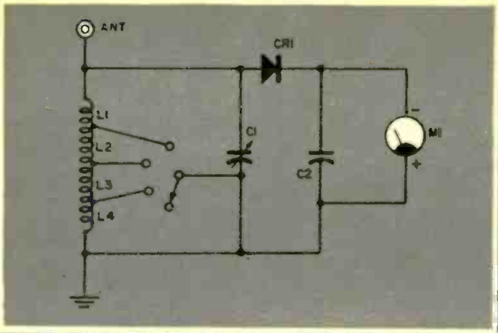


the field-strength meter's already overcrowded cabinet. Don't force a larger cell in place, or you will set up capacities that will detune the coils.

Be certain that the mounting holes for R2 and PB1 are located properly so that the pot and switch clear the back of the tuning capacitor. It's a good idea to run



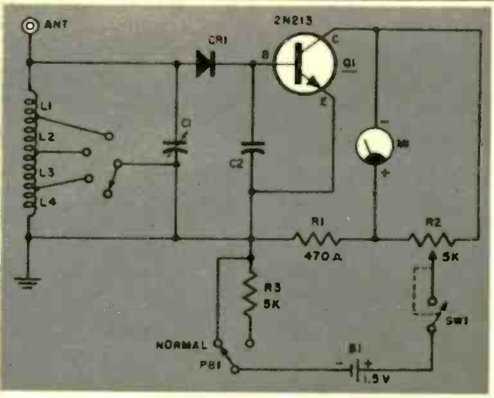
Modified unit showing location of added components. Only minor changes in wiring are required.



Before (left) and after (below) views indicate changes to be made. Tuning circuit is left undisturbed so as not to upset original frequency calibration on front panel.

PARTS LIST

TM-15 RF Field Strength Meter (Lafayette Electronics) Additional Parts required:
Q1—2N213 transistor
B1—1.5 volt dry cell, Eveready type #912 or #904
R1—470 ohms, 1/2 watt
R3—5000 ohms, 1/2 watt
R2,SW1—miniature 5000-ohm potentiometer with switch, slotted shaft and knob. (Lafayette VC-48 with KN-23 knob or equiv.)
PB1—Miniature SPDT pushbutton



all wires to a given tie-point *before* soldering the transistor lead in place; then a quick spot solder job on the globule of solder already on the tie-point limits the heat that will be applied to the transistor. Avoid moving the coils since this may change their spacing and make the frequency reading inaccurate. Keep your soldering tip away from the plastic cases of both the variable capacitor (C1) and the meter as they may melt. Wire in the battery *last* and be sure on-off switch SW1 is in the OFF position before making final connections.

Testing

Depress pushbutton PB1 and rotate the knob of zero balance control R2 until SW1 clicks on. The meter should read about half scale with no input signal. Now rotate the knob *slowly* clockwise until you notice the meter needle begin to drop. Release PB1 and the meter needle should then deflect all the way to the right. Continue to rotate R2's knob clockwise until the meter reads at or near zero. This adjustment is critical, requires a sensitive touch and patience, and may have to be repeated. As the transistor warms up, the needle will tend to climb but this can be offset with R2. Meter equilibrium should be reached in a few minutes and the instrument is ready for use. After readings have been taken, *always* depress PB1 while rotating SW1 to the OFF position. This protects the meter from overload when the bridge is unbalanced.

Operation

When using the instrument in a field of unknown strength, start with the antenna of the TM-15 removed and keep the instrument reasonably far from the antenna. If no reading is obtained, remain at the same distance and insert the *collapsed* antenna into its jack. To obtain greater sensitivity, extend the telescoping antenna as needed. If you should find it necessary to use the field strength meter close to the transmitter, work with the pushbutton depressed to keep R3 in the circuit and prevent meter damage. •

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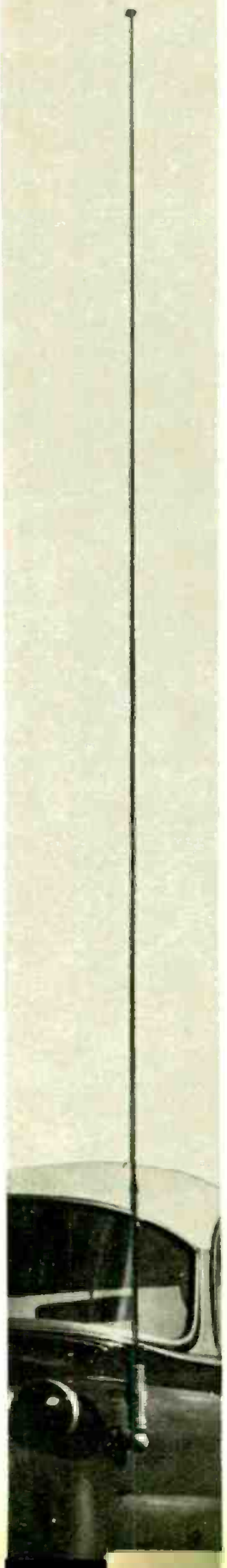
CBers! Here's how to get

More From Your Mobile Whip



A simple soup-up job on the antenna gives your transmitter the man-sized reach that you want!

By Herbert Friedman, 2W6045

AS THE chaps at the Federal Communications Commission can tell you, there's been a lot of agitation lately to allow increased power on the 27-mc Citizens Band. Most of the complaining has to do with range, particularly the range of mobile units.

The answer from the FCC, and from a good many informed individuals, is short and to the point: poor range is not in all likelihood due to the power limitations, but rather to inefficiency at the transmitter. Potential signal strength is just not being realized. The fault probably lies in the antenna.

Base-station antennas usually are erected by the CBer with great care and precision, and most stations are attaining ranges that exceed even the most optimistic original estimates. But mobile whips have been a source of trouble from the start. And no end of work and figuring by some licensees is able to correct the situation.

All this trouble is partly because the mobile whip antenna itself has built-in disadvantages. Among the worst is its impedance. A 50- or 70-ohm base station antenna can be matched easily by any length of common coaxial cable (such as RG-58AU or RG-59). But this is not possible with the standard whip because at resonant frequency it has a radiation resistance of 32 ohms, which is not matched by any common coax cable. The lowest impedance of these cables is 50 ohms.

This is what happens: with a 32-ohm antenna and a 50-ohm coax, you start out with a mismatch that results in a Standing Wave Ratio (SWR) of approximately 1.6 to 1. The ideal SWR, of course, is 1 to 1. In this mismatch situation the power delivered to your antenna is reduced by a factor amounting to all the other line losses (there always are some such losses) multiplied by the SWR. It's a little like sighting a rifle with a telescopic sight. With standard sights, a little tremor in the hands doesn't amount to much. But with a telescopic sight the same tremor is blown up in direct proportion to the magnification factor of the 'scope. If you're a little shaky, your aim is all over the landscape. A lop-sided Standing Wave Ratio acts just like the telescopic sight by magnifying normally small transmission problems. If your transmitter has a potential of three watts RF output and you're operating with an SWR of 1.6 to 1, your antenna is not receiving anything like three watts.

An out-of-balance SWR also causes a second problem. Because of standing waves on the coax, the input impedance of the cable can be considerably higher or lower than 50 ohms and it may be difficult to get the transmitter to load into the antenna system with any degree of efficiency at all.

What's the answer? The easiest one is to use the coaxial cable as an impedance matching transformer. If the cable is cut to an *electrical* half wavelength—or any multiple of a half wavelength—the values that appear at one end of the cable also are found at the other end.

In Fig. 1 the coaxial cable is cut to a half wavelength. At the input (left) end the current is high and the voltage

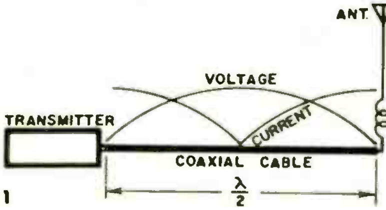


Fig. 1

is low, as shown by the curves. At the output (right) end the current and voltage are found in the same relationship. As far as the transmitter is concerned, it is working directly into the antenna. By using the half wavelength coax the transmitter "sees" only the antenna. It is as if the coax were not even there. Under this condition the transmitter delivers maximum power to the antenna.

When installing a CB unit, you may have noticed that as you changed the length of coax cable the transmitter output went up or down. Although you may not have been aware of it, this was an indication that you were approaching or receding from an electrical half wavelength (or some multiple of it).

To find out how long the coax should be, you must first sit down and figure out a half wavelength according to the standard formula. That would work out this way: length (in feet) = 984/f, where 984 is the radio-wave velocity factor and f is the frequency in megacycles. The CB frequency of 27 mc figures out to a wavelength of 36.37 feet, giving us 18.2 feet as a true half wavelength, as in Fig. 2 (A).

But what we need is an *electrical* half wavelength. Coaxial cable slows an RF wave and in effect shortens the wavelength. This must be taken into account.

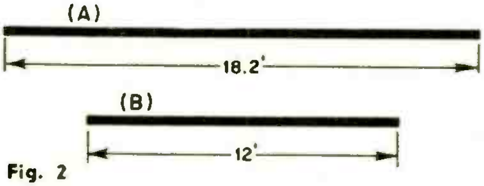


Fig. 2

The speed (Velocity Factor) for common coax is .66. To get an *electrical* half wavelength we multiply this factor by the true half wavelength, which works out this way: .66 x 18.2 = 12 feet, as in Fig. 2 (B). So an electrical half wavelength is 12 feet, and that is the length of coax you need.

After the proper length of coaxial cable is installed it is still possible to increase the transmitter's RF output. Even with ideal cable matching, the transmitter is working into a 32-ohm load. By raising the radiation resistance of the antenna we can make it approach a perfect match with the transmitter, and maximum power can be delivered. To raise the antenna's radiation resistance we simply lengthen the whip itself, and then insert a trimmer capacitor to readjust the frequency (see Fig. 3).

The normal CB whip is 108 inches (102-inch whip plus 6-inch spring). If the antenna is extended beyond 108 inches, the voltage and current relationship at the base of the antenna changes, and that changes the radiation resist-

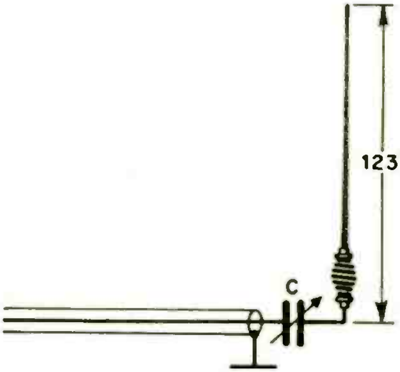


Fig. 3

ance. The practical limit of antenna extension to avoid breaking toll booth lights and striking overpasses is about 15 inches, depending on where on the car the antenna is mounted.

Lengthening the antenna raises the radiation resistance at 27 mc, but the resonant frequency is lowered. So the antenna resonance must be returned to the operating frequency. This is done by installing a 100 mmf trimmer capacitor between the base of the antenna and the center conductor of the coaxial cable. The capacitor electrically resonates the antenna to 27 mc. The capacitor is rotated for maximum loading or lowest SWR. Any small capacitor will do.

When the antenna is extended, two other important improvements result. The increased length lowers the radiation lobe of the antenna. This means that the signal will travel more parallel to the ground, resulting in a stronger signal at the receiving stations. Secondly, the high current area of the antenna is removed from the body of the car. The whip antenna radiates from the high current area of the whip, which is at the base. By extending the whip, the high current area is moved up and away from the car body, increasing radiation and improving the radiation pattern. Figure 4 illustrates this point. (A) is a standard whip with the current distributed as shown. (B) is an extended whip, illustrating how the current node is moved up the antenna.

While other subtle changes can improve performance there is one more major improvement which is possible with those CB transmitters having a fixed output link. Figure 5 illustrates the idea—a souped-up tank circuit. (A) shows a normal output tank coil with a link of one or two turns wrapped around it. These links are designed to operate with 50-ohm antennas. In many instances transmitters do not load up to full plate input because of reactances existing in the antenna system. By adding a trimmer capacitor in the ground lead of the link, the reactances can be tuned out, permitting the transmitter to be loaded to full potential. This modification is shown in Figure 5 (B). The capacitor is a 50 mmf variable, adjusted for maximum loading of the transmitter.

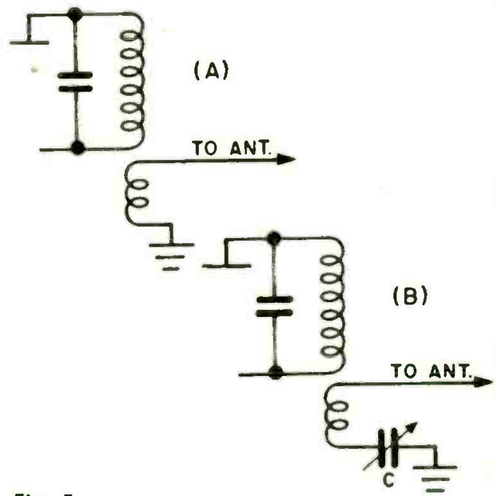


Fig. 5

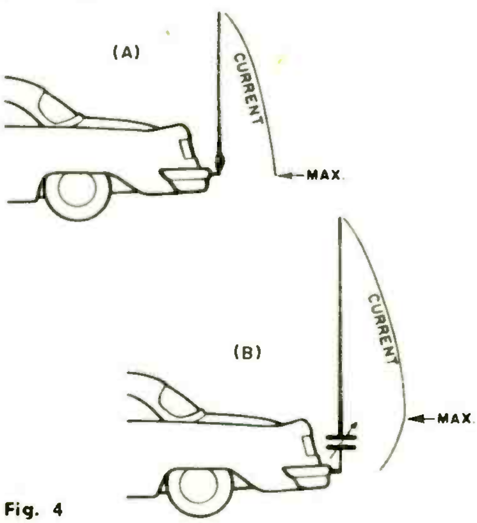


Fig. 4

Any practical method for improving a mobile antenna that you come across should be tried. It is difficult not to better the situation when there is so much room for improvement.

Manufacturers of Citizens Band antennas may in the future offer whips of improved design, incorporating many of the features we've discussed. But they seemingly have been reluctant to redesign their products thus far.

Keep in mind that all improvements made to the transmitting antenna also are applicable to receiving. An antenna system which gives top transmitting performance gives top receiving performance. •

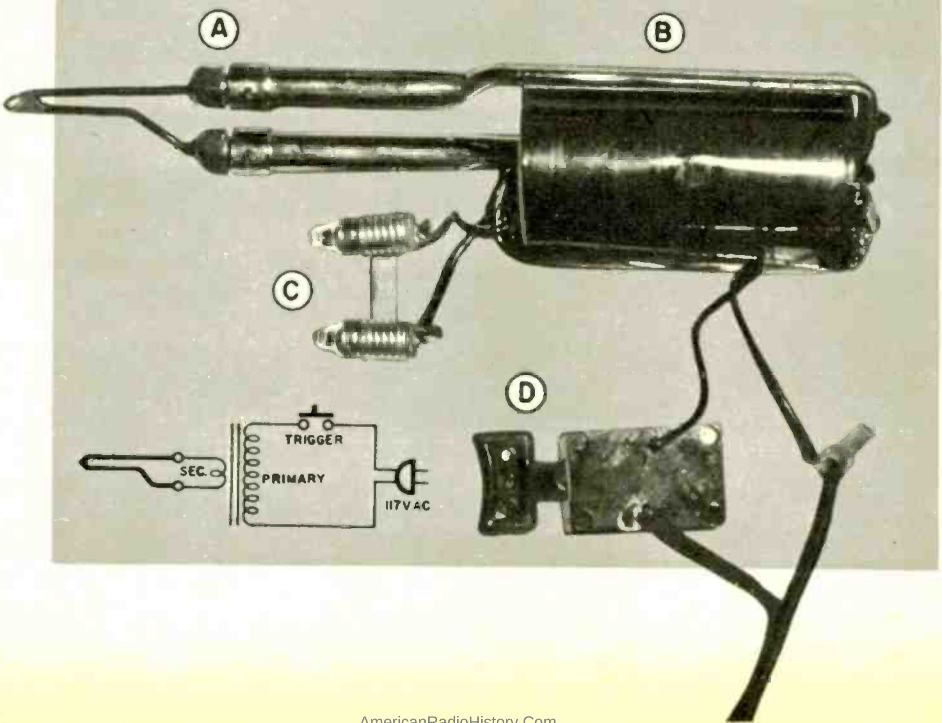
FIX THAT SOLDERING GUN!

First things first! A defective soldering gun can take all the fun and effectiveness out of any electronics project.

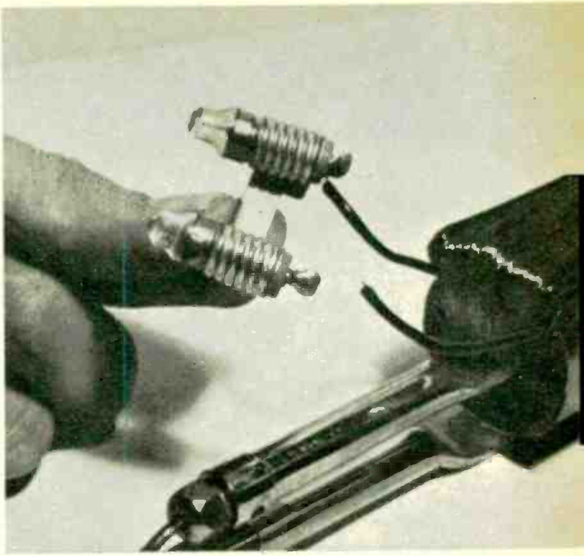
By John A. Comstock

DOES your soldering gun suffer from slow action . . . dim bulbs . . . low heat . . . and intermittent performance? A minor operation, and perhaps a few replacement parts are all that's required to give that trusty old gun a new lease on life.

Four basic trouble spots are: (A) Loose or corroded tip nuts. (B) Open transformer winding. (C) Defective socket, bulb, broken wire or (D) switch.

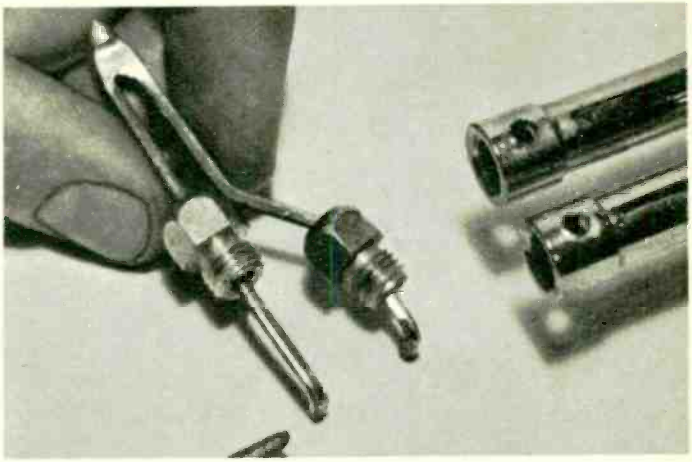


For a quick check, connect an ohmmeter across the gun's plug. Shake and tap the gun to check for an intermittent open in the primary circuit.

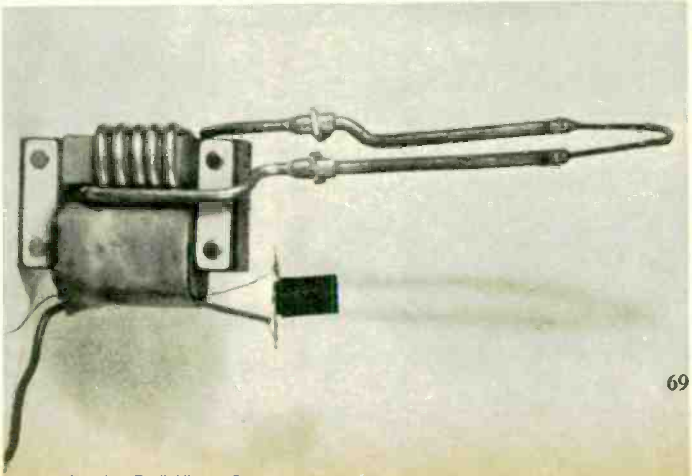


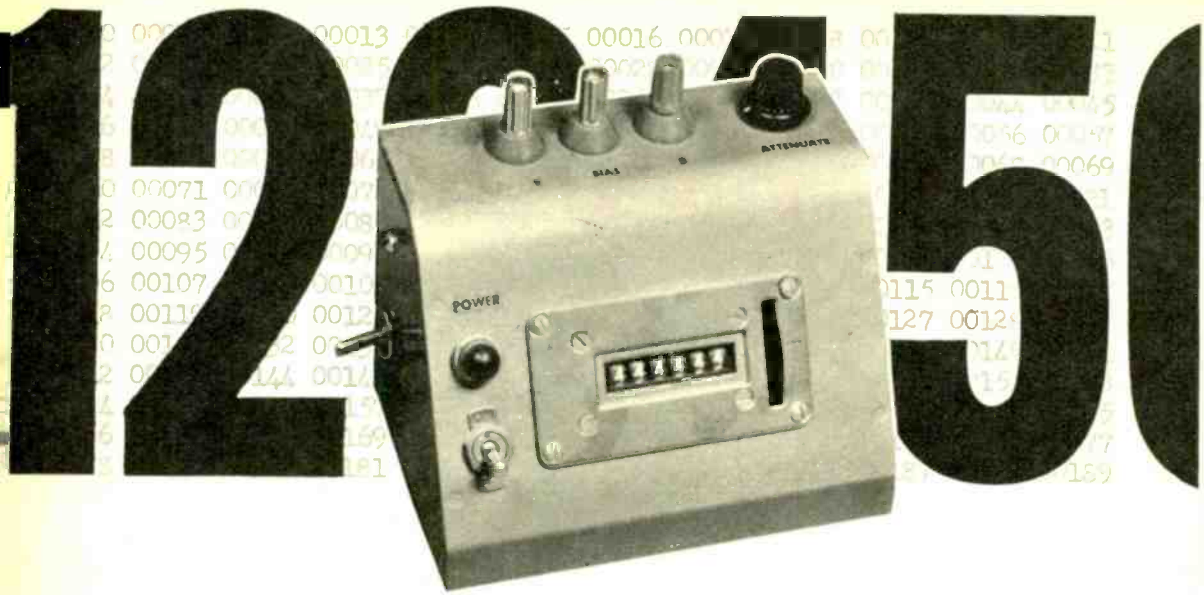
Remove a few machine screws and the gun's plastic housing will separate into two parts. Any broken wire connections will then be visible.

Unscrew the tip and file to remove corrosion. Replacement nuts and tips are available from your local dealer.



Internal construction of another brand of gun. The five heavy turns of wire is the secondary winding. Two bottom wires connect to switch and the heavy-duty line cord.





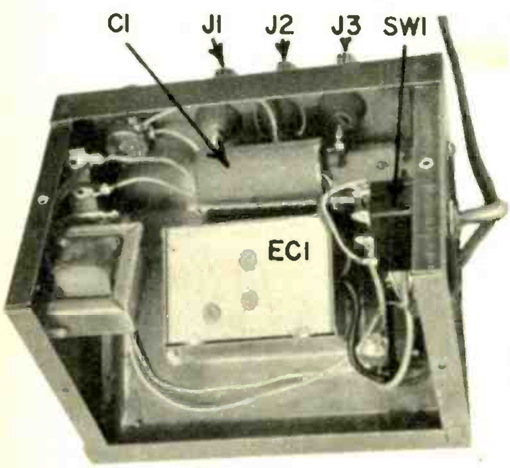
For the man with a need to enumerate electronically . . .

A General Purpose COUNTER

By Ronald Benrey

HAVE you ever needed to count the number of times an event occurred? How often a door has opened or a switch was closed; how many times a light flashed or a machine tool was used? Here's a device that will do the job electronically.

With a choice of input signals or switching devices, this little handyman will count everything from jellybeans to gold coins—from 0 through 999,999 of them—with never a mistake or a dropped digit. The unit can be built for about $17.



View from the bottom rear showing general component location. Arrangement used is non-critical.

Operation

The heart of the unit is a drum-type, solenoid-actuated digit counter. Every time a pulse of 117 V AC is applied to the coil, the counter advances one digit.

A small relay, RY1, driven by a one-transistor amplifier (Q1) energizes the counter's solenoid. Various sensing and switching elements may be attached to the input of the transistor amplifier, making the counter very versatile.

Depending upon the position of SW2, the counter is advanced by either energizing or de-energizing RY1. The choice depends on the input. For example, if closing a switch is to trigger the counter, set SW2 to (b). On the other hand, if RY1 is kept energized by a light beam shining on a photocell connected to the input, use position (a) of SW2 so that the counter advances each time the light beam is broken.

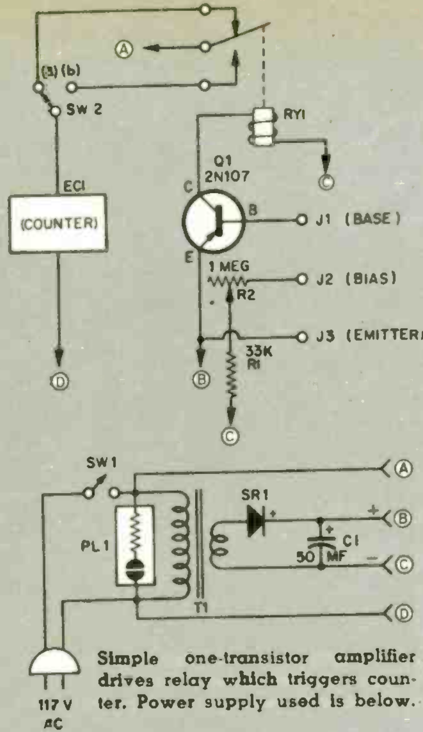
For best operation, the photo-cell should be shielded from surrounding light with a piece of cardboard tubing.

The operating procedure table suggests the connections to be used for typical switching and indicating elements. By using this table as a guide, you can adapt the counter to do almost any counting job.

Construction

Parts placement and wiring are not critical, and any desired layout can be used. Be careful of shorts around the power supply, or you will blow the house fuse. The counter is housed in a small sloping-panel aluminum cabinet, but any wood or metal cabinet will serve. RY1, Q1, SR1 and C1 are mounted on a small piece of perforated Bakelite.

Three insulated terminal posts (J1, J2 and J3) are used to connect input devices to the amplifier. If desired, they may be replaced by other connectors, such as phone jacks or a single barrier terminal strip. •



Simple one-transistor amplifier drives relay which triggers counter. Power supply used is below.

PARTS LIST

R1—33,000 ohms, ½-watt resistor
R2—1-megohm potentiometer (linear taper)
C1—50-mf, 50-volt electrolytic capacitor
PL1—neon pilot light assembly
Q1—2N107 transistor
RY1—SPDT relay, 2,300 ohms (Sigma 11F-2300-G/SIL)
SPST—DPDT toggle switch
SPDT—SPST toggle switch
SR1—130-volt selenium rectifier, 50 ma.
T1—24 or 26 volt filament transformer
EC1—Electric counter (Lafayette F-553, Radio Shack H97L055 or equiv.)
J1-J3—5-way binding posts
Misc.—Piece of perforated board, line cord, 4" x 4¼" x 6" sloping-panel cabinet (Bud C-1608 or equiv.), terminal strips, etc.

OPERATING PROCEDURE			
Switching Element	Element Connection	Set SW2	Notes
Selenium or silicon photocell	Positive terminal to J3, negative terminal to J1.	To (b) if a flashing beam is to activate. To (a) if interruption of a steady beam is to actuate.	Connect a jumper between J1 and J2. Adjust R2 for correct sensitivity.
Cadmium sulphide or cadmium selenide photocell	Between J1 and J2	Same as above.	Adjust R2 to the lowest value that will still allow counter to operate.
Any switch	Between J1 and J2	To (b) for normally-open switch. To (a) for normally-closed switch.	Same as above.
Any resistive element (moisture detector or thermistor)	Between J1 and J2	Depends on element.	Same as above.

build a

Flashing Electronic Taillight

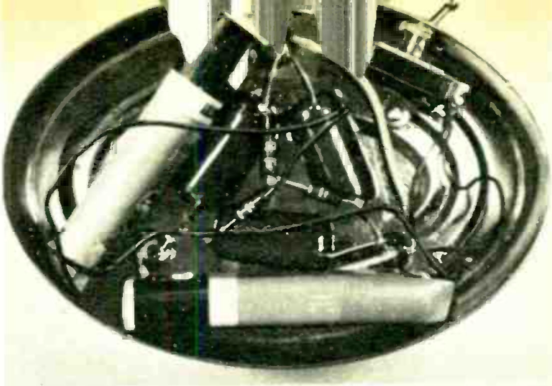
By Jack Allison

A sure-fire conversation starter and traffic stopper, this unusual gadget for your bike will add safety to your night trips and fun to any indoor gathering. The circuit is simple and easily constructed. The "chassis" can used by the author leaves plenty of room to work, but there's nothing to prevent you from building a smaller unit.

Construction is easy. Draw a circle on the can and drill holes on the circle for the reflectors and the neon lamps. Enlarge the holes with a reamer if necessary. You can use practically any neon lamp provided it does not have a built-in resistor. The larger the lamp, the greater the battery drain. The bulbs chosen are pushed through rubber grommets. (It will help if you moisten the bulbs first.) Pick the grommet that fits the bulb type you are using.

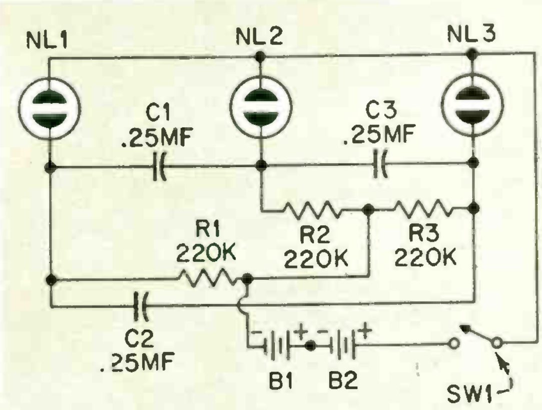
The pictorial shows the placement of parts. Make sure all connections are soldered well and that there are no shorts. Place tape over the battery terminals. As protection against moisture and vibration, drive small nails around the edge of the can into the wood back, then place a strip of tape around the edge of can. To prevent theft, attach taillight so you can remove it easily.

Components are soldered directly to the neon lamp bases. Spaghetti insulation should be used to avoid possible shorts.

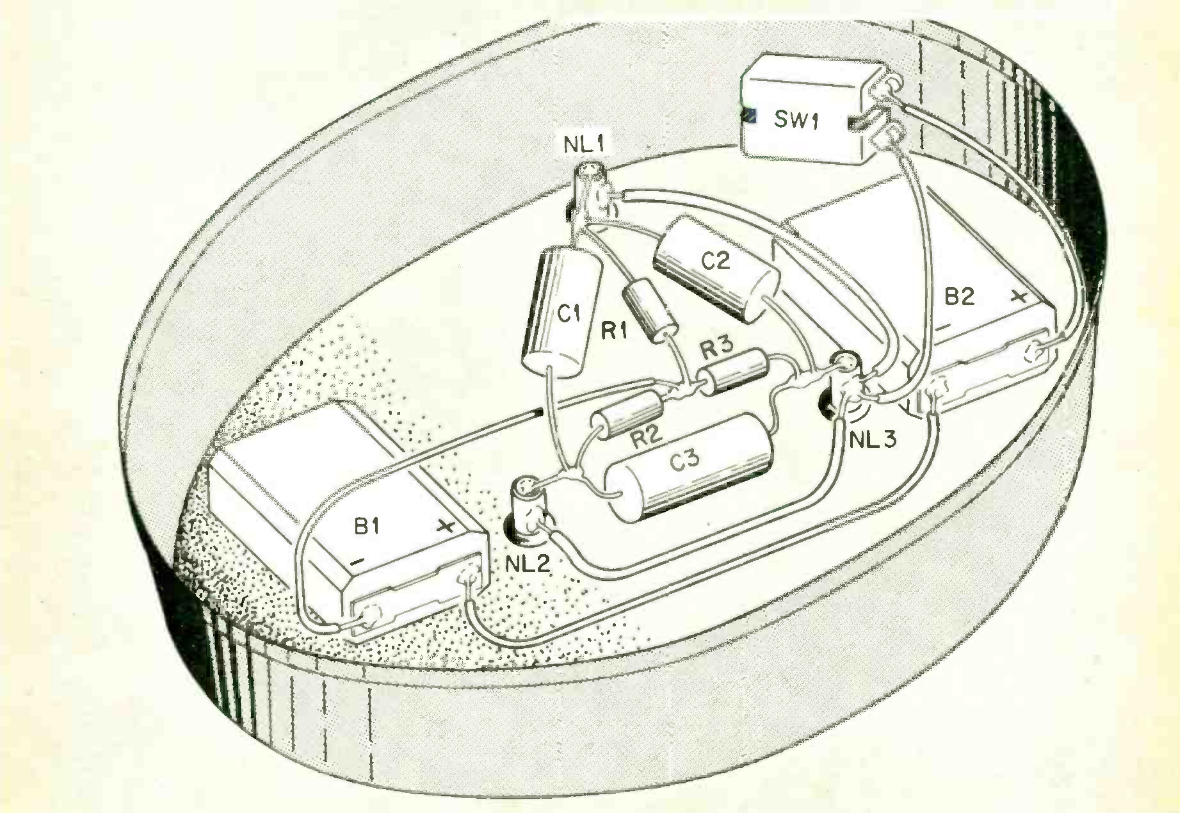


PARTS LIST

C1,C2,C3—.25 mf, 200 volts (or higher) capacitors
R1,R2,R3—220,000 ohms, 1/2 watt, 5% resistors
NL1,NL2,NL3—NE-51 or NE-51H neon lamps (see text)
SW1—SPST toggle switch
B1,B2—45-volt batteries (four-22.5 volt batteries may be substituted)
3—Red reflectors
3—Rubber grommets to fit lamps
1—Tin can and fitted wood back
Misc.—battery connectors, wire, etc.



It may be necessary to turn SW1 on and off a few times to start flasher. Neons are fragile and should be moistened so they can be fitted through grommets.



The Solar Wheel

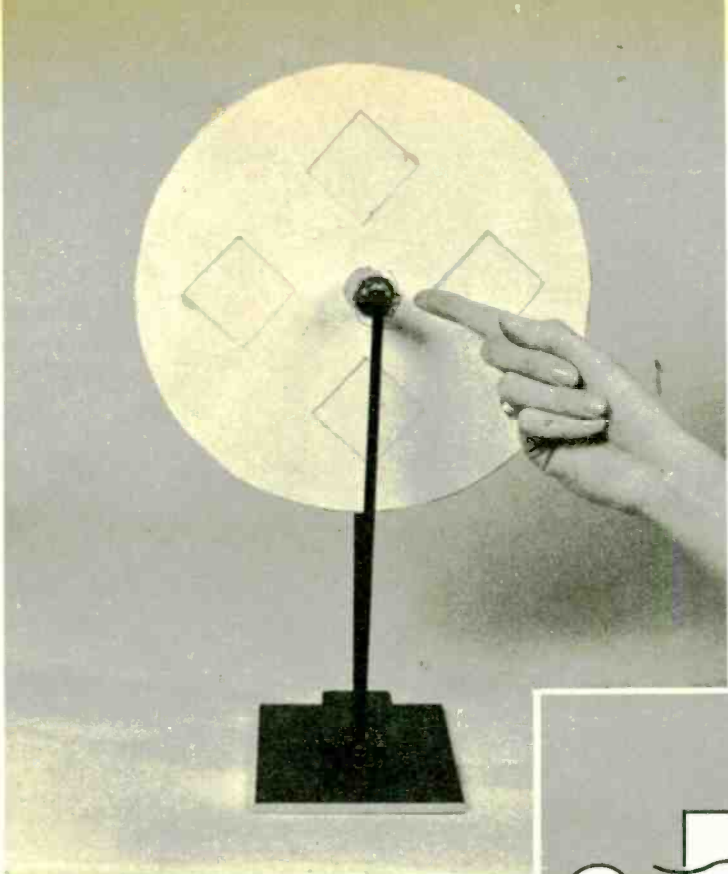
Mystery wheel blends fun with theory of solar cells.

By George Byron

THE mounted motor-driven wheel pictured on this page has no visible power cable, and no dry cell or battery is hidden in the base. However, when sunlight strikes the wheel's surface, it turns. Using a bright lamp will accomplish the same thing. In other words, the wheel is powered by light.

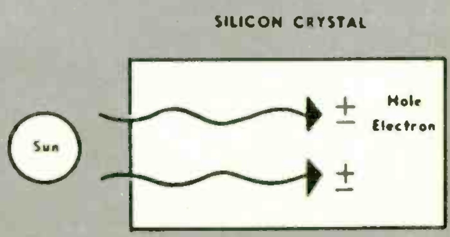
How does it work? The small black disk just above the motor housing provides the answer. It is the remarkable new solar cell which converts ordinary sunlight into electricity. This insignificant looking black chip may one day revolutionize the production of electric power.

Striking spiral effect has been painted on author's wheel. Black disc near eye of the wheel is a high-output Hoffman solar cell.

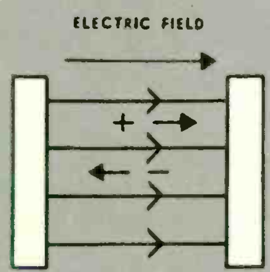


Miniature Aristo-Rev motor converts electrical energy of solar battery to high torque. Wheel is cut out in even sections for proper balance and lower weight.

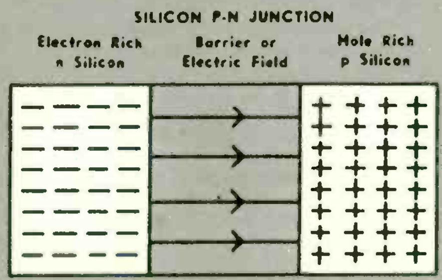
All drawings courtesy
Bell Telephone Laboratories



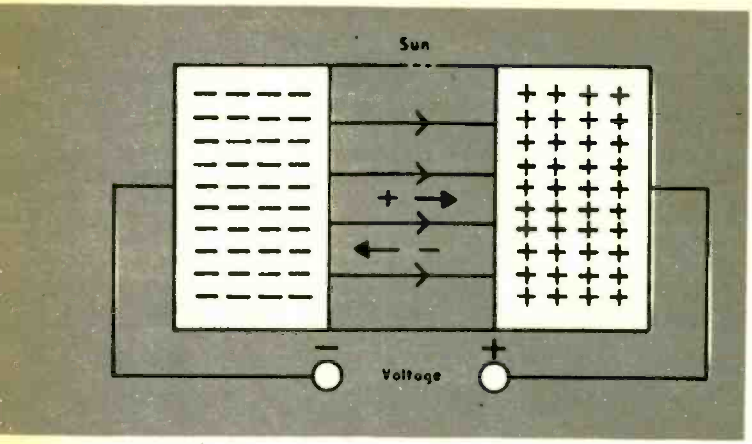
Light is absorbed in a silicon crystal by liberating loosely bound negative charges, (electrons) and the free-to-move holes.



An electric field exerts a force on charged particles, moving them if they are free. The force moves holes in one direction and negative electrons in the other direction.



In a thin barrier at junction between an electron-rich N-region and a hole-rich P-region, a strong built-in electric field exists which keeps the electrons and holes apart.



When the light is absorbed, freeing electrons and holes in the barrier region at a P-N junction, the built-in electric field forces the holes into the P-side, making it positive, and the electrons into the N-side making it negative. This displacement of charges causes a voltage to appear between the silicon crystal's ends.

During any 24-hour period, the amount of energy radiating on earth from the sun totals more than one quadrillion kilowatt hours. Since this figure is meaningless without some tangible comparison, we can express it another way: it is equivalent to all of the potential energy stored in all of the earth's known reserves of coal, oil, natural gas and uranium. Small wonder then that for centuries men have searched for methods of capturing even the smallest fraction of this stupendous energy source for useful power.

In April of 1954, Bell Laboratories made an announcement of outstanding significance. Three of their scientists,* working as a team, had developed a tiny silicon cell which converted ordinary sunlight *directly* into usable amounts of electricity. And silicon, which comes from ordinary sand, is one of the most abundant materials on earth. With one magnificent stroke, this device, now known as the Bell Solar Battery, swept aside the cumbersome process of producing electric power and harnessed the sun as a power source.

Like many important inventions of the past, the solar cell is basically simple in construction and operation. (It is a Solar Battery when two or more cells are connected together.) The cell consists of a wafer of silicon, about 1/25 of an inch in thickness and about the diameter of a quarter, in which a minute amount of arsenic is added as a necessary impurity. A layer of boron, .0001 of an inch in thickness, is diffused on one surface of the wafer to form a P-N junction, similar to that of a transistor. The silicon acts as the electron-rich N layer, while the boron is the hole-rich P layer. Between these two layers is a thin barrier region in which a strong electric field exists, keeping the electrons in the silicon and the holes in the boron.

Theoretically, a solar cell will never wear out, for there are no moving parts and nothing is destroyed or consumed in the energy conversion process. Its present efficiency of 11% compares favorably with the best gasoline and steam engines. Estimates are that the ultimate efficiency can be increased to 23%. It's nice to remember though, that the other 77% will not really be wasted as far as we are concerned, for it will all be supplied gratis, courtesy of old Sol.

The Solar Wheel illustrated can be used in laboratory demonstrations of the energy conversion process, or at science fairs. The Wheel also makes a puzzling window eye-catcher. Since ordinary display lamps will make the wheel turn, placing the entire assembly on a glass plate, with no visible sign of a power supply, will command a great deal of attention. The solar cell can also be dismantled of course and used for further experimentation. The solar cell used in author's model was Hoffman Type 2A, cost $7.50, but other equivalent current cells may be used.

You can obtain the solar cell from

* G. L. Pearson, D. M. Chapin, and C. S. Fuller

Allied Radio and other large electronic parts distributors.

The motor may be obtained from: Polk's Model Craft Hobbies, Inc., 314 Fifth Avenue, New York, N. Y. Aristo-Rev Motor No. 2, $3 postpaid. There are similar motors available from other distributors but they have a higher internal resistance and may not work properly. The correct motor has an internal resistance of less than 15 ohms.

Constructing the Solar Wheel

On a sheet of stiff cardboard draw a 10″ diameter circle. Draw another concentric $\frac{15}{16}$″ circle. Cut away the area *outside* the 10″ circle and *inside* the inner circle. Be sure to maintain balance for a low starting torque.

Force-fit the motor in the $\frac{15}{16}$″ center hole and fix it in place with glue. The disc should fit around the motor housing close to the end *away* from the armature brushes. Remove a pair of 4″ lengths of bare wire from a stranded wire cable. Solder one wire to the back and near the edge of the solar cell. This is the *negative* side and is silvered over. CAUTION: *Use a low-heat soldering iron and apply heat for a short time only.* Solder the other wire to the silvered rim on the other side. This is the *positive* end.

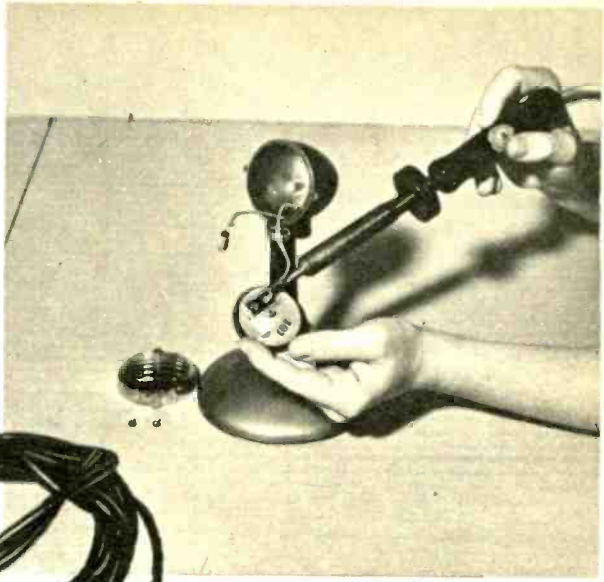
Punch two tiny holes through the cardboard about 1¼″ apart, about 1½″ above the motor body. Insert a wire from each side of the cell through the two holes until the cell lies flush with the wheel (black surface up). Then solder each wire to a separate armature brush. Obtain two 10″ lengths of ¼″ wood dowel. Drill a $\frac{1}{16}$″ hole near the end of each dowel, ⅛″ in depth.

Drill two holes same diameter as the dowels in a block of wood, 2¾″ apart, center to center. Insert and glue the dowels into the holes. The two $\frac{1}{16}$″ holes should face each other at the top. Make certain that the two holes are the same distance from the surface of the wood block. Then insert each end of the motor shaft into the holes in the dowels. Since the armature shaft is fixed in the supports, the motor *housing* will turn instead, thus turning the wheel.

The wheel will turn if strong sunlight falls on the surface of the disc at an angle of about 120 degrees or less. If you demonstrate this device indoors, use a 150-watt reflector spot lamp about 12″-18″ away from the wheel. The light should strike the surface of the wheel at an angle no greater than 60 degrees. If the wheel is perfectly balanced, it will be self-starting. A slight touch at the edge will provide starting torque. •

Electricity From Salt

WHAT does salt have to do with electricity? That was what scientists at the Honeywell Research Center got to wondering one day, and they didn't know the answer. Neither did anyone else. No one had ever done thorough research on the special characteristics of salt. So the wondering men at Honeywell launched a research program on common table salt (sodium chloride). They first took a fine-mesh platinum screen (see photo) and filled it full of salt. Then they heated the crystals until they melted. After that, they studied the infrared absorption qualities of salt (which gave them clues as to its structure). They found that salt can be made to generate electric power. Solid-state salt is an insulator but when molten it becomes a conductor, its resistance decreasing by as much as seven orders of magnitude. Thus salt may one day have a role in switching. •



Unsolder the defective cartridge. Be sure to indicate which is ground lead wire.

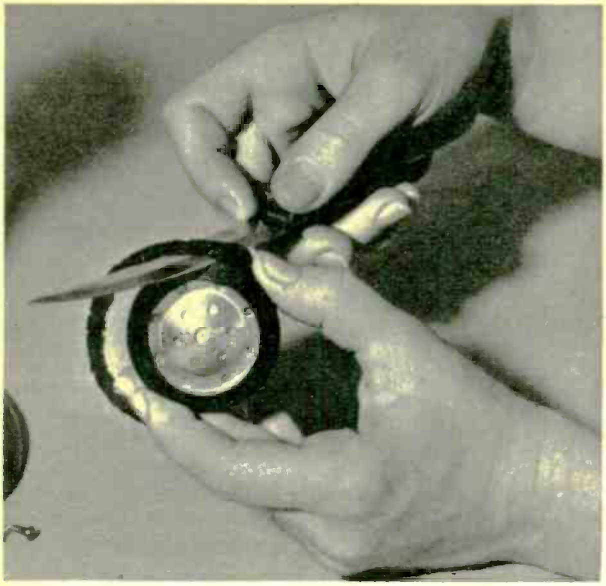
REPAIR THAT MICROPHONE!

By David Herman

SINCE a substantial part of a microphone's cost is in the case itself, you can save considerable money by rebuilding mikes whose cartridge is defective instead of re-buying the entire unit.

The inexpensive ($6.47) and rugged Shure R5 controlled magnetic cartridge is particularly suited for replacement service as it has a thick rubber rim which can be trimmed to fit a variety of microphone cases. Practically immune to heat and humidity, the R5 has a smooth frequency response, suitable both for recording and public address use. And by removing the cartridge's plastic damping cover you can cut its bass response to produce a communications microphone with a sharp, crisp quality. The R5 has a *minimum* mounting diameter of 1⅞" so make sure (before purchase) that it will fit the mike case.

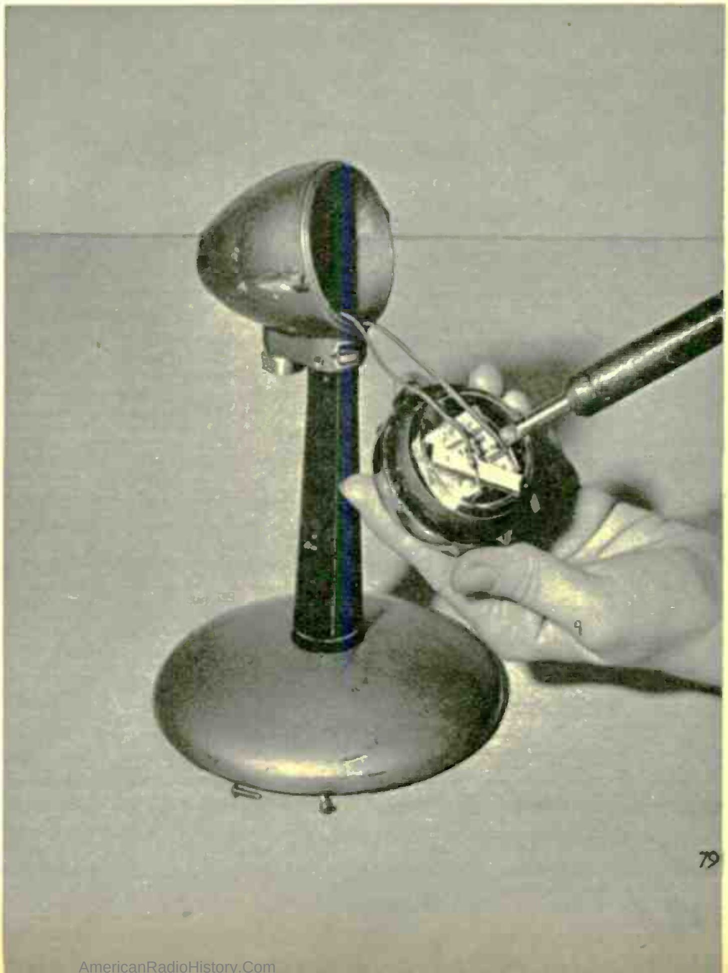
The Shure R5 is stocked by most large parts suppliers or it can be ordered through your local Shure microphone dealer. •



Part of rubber rim is trimmed away with sharp knife. Make certain R5 has snug fit in case.

Position cartridge in case and glue shock mounts in place. New shocks may be made of excess rubber.

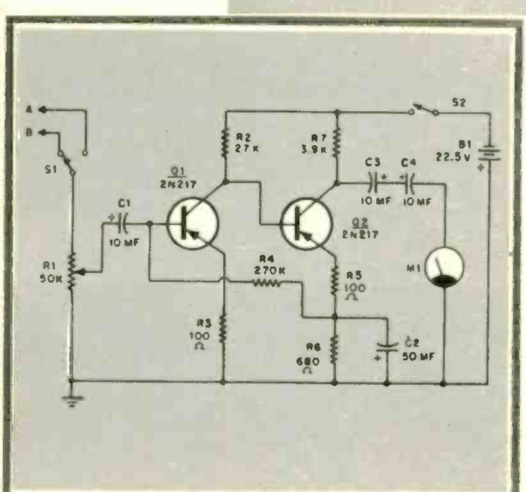
Solder both leads to new cartridge making sure that ground lead is connected to correct lug. Although cartridge is not heat-sensitive, it's best to use long-nose pliers to carry off the heat.



STEREO MIKE MIXER

For the home recording buff: a mixer plus VU meter that will handle four microphones per channel.

By Harry Kolbe



MIXER PARTS LIST

R1—240,000 ohms
R2—91,000 ohms
R3—330,000 ohms (original bias resistor)
R4—33 ohms
C1—2 mf, 15 v. electrolytic capacitor
Mixer—Olson Radio RA-345; Lafayette PA-292

VU METER PARTS LIST

R1—50 000-ohm potentiometer
R2—27,000 ohms
R3—100 ohms
R4—270,000 ohms
R5—100 ohms
R6—680 ohms
R7—3,900 ohms
C1,C3,C4—10 mf, 15 v.
C2—50 mf, 10 v.
B1—Battery, 22.5 v.
S1—SPDT
S2—SPST
Q1,Q2—RCA 2N217
M1—VU Meter (Lafayette TM-10; Olson ME75)

Schematic of the two-transistor VU meter amplifier. Toggle switch S1 connects the meter to either the right or left channel.

IN THE past year or two, home tape recording has boomed in popularity. Relatively inexpensive stereo recorders are now available with quality approaching that of professional machines. Once the tape-recorder owner is bitten by the bug, he tries his hand at taping live performances. As he becomes proficient in the techniques, he realizes that he needs additional equipment to get professional-quality results.

The professional recording of a live situation may require the use of two or more microphones on each channel, or the mixing of other material into the program. Unfortunately, most stereo tape recorders can take only two inputs at a time. Professionals use a device called a mixer which is capable of accepting several different inputs and mixing them in any desired proportion into a single signal. Of course, a separate mixer is needed for each stereo channel.

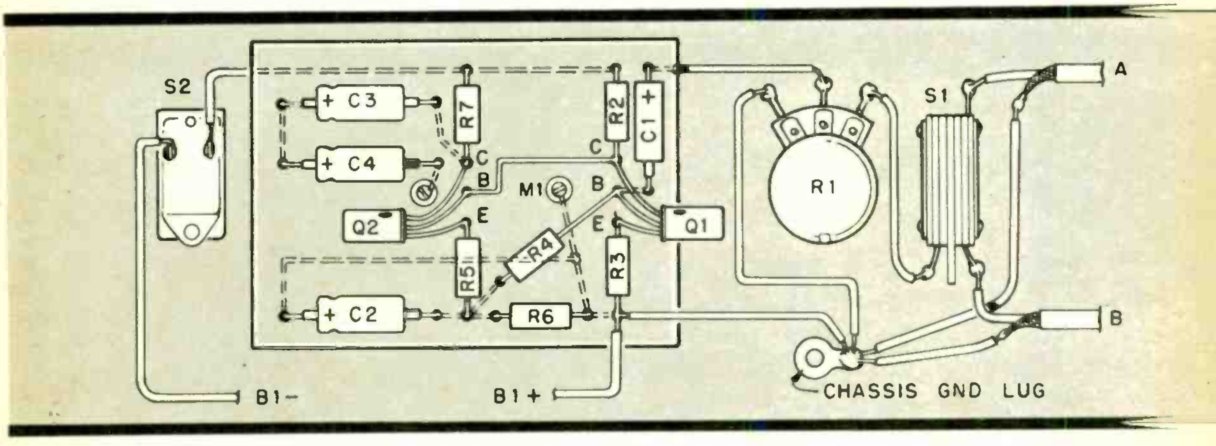
The amateur can get the same kind of professional results with an ingenious low-cost transistorized mixer—one that can be built for under $20. Each channel of this mixer can take up to four signals from microphones, tuners, phonographs, recorders, etc. The level on all four of the mixer inputs can be varied *independently* and combined into a single output. For example, you may be taping a stereo record and at some point you may want to fade in a microphone and fade out the phonograph to make an announcement. With this mixer it's a cinch.

In addition to the mixing facilities of the unit, a VU meter is included so the output of *either* channel of the mixer may be monitored. Once the VU meter is calibrated, it will be possible to adjust the relative levels of any of the mixer inputs so the signal to the recorder is at the proper recording level.

The heart of the stereo mike mixer consists of a pair of commercial four-channel transistorized microphone mixers. We found that these mixers had frequency response that was down 3 db at 8.5 kc and a gain of little over 1.5 db. Although this is sufficient frequency response for the microphones supplied with the average inexpensive recorder, it was felt that some attempt should be made to improve the response characteristics of the mixer for those people who have purchased better quality microphones. By adding three resistors and a capacitor, it was possible to broaden the frequency response to a point where the mixer was down only 3 db at 18 kc at a slight sacrifice in gain. At the low end, the mixers are flat to below 20 cps.

A high-input-impedance, high-gain, two-transistor amplifier is used to drive the VU meter and its gain is high enough that even a microphone signal of a few millivolts gives full-scale meter deflection. The current drain is so low

VU meter board. Dotted lines represent wiring on reverse side. In board's center are meter terminals.



the battery will last almost its shelf life. The input of the VU meter amplifier is connected through an SPDT switch which permits the meter to be switched to the output of either channel.

Modifying the Mixers. A good starting point in the construction of the mike mixer is the modification of the mixer units. Remove the covers of the two mixers. Soldered to one level control is a four-terminal tie strip (see Fig. 3). Remove the 330,000-ohm (orange-orange-yellow) resistor (R3). In its place, connect R1, R2 and C1 as shown. Next, referring to the transistor lead marked with an X in Fig. 3, install a 33-ohm resistor (R4) as shown. Connect a 10½-inch length of shielded audio cable to the output jack of each mixer. The inner conductor connects to the center terminal of the jack, shielding to the ground side. This completes the electronic modification of the mixers.

The VU meter and amplifier are mounted in a 5 x 2¼ x 2¼-inch Minibox. Drill the holes required for M1, R1, S1, S2 and the audio cables from the mixers. Install the cabinet mounting components.

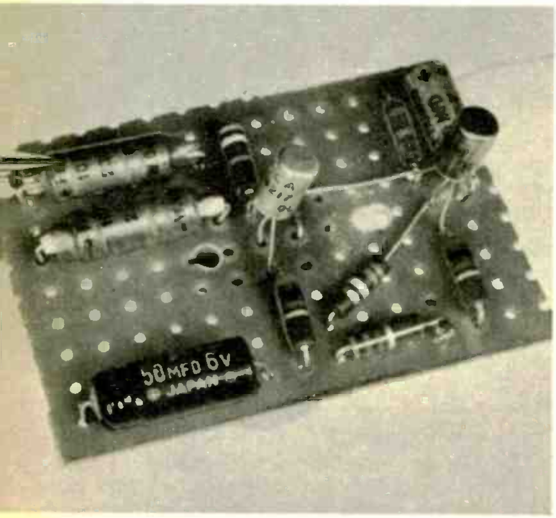
The VU meter amplifier is built on a 2½ x 2-inch piece of perforated board. Mount the components by pushing leads through the board's holes. Solder the connections on the reverse side as shown in the pictorial. Take care not to heat-damage the transistors. Mount the completed amplifier on the meter terminals and then make the appropriate connections between the amplifier and other components as shown.

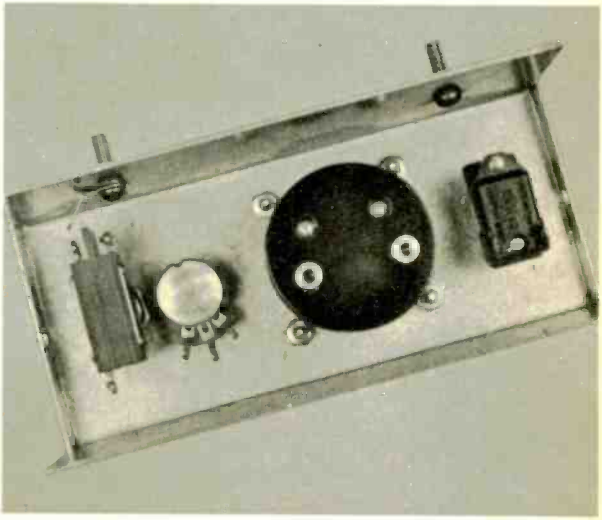
The unit pictured was stacked by running bolts through the covers. If your setup requires a different arrangement, feel free to make modifications.

A word of caution: You may feel it's more efficient to operate the two mixers from a single 9-volt battery. Don't do it or you may run into a feedback problem due to the common power supply.

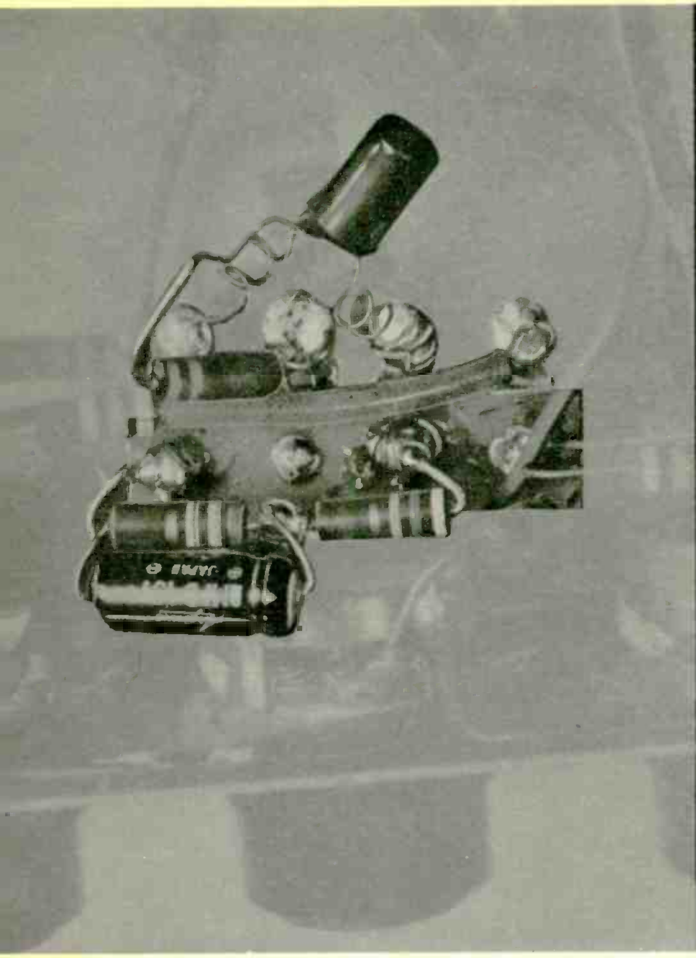
For maximum usefulness, the VU meter in the mixer should be calibrated to operate in conjunction with your recorder's level indicator. Although not shown in the author's prototype, use a pointer knob and scale on VU level control R1 to enable accurate re-setting. Make some test recordings with your usual microphone setup, and adjust R1 so that the average recording level falls on or about 0 db immediately before the recorder's indicator shows overload.

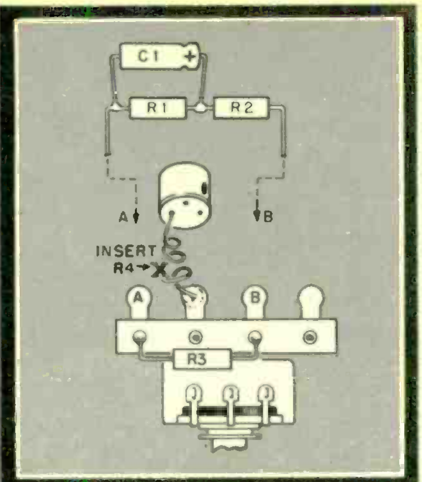
Note that the mixer's low output impedance enables long lines to be run between the mixer and recorder without noise pickup or high-frequency loss. •

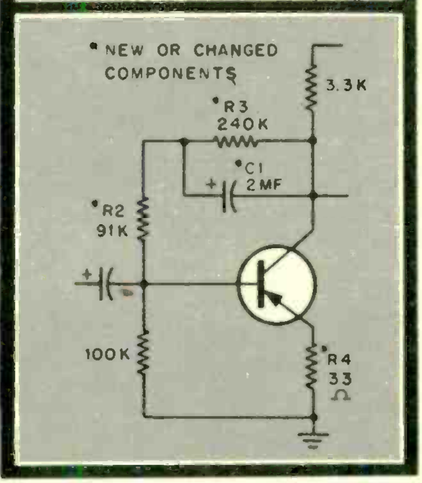




VU amplifier board subassembly is seen at left. Completed board is installed in cabinet (right) after the meter, two switches and potentiometer are mounted. The board is supported by the meter terminals.

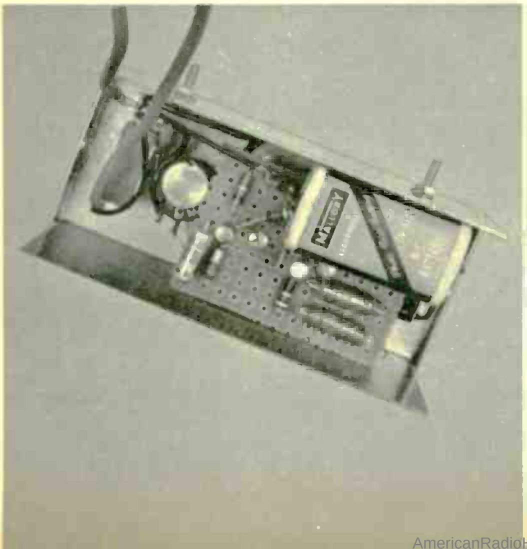






Details of feedback conversion made to commercial mike mixer to extend mixer's frequency response. Olson mixer is shown. Lafayette unit has same parts values, but different tie-strip arrangement.

Internal view of the completed VU meter amplifier. The bolts protruding from the case are used to hold the three units together when stacked as in photo at right. Any workable setup may be used.



For The First Time ANYWHERE!

a build-it-yourself

By Bert Mann

FOR ALMOST 20 years we've known you can get the cleanest clean, not by using those detergents you hear about on TV, but with an ultrasonic cleaner. The only flaw lay in the price of silent-sound scrubbers. The smallest ones cost $75 to $100.

We herewith present the first build-it-yourself ultrasonic cleaner, which you can put together for about half the cost of commercial units.

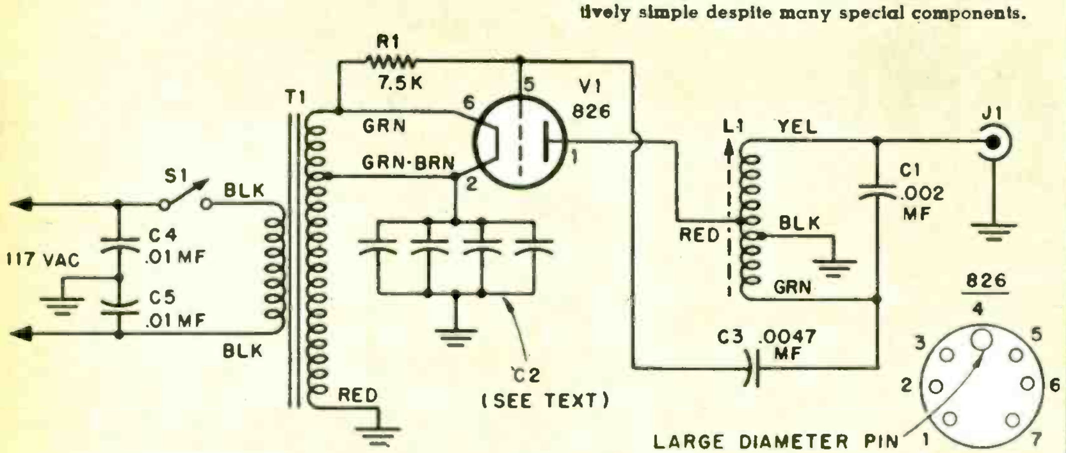
In an ultrasonic cleaner it's the cleaning fluid that does the work, doing a better job in seconds than you could do in hours of hand-scrubbing. Jewelry, small parts, even your eyeglasses come out with more sparkle than when new.

An ultrasonic cleaner is a comparatively simple device consisting of a generator (or power oscillator) producing a high-frequency electrical signal and a transducer which converts this electrical energy to mechanical energy (sound waves) and couples it to a cleaning fluid. When the h-f acoustic energy hits the cleaning fluid, cavitation takes place and that's what does the scrubbing. Millions of microscopic vacuum bubbles or cavities are formed. As the cavities collapse (implode) they create pressures up to 20,000 pounds per square inch. The term cavitation comes from these cavities.

Anything immersed in cavitating fluid thus is subject to immense pressures, and dirt clinging to it is blasted away. Yet ultrasonic cleaning is so gentle that a delicate microscope slide comes out spotless and also in one piece.

This ultrasonic cleaner has a one-pint capacity and uses an easy-to-build generator circuit. Arrangements have been made with a manufacturer of ultrasonic cleaners (see Parts List) to supply all special components as a kit for $39.95. While some of the items are standard, the kit includes them because we were able to obtain an extremely low price on them. Including chassis and finishing

Cleaner's power oscillator schematic is relatively simple despite many special components.



ULTRASONIC CLEANER

components, the total cost is approximately $45.

The generator is built on a 7 x 9 x 2-inch aluminum chassis with the layout shown. To avoid an arc-over from the tube socket to the chassis, use a 2-inch diameter cut-out for the socket. Notice that the tube socket has seven pins, one larger than the others. Position the socket so the large pin is toward the front panel. Be sure to leave sufficient space between the socket and panel for power switch S1.

L1 is tuned by a metal slug attached to a rod. Since the slug must slide freely inside L1, the rod's grommet hole must be carefully positioned on the front panel. Drill a 3/8-inch hole 1/2-inch down from the top of the chassis on the centerline of L1's cut-out.

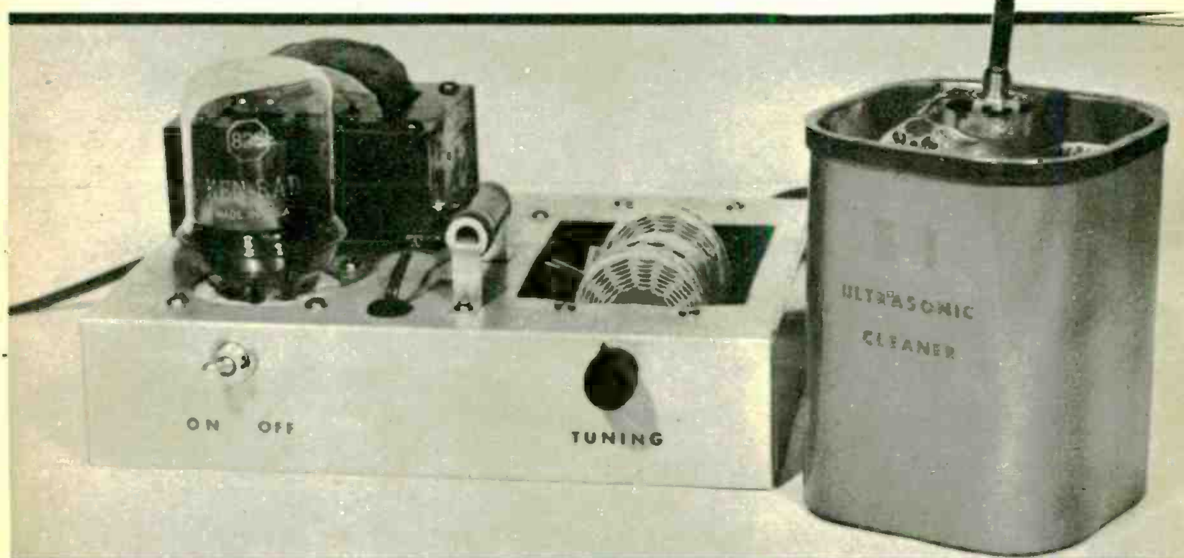
Assemble as follows: First insert the tuning rod inside L1. Then mount L1 in place with a 1/2-inch conduit strap at each end; the straps may have to be expanded to fit around L1. With the mounting strap screws loose, position L1 so the tuning rod slides in and out through the grommet without binding. Tighten the strap screws, then push the tuning rod all the way back into L1. The

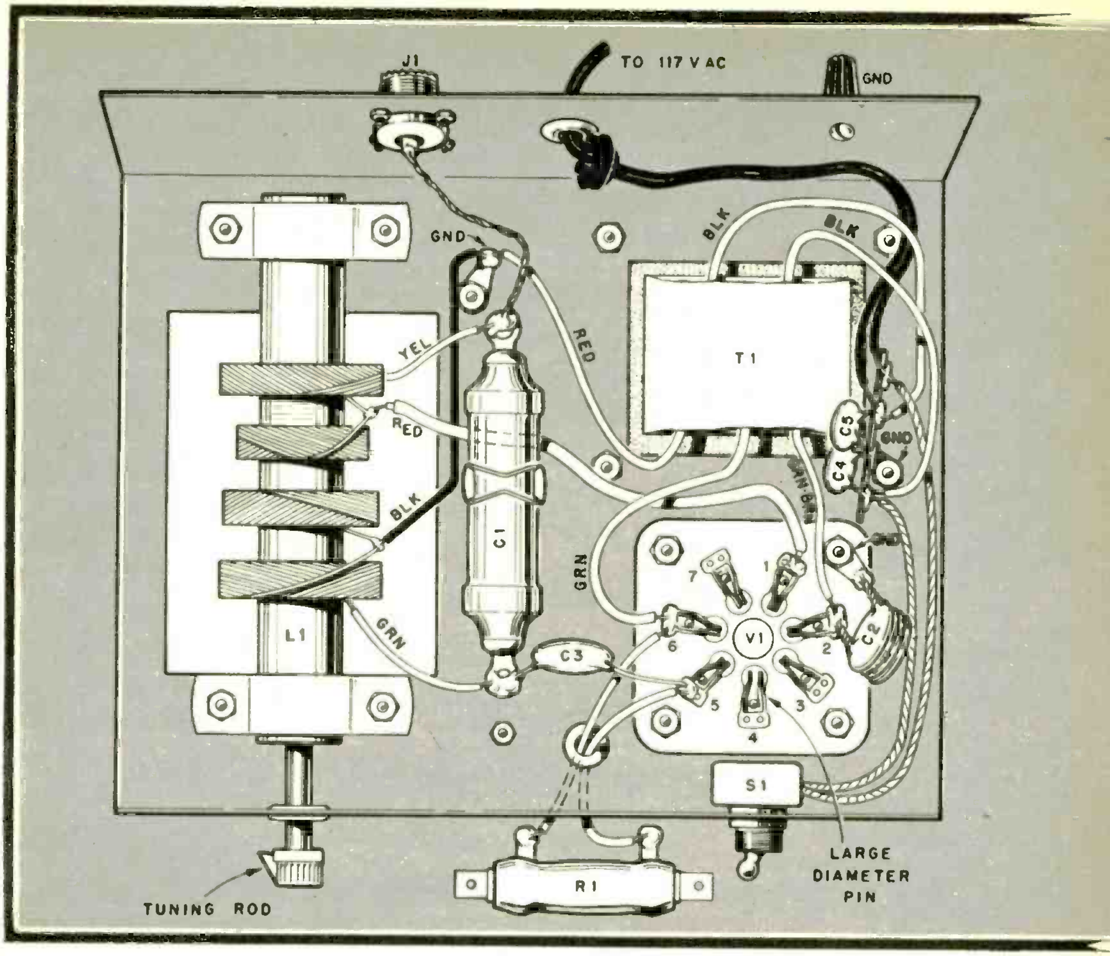
PARTS LIST

R1—7,500 ohm, 25-watt resistor
C1—.002 mf, 3KVDC (Special or transmitting mica capacitor, UI 40C1-42)
C2—.02 mf, 3KVDC (4 parallel-connected .0047 mf, 3KV disc capacitors)
C3—.0047 mf, 3KVDC ceramic disc capacitor
L1—Coil and tuning slug assembly (Special, UI 40C1-24 and UI 40C1-20)
V1—826 tube and socket (Johnson type 247)
T1—Power transformer (Special, UI 40C1028)
Misc.—transducer, tank and hardware (Special)

The above components are available as a kit from Ultrasonic Industries Corp., Ames Court, Engineers Hill, Plainview, N. Y. The price is $39.95 postpaid. Optional tank housing is $3.50 additional postpaid.

C4,C5—.01 mfd 600 vdc ceramic disc capacitors
J1—Coaxial jack type SO-239
PL1—Coaxial plug type PL-259
S1—SPST
Misc.—2½-inch conduit straps (to clamp L1) available at hardware stores; 4 feet coaxial cable (type RG59A/U)





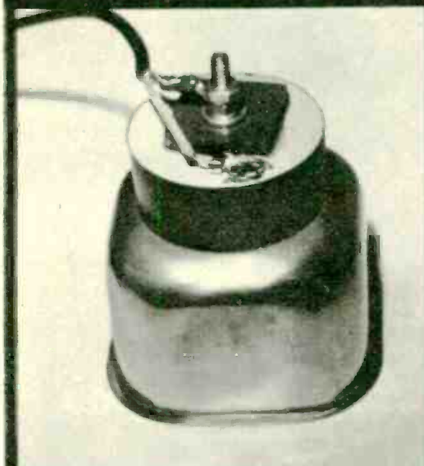
rod will stay inside the chassis, avoiding damage as you complete the wiring.

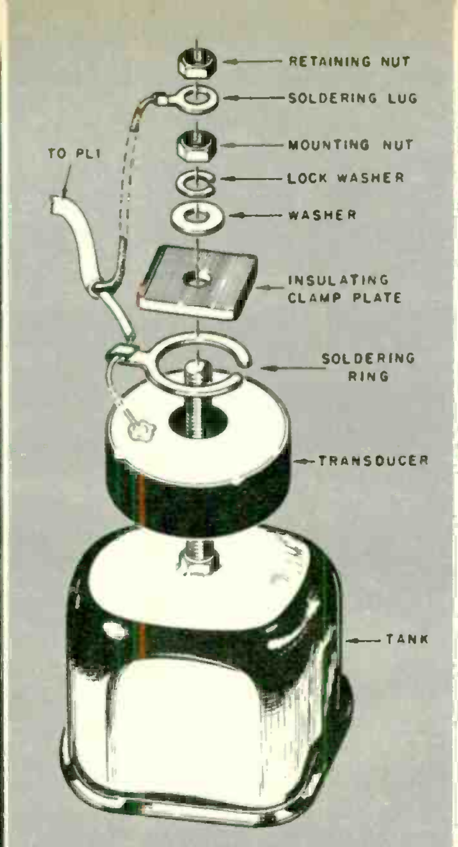
Capacitor C2 is four paralleled .0047 mf ceramic discs totaling approximately .02 mf. Use the parallel arrangement since a single .02 mf capacitor may be destroyed by internal heating. Prior to installation, twist C2's leads together and solder each as one heavy lead.

While there *is* room for R1 under the chassis, it gets fairly hot and is best mounted on the top as shown. After mounting, make sure R1's contacts cannot touch the chassis. When all wiring is completed, pass the tuning rod through its grommet and attach a knob. Since the generator develops over 1,000 volts, both a protective bottom plate and a well-ventilated chassis cover should be provided.

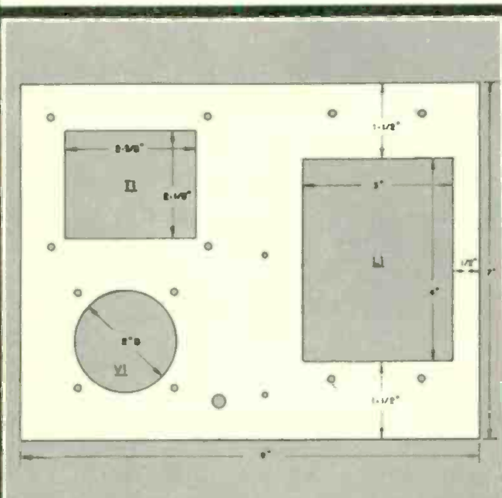
The tank assembly is shown in an exploded view. Note that both sides of the transducer appear to be painted white. It is not paint however, but a layer of silver and must be handled carefully. Prior to assembly, clean both sides of the transducer and the bottom of the tank with a solvent such as Chlorothene (a household detergent will do in a pinch, but be sure to rinse the components).

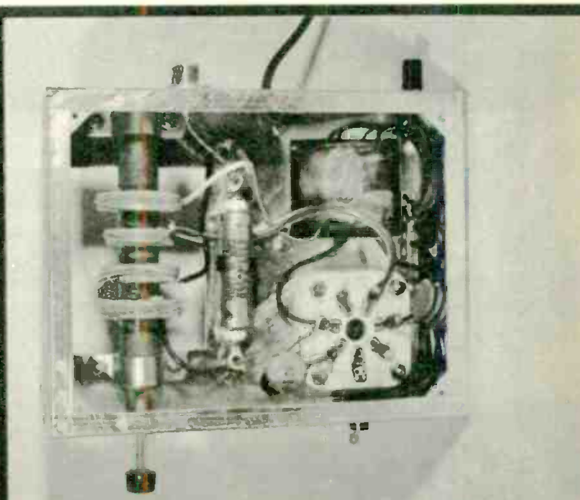
For proper transmission of the acoustic energy, the tank must be assembled with epoxy. And since the bottom of the





Assembly of transducer is critical. Follow the text carefully as an assembly error after the use of epoxy glue cannot be remedied.





Chassis layout (top view) should be followed. Space high-voltage components away from chassis to prevent arc-over. Tuning rod hole is drilled last.

tank serves as the ground connection it must also be in good electrical contact with the transducer. Arrange short lengths of stranded wire on one side of the transducer (see photo) and coat the surface with epoxy. Place the insulating sleeve (not shown) around the tank stud and lower the transducer, epoxy side down, centered around the tank stud. Place the soldering ring on the transducer so it is also centered around the stud. Apply a coating of epoxy to one side of the insulating clamp plate and lower the plate, epoxy down, on the soldering ring. Apply a flat washer, a lock washer and the nut. Tighten firmly. Allow 24 hours for the epoxy to set. Then place a solder lug on the stud held in place by a second nut.

The tank housing can be fabricated from sheet metal, but a rubber rim must be placed between the housing and the tank's rim to prevent spilled solvent from getting to the transducer. A housing complete with rubber rim is available for $3.50 (see Parts List).

Strip three inches of the outer insulation from one end of the coaxial cable and pull the center conductor through the shield at the insulation. Solder the shield, as near as possible to the insulation, to the soldering lug on the tank's stud. Strip 1½ inches of insulation from the center conductor and tin the exposed strands. Force the center conductor against the transducer's silvered surface and, using a low-wattage iron, solder the wire to the soldering ring and transducer. Pass the free end of the coaxial cable through the tank housing and install coaxial connector PL1. If desired, the free end of the cable can be connected directly to the generator's output terminal and ground. If a direct connection is made, use a cable clamp at the generator to secure the cable.

Before connecting the tank to the generator, check it out with an ohmmeter. The cable shield should have continuity to the tank and open circuit to the center conductor. The center conductor should read continuity to the transducer's exposed silver surface. Pass the excess cable through the housing and force the tank into the housing, pulling the cable through.

WARNING: NEVER OPERATE WITHOUT FLUID IN THE TANK.

For your protection, ground the generator by connecting a wire (#18 or #16) between the generator chassis and an external ground.

For check-out, pour a mixture of water and liquid detergent into the tank (10 oz. water, .5 oz. detergent). Turning on the power will result in the 826's filament glowing a bright white-yellow. In a few seconds the fluid will cavitate (cold boiling). Adjust the tuning rod for maximum activity as evidenced by vigorous boiling. Boiling may occur at several settings of the tuning rod but one or two settings will provide maximum action.

Remember: never put your hand in the solution while the unit is on.

The proper cleaning solution depends on what you're trying to clean. Plain detergent and water is good for some applications. A dash of ammonia helps. The kit of parts for this unit includes a Cleaning Solution Data Chart. There are several precautions to be observed:

- Do *not* use highly inflammable solutions since cavitation causes heat.
- Do *not* use toxic or low-flash-point solvents. Under ultrasonic agitation, carbon tetrachloride will form phosgene, a deadly gas. Low-flash-point solvents like benzene and naphtha develop vapors which are easily ignited. •

150,000 RPM

A NEW three-phase induction motor (above) built by Toshiba of Japan is capable of doing 150,000 rpm, a record in its class. The water-cooled unit operates on 300-380 volts at 2,500 cycles, requiring a special static inverter which has a silicon-controlled rectifier. It has a rating of about 270 hp. The motor will be used to turn high-speed lathes and grinders. •

make your own

Printed Circuits

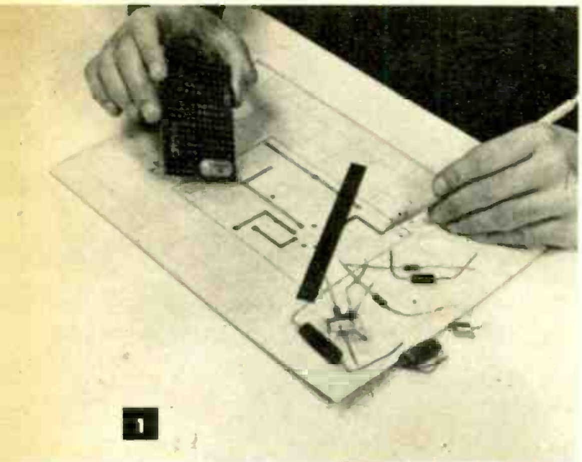
By Harry Kolbe

NEW, INEXPENSIVE techniques and materials have brought printed circuit projects within the reach of all. Hard to get materials and tedious drilling have been eliminated by a number of new developments. The introduction of *perforated* copper-clad boards, and a whole variety of resists take the work out of do-it-yourself printed circuit-board design and fabrication.

Let's look at the boards first. The holes in the board are $\frac{1}{16}$" in diameter with $\frac{3}{16}$" between hole centers. Four different board sizes are available, one of which should be about right for your latest project. Of course, the boards may be easily cut with a variety of tools to any desired size.

Circuit Layout and Design. Most of the same techniques used to lay out perforated chassis boards also apply to the copper clad boards. Without repeating the entire discussion, there are several points worth mentioning.

Graph paper is an excellent design aid for use with these boards.



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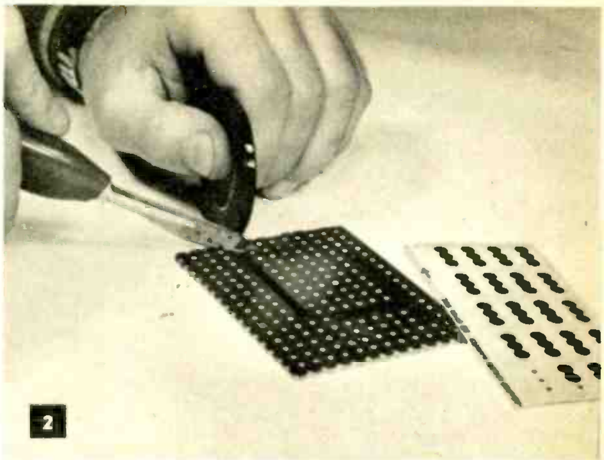

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Each intersection of vertical and horizontal lines represents a hole in the board and the layout sketch made on the graph paper need not be to scale. It's a good idea to have all the components on hand before starting for you can plan your layout by mounting the components temporarily on the board. Simply bend the component leads and push them through the board perforations. After the components are in their final position, sketch in the common buss lines such as ground and B+.

How to use Resist. After the circuit has been designed on paper, it must be transferred to the copper foil on the board. Here's where we depart from the non-copper clad perforated board techniques. First a resist is laid down on the copper foil in the areas that are to serve as the "wiring." The areas unprotected by resist are eaten away by the acid. Available to the do-it-yourselfer are tape resists, liquid resists and ballpoint tube resists. All are inexpensive, easy to use, and stocked by most large mail order radio supply houses.

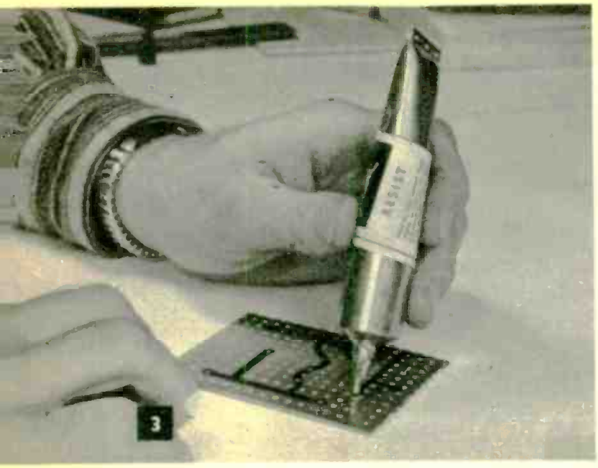
Tape resists are available in rolls of three widths (1/32", $\frac{1}{16}$" and ⅛"). To use tape resist, simply reproduce the conductor pattern in tape on the copper foil. Press the tape down firmly at conductor intersections and joints to prevent etchant leaking under the tape. Tape resist $\frac{3}{16}$" circles may be used at points where component leads are brought through and connected to the foil but are not really necessary with the perforated board. Remember to lay out the resist over the holes, not between the rows of holes.

Liquid resist is etchant resistant paint which can be applied to the foil with a small brush. Unlike tape resist, which is more or less limited to straight line conductor paths, liquid resist can follow the convolutions of any circuit pattern. When large areas of foil are to be covered, liquid resist is handiest to use. Its only disadvantage is that it must be removed from the foil before soldering. Fine steel wool will do the job easily.

The third, and perhaps most convenient to use, is a liquid resist dispensed in a $\frac{1}{16}$" stripe from a ballpoint tube. As with the other liquid resists, the resist must be removed later at points where the foil is to be soldered.

Etching the Board. It's important to realize that the chemicals used are highly corrosive and therefore dangerous. Keep the etchant in its tightly closed bottle and be careful not to splash it on your skin, clothes, or surrounding work areas. If an accident occurs, flood the etchant with water immediately and neutralize with sodium bicarbonate (baking soda). It might be a good idea to wear rubber gloves and work at the kitchen sink.

A recommended etchant manufactured by Techniques, Inc. is available in 6 ounce, pint, and quart sized unbreakable plastic bottles.



1 Graph paper ruled in ¼-inch squares is helpful in planning initial layout. 2 Tape resist may be used for straight lines and 3 ballpoint tube resist will serve for curves. Another type of resist 4 is a liquid which is applied with a small brush. This is suitable for covering large areas of foil. 5 After circuit is laid down in resist, the board is dipped in an acid bath. After etching is completed, the board is washed in water and is then ready to have the components installed.

Pour the etchant into a flat-bottomed glass dish, *never* a metal container. Carefuly check the resist on the circuit board in order to make sure that you have covered all of the copper foil that you wish to retain. Immerse the board in the etchant. Agitate the board in its bath every minute or so to encourage fresh acid to reach all areas of the exposed copper. Continue for 5 to 10 minutes until all the exposed copper has been eaten away. The time required cannot be stated exactly since it depends on temperature, thickness of copper, number of times etchant has been used, etc.

After the etching is complete, wash off the etchant under cold running water and then dry the board with a cloth. Strip off the tape resist, or if a liquid resist was used, remove it by rubbing lightly with fine steel wool. For ease of soldering, polish the copper with steel wool until it is shiny. Your etched circuit board is now complete. To use, simply place the components on the non-foil side of the board, push their leads through the perforations and solder them to the foil.

The total cost for the resist, boards, and etching materials is only about $3.00—and since there is enough material for seven or eight more projects, that figure comes down to about 37¢ a project. But your big pay-off is a professional-looking electronic device that is a snap to build. •

BASIC TRANSISTOR CIRCUITS

PART I

We take a look at the inner workings of a crystal diode for clues to transistor operation. Comparisons are made among the basic tube and transistor configurations and their biasing requirements.

PART II

What happens to the phase of a signal going through an amplifier? The question has practical significance since it determines whether a common-collector, common-emitter or common-base mode best suits a circuit.

PART III

Transistor amplifiers have three types of gain. With tubes, it's usually voltage gain that counts. But transistors are current-operated devices, so current and power gains are most important.

FROM pocket radios to computers, the transistor and its semiconductor relations are taking over a host of jobs previously reserved for the vacuum tube. A working understanding of these mighty midgets is as important to today's electronics enthusiast as his soldering iron or Ohm's Law. One of the best ways to become familiar with an electronic circuit or component is to put it through its paces in a variety of test setups. This is the approach we take in our basic transistor course.

Before dealing with the transistor, it would be a good idea to take a look at exactly how a diode works. A diode is made up of two crystals, a positive type (P) and a negative type (N) joined together. The P crystal serves as the anode and the N as the cathode. Fig. 1 shows a diode for two conditions of applied polarity. When the negative side of the battery is connected to the diode's anode and the positive to the cathode you have a situation known as reverse bias (A). Without getting into the matter of majority or minority current carriers, let it suffice to say that in the reverse bias condition current flow is minimized. In the forward bias condition (B), current flow is encouraged.

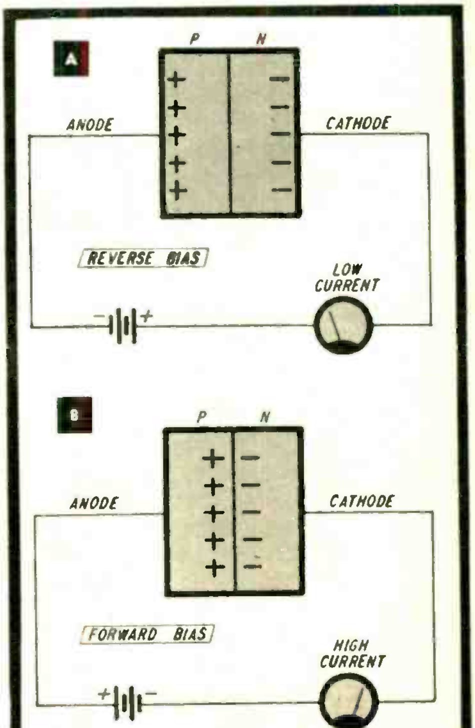


FIG. 1

Under reverse bias, the diode exhibits a high resistance, known as the *back* resistance of the diode. You can check it out with an ohmmeter and any diode, such as a 1N34A. Simply place the ohmmeter leads across the diode and take a reading. Now reverse the ohmmeter leads and the reading will differ considerably. It is the polarity of the battery in your ohmmeter that determines whether the diode is biased forward or reverse.

Transistors vs Tubes

All common transistors are three-terminal, three-element devices. Unlike the two-element diode, the transistor consists of a three-layer sandwich of P and N semiconductor materials. NPN transistors have two layers of negative material sandwiching one of positive; PNP's have the opposite.

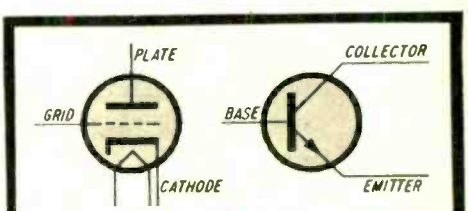


FIG. 2

The interactions of the layers in a transistor can be compared to the functions of the three elements in an electron tube (see Fig. 2). The emitter is comparable to the cathode, the base to the control grid and the collector to the plate. In both devices a flow of current originates at the first element, is regulated or controlled by the second and is received or collected by the third.

In a tube and in an NPN transistor the charges that travel from cathode to plate or from emitter to collector are electrons. In a PNP transistor, however, positive charges called holes are the carriers of electricity. This difference has little practical significance because PNP and NPN transistors in a circuit function the same way except that opposite polarity DC bias voltages are required.

On The Bias

If you've done any work with transistors, you're aware that they are biased differently than vacuum tubes. In tubes, the control grid is usually given a negative voltage with respect to the cathode (reverse bias) which tends to repel electrons coming toward it from the cathode. By varying this negative voltage, we can control the number of electrons attracted toward the positively charged (forward-biased) plate.

In the NPN transistor, a forward bias voltage is set up between emitter and base, while a reverse bias is established between collector and base, as in Fig. 3. The negative potential of battery B1 repels the electrons from the N-type emitter, while the positive potential at the base attracts them. Resistor R1 sets the bias level and, therefore, establishes the amount of current flowing from emitter to base.

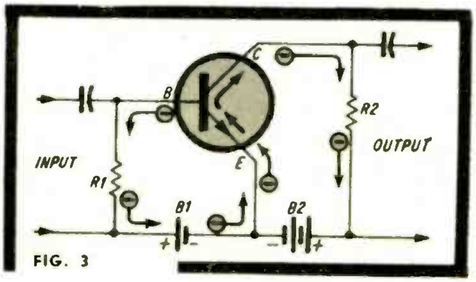


FIG. 3

Now let's look at the emitter-collector (EC) circuit. We take another battery (B2) and connect its negative terminal to the emitter and its positive terminal through R2 to the collector. Now the positive biased collector attracts the electrons from the base-emitter (BE) junction. However, the number of electrons that can enter the collector is determined by the current flow through the base-emitter junction. Without going into the complexities of semiconductor physics, let it suffice to say that the current flow in the base-emitter circuit controls the current in the emitter-collector junction. And since a small current variation in the BE circuit causes a much larger variation in the EC circuit, we have amplification.

The PNP transistor works in the same way as the NPN type discussed above. There *is* a difference in the hole and electron flow but, as we mentioned, the only practical distinction is in the bias polarities. It's easy to remember: the PNP transistor operates with a positive voltage on its emitter with respect to the collector and base; the NPN transistor operates with a negative voltage on its emitter.

Three Ways to Amplify

Vacuum tubes can be used in three distinct circuit configurations: grounded cathode, grounded grid and grounded plate, as shown in Fig. 4. A similar division exists among transistors. The common-base (CB), common-emitter (CE) and common-collector (CC) types are shown in Fig. 5. A standard CE amplifier using a PNP transistor is shown in Fig. 6. *(NOTE: all resistors shown are ½-watt, 10% except R8, which is 2 watts. All capacitors are electrolytic, 10 volts or higher rating.)* The input signal is applied to the base and the output is obtained at the collector. In the equivalent vacuum-tube amplifier the input signal is fed to the grid and the output obtained at the plate.

Note that unlike our previous theoretical example, in the practical circuit of Fig. 6 a single battery (B1) supplies bias voltage to both the base and collector. At the input, the base connects into the voltage divider formed by R1 and R2 across battery B1. This places a bias voltage on the base (with reference to the emitter) of about 1/10 the battery voltage.

Another resistor, R3, has been placed in the emitter lead. With

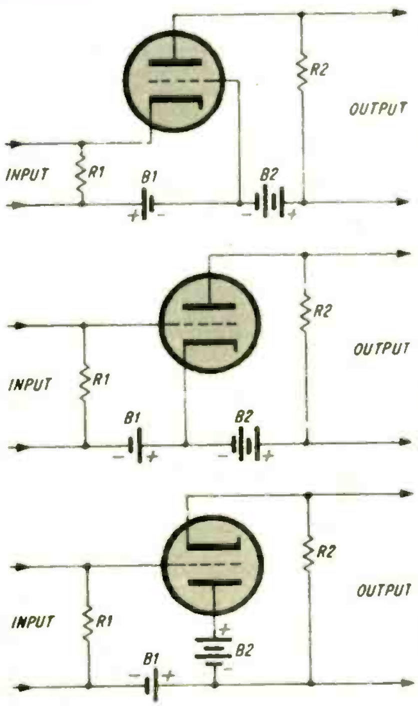


FIG. 4

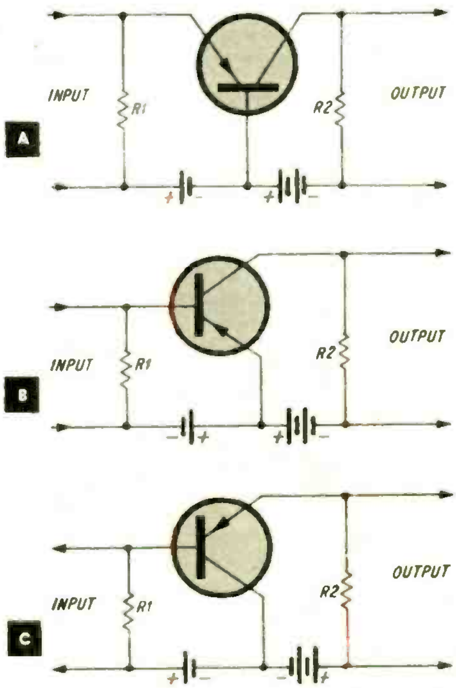


FIG. 5

Three basic tube configurations and their transistor equivalents. Batteries are used to indicate polarity of the voltages applied to the elements. Note that the terms "common" and "grounded" are used interchangeably, although no grounds are shown in the schematics. The ground in each case can be placed at the junction of the two batteries.

A Grounded grid and grounded (or common-base) amplifiers. The tube version is encountered in RF front-ends and in cathode-coupled phase inverters. The common-base transistor circuit usually serves in oscillators.

B The grounded cathode tube and grounded (common) emitter transistor configurations are the standard workhorses found in conventional single or multi-stage amplifiers.

C The common-plate (better known as the cathode-follower) and the common-collector (or emitter-follower) generally serve to match a high impedance at their input to a low impedance at their output.

current flowing through the transistor, a voltage develops across R3 which makes the emitter negative with respect to R3's lead going to B1+. The total base-emitter voltage is thus equal to the voltage across R2, *minus* the voltage across R3. The two voltages buck each other, but the voltage across R2 is always larger; otherwise, no current would flow.

It is also necessary to provide a negative voltage (reverse bias) between collector and base. This is accomplished in Fig. 6 by connecting one end of resistor R4 to the negative terminal of the battery. Note that the negative voltage at the collector is far higher than the voltage the divider permits at the base. This establishes the reverse bias between these two elements.

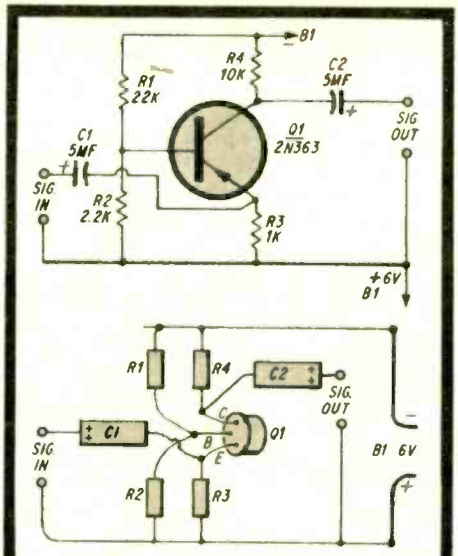


FIG. 6

In Part II we will examine the three basic circuits from the point of view of two of their significant operating qualities—input and output phase and amplification.

PART TWO

The phase change (or lack of it) that takes place when a signal travels through an amplifier stage is important when dealing with phase inverters and oscillators.

Phase Flipping

The standard common-emitter, like the standard amplifier tube circuit, reverses the phase of any signal passing through it. We can demonstrate this in a simple experiment using the circuit of Fig. 6. Connect a volt-meter or VOM set for a low DC voltage range with its negative lead to the collector and its positive to ground (B1+). The meter will read between 2 and 4 volts.

As a signal source we will use a 1.5-volt flashlight battery with a

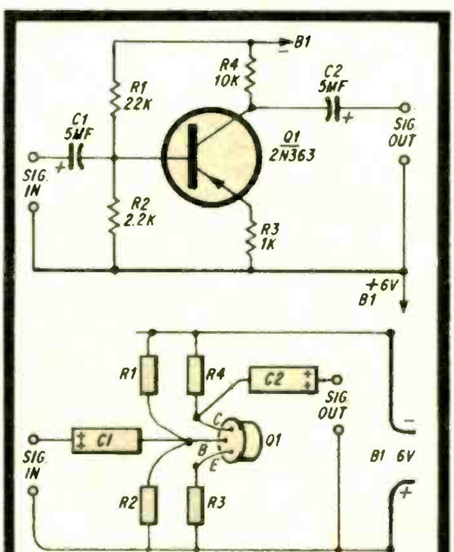


FIG. 7

4-inch piece of wire soldered to each terminal. Momentarily connect the positive battery lead to the base of Q1 and the negative lead to the common-ground (B1+). Note that the meter (which is reading the *negative* collector voltage) rises two or three volts. In other words, the collector went *more* negative. If we reverse the situation and connect the positive terminal of the battery to ground and the negative terminal to Q1's base, the meter reading falls: the collector goes more positive (or less negative).

We see, therefore, that a positive input signal produces a more negative collector voltage. This 180° signal phase change is characteristic of the common-emitter amplifier.

There are two remaining transistor amplifier arrangements, common-base and common-collector. We'll examine the common-base arrangement (Fig. 7) first.

In a CB amplifier, the input signal is fed to the emitter and the output signal obtained from the collector. As with the other circuits, the name for this arrangement stems from the fact that one element (in this case the base) is common to both the input and output circuits. Note that the CB circuit is equivalent to the grounded-grid vacuum-tube amplifier configuration, such as is used in phase inverters and RF amplifiers.

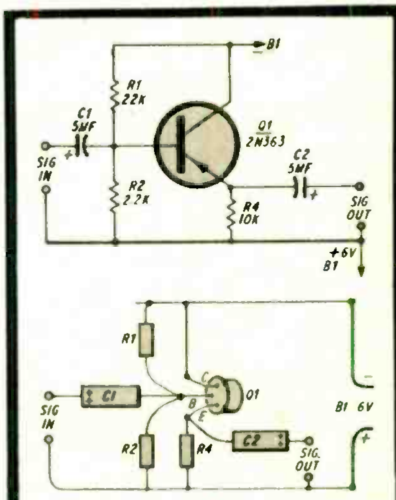


FIG. 8

To determine what happens to the phase of a signal we'll use the circuit shown in Fig. 7. Connect the negative lead of the voltmeter to Q1's collector and the positive lead to common-ground (B1+). With the circuit in operation, the voltmeter will indicate 2-3 volts.

As before, we'll use the battery as a signal source. With the negative lead of the flashlight battery on the common ground (B1+), touch the positive lead to Q1's emitter and observe the meter needle. It will fall below scale and if you switch the meter leads you'll find that you have a reading of over 1 volt. In other words, a positive voltage signal at the input (emitter) of the common-base amplifier causes a corresponding positive signal at its output (collector).

As a double check, we can connect the battery with its positive terminal to ground and the negative lead to the input terminal (emitter). Note how the meter rises about 3 volts from its previous reading—indicating, as we would expect, that the voltage at the collector has gone more negative.

Now let's check the common-collector circuit of Fig. 8. Since the CC is the transistor analog of the vacuum-tube cathode-follower, it is frequently referred to as the emitter-follower. Like the CE amplifier in Fig. 6, the input signal is applied to the base. However, the collector doesn't feed a load resistor. It is connected directly to the battery. Signal output is obtained at the emitter, clinching the resemblance to the cathode-follower.

We can check the phase shift from input to output in the following way. With the circuit wired as shown in Fig. 8, place a voltmeter across R4 with the positive lead to ground (B1+). Less than 1 volt should be read.

Now connect the test battery with its negative lead to ground (B1+) and its positive lead to Q1's base. The meter falls to slightly *below* zero. Reversing the battery and placing the negative lead on the base of the transistor causes the voltage to rise about 1.5 volts. In other words, a negative signal at the input of a CC circuit caused an *increase* in the negative voltage at its output terminal. And, conversely, a positive voltage causes a *decrease* in negative voltage. This means that there is *no* phase reversal as a signal passes through the circuit, which is exactly the case with a vacuum-tube cathode-follower.

PART THREE

A key characteristic of an amplifier is its gain. In transistor amplifiers, we have three types of gain to consider. Most familiar (from vacuum-tube amplifiers) is voltage gain—the ratio of the output voltage of a stage to its input voltage.

Secondly, there is current gain—the ratio of output current to the input current. Finally, there is power gain—the ratio of output power to input power.

Amplification: E and/or I

Since transistors are primarily current-operated devices, current and power gain are most important. Transistors usually are employed as power amplifiers, even when used in the RF stages of a radio or TV receiver. Vacuum-tube amplifiers, on the other hand, usually are voltage amplifiers and their power gain becomes important only when a power-operated device such as a loudspeaker is to be driven.

There are times when transistor voltage amplification *is* important (for example, when a transistor drives a TV picture tube); however, if a transistor drives another transistor or a speaker, it must provide power—not voltage. Remember, in any circuit power equals voltage × current ($W=EI$) or the square of the current × the circuit's resistance ($W=I^2R$). This means that any transistor with a high current gain usually has a high power gain. That is why such emphasis is placed on the current gain of a transistor stage.

In the experiments below we will first measure voltage gain and then check the individual current gains of the three basic amplifier configurations. From these two characteristics, we will be able to calculate their respective power gains.

Voltage Gain. For the experiments, we will use the transistor circuits of Figs. 6, 7 and 8. In each case, a small 6.3-volt filament transformer serves as the signal source, using the circuit shown in Fig. 9. The AC input signal is kept small in order not to overdrive the transistor. An oscilloscope will be used to view the transistor output.

The general procedure for each amplifier circuit is the same. We'll use the circuit of Fig. 6 and apply the AC signal voltage at the input of the stage. The oscilloscope is connected across the output terminals. Start with zero AC input and gradually increase the signal (by rotating potentiometer R6) until the waveform of the oscilloscope screen starts to lose its sine-wave shape and distort. Then, back off R6 until the distortion disappears. Note the height of the pattern by measuring it with a ruler or using the ruled mask over the scope screen. Then, without touching anything else, place the input leads of the scope across the input voltage and measure the height of the sine-wave appearing on the screen. By dividing the input voltage reading into the output voltage reading, the voltage gain of the amplifier stage can be computed quickly. Check each set of measurements several times to make certain the correct figures are obtained.

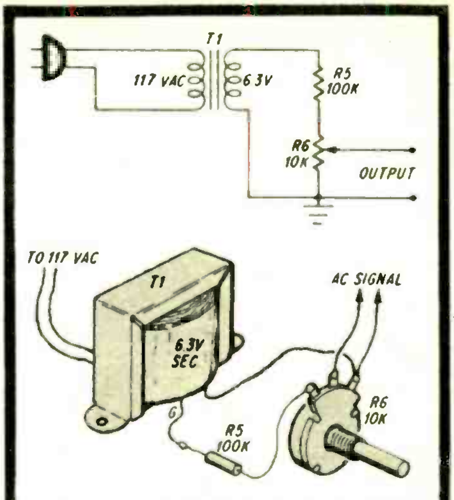


FIG. 9

Of the three circuits, it will be found that the CB amplifier has the largest voltage gain, while the common collector has the smallest. In fact, the voltage gain of the CC amplifier is somewhat less than 1—which means that you actually get less signal voltage out than you put in. In the CE and CB arrangements, a fairly sizeable voltage gain will be obtained.

Finding the Beta

Now we'll measure the current gains of each amplifier type, starting with the common-emitter circuit of Fig. 10. In the CE mode, current gain is referred to as *beta*. Actually there are two current gains to deal with—AC and DC. A small-signal AC *beta* test is made on low- and medium-power transistors. The large-signal DC *beta* test is for high-power transistors. Low-power transistors designed for switching are exceptions to this rule, since the DC *beta* test best simulates their actual operating conditions.

DC Beta. When dealing with DC current gain, as we will be in the experiment below, the gain is determined with the formula:

$$beta = \frac{\text{collector current}}{\text{base current}}$$

To set up the experiment, adjust R7 (Fig. 10) to 50,000 ohms as measured by an ohmmeter. The resistance in the base-emitter circuit (R7 plus R4) then totals 60,000 ohms. The 1,000 ohms of R3 can be disregarded since it is negligible in comparison to the other figures.

With a 6-volt power supply and 60,000 ohms in the base-emitter circuit there is .1 ma of current flow. Now measure the voltage across R8 (say it's about 1.5 volts) and divide it by R8's resistance (470). This gives you about .003 amps (3 ma) as the collector current. If we now divide this 3 ma collector current by the .1 ma base current, we have the DC current gain for the stage—30. It's as simple as that!

With the 2N363 transistor, current gain of anywhere from 15 to 40 can be expected. As a check, we can set R7/R4 for a total of 40,000 ohms. Now .15 ma is flowing in the base circuit. If you calculate the collector output current as above, you'll find that the current gain has remained the same. This will be true over a moderately wide range of input current.

AC Beta. The AC current gain test gives a better idea of what we may expect of a transistor under operating conditions. The AC *beta* describes the amount that a small change in base current (Ib) is reflected by a change in collector current (Ic). Expressed as a formula:

$$\text{AC } beta = \frac{\text{Ic change}}{\text{Ib change}}$$

The circuit of Fig. 10 will serve also for AC *beta* checks. As a start, we have the figures obtained in the DC *beta* measurement—.1 ma base current and 3 ma collector current.

Now set the R4/R7 combination to provide a total base circuit resistance of 30,000 ohms. With the 6 volts of B1, this produces a base circuit current of .2 ma (I=E/R). This represents a *change* in base current (Ib) of .1 ma from the previous value. This figure goes in the denominator of the equation.

For the Ic change figure needed for the numerator, we measure the voltage across R8 and divide it by R8's resistance. This gives the new Ic. The difference between this value of collector current and the previous DC *beta* value is placed in the numerator. Work out the equation and the answer is the AC *beta* value for the specific 2N363 transistor you used in the circuit of Fig. 10. (For other circuit arrangements, the transistor, may have slightly different values of AC and DC *beta*. In normal operation, however, all will be fairly close together.) If one checks out, the other will too.

Analyzing the Alpha

Let's turn to the current gain of the common-base circuit shown in Fig. 11. In the common-base configuration, the symbol *alpha* is used for current gain. *Alpha* expresses the ratio of collector current (Ic) to emitter current (Ie) or

$$alpha = \frac{\text{Ic}}{\text{Ie}}$$

Common Base Gain. First, adjust R2/R4 to a total value of 6,000 ohms for a current flow of about 1 ma in the base-emitter circuit. If you measure the voltage

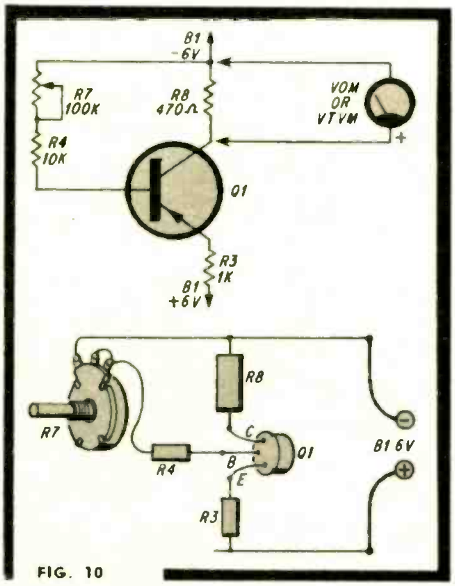


FIG. 10

across R8 and divide it by 470 (ohms) you'll find a collector current of between .9 and .95 ma. In spite of the fact that the common-base amplifier provides the best voltage gain, its current gain is less than 1. This means there's a current *loss* between input and output.

As with the previous circuits checked, stage amplification can be approached from both DC and AC gain. The AC *alpha* is measured in much the same way as with the previous circuits. The formula is:

$$\text{AC } alpha = \frac{\text{Ic change}}{\text{Ie change}}$$

Note the currents in the emitter and collector circuits from the DC check. Now reduce the emitter current by increasing the resistance of R4 and note the corresponding change in collector current. Subtract the new figures from the old ones, insert them in the above equation—and you have the AC *alpha*.

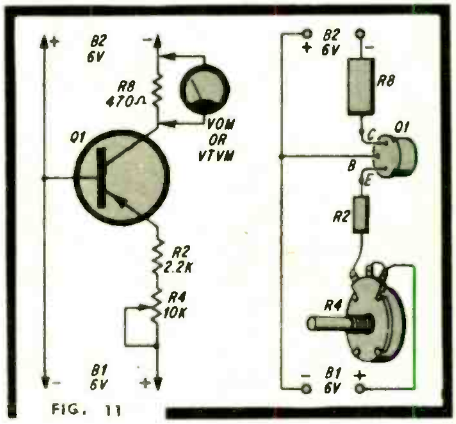


FIG. 11

If you're wondering what the relationship is between *alpha* and *beta* (other than the fact that they follow each other in the Greek alphabet), it's expressed in the formula:

$$beta = \frac{alpha}{1 - alpha}$$

Common-Collector Gain. Fig. 12 shows how a common-collector circuit's current gain is checked, using the same techniques that served us for the other circuits. The R4/R7 combination is adjusted for a total resistance of 60,000 ohms. (We can ignore R8.) Measure the voltage across R8 and divide this value by 470 (ohms) to arrive at the current flowing in the emitter circuit. As in the common-emitter arrangement, a fairly high current gain is obtained.

Now let's review our findings. We saw that the common-emitter and common-collector circuits have about the same current gain, whereas the common-base arrangement produces a current gain of less than 1. If we combine this information with the voltage-gain data determined earlier, we can determine the relative power gain of the three configurations.

In the CE stage, the voltage and current gain were both good. When these two quantities are multiplied together (W=EI) excellent power gain will result. In the CB amplifier, the voltage gain was good, but the current gain low. Its power gain, therefore, is less than that of the common-emitter. Finally, in the common-collector circuit, we found a voltage gain of less than 1, but a good current gain. Here again, we see that the power gain of a CC amplifier is not as high as that of the common-emitter amplifier. Actually, the CC's gain is the lowest of the three types.

Because the common-emitter arrangement has the best combination of current and power gain it is the type most frequently used.

The common-base arrangement is an excellent choice for oscillator circuits because the input and output phase are the same. By simply feeding a small amount of output voltage back to the input, oscillation can be obtained.

Finally, the common collector is useful as an impedance matching device because, like the tube cathode follower, it has a high input impedance and a low output impedance.

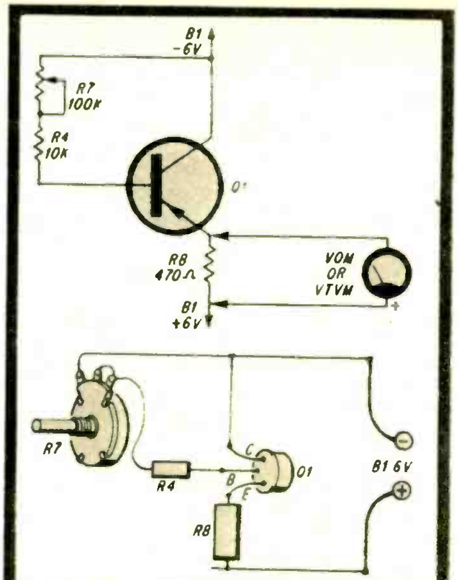


FIG. 12

For those interested in pursuing transistors and transistor circuitry further, scores of books and pamphlets are available from libraries, bookstores, parts distributors or publishers. Here is a selection of these publications:

Basic Theory and Application of Transistors.
U.S. Govt. Printing Office, Washington 25, D.C. $1.2[illegible]
Facts on Transistors. By Walter J. Cerveny
Hickok Electrical Instrument Co., 10532 Dupont Ave., Cleveland, Ohio. $
Power Transistor Handbook. Motorola Semiconductor Div., Phoenix, Ariz.
Semiconductor Devices. By Rufus P. Turner
Holt, Rinehart & Winston, Inc., 383 Madison Ave., New York, N. Y. $7.5[illegible]
Transistor Circuit Handbook. By L. Garner
Coyne Electrical School, 1455 W. Congress Parkway, Chicago 7, Ill. $4.9[illegible]
Transistors in Radio and Television. By Milton S. Kiver
McGraw-Hill, 330 W. 42nd St., New York, N. Y.
Transistor Manual, 4th Ed. General Electric Co., Syracuse 1, N. Y. $
Transistor Physics and Circuits. By Robert L. Riddle, Marlin P. Ristenbatt
Prentice Hall, Englewood Cliffs, N. J.
Understanding Transistors. By Milton S. Kiver. Allied Radio, Chicago, Ill. 50¢

GERNSBACK LIBRARY, 154 W. 14th St., New York, N. Y.
Basic Transistor Course. By Paul R. Kenian.
Fundamentals of Semiconductors. By M. B. Scroggie. $2.9[illegible]
Transistor Circuits. By Rufus P. Turner. $2.7[illegible]
Transistor Techniques. $1.5[illegible]
Transistors. $1.9[illegible]
Transistors—Theory and Practice. By Rufus P. Turner. $2.9[illegible]

JOHN F. RIDER, INC., 116 W. 14th St., New York, N. Y.
Basic Transistors. By Alexander Schure. $3.9[illegible]
Fundamentals of Transistors, 2nd Ed. By Leonard Krugman. $3.5[illegible]
Fundamentals of Transistor Physics. By Irving Gottlieb. $3.9[illegible]
International Transistor Substitution Guidebook. By Keats Pullen. $1.50
Principles of Transistor Circuits, 2nd Ed. By S. W. Amos. $3.9[illegible]

HOWARD W. SAMS & CO., Indianapolis, Ind.
ABC's of Transistors. By George B. Mann. $1.2[illegible]
Transistor Circuit Manual. By Allan Lytel. $4.9[illegible]
Transistor Substitution Handbook. $1.5[illegible]

transistorized FM BOOSTER

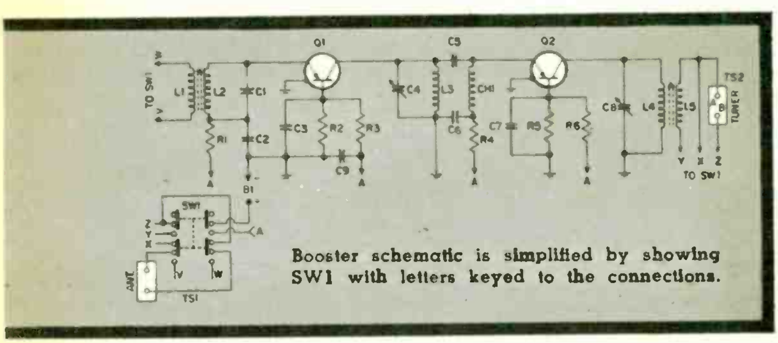
If stereo FM has put you in the fringe area, get back to hi-fi with an 18-db boost in signals.

By Ed Lininger, Amperex Electronic Corp.

STEREO FM broadcasting brought new problems, as well as new joys, to the ardent audiophile. FM tuners which had more than adequate sensitivity for standard FM broadcasts suddenly delivered noise and distortion when adapted for stereo. As has been mentioned many times, the effective range of stereo broadcasts may be cut by a third in comparison to the signal strength of the equivalent mono broadcast. A better antenna usually helps, but if its installation presents difficulties for you, a booster may be the answer.

This transistorized FM Booster adds two RF stages to your tuner. Connected between the antenna and the tuner, the Booster's 18-db gain (and noise figure of better than —50 db) will bring in those once faint stations with excellent fidelity.

Construction. The prototype was built on a perforated Bakelite board, but the reader has the option of construction techniques. To eliminate hand capacity effects, the Booster board could be enclosed in a metal cabinet. For clarity, the pictorial shows the leads somewhat longer than necessary. In practice, keep the leads as short as possible. The two coil forms shown (L2, L4) are modified by the addition of L1 and L5. These consist of 2½ turns of No. 28 enamel wire interwound between existing turns of



Booster schematic is simplified by showing SW1 with letters keyed to the connections.

input and output coils L2 and L4.

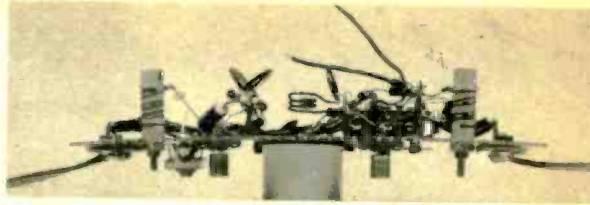
Inductance L3 consists of 2½ turns of No. 18 enameled wire wound on ⅜" rod with the turns spaced about the diameter of the wire. After winding, remove the rod and mount L3 directly to the terminal strip.

If you have difficulty obtaining the coil forms specified for L2 and L4, you can make two more coils like L3, except this time leave in the ⅜" diameter forms. Then wind L1 and L5 on the forms as before.

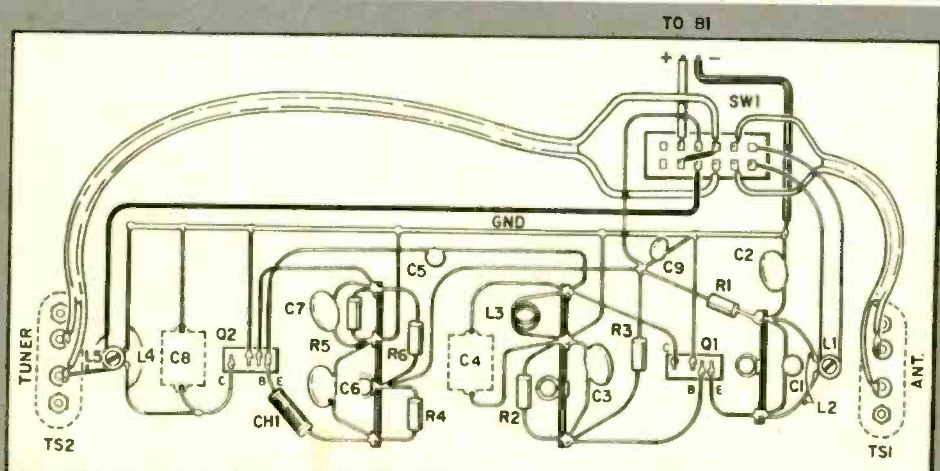
Choke CH1 consists of 30 turns of No. 28 enameled wire close wound on (and soldered to each lead of) a 1-megohm, 1-watt resistor.

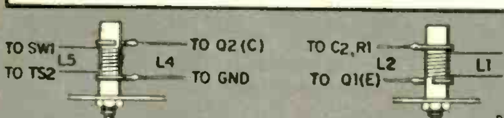
Switch S1 both turns the booster on and off and switches the antenna from the input of the booster to the input of the FM set. A transistor radio 9-volt battery eliminator serves as B1.

Adjustment and Operation. For general use, tune in a weak station at the center of the dial and then switch on the booster. Tune C4 and C8 for maximum response as indicated either by the tuner's tuning eye or meter. If it is not possible to peak C4 or C8 for maximum tuner response, its corresponding coil may not have sufficient inductance. You can vary the inductance by adjusting the coil cores. Note that the bandpass of the Booster is about 4 megacycles wide. This means that it would be best to use C4 and C8 to tune the Booster to the station you're most interested in receiving. •



Profile of the Booster shows the relationship of the coil forms and the other major components.





Pictorial of Booster shows parts drawn with long leads for clarity. In practice, keep the leads short.

PARTS LIST

Resistors: ½-watt, 10% unless otherwise indicated
R1,R4—560 ohms
R2,R5—6,800 ohms
R3,R6—1,500 ohms
Capacitors: low-voltage ceramic disc, unless otherwise indicated
C1—33 mmf
C2,C3,C6,C7—820 mmf
C4,C8—3-30 mmf trimmer
C5—3.3 mmf
C9—.002 mf
CH1—30 turns #28 enamel wire wound on a 1-megohm, 1-watt resistor
SW1—Four pole, double throw switch (Lafayette SW-91)
Q1,Q2—2N2089 transistors (Amperex)
L1,L4—coils, Cambridge Thermionic LS3-60 mc (see text)
B1—9 V. power supply (see text)
L2,L3,L5—see text
Misc.—terminal strips, lugs, transistor sockets, etc.

A kit of the above parts (less power supply) is available from the Thermocare Co., 54 Butehorn St., Bethpage, N. Y. Price is $9 postpaid.

for on-the-nose RF accuracy

A Dual-Frequency Crystal Calibrator

By Herb Friedman, W2ZLF

TO MANY, a crystal calibrator is just a means of complying with one of the FCC requirements. But for others, amateurs, experimenters and SWLs, the crystal calibrator is an important tool; useful for calibrating home brew receivers and converters, zeroing bandspread dials on communication receivers and insuring accuracy of test equipment. For the usual cost of a factory-wired single-frequency calibrator (about $15), you can build a calibrator having *both* a 100 kc and 1 mc output. Each output is independent and can be individually calibrated against WWV. The 1 mc output is of particular advantage on the very high frequencies since there is much commercial and home brew equipment for 6 meters (and some for 10 meters) using superregen receivers. The 1 mc markers will clearly indicate the band edges.

Construction

The major components are mounted on a piece of perforated board as shown in the pictorial. The crystal socket is mounted with a 4-40 screw using a ¼" spacer or stack of washers between the socket and the perforated board.

Frequency correction capacitors C1 and C2, must be mounted rigidly; don't depend on wire alone to hold them to the board. Screws are passed

through their solder tabs and the board and connection is made to the supporting tab by a solder lug or by wrapping wire around the mounting screw. Use a heat sink such as an alligator clip on the lead when soldering the transistors. Note that transistor Q2 (2N274) has four leads; the center shield lead is unused and should be cut short.

After the board wiring is completed, mount switches SW1 and SW2 and antenna jack J1 on the cabinet. Two ⅜" holes should be drilled to permit adjustment access to C1 and C2.

An L-bracket at each end of the board is sufficient for mounting. Take care that the adjustment screws of C1 and C2 *do not* touch the cabinet and that there is room for the battery. The antenna is made from an 8"-10" length of stiff wire.

Adjustment

Before applying power, adjust coils L1 and L2, aligning the bottom of the slugs with the lower coil winding. Remove the crystals from their sockets and connect up a 10 ma meter in series with the battery. Turn on the unit and if the calibrator is wired correctly the meter will show only a slight indication (about 150 microamperes). Install the 100 kc crystal and set SW2 to the 100 kc position; the meter will read about 3.5 ma. Adjust L1 for maximum current flow. The tuning is very broad and if after four turns there is no change in current, leave the slug where it is.

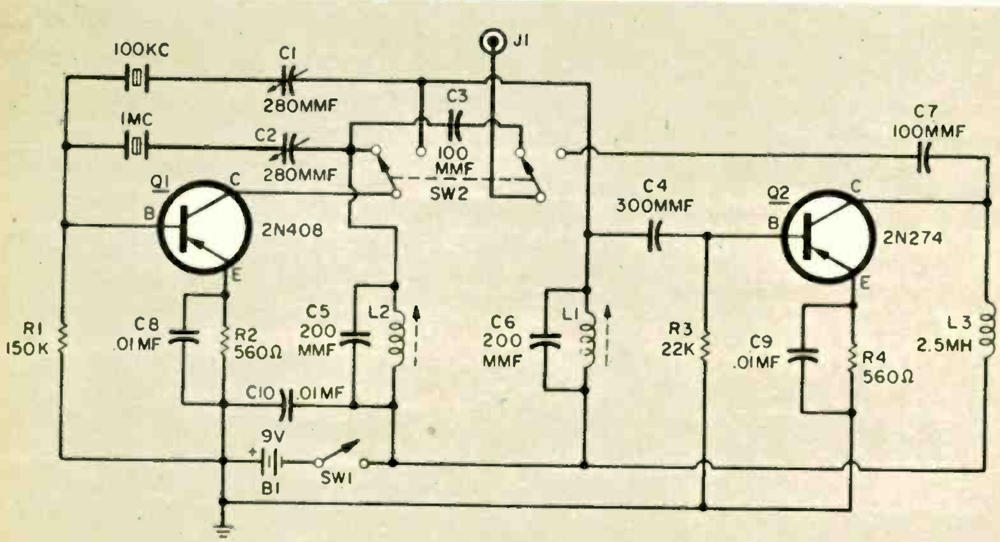
Next, plug in the 1 mc crystal and set SW2 to the 1 mc position. Repeat the above, adjusting L2 for maximum current. Disconnect the meter and the calibrator is ready for use.

For precision use, the two outputs can be tuned against WWV. Tune in WWV at a frequency which provides a medium signal level. Turn on the calibrator set to 100 kc and let it warm up for about a minute. Couple the calibrator's signal into the receiver either by radiation or by direct connection. A distinct beat-note will be heard in the receiver. Using an insulated alignment tool, adjust C1 so the beat-note changes to a low growl and disappears. This is the correct setting for C1. Repeat the same procedure for the 1 mc crystal, adjusting with C2.

Checking Mobile Equipment

A mobile receiver or converter can easily be checked for calibration with-

Separate crystals and calibration capacitors are used for each of the two fundamental frequencies.



Most parts are mounted on perforated board which is installed in cabinet using small brackets.

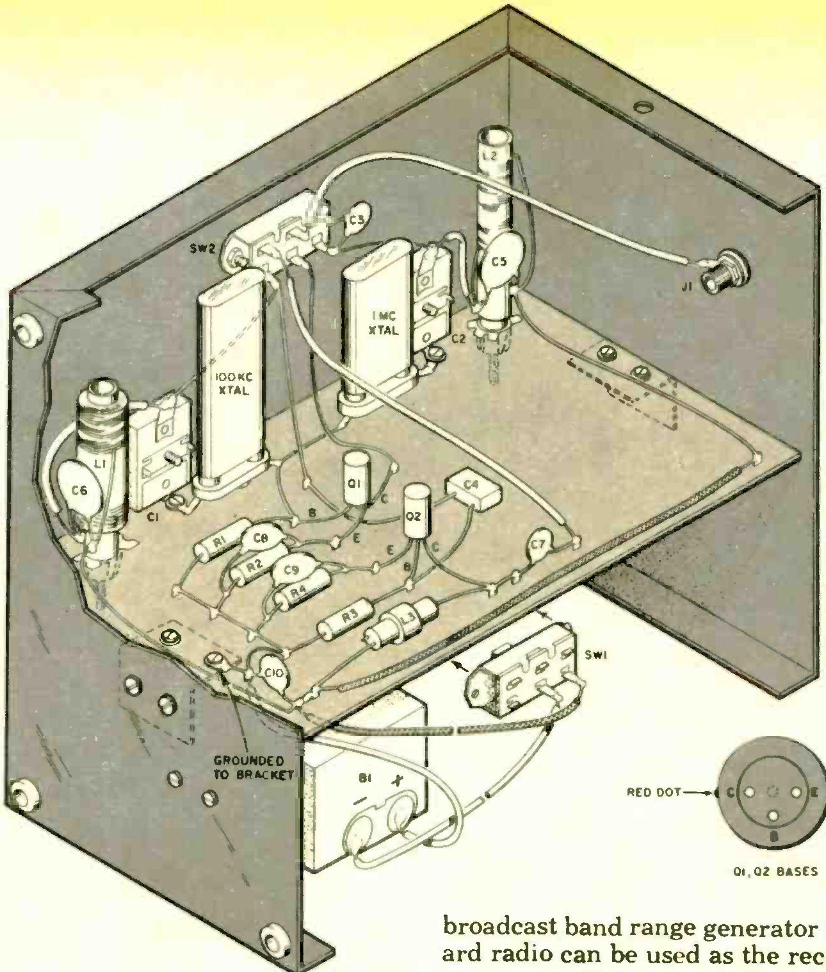
PARTS LIST

Resistors; ½ watt, 10%

R1—150,000 ohms
R2,R4—560 ohms
R3—22,000 ohms

Capacitors

C1,C2—25-280 mmf, trimmer capacitor
C3,C7—100 mmf ceramic disc
C4—300 mmf mica
C5,C6—200 mmf ceramic disc or mica
C8,C9,C10—.01 mf ceramic disc
S1—SPST slide switch
S2—DPDT slide switch
L1—2-18 millihenry slug tuned coil (Miller 6314)
L2—54-245 microhenry slug tuned coil (Miller 6196)
L3—RF choke, 2.5 millihenry
Q1—2N408 transistor
Q2—2N274 transistor
B1—9 V battery (largest that will fit cabinet)
J1—banana jack
Misc.—1 perforated board (Lafayette Radio MS-305); 1 cabinet 6"x5"x4"; 1 banana plug to fit J1; 2 packages flea clips (Lafayette Radio MS-263); 2 crystals (xtal) 100 kc, 1 mc plus sockets (Use Texas Crystal units as other types may not work properly.)



out removal from the car. The calibrator with its antenna is placed several inches from the mobile antenna; a distinct hush will be heard in the receiver at the calibration points. If the mobile receiver is equipped with a BFO so much the better. Up at 6 meters, it may be necessary to connect the two antennas with a clip lead.

A mobile VFO's calibration can be checked by zero-beating the received calibrator marker frequency against the VFO. Tune in a marker (e.g.: 7 mc) and adjust the transmitter's oscillator until zero-beat. The VFO is then set for 7 mc. The same procedure is used for other frequencies.

Using a similar procedure, the calibration of RF signal generators can be checked. The output from a signal generator is fed into a receiver with the output of the calibrator and the generator is calibrated at zero beat. With a broadcast band range generator a standard radio can be used as the receiver.

At very high frequencies where the calibrator's output is reduced, run a wire from the calibrator to an alligator clip on the insulation of the "hot" antenna wire. In some instances, such as calibration of an FM tuner, the calibrator will have to be connected directly to the receiver's antenna terminals. For maximum stability, always ground the case of the calibrator to the equipment under test. Using the 1 mc output, an FM tuner dial can be adjusted or marked "on the button" across the dial.

Oscillator transistor Q1 has an anti-resonant feedback path connected between collector and base. At 100 kc, the low-Q coil L1, has low output and requires the use of amplifier Q2. Since the base-emitter conduction of Q2 has a diode action, a signal rich in harmonics is produced. At 1 mc, high-Q coil L2 becomes the oscillator tank coil and the high 1 mc output does not require amplification. This permits the use of low-cost transistors and stock coils. •

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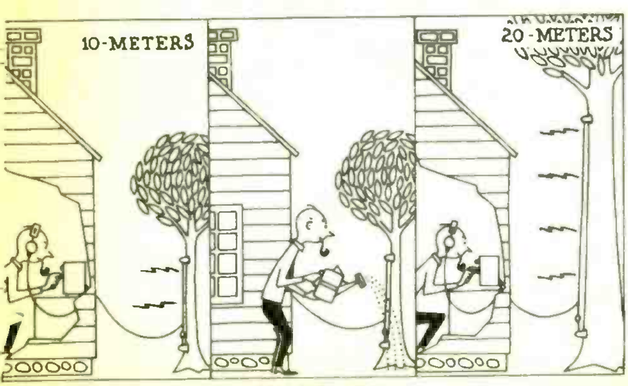
ARBOREAL ANTENNA

IF YOU HAVE a tree of fair height on your grounds and a bunch of neighbors who are TV-suspicious of all hams, you will appreciate our ingenious design, merely a nondirectional vertical antenna stretched up a tree trunk and having some characteristics of a long-wire (because of the insulator on either end). Its truly unique (or devilish) quality is the black plastic insulation covering its radiating wire, and making it hard to see. The service entrance insulators are brown porcelain with a hole and a screw base. They are screwed directly into the tree trunk. With longer antennas, one of these insulators should be put in every 10 feet and the wire dropped through the hole (not secured). A coil spring at the bottom stretches when the tree bends in the wind. Simply thread the wire down through any branches and don't worry about touching them (the wire is insulated). Unless you have very tall trees and suction cups on your feet we recommend a *quarter*-wave radiating element (62′ 3″ for 80 meters, 31′ 1″ for 40 meters, etc.). Quarter-wave radials buried in the ground at the base like spokes will improve performance.—*Howard S. Pyle. W7OE* •



For CBers and Hams

The Monitor Meter

By Tracy Diers, W2OQK/2W4975

TO GET THE BEST REACH from any Citizens Band or amateur transmitter, all the radio-frequency (RF) power available must be pushed out the antenna, of course. But that's only part of the story. The transmitted carrier also must be modulated as close to 100% as possible.

The modulation problem is a tough one. More than 100% modulation produces distortion, while under-modulation buries your signal in noise.

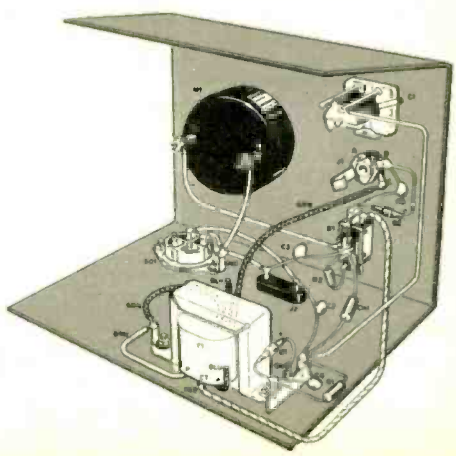
The Monitor Meter (MM) is a device which not only indicates when the maximum RF output is being fed to the antenna, but in addition gives you your modulation percentage. And by plugging a good-quality (2,000 ohms or higher) headset into monitor jack J1 you can determine whether your signal is clean and free from noise and distortion.

Construction. The Monitor Meter is built in a metal cabinet and, except for J2, SO1 and T1, all components are mounted on the front panel. While parts layout isn't critical, the RF leads must be separated from the audio leads.

The value of the hand-wound pickup coil that plugs into SO1 (and is shown in position atop the MM box in our lead photo) is determined by the frequency you are using. See chart for number of turns and wire size.

Install D1 and D2 last and use a heat sink (alligator clip) on each lead before soldering.

Because of the low output from a CB transmitter, a separate RF pickup unit is required. The center terminals of coax connectors J4 and J5 are joined with a short length of #16 wire or buss bar.



MM is shown top side down for clarity. All major components except J2, SO1, T1 are mounted on front panel. Keep audio and RF leads separated.

The pickup coil is six turns of #18 plastic-insulated solid hookup wire wrapped tightly around the buss bar.

The pickup unit is connected between the transmitter and antenna at a point 6 to 12 inches from the transmitter. The hookup line is a short length of coax cable (RG-58/U or RG-8/U, depending on which is used for the antenna feedline) with a PL-259 on one end and a plug which matches the transmitter output jack on the other.

The connecting link between the RF pickup unit and the MM is 18 inches of #20 plastic-covered hookup wire with plastic twinlead connectors at each end. (Twinlead connectors fit the crystal sockets.) The wires should be twisted together to prevent capacity changes.

Operation. Set S1 to *calibrate-tune* and connect the MM into your antenna system.

Turn on the transmitter and adjust C1 for a half-scale reading on meter M1. Now tune the transmitter for maximum meter reading.

If the meter needle goes off-scale,

PARTS LIST

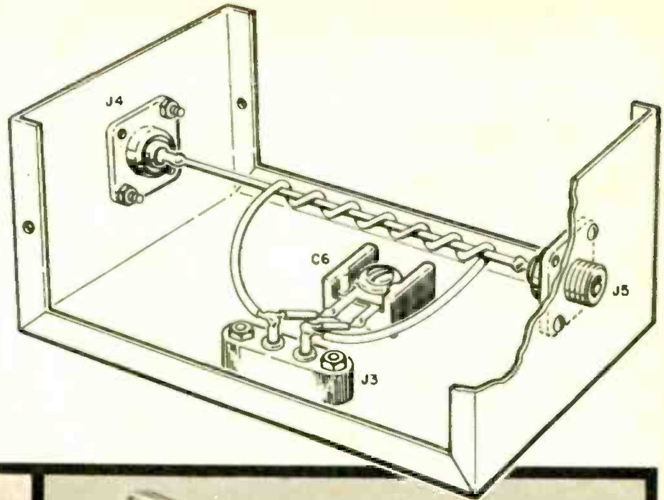
Resistors:
R1—1,200 ohm, 1 watt, 10%
R2—16,000 ohm, 1/2 watt, 5% or better
Capacitors:
C1—100 mmf variable with 1/4" shaft
C2,C3—.001 mf ceramic disc
C4—12 mmf ceramic disc
C5—470 mmf ceramic disc
C6—50 mmf trimmer (in pickup box)
D1,D2—1N34A crystal diode
T1—Driver transformer (Stancor A-4711)
CH1—24-microhenry ferrite core choke (value not critical)
M1—0-1 ma meter (Lafayette TM-60 or equiv.)
SO1—4-prong ceramic tube socket (Millen type 33004 or equiv.)
J1—Closed-circuit phone jack
J2,J3—Crystal socket (Millen type 33302 or equiv.)
J4,J5—Coax sockets to match transmission line connectors
S1—DPDT Toggle switch
Misc.—1—Meter cabinet, 6"x5"x4"; 1—Pick-up cabinet, 5 1/4"x3"x2 1/8"; twin-lead connectors; wire; coil forms, etc.

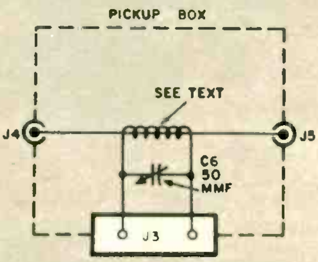
PLUG-IN COIL DATA

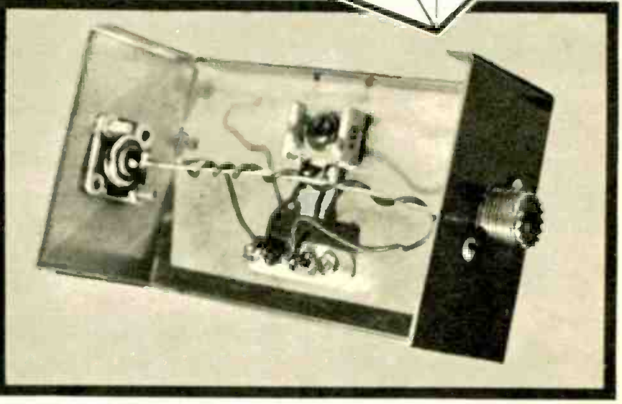
Frequency (mc)	Turns	Wire Size
27-28	4	22
21	10	22
14	15	22
7	30	22
3.5	50	26

All coils closewound on 4-prong, 1-inch forms (Millen 45004 or equiv.). Wire is enameled type.

Pickup unit, for use with low-power transmitters, is simple to construct. It is connected right into the feedline. Bare buss bar radiates more energy into the pickup coil than does coax cable.







bring it down with C1. The meter reading is determined by the RF current flow in the antenna feedline and is an accurate indicator of transmitter tuning.

To check the modulation percentage, first set S1 to *calibrate-tune* and, without modulation, adjust C1 for full-scale (1 ma) reading on M1. Then reset S1 to the *modulation* position and speak into the microphone. The meter needle will follow the speech with the peak meter indication representing per cent modulation. Full scale (1 ma) equals 100% modulation; .9 ma equals 90% modulation, etc.

If you don't get a 1-ma reading when S1 is on *calibrate*, reverse the twinlead connector at the Monitor Meter or RF pickup unit. Leave it plugged in the way that provides the highest reading.

Now adjust C6 in the RF pickup box. You will find a setting where the meter reading suddenly peaks.

To check audio quality, plug a set of headphones into J1 and set S1 to *modulation*. Signal volume can be adjusted with C1. The meter is cut out when phones are used.

In amateur stations, running higher power than CB rigs, Monitor Meter coupling is simplified. You probably won't need the RF pickup unit and the MM can be located farther from the transmitter.

Connect a short length of hookup wire to J2's ungrounded terminal and wrap the free end five or six times around the transmission line. Connect J2's ground terminal to transmitter ground. If you get too little pickup, increase the number of turns or try moving the wrap-around coil to another spot. •

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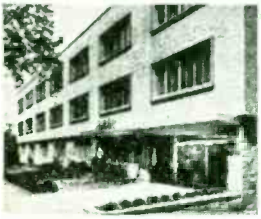

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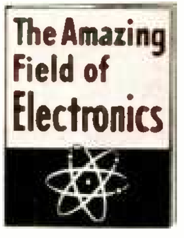

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