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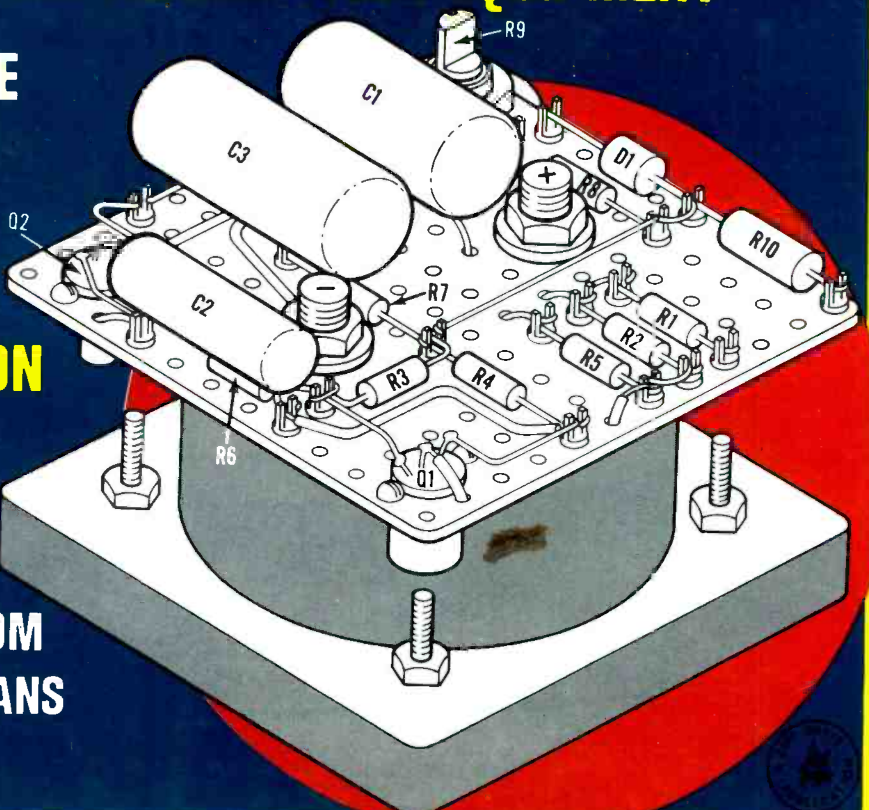

MAKE YOUR OWN 0-5000 RPM TACH FROM SIMPLIFIED PLANS (see page 11)

1965 POPULAR ELECTRONICS ELECTRONIC EXPERIMENTER'S HANDBOOK

SPRING EDITION

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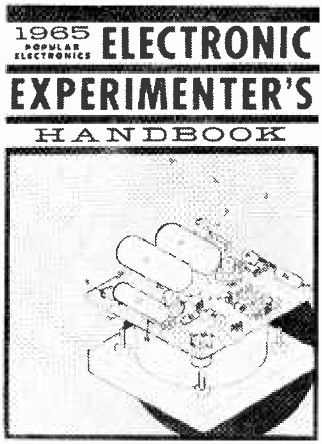

MPA

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THIS is the Ninth Annual Edition of the ELECTRONIC EXPERIMENTER'S HANDBOOK. If you looked closely at the cover, you will have noted that we said "Spring Edition." Yes, in response to hundreds of requests, the EXPERIMENTER'S HANDBOOK will be issued twice in 1965—the usual Spring Edition, and a brand-new "Fall Edition." We are also pleased to announce that projects will appear in both editions that are new and not reprints from POPULAR ELECTRONICS. As in the past, your Editors have taken great pains to double-check all circuit diagrams and parts listings. We believe them to be as correct as possible at time of printing. We hope you enjoy the projects described herein and that you will look forward to the Fall Edition. THE EDITORS

1965 ELECTRONIC EXPERIMENTER'S HANDBOOK, Spring Edition, published by the Ziff-Davis Publishing Company, One Park Avenue, New York, New York 10016. Also publishers of Popular Electronics, Electronics World, HiFi/Stereo Review, Communications Handbook, Tape Recorder Annual, Stereo/Hi-Fi Directory.

1965 POPULAR ELECTRONICS ELECTRONIC EXPERIMENTER'S HANDBOOK Spring Edition

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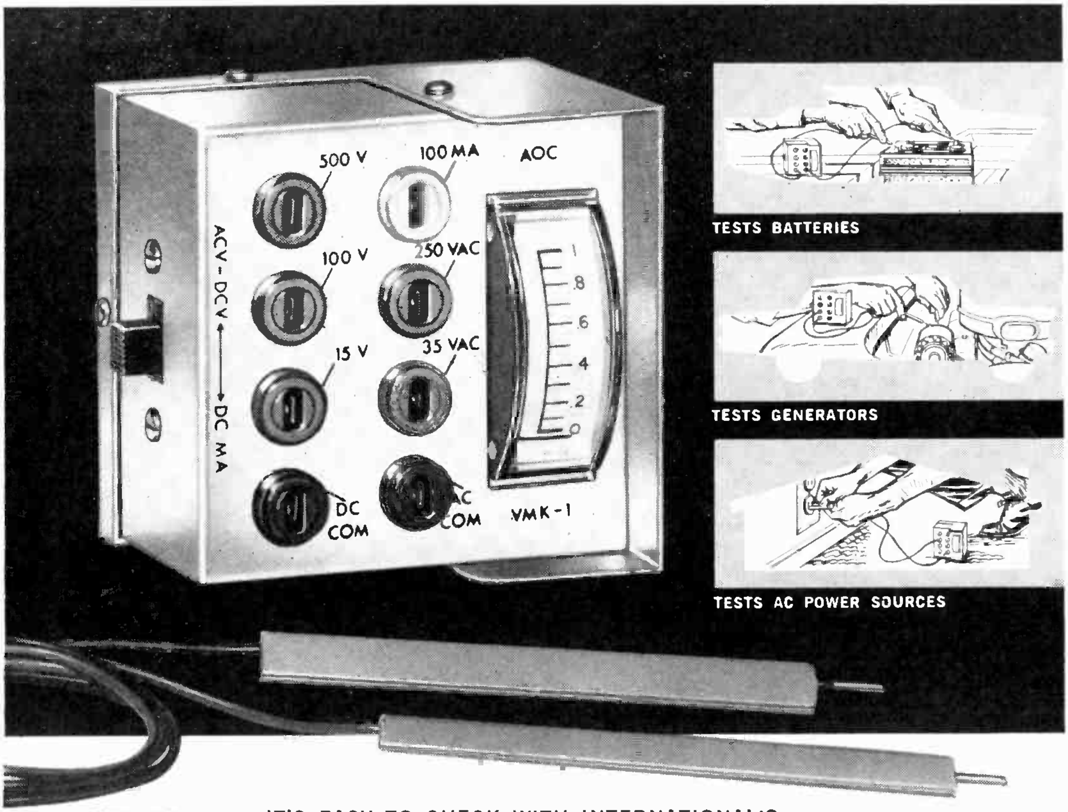
VOLTAGE PROBLEMS?



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Chapter 1 ELECTRONICS AROUND the HOME

ELECTRONIC gadgets or devices that you can build for use around your home are practically limitless. In this chapter, your Editors have offered a sampling that is sure to attract your interest and attention. Automotive electronics is represented by four projects, including a precision tachometer with a 0-5000 or 0-6000 rpm range; a battery charger that thinks for itself; a "Car Battery Saver"—just in case you (or someone in the family) has a tendency to walk off and leave the headlights burning; and a simple "Safety Flasher."

Everyone with a portable TV set should read Lew Harlow's story on rabbit-ear antennas, and SWL's, CB'ers, or hams bugged by TV sync interference should find Bill Orr's ideas on suppression of value.

The remaining projects include some telephone attachments, a metronome, a science fair project, and a photoelectric alarm that actually tells which way a person is moving when the light beam is broken.

THE CLOUD SENTINEL

Watch far-off flashes of lightning, small storm discharges, and fair weather currents as they animate the meter needle

BOLTS OF LIGHTNING have frightened, puzzled, and fascinated mankind from the beginning of recorded time. These bright, intense flashes of electricity between clouds and earth, or between concentrations of opposite polarity within clouds, may pass average currents as high as 30,000 amperes. Not so familiar as visible and audible discharges, however, are the infinite number of unspectacular discharges which pass varying and continuous currents so small that even sensitive microammeters have difficulty detecting them.

These tiny currents, which pass through any conductor rising above the earth's surface, flow during both fair weather and foul. With a device that shows the direction of current flow and the amount and rapidity of the changes constantly taking place, it is possible to predict the approach of a storm, and to "see" far-off flashes of lightning as they occur. Day-to-day observations can be correlated with weather conditions for a science fair project, or just to satisfy your curiosity.

"The Cloud Sentinel" is a simple, easy-to-build device which you can use

By **H. E. SANDERS,** W4CWK

PARTS LIST

B1—Size AA dry cell
B2—Size D dry cell (two required)
M1—0-50 μa. meter (Lafayette TM-200, $4.95)
Q1—Pnp transistor (G.E. 2N508 or 2N107)
R1—1.5-megohm, ½-watt resistor
R2, R5—2200-ohm, ½-watt resistor
R3—10,000-ohm potentiometer, log taper
R4—500-ohm potentiometer, linear taper
S1—S.p.s.t. snap-action switch
S2—S.p.s.t. slide switch
S3—2-pole, 3-position lever switch
1—Battery holder for AA cell (Keystone #139 or equivalent)
1—Battery holder for two D cells (Keystone #176 or equivalent)
1—Transistor socket
1—3" x 4" x 5" Minibox (Bud CU-3005A)
Misc.—2" x 2½" component mounting board, plastic pill box cap, knobs, wire, bracket, rubber feet, solder, hardware, panel decals

Antenna Ground System

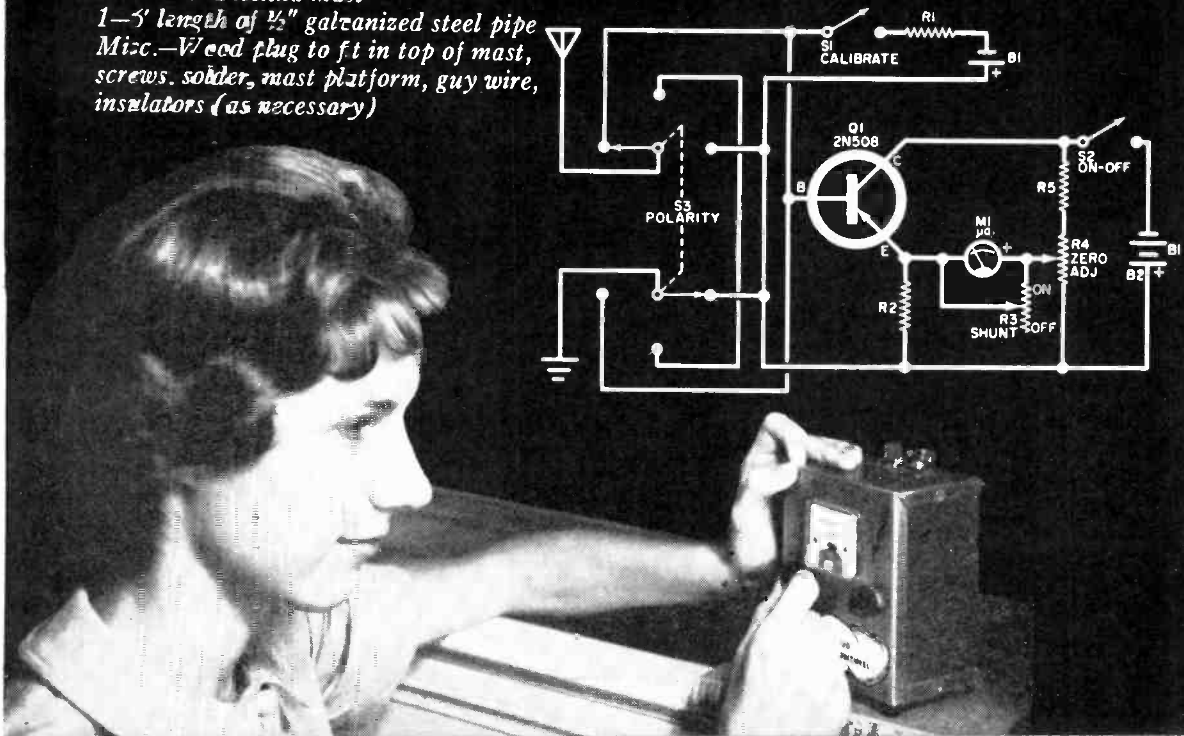
1—30'-50' length of #14 insulated solid copper wire
1—30'-90' length of microphone cable (Belden #8401)
1—3' length of #14 galvanized ground or guy wire
1—10'-40' antenna mast
1—5' length of ½" galvanized steel pipe
Misc.—Wood plug to fit in top of mast, screws, solder, mast platform, guy wire, insulators (as necessary)

to detect cloud-earth currents as low as several hundredths of one microampere as they pass through your antenna-ground system.

How It Works. The Cloud Sentinel is essentially a basic d.c. current amplifier circuit which has been expanded to include a meter shunt to allow the operator to reduce amplification as a storm approaches and electrical activity increases. Another switch permits reversing the polarity of the input in the event of cloud-earth polarity reversals.

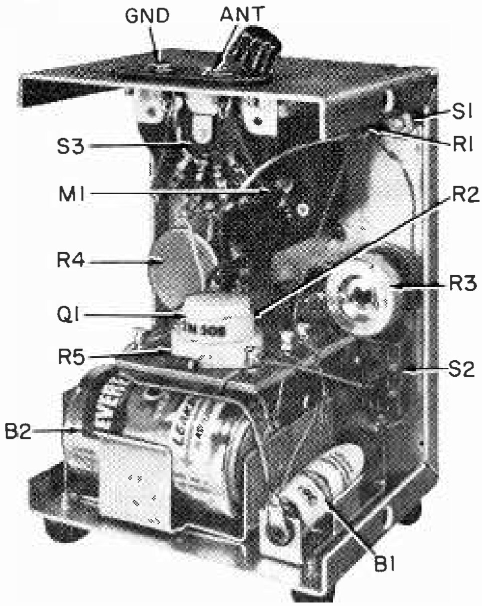
Transistor *Q1*, resistors *R2* and *R5*, potentiometer *R4*, switch *S2*, and battery *B2* form the d.c. current amplifier, with meter *M1* and shunt potentiometer *R3* providing current indications. On the author's unit, a current amplification of 30 is obtained with *R3* in "off" position. With *R3* in the "on" position there is no noticeable meter movement. Various in-between settings allow the operator to choose any desired amplification factor.

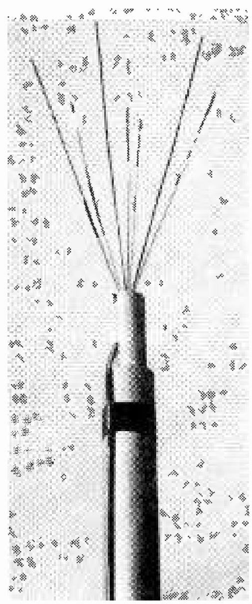
Switch *S3* connects the antenna and ground to the transistor's base and emitter with a choice of polarities. With *S3* in its neutral position, the antenna is connected directly to ground. Switch *S1*,



Q1, R2, R5, and several tie points, and is attached to the front panel with a ½" x ½" x 2" bracket. Battery holders for *B1* and *B2* are screwed to the bottom of the box with ¼" space above them to provide clearance for wiring the transistor. Mechanical details, parts layout, and lead dress are not critical, and may be altered as desired.

Although not absolutely essential, it is a good idea to surround the transistor with a thermal barrier. For the proto-





Completed Cloud Sentinel is shown above, the parts layout at the right. Parts values and arrangement are not at all critical; principal requirement is sensitive meter. (The new Lafayette catalog number for the TM-200 specified in the Parts List is 99 G 5060.) At the far right is a photo of antenna used by the author (see text). Use #14 bare copper wire for spikes, insulated wire for the lead-in taped to mast.

resistor *R1,* and battery *B1* provide a known current of one microampere to the amplifier for calibration purposes.

Construction. The prototype Cloud Sentinel was built into a 3" x 4" x 5" Minibox which provided ample space for easy assembly with the miniature meter and batteries specified. The on-off switch (*S2*), meter *M1*, and potentiometers *R3* and *R4* are mounted on the front panel, and the antenna-ground terminal board and polarity-reversing switch, *S3,* are fitted on the top. The calibrate switch, *S1,* is a microswitch mounted behind the front panel at the left top corner, and is actuated through a hole in the top of the unit.

A small 2" x 2½" piece of component mounting board is used as a chassis for type, papier-mâché was made by soaking newspaper in water. A plastic pill box lid was filled loosely with this mixture and pressed down over *Q1.*

Parts Substitutions. Resistance values specified for the Cloud Sentinel may be altered within reason. The author satisfactorily used a large surplus 50-0-50 microammeter in a breadboard version of the Sentinel, which eliminated the need for polarity-reversing switch *S3.* A multi-position switch and a series of resistors in place of *R3* would permit the operator to switch from one known amplification to another and eliminate the need for the calibration circuit. With minor resistance changes which can be worked out by the reader, up to 6 volts

(*Continued on page* 159)

COVER STORY

X-Line Tachometer

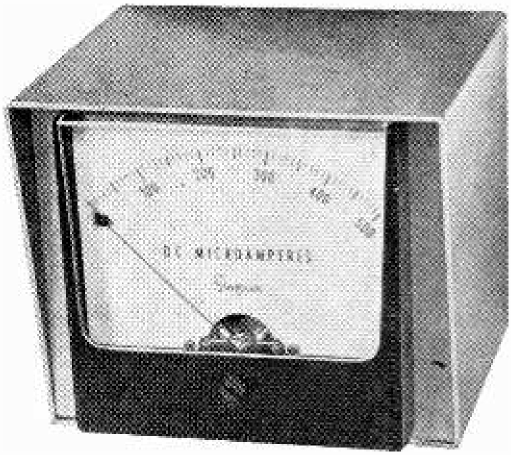
Pre-packaged low-cost semiconductors offer opportunity to build linear-scale, high-accuracy tach for automotive or marine use

By CHARLES CARINGELLA, W6NJV

MOUNTED under the dashboard in the photo above is a tachometer that would make any hot-rod enthusiast green with envy. The circuit and some of the semiconductors were taken from General Electric Company's new "Experimenter Line" of control devices which come complete with schematics. These devices consist of zener diodes, transistors, reed switches, etc., and the "Line" is available throughout the United States. The tach described here uses two of the packaged devices. The remaining tach components can be purchased at prices ranging from about $20 to a high of $30.

How It Works. The tachometer input terminals are connected directly across the distributor breaker points. While the points are closed during the dwell time, the base of transistor Q1 is at ground potential. Since the Q1 emitter is biased positive through resistors R3 and R6, Q1 is held cut off, with its collector about 8 volts positive to ground. When the breaker points open, the inductive kick from the coil primary drives the tach input sharply pos-

X-Line Tachometer



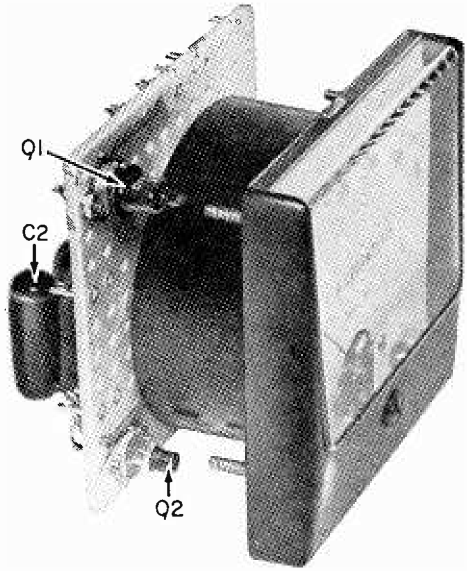
itive. Reduced by the input network (*R1*, *C1*, *R2*, and *R5*) to a safe value, this positive-going impulse turns *Q1* on, dropping its collector to about ground potential.

This negative-going pulse is coupled through *C2* to base 2 of *Q2*, which was held cut off until this time by positive bias through *R7*. The duration of the negative pulse at base *B2* is very short, since it exists only while *C2* is charging through *R7*. Transistor *Q2* is turned on by the short negative pulse, and becomes a short-circuit path to ground through which *C3* discharges. The discharge current from *C3* through base *B1* holds *Q2* on until the discharge is completed, regardless of the return of base 2 to a positive bias condition.

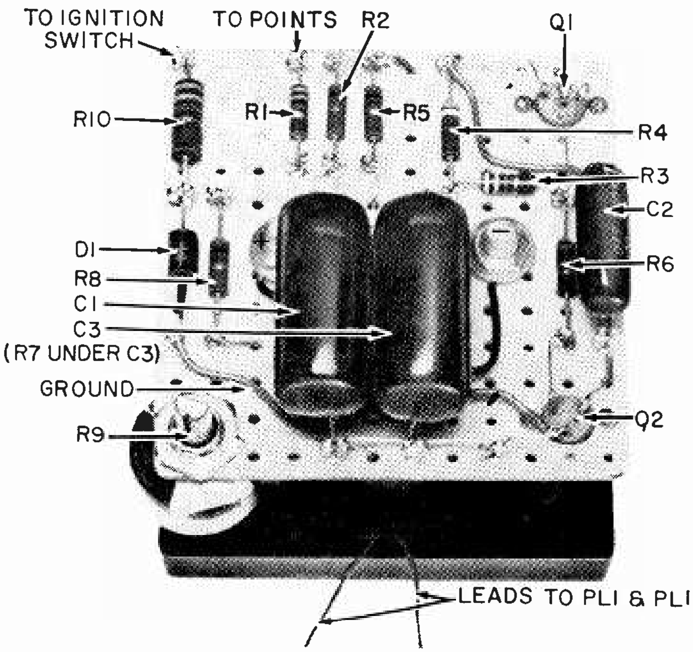
When *C3* has fully discharged, *Q2* again cuts off, and *C3* charges through *R8* and *R9*. Since the voltage at the plus end of *R8* is held at 8.2 volts by zener diode *D1*, the amount of current that flows each time *C3* is recharged is always the same. Since *C3* is recharged once each time the breaker points open, the average current through the meter is directly proportional to engine speed, despite changes in point dwell time and other factors. The required capacitance value for *C3* for different types of marine and automobile engines is given in the small table near the top of page 14.

Construction. Probably the easiest way to construct the X-Line Tach is to mount all components on a 3¼" x 3¼" piece of Vectorbord. Component layout is not critical, however; the close-up view on the next page can be followed with assurance that everything will fit properly.

Regardless of the meter used on your tach, prepare to mount the Vectorbord on the meter terminals; use push-in terminals to hold the components rigidly in place. Both transistors are seated in sockets and calibration potentiometer *R9* is attached to the Vectorbord in one corner. Only three wires need exit from the metal cabinet—or two if the metal frame of the cabinet is grounded to the metal of the dashboard.

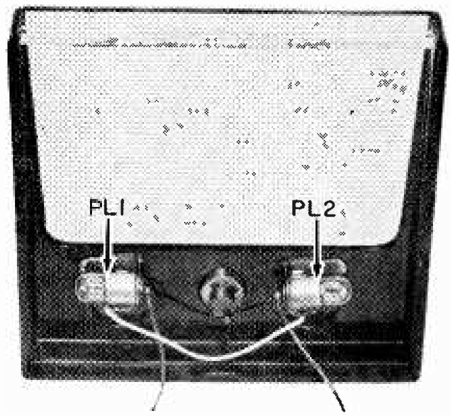


No effort has been made to draw up a new scale for the X-Line tachometer since many builders may not use this meter. The scale is perfectly linear, with 100 equal to 1000 rpm, 200 to 2000 rpm, etc.



All components can be conveniently mounted on a small piece of Vectorbord. Push-in terminals (22 required) are used as tie points. Vectorbord is attached to terminal posts of 500-μa. meter.

Two miniature 6-volt bulbs—wired in series—are cemented to the back of the plastic meter face, providing nighttime illumination of dial. A dropping resistor (not shown) cuts down on brightness.



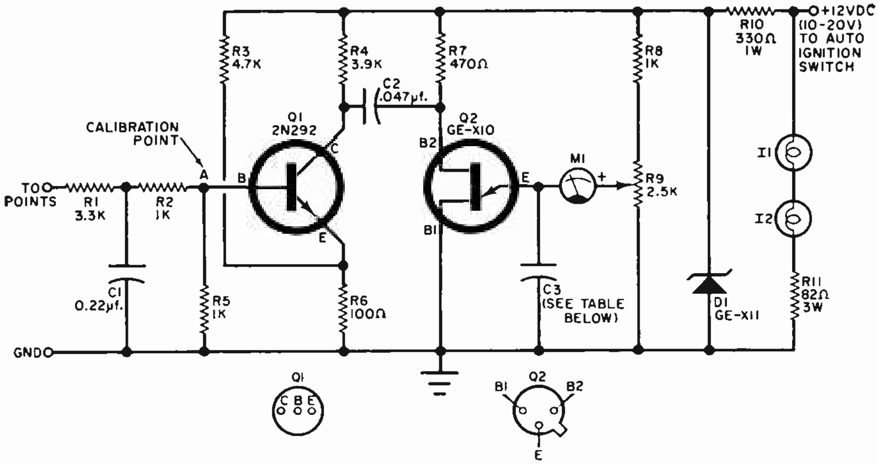
The most expensive item in the X-Line Tach can be the 0-500 μa. meter. To verify the linearity and accuracy of the circuit design, a high-quality Simpson Model 1327C meter was used in the author's prototype. While this meter has many admirable features, a substantial saving can be made by shopping around for meters costing $7-$8 less. An additional saving can be made by eliminating the special cabinet and mounting the meter—and Vectorbord—on a solid sheet of plain aluminum.

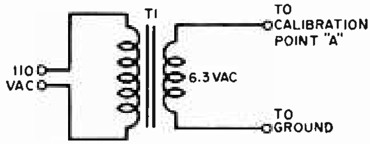
Meter Illumination. For convenience while driving at night, the meter used in this prototype has been provided with illumination by mounting two small lamps along the bottom edge of the meter scale. Similar illuminating methods can be devised using the same parts (*I1*, *I2*, and *R11*) with different meters.

If the Simpson meter is used, pry off the meter front cover with a penknife or thin screwdriver blade. Use epoxy cement to attach the lamp sockets to the plastic meter face (see photo). Then wire the two lamps in series—they are rated at 200 ma. and 6 volts—bringing thin wire connecting leads out through a small hole in the rear of the meter.

Resistor *R11* is used to cut down on the brilliance of the bulbs. It is not visible in any of the illustrations, but is soldered to the ground lug on the Vectorbord between *D1* and *R9*. If you want to adjust the brilliance with the car's dashboard control, there is no reason why the lead from *I1* cannot go to the dashboard rheostat.

Calibration. The range of the X-Line Tach can be set between 0-4500 and 0-7000 rpm by adjustment of *R9*. Practically all pre-1964 Detroit cars are covered in the range of 0-5000 rpm. This range has the advantage of not requir-





	No. of Cylinders 4	6	8
C3 in µf. for 2-cycle engine	0.33	0.22	0.15
C3 in µf. for 4-cycle engine	0.68	0.47	0.33

In this circuit capacitor C3 is discharged through unijunction transistor Q2. Charging up C3 depends upon the type of engine (2- or 4-cycle) and the number of cylinders. Select a value for C3 from the table above to match the engine. Calibration is accomplished by connecting 6.3 volts a.c. between ground and point "A". Potentiometer R9 is adjusted so that a reading of 900 rpm is obtained. The scale is linear; only one calibration point is needed.

PARTS LIST

C1—0.22-µf. Mylar capacitor
C2—0.047-µf. Mylar capacitor
C3—See table above
D1—8.2-volt, 1-watt zener diode (General Electric X-11 Kit)
I1, I2—No. 328 midget bulb (G.E. or equivalent)
M1—500-microampere d.c. meter—see text
Q1—2N292 transistor (G.E. or equivalent)
Q2—Unijunction transistor (G.E. X-10 Kit)
R1—3300 ohms
R2, R5, R8—1000 ohms
R3—4700 ohms
R4—3900 ohms
R6—100 ohms
R7—470 ohms
(All resistors ½ watt unless otherwise stated)
R9—2500-ohm potentiometer
R10—330 ohms, 1 watt
R11—82 ohms, 3 watts
T1—6.3-volt filament transformer
Misc.—Cabinet (LMB "Glamor" Type W-2A used), transistor sockets, Vectorbord, push-in Vector terminals, wire, solder, etc.

ing a new meter scale—if a 0-500 µa. meter is employed.

In any case, the linearity of this circuit is such that calibration need only be established at one point. The circuit above illustrates a simple bench method (provided a 12-volt d.c. supply is available). The output of the filament transformer is connected to calibration point "A" at the junction of *R2* and *R5*. Adjust *R9* to read 900 rpm, and the remainder of the linear scale will fall into line.

Calibration can also be done at your local service station or garage by tying the X-Line Tach in parallel with a tachometer of known accuracy.

The X-Line Tachometer was used for several months in conjunction with a special transistorized ignition system which appeared in the June, 1963, issue of POPULAR ELECTRONICS. It had no adverse effect on the transistor system. The X-Line Tach can be mounted under the dash (as per the lead photo) or on the steering column. Use a worm drive hose clamp (available at most garages) to hold the cabinet securely. —30—

NOTE: The unijunction transistor is mainly responsible for the accuracy of the X-Line Tach. Once turned on by the negative pulse at B2, conduction through the emitter to the base 1 path maintains itself, regardless of the recovery of base 2, insuring a uniform time period for charging and discharging C3.

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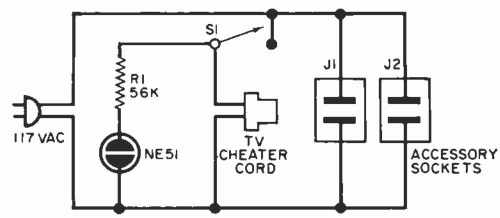
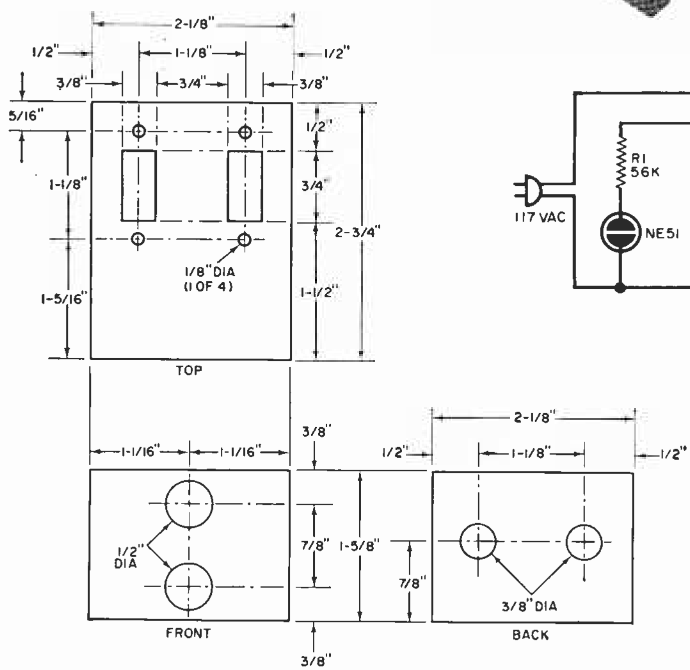
Cheater Cord De Luxe



If your junk box doesn't contain the parts for the indicator light, buy a preassembled unit. Extra bright neon bulbs are available in most radio stores for a few cents more.



Chassis cutouts and drilling notations are based on use of Premier PMC-1000 utility box.

THE FAMILIAR TV interlock, which disconnects your set from the a.c. line when you take the back off, can be a nuisance when it comes to servicing. Assuming that you have a "cheater cord," you often have to scramble around to find a place to plug it in. And you also have to find an outlet for, say, a soldering iron and a VTVM. If you're tired of stringing extension cords all over the room, here's a gadget that will make the job easier. The "Cheater Cord De Luxe" supplies the TV set with power and has a safety pilot light to indicate when it's on. Two accessory sockets (*J1* and *J2*), not controlled by the switch (*S1*), take care of your trouble-shooting equipment.

The Cheater Cord De Luxe can be constructed in an aluminum box measuring 2¾"x2⅛"x1⅝" (Premier PMC-1000). You'll need two a.c. accessory sockets (chassis mount), s.p.s.t. toggle switch, a.c. line cord, and the business end of a TV cheater cord. The indicator lamp can either be purchased preassembled (Dialco 95408) or made up from junk box parts using an NE-51 and a 56,000-ohm resistor (*R1*). Keep in mind that the box will be connected to the 117-volt a.c. line and carefully insulate all connections.

—*James A. Fred*

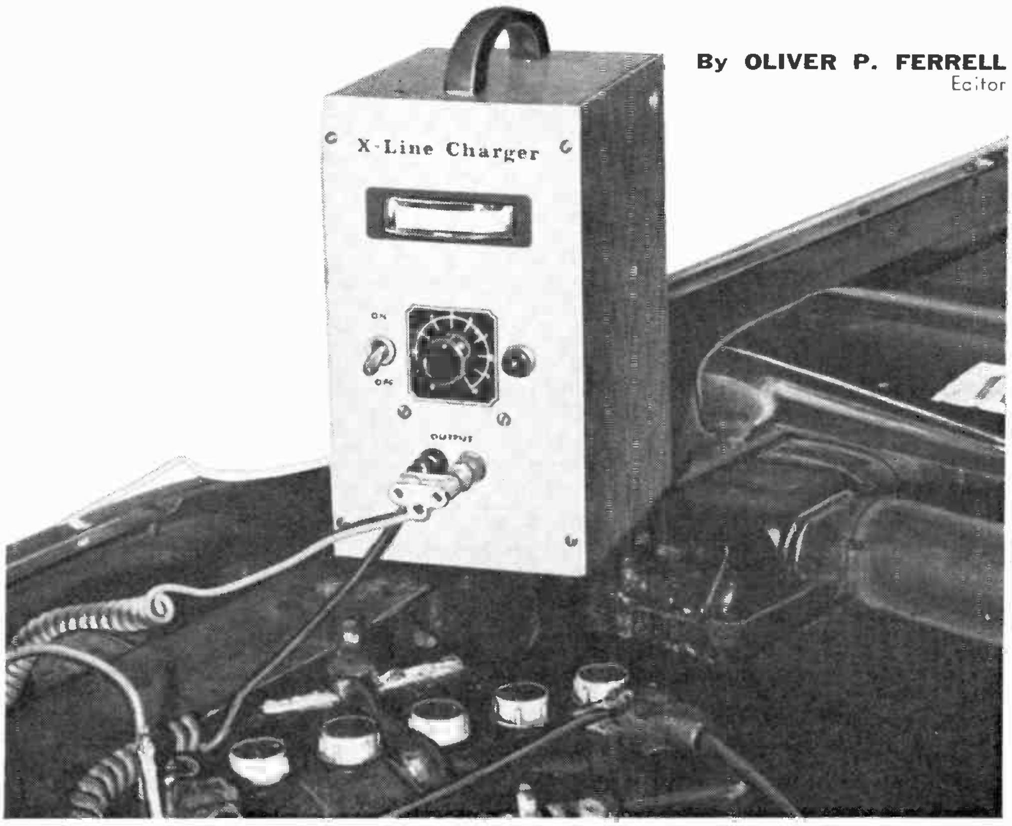
X-LINE CHARGER

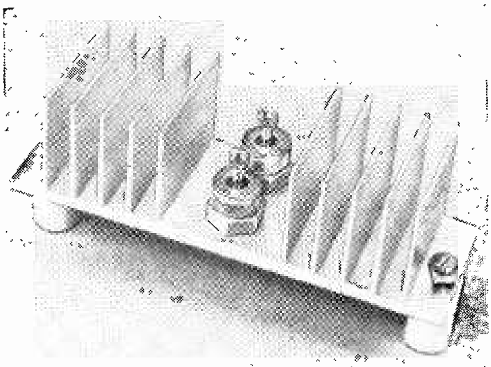
Advanced design using silicon-controlled rectifiers permits automatic operation

THE DEMANDS upon the lead-acid battery in the American automobile are ever-increasing. In wintertime, the ampere-hour capacity is reduced by freezing temperatures. Summertime woes include more frequent short trips, more use of radio equipment, and last—but not least—the electrical requirements of air conditioning. Recharging the battery with a typical generator setup is usually not enough for year-round trouble-free battery performance.

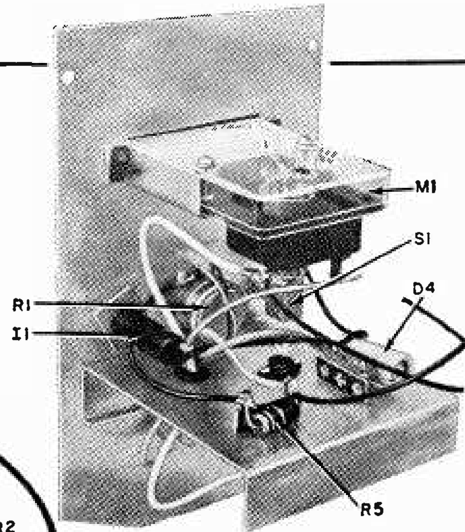
Electronics experimenters are aware of the good and bad things about battery chargers. Low-cost, low-amperage chargers selling for around $5 are sometimes helpful—if you want to wait five to ten times as long as necessary for the battery to recharge. Higher-amperage chargers (3-6 amps) are better built, but must be watched

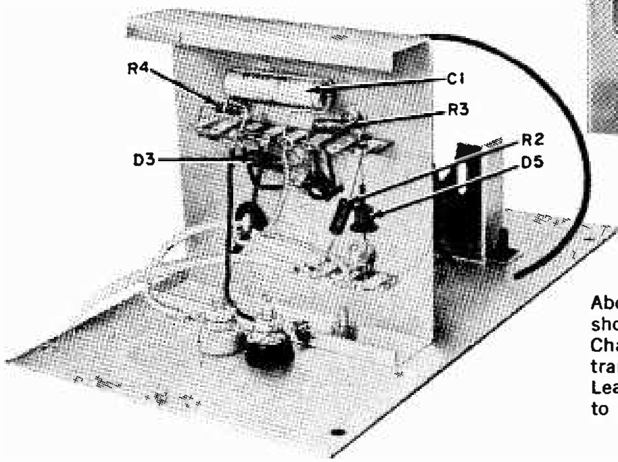
By OLIVER P. FERRELL
Editor





High-amperage silicon rectifiers D1 and D2 are mounted side by side on a Delco heat sink. Steatite stand-off insulators electrically isolate heat sink from metal cabinet.





Above and below open-end chassis views show location of various components. Chassis is assembled after heat sinks and transformer have been attached to box. Leave sufficient wire length for connection to a.c. line, transformer, and heat sinks.

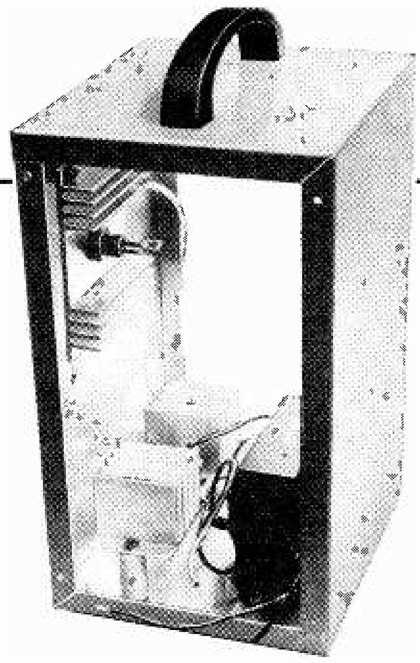
closely since only the most expensive models have provisions to eliminate the hazards of overcharging. Leave a high-amperage charger connected to the battery for too long and either the electrolyte boils away, or the plates start to warp.

If you have been plagued with any of the above problems, you need the "X-Line Charger." This is an all-electronic gadget that is set up once for your optimum battery charge. It need never be set again. When connected to the car battery, it senses the battery's condition. If it is low and needs a charge, the X-Line Charger automatically goes into operation. As the charge level comes up, the charging rate goes down. When the preset level has been reached, the X-Line Charger automatically turns itself off.

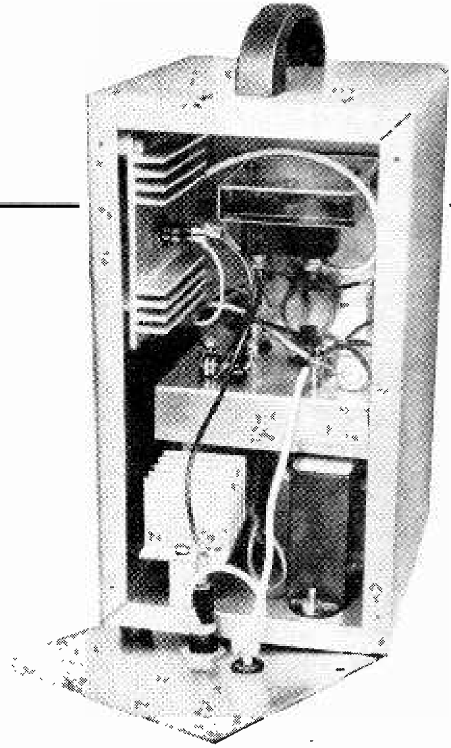
No relays are used in the circuit of the X-Line Charger; instead, it is built around silicon-controlled rectifiers now offered at moderate prices by the General Electric Company. These SCR's—and other semiconductors—are sold in numerous radio stores as the GE "Experimenter Line."

The basic circuit of the charger was obtained from the GE "Hobby Manual." Cost of building this project will vary between $25 and $45—depending upon refinements and whether or not the charging rate is metered.

How It Works. The circuit surrounding transformer *T1* and rectifiers *D1* and *D2* is that of a full-wave rectifier. Connected to the primary of *T1* is a fuse, switch, neon pilot light indicator, and Thyrector (*F1*, *S1*, *I1*, and *D4*, respec-



Transformer is bolted to bottom of box. Rectifier heat sink is at left and heat sink for SCR1 is attached to the side.



Prior to attaching the back panel, the completed X-Line Charger looks like this.

tively). Any one—or all—of these components may be eliminated from your working model—depending upon the conditions under which your X-Line Charger will be operating. Thyrector *D4* is a special semiconductor consisting of two selenium diodes mounted back to back. Rated at 120 volts, *D4* protects the solid-state rectifiers in the charger from harmful a.c. power line surges.

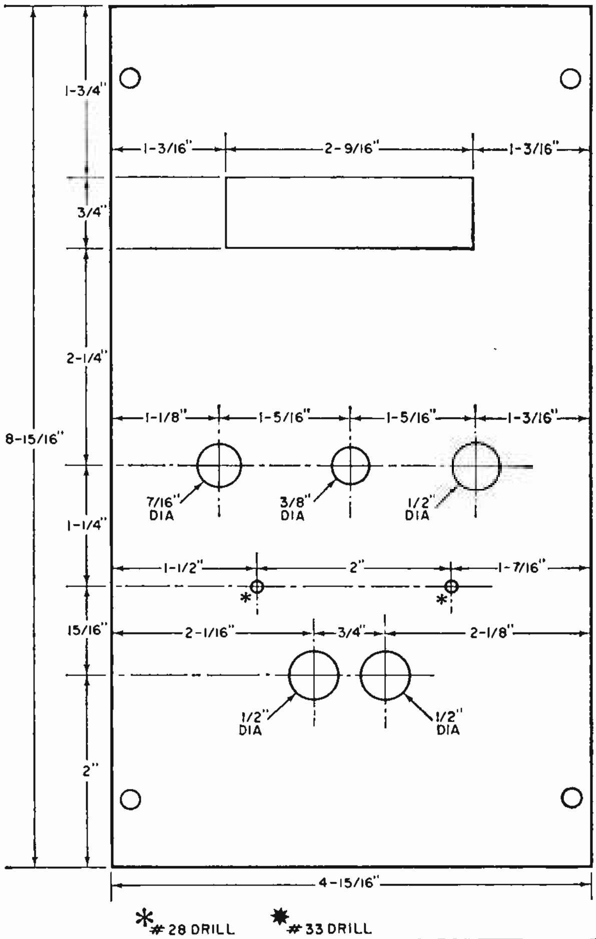
Heavy-duty *SCR1* is operated as a switch in series with the battery and rectifiers. A positive-voltage gating signal to turn on *SCR1* comes from *SCR2* through *R3* and *D5*. The gating signal to turn on and off light-duty *SCR2* is established by the battery voltage according to the setting of *R1* and the charge held by capacitor *C1*. As the battery voltage rises and the charge of *C1* increases, zener diode *D3* conducts, turning on *SCR2*. Since *R2*, *R3*, and *SCR2* are all in series, a voltage divider is formed; and when current flows through this circuit, the gate of *SCR1* cannot receive a positive signal and is therefore turned off—preventing further battery charging.

Construction. All components can be made to fit comfortably into a 6" x 9" x 5" box. A Premier gray hammertone Model PAC-695 suited these requirements. Four rubber feet were attached to one 6" x 5" end of the box. A metal handle salvaged from the junk box was affixed to the opposite end. The box now rests so that both the front and rear panels (9" x 5") are removable.

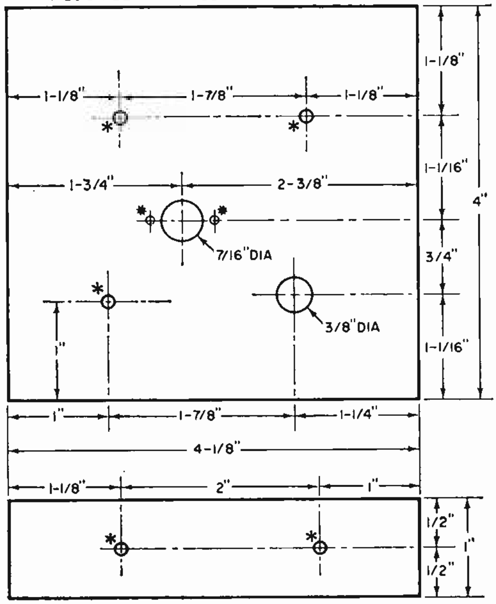
A drawing of the cutout dimensions for a front panel is shown on the next page. Sufficient room is left near the top of the panel to mount any 0-10 ampere meter, although the cutout shown is for an edgewise Simpson Model 1502 meter.

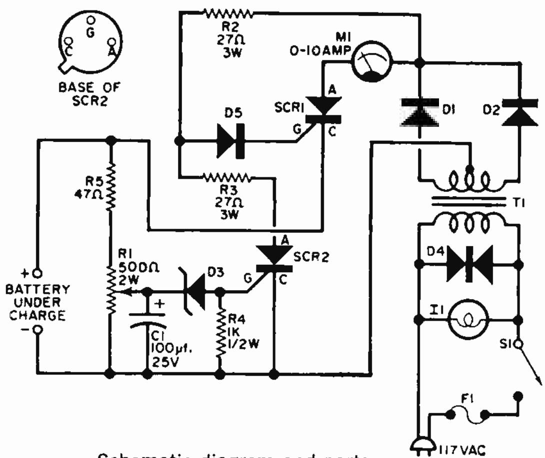
Mounted in the three holes below the meter are *S1*, *R1*, and *I1* (from left to right). Near the bottom are two holes on ¾" centers for heavy-duty binding posts. Attached to the front panel is a small open-end chassis used to mount some of the small components. Transformer *T1* is bolted to the bottom of the

Front panel dimensions are those of a Premier PAC-695 aluminum box. An oblong cutout near top of panel is for an edgewise Simpson meter. Any round or square meter can be mounted in this position by adjusting the necessary cutout size. See text for data on three holes directly below meter. Holes near bottom are for heavy-duty output lead binding posts.



Small open-end chassis holds socket for SCR2 and other miscellaneous components. Hole in lower right corner is grommeted to pass leads above and below chassis deck. Two holes in lip align with holes in panel for rigidity when assembly is complete.





Schematic diagram and parts list for the X-Line Charger.

C1—100-μf., 25-volt capacitor
D1, D2—15-amp., 50-volt silicon rectifier (GE X-4 Kit)
D3—8.2-volt, 1-watt zener diode (GE X-11 Kit)
D4—Transient voltage suppressor (GE Thyrector Type 6RS20SP4B4)
D5—100-volt, 600-ma. silicon rectifier (GE Type 1N1692 or equivalent)
F1—2-amp. fuse
I1—120-volt neon indicator light (Calrad N.P.L. or equivalent)
M1—0-10 amp. meter (Simpson 1502 or equiv.)
R1—500-ohm, 2-watt linear scale potentiometer (Ohmite CU-5011 or equivalent)
R2, R3—27-ohm, 3-watt resistor
R4—1000-ohm, ½-watt resistor
R5—47-ohm, 2-watt resistor
S1—S.p.s.t. toggle switch
SCR1—Silicon-controlled rectifier (GE X-3 Kit)
SCR2—Silicon-controlled rectifier (GE X-5 Kit)
T1—Power transformer: primary, 117 volts a.c.; secondary, 24 volts, CT (Triad F41X or equivalent)
Misc.—Cabinet (Premier PAC-695), heat sinks, handle, rubber feet, binding posts, stand-off insulators, fuse holder, line cord, etc.

X-Line Charger has clean-cut appearance. Although not visible in photos, two screened ¾" holes are cut in the bottom and back panel for ventilation.

box with *8-32* machine screws and bolts.

Two heat sinks are required for the mounting of *D1-D2* and *SCR1*. Almost any sink of reasonable size can be used at these points. The sink retaining *D1-D2* is electrically isolated from the box by Steatite stand-off insulators. Cathode connection to *D1-D2* is made to a soldering lug that also serves to hold the sink to the insulator. An insulator manufactured by E. F. Johnson (Type 501) works well in this application. Controlled rectifier *SCR1* is electrically isolated from its heat sink, but it is also held away from the aluminum box with stand-off insulators (Type 500). A lead is soldered to the anode before mounting the sink to the box wall.

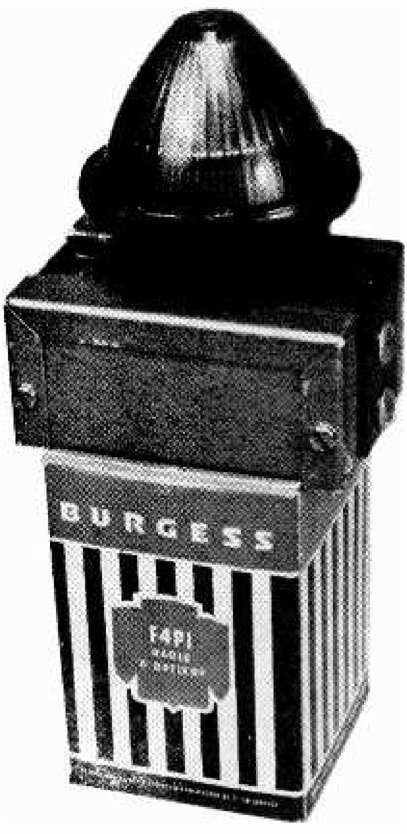
Wiring of the X-Line Charger is not difficult as long as the polarities of the diodes and SCR's are observed. Details on mounting and wiring *SCR1* are included in the GE "Experimenter Line" X-3 package.

Operation. After double-checking your wiring, bench-test your X-Line Charger by inserting a high-wattage, very low ohm wire-wound resistor across the output terminals. Read the output amperage—a 3-ohm resistor should give a reading of about 4 amperes.

Now make sure your car battery is fully charged by measuring the specific gravity. Connect the charger to the battery and rotate *R1* until the meter reads zero. Turn on the bright headlights and see if the charger operates. Turn off the headlights and the charging rate should slowly taper off and gradually return the meter to a zero reading. —30—

Build This Automatic

This caution light turns itself on at dusk and off at dawn

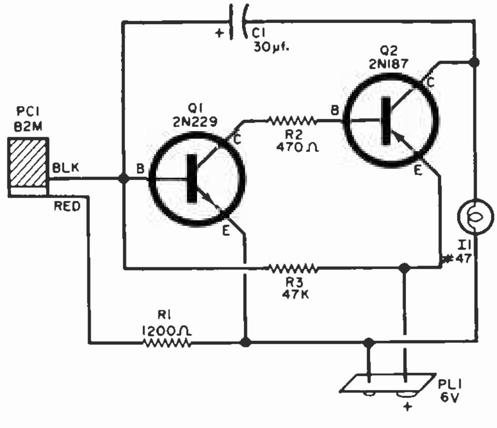


THE HOME OWNER will find many uses for this automatically operating safety flasher. It can warn of an open ditch or hole, attract the attention of a taxi driver or doctor arriving at night, or serve as a beacon to point the way for after-dinner guests. And you can take it on trips as a safety accessory in case of highway breakdowns.

The handy part about this flasher is that it may be left unattended. As sky lighting decreases, it is sensed by photocell *PC1*, and the flasher automatically goes into operation. When the photocell is again illuminated, *Q1* is biased to cut-off by the action of *PC1*, causing the flasher to stop operating.

Construction. The safety flasher is easily assembled from inexpensive components and housed in a standard aluminum box. The 6-volt battery drain is so low that the battery can be attached to the flasher through plug *PL1*, eliminating an on-off switch. The battery plug

If other transistors are substituted for Q1 and Q2, different values of R2 and R3 may be needed.



Safety Flasher

By LOU GARNER

is affixed to the edge of a small perforated Bakelite subchassis. This insulated chassis holds all of the components. The transistor sockets are wedged into place through holes cut in the Bakelite and the leads are arranged to support the rest of the circuit.

Neither lead dress nor layout is critical. The transistors could be wedged into the Bakelite chassis and the leads permanently soldered into place. However, if you do this, be sure to use a heat sink to prevent accidental heat damage. Regardless of the layout used, cut a hole in the aluminum box to permit light to shine on *PC1*.

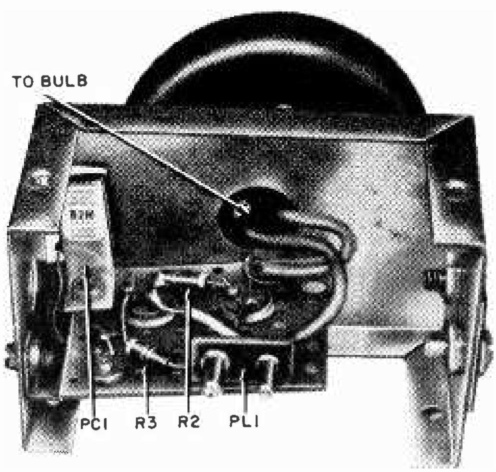
Modifications. Some builders may prefer to construct a larger unit with four flashlight D cells in series. This design would require an on-off switch, since without it the flasher would turn itself on when stored in darkness. The unit shown here can be stored just by unplugging the battery.

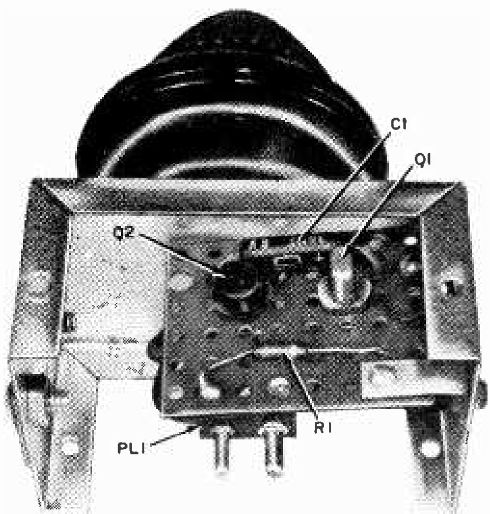
Experiment with the value of *R3* for optimum performance, or, as an alternative, use a 100,000-ohm potentiometer in place of this bias resistor. The flashing rate can be adjusted by changing the value of *C1*; use smaller values for a faster rate. Keep in mind that the light will not appear as bright as a continuously lit bulb—the flasher applies current to the bulb in short pulses and the light output is accordingly somewhat lower. —30—

PARTS LIST

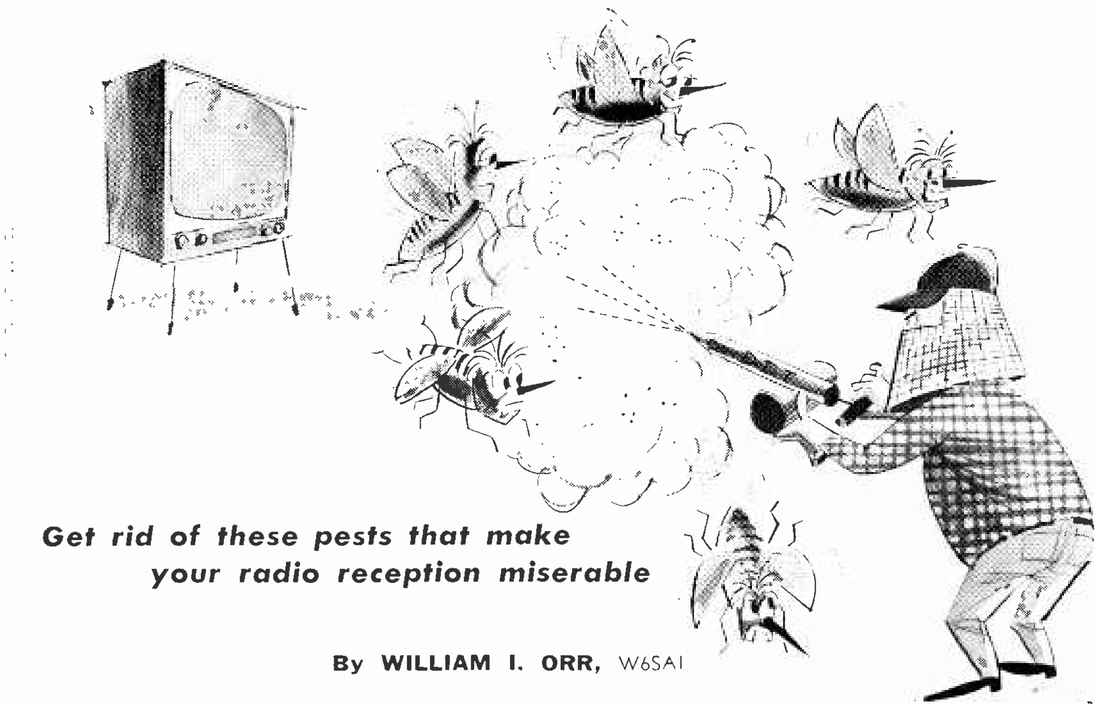
C1—30-µf., 10-volt electrolytic capacitor
I1—#47 pilot lamp
PC1—B2M photocell (International Rectifier)
PL1—Battery plug for Burgess F4P1 battery
Q1—2N229 npn transistor (Sylvania)
Q2—2N187 pnp transistor (General Electric)
R1—1200-ohm, ½-watt resistor
R2—470-ohm, ½-watt resistor
R3—47,000-ohm, ½-watt resistor
Misc.—Small aluminum box, clearance light assembly and bracket, transistor sockets, lantern-type battery (Burgess F4P1), Bakelite chassis—see text, screws and nuts, wire, solder, etc.

Don't forget the hole in the chassis to let in daylight on the B2M self-generating photocell.





EXTERMINATE TV



Get rid of these pests that make your radio reception miserable

By **WILLIAM I. ORR,** W6SAI

ARE YOU plagued by TV "sync-bugs?" Many amateurs and SWL's hear this persistent nuisance, which is threatening to make a shambles of the radio spectrum, as rough, unstable signals found at close points across the dials of their short-wave receivers.

Sync-bugs creep across the bands with a slow, measured tread, uncanny in their instinct for squatting directly atop the signal you're trying to listen to. The broadcast listener hears them in the form of "birdies" and "whistles" across the dial that turn Toscanini and Fabian into a cacophony of howls and catcalls.

Where do these "insects" come from? The truth of the matter is that they are generated by a nearby TV set (which is probably operating quite normally). The 15 kc. horizontal oscillator, which possesses about as much stability as a hundred-foot antenna mast made of "two-by-four's," generates powerful pulses of energy rich in harmonics which can be radiated for hundreds of yards. You can identify the sync-bugs by the fact that they appear every 15 kc. across the dial; check to see if it's your TV set you're hearing by turning it on and off.

TV Set Radiation. Sync-bugs can reach your receiver in three different ways: they can be radiated by the TV lead-in and antenna system, they can travel down the power cord and into the a.c. line to be "piped" to your receiver, or they can be radiated directly by the wiring of the TV set. Since you can't eliminate the *source* of the radiation (without, that is, eliminating your TV viewing), the answer is to prevent the interference from being radiated beyond the immediate vicinity of the set.

The first step is to effectively trap the sync-bugs that are radiated by the antenna system of the television receiver. This can be accomplished by shunting the radiations to ground (the chassis) while permitting the TV signals to pass down the antenna to the set without appreciable attenuation. A simple linear trap made of a length of 300-ohm TV "ribbon" lead-in affixed to the antenna terminals will do the job.

To make the trap, cut a length of

SYNC-BUG INTERFERENCE

300-ohm line 25″ long. Strip 1½″ of insulation from each end and tin the leads; twist the wires at one end together. Connect a .01 μf. capacitor between the twisted ends of the stub and TV chassis ground, as shown in Fig. 1.

When you're dealing with antennas and tuned stubs, much of the work has to be "cut and try." Sometimes one problem is solved only to have another crop up. Check to see if all channels are coming in properly after you have hooked up the stub. If all but one or possibly two channels work well, you may want to add a low-loss switch to disconnect the stub when viewing the troublesome channel.

Wiring and Power Line Problems. The next step is to prevent unwanted sync-bugs from reaching your receiver via the a.c. cord of the TV set and the house wiring. To block this exit from the set, two .01 μf., 1000-volt ceramic capacitors are placed across the a.c. line to ground at the point where the line leaves the TV chassis. With most TV sets, the power connection is made through a simple interlock mounted at the rear. It may be possible to solder the capacitor leads to the back of the plug pins (see Fig. 2), or a bit of insulation can be removed from the power wires and the leads soldered to them. Tape the wires securely. Solder or bolt the other two capacitor leads to the chassis.

Radiation is especially apt to take place from the wires running from the chassis to the socket of the picture tube. The cure for this problem is a simple shield made from heavy aluminum foil, such as "Reynolds Wrap." Form the wires into a bundle, and wrap them with a covering of electrical tape. Trim the foil to size and carefully wrap it over the tape. Smooth the foil and form the rough edges back on themselves until the wires are substantially shielded. *Do not shield the high voltage lead going to the bulb of the picture tube.* Finally, wrap several turns of wire around the foil, twist it tight, and connect the other end to the chassis.

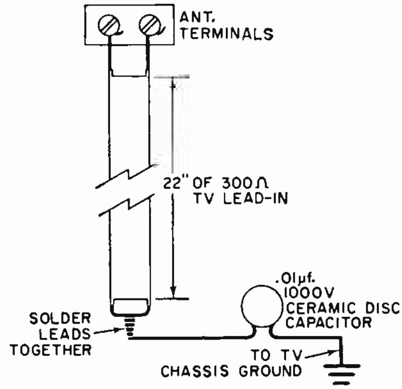


Fig. 1. Simple trap for eliminating sync-bugs from antenna system consists of 22″ of TV lead-in and a .01 μf. bypass capacitor.

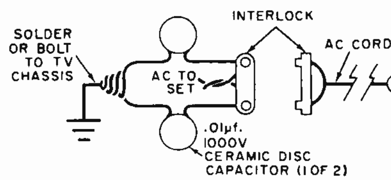


Fig. 2. Radiation into power line can be cured by bypassing to ground (the chassis) both sides of the a.c. line with capacitors.

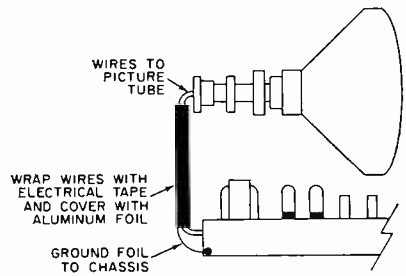
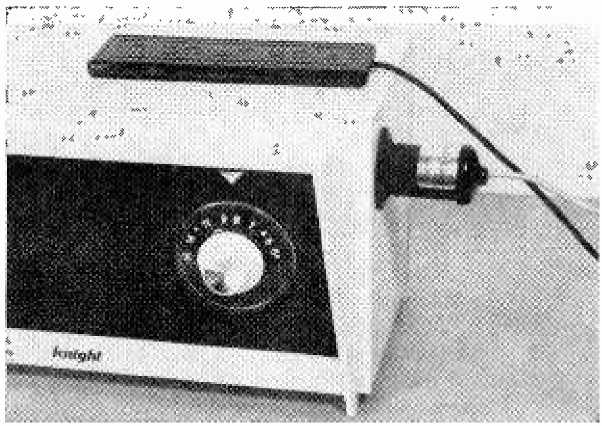


Fig. 3. To stop the set's wiring from radiating, shield the wires running from the chassis to the picture tube socket; see text.

The results of all this? In the author's case, the sync-bugs almost vanished, going from S9 to S3 in strength on 80 meters. On an a.c.-d.c. receiver, the sync-bugs had almost obliterated a local station; after "exterminating" them, they were unnoticeable. —30—

PICKUP

It's a combination recording pickup, oscillator, and tachometer—for less than $2!



Two types of pickups are shown above. To couple to a radio, simply place a pickup in the strong inductive field of the speaker or the audio output transformer.

ONE OF THE MOST fascinating and useful electronic gadgets in existence consists, quite simply, of several thousand turns of fine wire enclosed in a small plastic shell. Its price is low—under $2. What is this miracle item? As the illustrations reveal, it's the telephone pickup.

This flexible pickup can be used to make "clean" tape recordings from your radio or phonograph without any wiring changes or other alterations, to construct an inexpensive meter-readout tachometer, or an audible code-practice oscillator.

Two types of pickups are shown in the photographs—one is the flat, rectangular type which can be placed on top of a unit or under a telephone (Lafayette Radio 28 G 0901 at $1.95 is one of these). The other kind of pickup is in the form of a small cylinder with a suction cup attached to one end (Allied Radio 58R297 at $1.50).

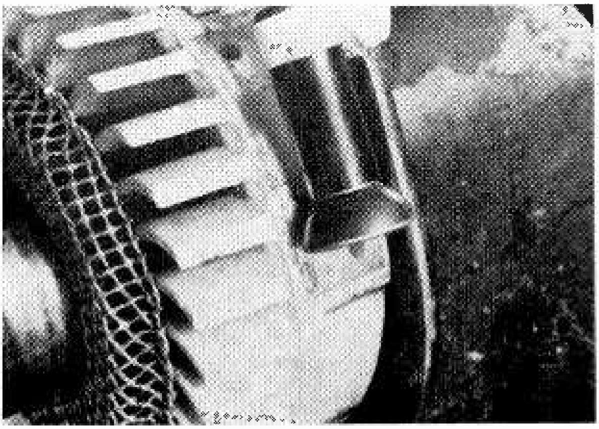
Basic Uses. When a pickup is mounted on a receiver end of a telephone handset (or, if its the flat type, placed underneath), it picks up the telephone signals by induction. The output of the pickup depends on the strength of the inductive field it is in, and is quite low when used to pick up telephone conversations. However, almost any amplifier or tape recorder has sufficient gain to produce a good output. (Be sure to check federal, state, and telephone company regulations before *recording* telephone conversations; in many cases, it is illegal.)

The impedance of the pickup is several thousand ohms, and it can be connected directly to a hi-fi amplifier or simple transistor amplifier for group listening to long-distance family calls or business "conference" calls. The Lafayette Radio 99 G 9042 transistor amplifier ($4.95) will provide sufficient gain with the pickup (100 mw.) to drive a speaker. If you have a tape recorder with a "monitor" function, it can also be used.

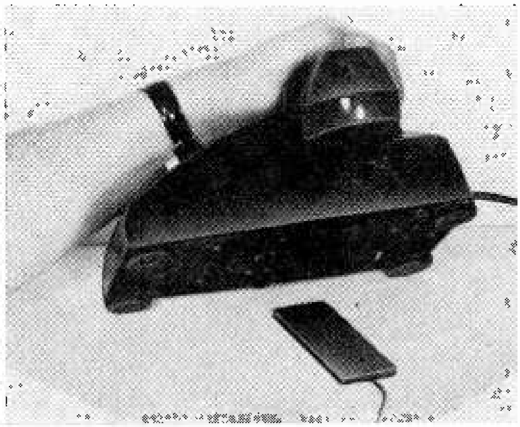
Tape Recording Techniques. Since the pickup is really nothing more than an "inductive sensor," why not use it to "sense" the inductive field of a speaker coil? This is very easy to do: The speaker field is so strong that it's not even necessary for the pickup to be in close proximity—the speaker grille of a radio or phonograph is usually close enough.

PRANKS

By Fred Blechman, K6UGT



A tachometer based on a pickup is easy to construct following the information in the text. Either the relative or—with calibration—actual rpm can be read.

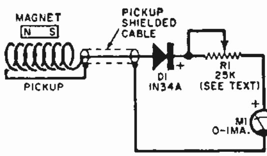


Flat type pickups can be placed under a telephone as above. By connecting the pickup to an amplifier, you can monitor family, business conference calls.

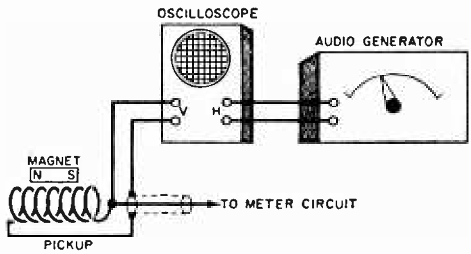
Just place the pickup against the speaker grille, plug the cable into the microphone jack of the recorder, and adjust speaker and recorder volume as desired. Unlike a microphone, the pickup will not record speaker distortion and room noise; this setup also allows you to monitor while recording.

The "Induc-Tach." It is very often desirable to know the speed of a motor or engine. "Go-Kart," quarter-midget racer, and hot-rod competitors, for example, need a means of determining whether a given engine modification results in higher engine speed or acceleration. The pickup, especially with magneto-operated engines, provides a simple, inexpensive way to read relative engine rpm, and, with a little extra trouble, can be calibrated to read actual rpm.

The photo above shows a pickup attached to a lawn mower magneto engine in such a position that the magnets on the flywheel pass by the pickup on each revolution. Relative rpm can be read by connecting a diode rectifier, potentiometer, and 0-1 ma. meter as shown in the schematic. The reading will depend on meter sensitivity, magnet strength, pickup proximity and orientation, rpm,



A circuit for reading relative rpm is shown at the left. A signal is picked up from rotating magnets on the engine or the motor.



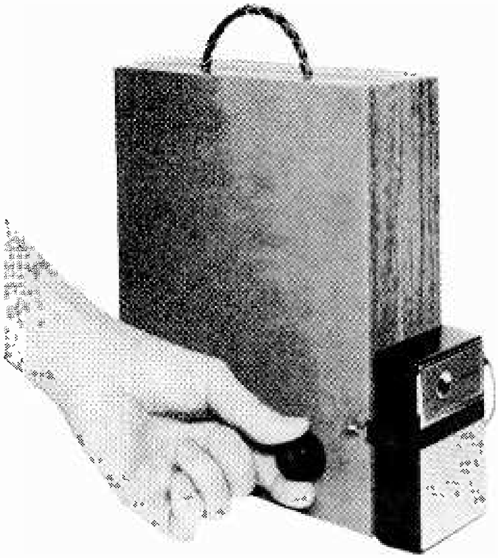
A pickup tachometer can be calibrated with an oscilloscope and audio generator. With a bit of work, a meter scale can be drawn which shows actual rpm.

and the value of the potentiometer (*R1*).

For slow speeds and small magnets, *R1* may not be needed. If required, *R1* should be adjusted to full scale at maximum rpm; it can be replaced with a fixed, ½-watt resistor if desired.

For spark engines or motors, it is necessary to place a magnet on the shaft

(*Continued on page* 156)



BOOST BOX

Get better tone and more sensitivity from your six-transistor pocket radio receiver

DO you want more sound and greater sensitivity from your pocket transistor radio? Here is a simple and relatively inexpensive way to get both.

As shown in the photos, a 6″ PM speaker is mounted in a homemade wood and compo-board baffle box measuring 10″ x 8″ x 3″. Approximately 80 feet of #26 wire is close-wound around the outside of the box and, when connected across a 365-pf. variable capacitor, gives you a tunable loop.

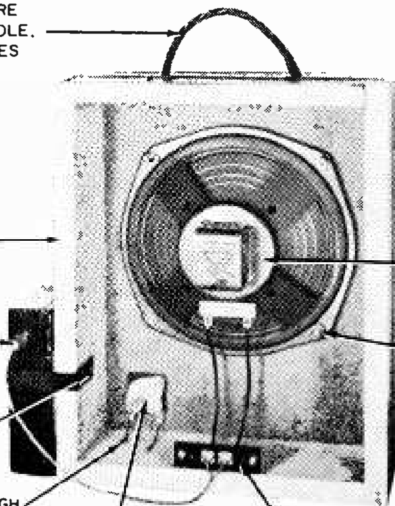
In operation, your small transistor radio is clamped to the outside of the box so that the receiver's loopstick antenna parallels the loop on the box. First, tune in a weak distant station and then turn the radio and box in the direction of the station for the loudest signal. Next, tune the large loop for maximum boost. And finally, plug the 6″ speaker into the radio's jack (the earphone jack).

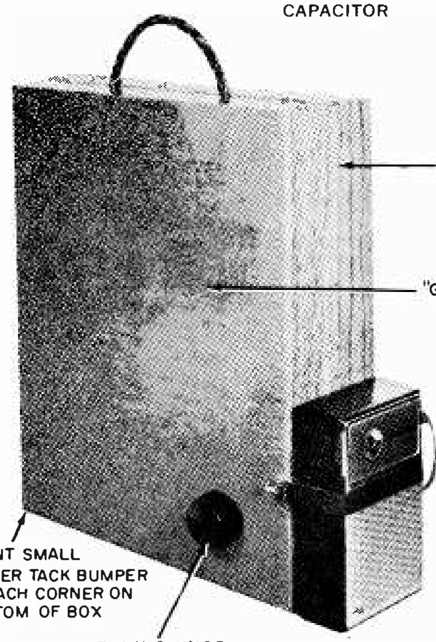
If you want to use a larger box, wind fewer loop turns; for a smaller box, wind more. The right number of turns for the 365-pf. capacitor can best be determined by experiment.

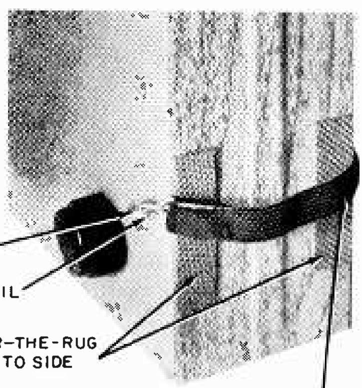
The "clamp" used to hold the transistor radio to the side of the box is easy to make and can be fastened with tacks or staples. Some transistor radios have their loopsticks mounted vertically; if this is the case with yours, design the holder so that the radio mounts horizontally on its side.

When not being used as a booster, your "box" can serve as a test-bench speaker or an extension radio speaker. Or, if you connect a 1N34A germanium diode and a pair of high-impedance headphones in series across the variable capacitor, you'll have a crystal set for tuning in local stations—or a hi-fi tuner for AM. You can probably think of other uses as well.

By ART TRAUFFER


THE WRITER USED DIME STORE BRAIDED LEATHER FOR HANDLE. PASSED THROUGH TWO HOLES AND TACKED TO INSIDE OF WOOD BOX
WOOD BOX IS 10" HIGH, 8" WIDE, 3" DEEP
MINIATURE PLUG AND 75-OHM TWIN-LEAD CONNECTS TO 2-TERMINAL STRIP
ONE END OF ELASTIC BAND IS TACKED TO INSIDE OF FRAME
ENDS OF LOOP PASS THROUGH SMALL HOLES TO LUGS ON VARIABLE CAPACITOR
365 PF VARIABLE CAPACITOR
6" PM SPEAKER. MOUNTED OVER 5 1/4" HOLE IN PANEL
MOUNT SPEAKER WITH FOUR 8–32 BY 1/2" FLAT-HEAD MACHINE SCREWS, WITH NUTS TO FIT. COUNTERSINK HOLES ON FRONT OF PANEL
2–TERMINAL STRIP. MOUNTED WITH TWO SMALL METAL ANGLES SCREW–FASTENED TO INSIDE OF FRAME


LOOP ANTENNA IS 20 TURNS OF #26 ENAMELLED COTTON-COVERED COPPER WIRE WOUND AROUND OUTSIDE OF BOX AND COVERED WITH BROWN "CONTACT" PLASTIC MATERIAL
"GRILLE CLOTH" IS BROWN LADIES HANDKERCHIEF COVERING ENTIRE FRONT
MOUNT SMALL RUBBER TACK BUMPER ON EACH CORNER ON BOTTOM OF BOX
TUNING KNOB


SMALL SCREW-EYE
HOOK BENT FROM SMALL FINISHING NAIL
STRIPS OF "NON-SKID" UNDER-THE-RUG RUBBER MATERIAL CEMENTED TO SIDE OF BOX
6" LENGTH OF 1/2" WIDE ELASTIC BAND

Build a Telephone Beeper

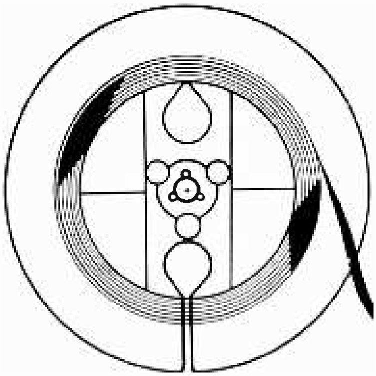
The law says you must put an audible tone on the line when you record a phone call—here's an inexpensive gadget that does the trick for you

By FRED BLECHMAN, K6UGT

SINCE the introduction of inexpensive tape recorders and inductive pickups, the practice of recording telephone conversations has become widespread. In business or private life, it often saves the day for people who can't take shorthand, permitting them to transcribe the important facts of the conversation at their own pace later on. But there's a catch: An FCC Order issued May 20, 1948, directed that an audible tone signal must be sent over the line at least once every 15 seconds on calls that cross a state or national boundary when a conversation is being recorded. Not long thereafter, most telephone companies filed new tariff regulations with the Public Service Commissions of the various states, imposing the same requirement for calls within state boundaries. And when these regulations were approved, they acquired the force of law.

You can equip yourself to comply with this requirement by building the "Telephone Beeper." The outlay is modest (around $8.00), and the unit is small, self-contained, and requires no electrical connection to the telephone. This latter point is of some importance, since telephone companies are understandably touchy about having unauthorized devices connected to their equipment.

Many tone signal units in commercially available equipment are



Induction pickup for recorder is attached to earpiece. Clip holds Telephone Beeper to mouthpiece as shown.

inductively coupled to the telephone earpiece. This usually results in a very loud BEEP on the recording, but a rather low-level tone at the other party's end. In fact, to make the tone audible at the distant end, it may be necessary to raise the beep to such a level that some incoming words are smothered on the recording.

In addition, it's easy to forget to turn off some units, since only the position of the power switch indicates the "on" or "off" condition of the tone signaler.

What the "Beeper" Does. The Telephone Beeper overcomes all of the above disadvantages neatly and simply. The tone signal itself is an audible "beep" emitted from a miniature loudspeaker positioned so that the sound enters the telephone transmitter (microphone) acoustically, along with the voice of the user. Thus, there's no need for any electrical coupling or connection to the phone.

The signal is also coupled to the recording pickup on the earpiece via the sidetone path provided between mouthpiece and earpiece within the telephone circuit itself. It is this sidetone circuit that allows you to hear your voice in the earpiece when you speak, and of course it carries the sound of the Beeper just as well. Because of this arrangement, the Beeper is recorded at about the same level as it is heard at the other end of the line.

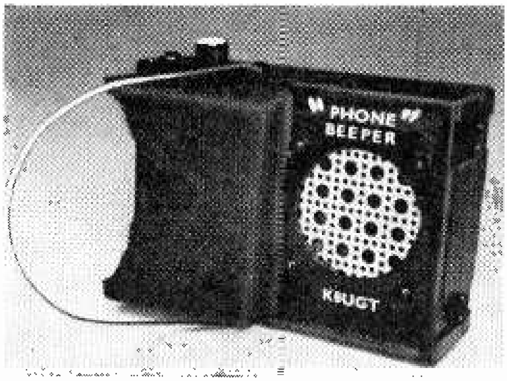
As for forgetting to shut off the unit, its continued beeping after you've hung up the phone will be an unfailing reminder to you to do so.

The photograph on page 34 shows how the Beeper is mounted and used. The device contains an oscillator, speaker, and a timing circuit, along with two 9-volt transistor batteries for power. It is held in position adjacent to the mouthpiece by a retaining clip made of piano wire. It does not interfere with normal use of the telephone, and may be left permanently in place.

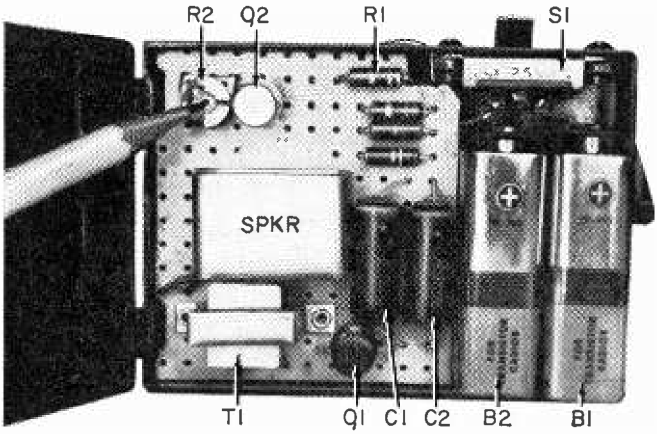
How It Works. The simple circuit that generates and times the beeps is shown in the schematic on the next page. Transistor *Q1* is a unijunction type, which is energized by the two 9-volt batteries in series. When switch *S1* is closed, capacitors *C1* and *C2* are charged through resistor *R1*. When the voltage at the emitter of *Q1* reaches a certain value, *C1* and *C2* discharge through resistors *R4* and *R5*, and the emitter-base 1 junction of *Q1*. The resulting positive voltage at the junction of *R4* and *R5* provides conductive bias for oscillator transistor *Q2*. Feedback for oscillation is obtained through the center-tapped primary of transformer *T1*, which also couples the oscillator output to the speaker. Variable resistor *R2* controls the oscillation frequency.

This circuit is somewhat critical, so you must use the parts specified for transformer *T1* and transistor *Q1*. Transistor *Q2* may be just about any inexpensive *pnp* germanium transistor (CK722, 2N107, etc.) since adjustment of *R2* will compensate for any difference between specific transistors. Potentiometer *R2* is the smallest unit available.

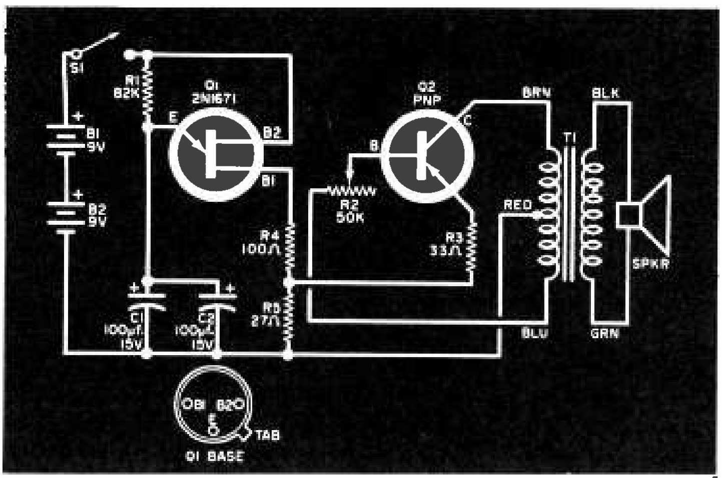
(*Continued on page* 162)



Contoured block of sponge material fits phone shape, secures Beeper in position.



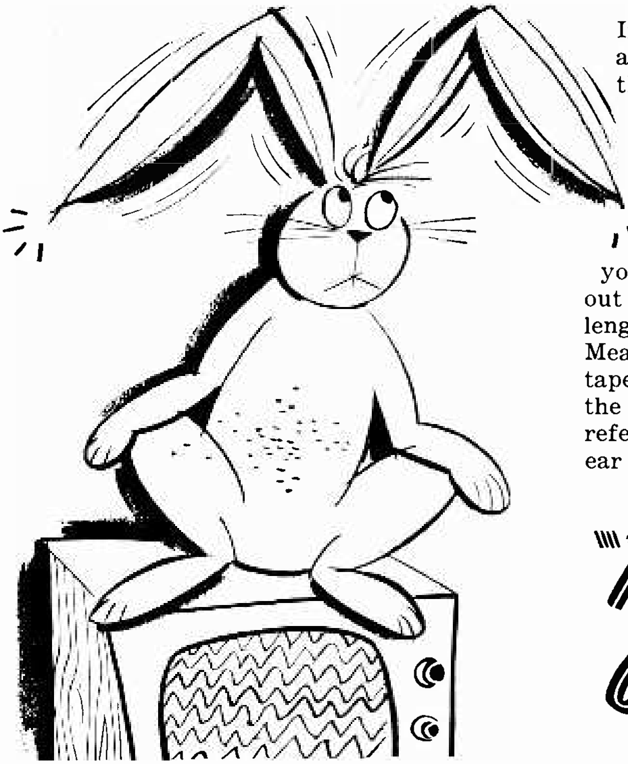
Parts placement isn't critical. Author's layout shown here permits easy assembly.



Simplicity of basic circuit is clear in schematic. Only critical parts are T1, Q1.

PARTS LIST

B1, B2—9-volt transistor radio battery
C1, C2—100-µf., 15-volt miniature electrolytic
Q1—GE 2N1671 unijunction transistor*
Q2—CK722 or 2N107 pnp germanium transistor
R1—82,000 ohms
R2—50,000-ohm subminiature potentiometer (Lafayette 99-6142); alternate, 10,000-ohm unit (Lafayette 99-6144)
R3—33 ohms } *all resistors*
R4—100 ohms } *fixed,*
R5—27 ohms } *½-watt carbon*
S1—S.p.s.t. slide switch
T1—Output transformer (Lafayette 99-6123 or Philmore ST-32)*
1—Induction type pickup (Lafayette 99-6197)
SPKR—1½"-diameter speaker (Lafayette 99-6035)
Misc.—Case (author used plastic box 3¾" x 2¾" x 1¼"), perforated circuit board, perforated aluminum for grille, stiff wire for clip, foam rubber, battery terminals, etc.
*Do not substitute for these parts



In the chart on the next page is the answer to TV's best guarded secret—the *electronically* right length for rabbit ears. Measurements to a small fraction of an inch may seem like lint-picking if you're entirely happy about the picture quality you are getting by adjusting your ears "esthetically." If, however, you're fighting to get a good picture out of a troublesome channel, exact-length rabbit ears will improve things. Measure with a steel tape or that cloth tape in the sewing basket, starting where the ears come out of the base. Small reference scratches can be made on each ear with a file so that you can quickly retune them for best results on any channel.

"TV'S BEST GUARDED SECRET—"

By LEWIS A. HARLOW

WHEN you took your original rabbit ears out of the box in which they came to you, it's almost certain that you did *not* find adequate instructions for their use. All of the manufacturers of rabbit ears, having built a very fine product, seem to have agreed that you must learn about it the hard way. So, they tell you nothing, or next to nothing, and your only recourse is to regard the adjustment of your ears as another of the "pleasant" mysteries of television.

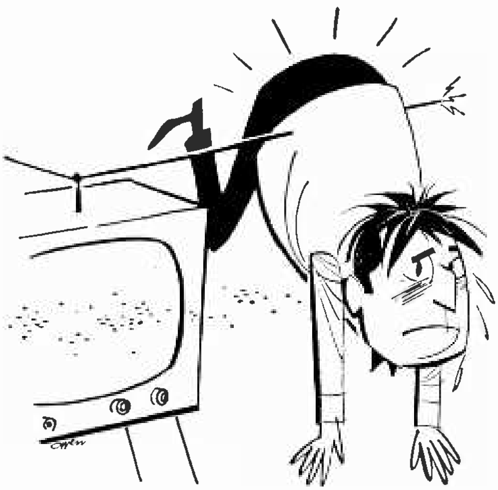
Perhaps you have decided, after much experimenting, that you get best results with a long ear pointed at Chillicothe, Ohio, and a short ear pointed at the moon. Now this is all wrong—for several dull scientific reasons which can quickly be passed by. However, since the manipulation of rabbit ears is quite critical, producing either (and usually unexpectedly) a shocking improvement or degeneration in picture quality, a few helpful comments are in order.

As on the rabbit, the ears should be the same length, and if you need utmost sensitivity from your antenna, this length should be changed every time you switch channels.

Wide or Narrow Ears? There's a catch to the problem of adjusting rabbit ears. They do not do their best when pointed up in a wide or tight V—they should be extended out to the sides! Unfortunately, this introduces a situation which is socially impractical, and one which has an element of danger. An unsuspecting guest may back into a rabbit ear point and impale himself upon it.

What happens, you ask, when rabbit ears are turned up into a V position? How long should they be? The arithmetic for this can get very complicated because everything changes a little every time you change the angle of the V.

In general, when using rabbit ears in this unscientific position, they should be slightly longer (maybe 10 percent) than the exact figures given for horizontal ears in the chart. They should be as



widely spread as possible, and, of course, they should be the same length as one another.

Different Types of Ears. In addition to the ordinary, garden-variety rabbit ears, other types available include exact replacements for those built into portable TV sets (sold through electronics supply houses), and at least a dozen models that include a switching arrangement in addition to the basic adjustment of the ears. These switches, which perform a variety of matching and orienting functions, may have as few as three positions or as many as twelve, depending, seemingly, upon whim.

If the switch positions correspond to Channels 2-13, fine. If, however, the positions are numbered 1-12 or, as in one case, 1-9 followed by A, B, and C, the contribution of the switch is far more subtle, and the best position can be found only by "cut-and-try."

Guaranteed Method. Here is a three-step experiment that will guarantee absolute maximum performance with switches. Before starting, adjust the ears to exact length, and provide room to swing them around. It is necessary to carry out the steps in the order indicated, since you are dealing with three variables which are inter-related; if your method lacks scientific orderliness, your results will be confusing.

Step One: Set the rabbit ears selector switch to its lowest position.

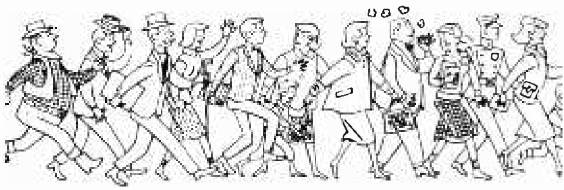
Step Two: Swing the ears in a circle to get the best picture. You are trying to do two unrelated things—strengthen the incoming signal and, secondly, eliminate "ghosts." If the main signal is strong enough so that the rabbit ears do not need to be positioned critically, the ears can then be set to reject ghosts. A compromise may be necessary.

Channel	Inches	Channel	Inches
2	50⅞	8	15½
3	45⅞	9	15
4	41¾	10	14½
5	36⅜	11	14⅛
6	33¾	12	13⅝
7	16	13	13¼

Step Three: After obtaining the best possible results with the above steps, adjust the TV set's fine tuning control. Now move the selector switch on the rabbit ears to its next position, and repeat Steps Two and Three. And so on, *ad nauseam.*

What About UHF? The standard or domestic rabbit ears (13¼" minimum to 50⅞" maximum) are too long for fully efficient signal collection from the ultra-high-frequency stations using Channels 14 to 83. Baby rabbit ears should be about 6½" in repose and about 12" fully extended. So far, this miniature size is not available. You can experiment, though, with your regular ears, which will do a fairly efficient job at *double* these lengths. Twenty-four inches is about right for Channel 14, and fully contracted, your rabbit ears can almost reach the resonance of Channel 83. –30–

COMING or GOING



By ARTHUR J. DAVISON

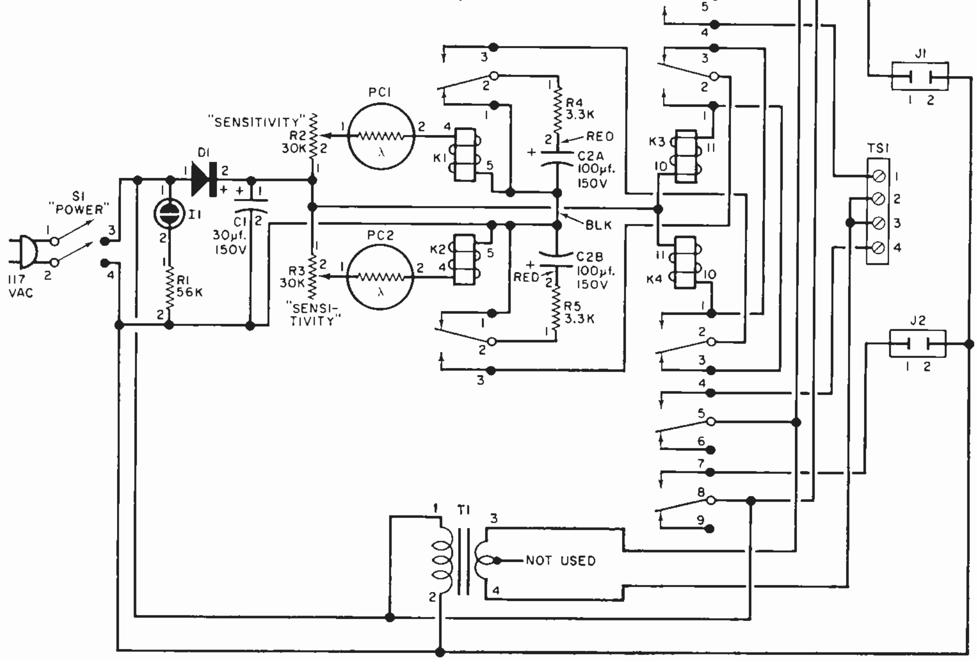
This photoelectric sensing device not only tells you when something is passing in front of it—the gadget will also indicate whether that something is . . . coming or going!

MOST "CUSTOMER-ANNOUNCING" SYSTEMS do a fine job of letting a storekeeper know when someone has passed through his shop door. But suppose the storekeeper's working in back when the signal sounds. Does the clerk in front need help with another customer—or has the original customer gone *out* the door?

This interesting photoelectric device will solve the problem very nicely. Employing twin photocell-and-relay systems, it unfailingly announces the direction of movement of any person or object breaking an associated light beam. You can use it to actuate separate "in" and "out" lamps, a buzzer and bell combination, or whatever else your imagination suggests.

Construction. The components are mounted in a 6" x 6" x 6" utility box having a built-in chassis. Parts placement is illustrated in the photos and diagrams but (except for photocells *PC1* and *PC2*) isn't critical and

If the schematic diagram of the "sensor" looks a trifle complicated, keep in mind that one side of the circuit is simply a "mirror image" of the other side (two separate circuits are required to indicate both "coming" and "going"). The numbers from 1 to 11 on this diagram correspond to similar numbers on the two pictorials.



can be varied to suit your own taste.

For the sake of clarity, most of the wiring has been eliminated from the pictorials. The leads or terminals of all important components, however, are keyed to the schematic diagram by means of matching numbers.

When carrying out the wiring, no special care need be taken with the lead dress; all leads may be routed in the most convenient manner. Install rubber grommets as shown in the pictorials to pass wires through the chassis.

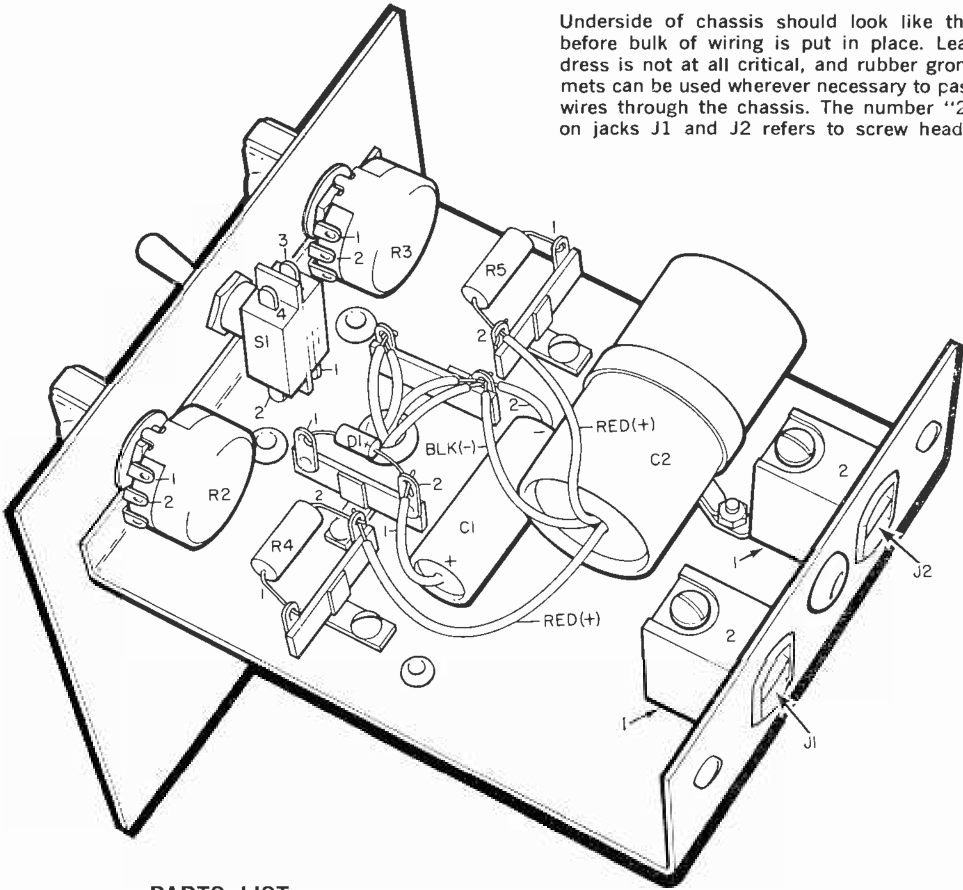
Photocells *PC1* and *PC2* are installed on the box's front panel as shown on page 44. In order to prevent stray light from affecting the photocells, they are set back in 2¼" "wells" made from 9-pin tube shields. These wells are set far enough apart (1¼") so that *PC1* and *PC2* will operate independently.

Note that the shields are press-fitted over shield bases (see Parts List) which have been pushed through holes in the panel. The circular lip at the top of each shield is first sawed off, and slots are cut to clear the shield-retaining bosses on the base. The opening at the other end is slightly enlarged with pliers so that it will fit the casing of the photocell snugly.

The spacing of the pin terminals on the photocells specified for *PC1* and *PC2* is such that any pair of opposite contacts on a 9-pin tube socket will slip over them. This type of socket, then, is used to make the connections to the photocells.

Setup and Adjustment. First provide yourself with a suitable light source. A 6-volt, lantern-type flashlight—among other things—will do the job. If you use such a flashlight, a 6-volt filament transformer can be installed in place of the battery. But be sure that the flashlight's reflector is made of metal rather than plastic. It's possible that transformer heat might warp some plastics.

Aim the light beam so that it crosses the doorway and strikes *PC1* and *PC2*—making sure that the two photocells are



Underside of chassis should look like this before bulk of wiring is put in place. Lead dress is not at all critical, and rubber grommets can be used wherever necessary to pass wires through the chassis. The number "2" on jacks J1 and J2 refers to screw heads.

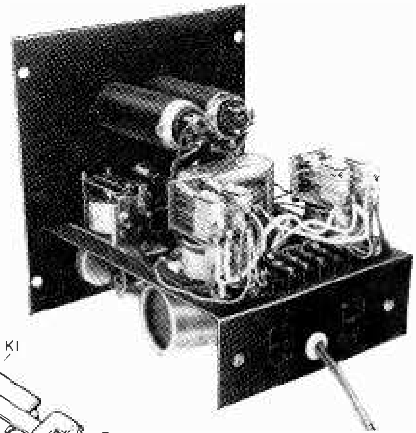
PARTS LIST

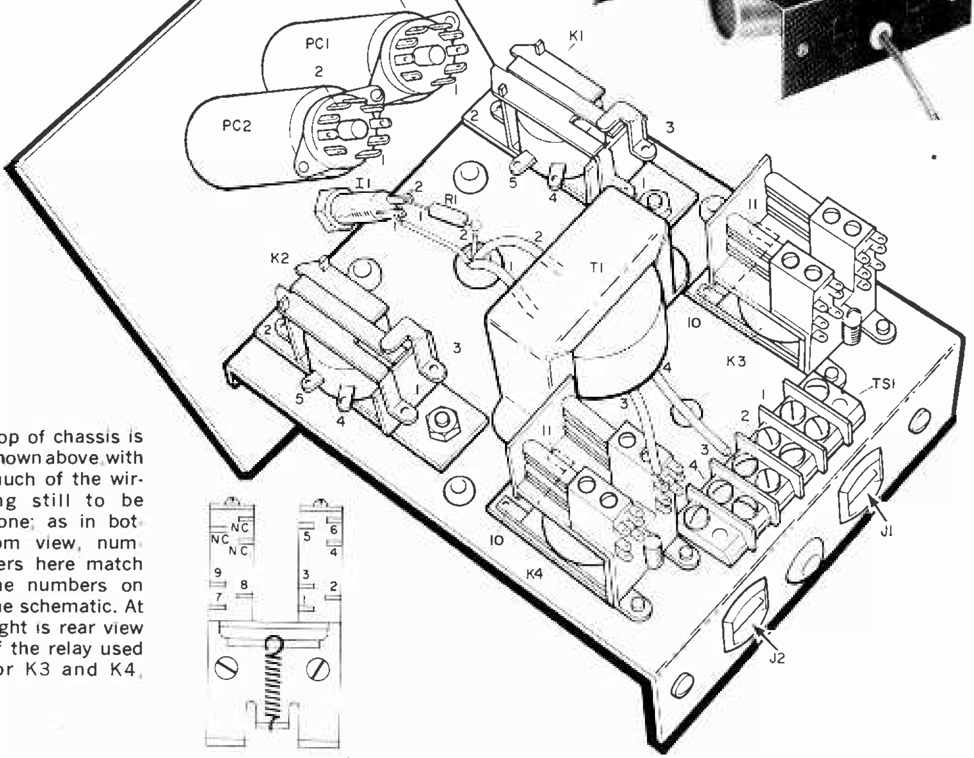
C1—30-µf., 150-volt electrolytic capacitor
C2—Dual 100-µf., 150-volt electrolytic capacitor
D1—400-PIV, 750-ma. silicon diode
I1—NE-51 neon lamp
J1, J2—Chassis-mounting a.c. outlet
K1, K2—5000-ohm plate relay, s.p.d.t. contacts (Potter & Brumfield Series LB-5 or equivalent)
K3, K4—5000-ohm plate relay, 3-p.d.t. contacts (Guardian "Universal 200" Series; 200-5000 D coil, 200-M5 contact assembly with one pole unused—or equivalent)
PC1, PC2—Heavy-duty cadmium photocell (Lafayette 99 G 6316 or equivalent)
R1—56,000-ohm, ½-watt resistor
R2, R3—30,000-ohm potentiometer
R4, R5—3300-ohm, 2-watt resistor
S1—D.p.s.t. toggle switch
T1—Filament transformer; primary, 117 volts; secondary, 6.3 volts @ 1.0 amp. (Knight 62 G 030 or equivalent)
TS1—4-terminal, barrier-type terminal strip (Cinch-Jones 4-140 or equivalent)
1—6" x 6" x 6" utility case with 4⅞" x 5⅞" x 1¾" chassis (Premier CA-1405 or equivalent)
2—Shield bases for 9-pin miniature tube socket (Cinch-Jones 9SB1 or equivalent)
2—2⅜" shields for 9-pin miniature tube (Cinch-Jones 9SJ3-1 or equivalent)
2—9-pin miniature tube sockets
Misc.—Line cord and plug, rubber grommets, terminal strips, hardware, wire, etc.

illuminated with equal intensity. Then turn on "power" switch *S1*. Neon power indicator *I1* should now glow.

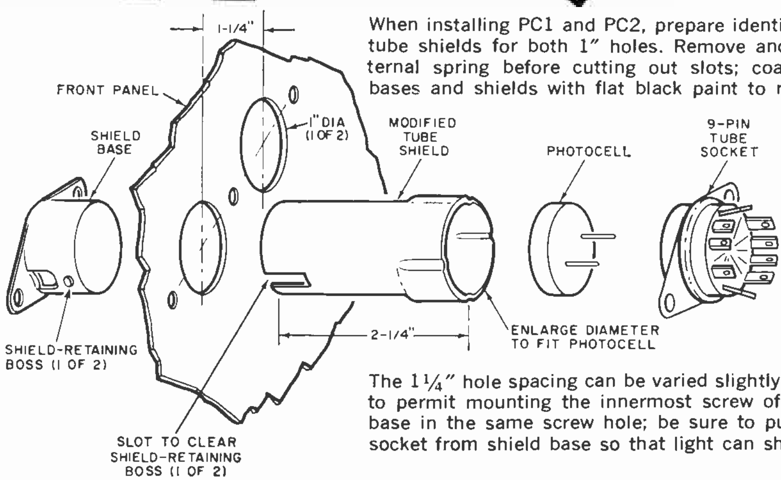
Move both "sensitivity" controls (*R2* and *R3*) to their maximum-resistance positions. Then turn them in the opposite direction until the relays they control (*K1* and *K2*, respectively) pull in—and continue for another quarter-turn. These settings should be about right, but in the first few hours of operation there may be resistance changes in the photocells calling for further reduction in the resistances of *R2* and *R3*.

Now all you have to do is connect the signaling devices. If the photocell unit is placed so that people on the way in will darken *PC1* first, connect the "in" signals to *J1* and/or terminals 1 and 2 of *TS1*. The "out" signals are connected to *J2* and/or terminals 3 and 4 of *TS1*. If people coming in will darken *PC2* first,



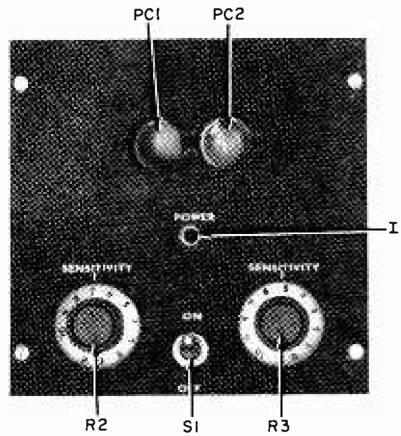


Top of chassis is shown above with much of the wiring still to be done; as in bottom view, numbers here match the numbers on the schematic. At right is rear view of the relay used for K3 and K4.



When installing PC1 and PC2, prepare identical modified tube shields for both 1" holes. Remove and discard internal spring before cutting out slots; coat insides of bases and shields with flat black paint to reduce glare.

The $1\frac{1}{4}$" hole spacing can be varied slightly if necessary to permit mounting the innermost screw of each shield base in the same screw hole; be sure to push out tube socket from shield base so that light can shine through.



Front panel of the "sensor" is extremely symmetrical, with photocells, pilot lamp, and sensitivity controls arranged in a neatly balanced fashion.

HOW IT WORKS

The a.c. line voltage is rectified by diode *D1* to furnish d.c. for relays *K1-K4*, and capacitor *C1* filters this d.c. voltage well enough to prevent chattering. The coils of relays *K1* and *K2* are each connected, across the d.c. supply, in series with a "sensitivity control" and photocell (*R2* and *PC1*, *R3* and *PC2*).

As long as a light beam strikes the photocells, their resistances remain low, and *R2* and *R3* can be adjusted to pass enough current to pull in *K1* and *K2*, respectively. But if either *PC1* or *PC2* is darkened, its resistance will immediately increase, and the current flow will decrease enough to drop out the appropriate relay.

The photocells are so placed that a person walking by them, depending on whether he's coming or going, will darken *PC1* or *PC2* first. If *PC1* is darkened first, *K1* drops out and contacts 2 and 3 of that relay close. This connects capacitor *C2a* and resistor *R4* (through contacts 2 and 3 of *K4*) in series with the coil of *K3* and the d.c. supply.

Current from the supply flows through *K3's* coil and *R4* to charge *C2a*, and the charging current pulls in *K3*. Since contacts 4 and 5 of *K3* have now closed, the 6.3-volt secondary of transformer *T1* is connected across terminals 1 and 2 of terminal strip *TS1*. In addition, contacts 7 and 8 of *K3* make the a.c. line voltage available across outlet *J1*.

Though contacts 1 and 2 of *K3* also close, this accomplishes nothing until photocell *PC2* is darkened. Then *K2* drops out, closing its contacts 2 and 3. Accordingly, charging current for capacitor *C2b* flows (via contacts 1 and 2 of *K3*) through resistor *R5* and the coil of *K3*—helping to keep the latter relay pulled in.

If the photocells remain darkened, the charging currents for *C2a* and *C2b* will keep *K3* pulled in for about 3 seconds. Therefore, any electrical signaling devices connected to *J1* or to terminals 1 and 2 of *TS1* will operate for that length of time. Should light hit the photocells before the three seconds are up (as is usual), *K1* and *K2* will pull in—dropping out *K3* and cutting off the prior signals. Note that capacitors *C2a* and *C2b* discharge through resistors *R4* and *R5*, respectively—readying themselves for the next cycle—when *K1* and *K2* pull in.

Should *PC2* be darkened first, the reverse situation occurs. Relay *K2* drops out and *K4* is pulled in by charging current for *C2b*. Then as *PC1* is darkened, *K1* drops out—adding the charging current for *C2a* to that already flowing through *K4*'s coil. The result is that 6 volts appears across terminals 3 and 4 of *TS1* and 117 volts appears across *J2*. As before, these signal voltages remain available for about 3 seconds—but will be cut off earlier if light strikes the photocells.

then simply reverse these connections.

Remember that outlets *J1* and *J2* are for signaling devices (such as illuminated "In" and "Out" signs) which operate on 117 volts. Six-volt devices (such as bells, buzzers, etc.) should be connected to *TS1*.

And there you have it! Chances are you'll stumble across all kinds of interesting applications for this novel alarm. For example, let's say you want to count the number of objects—people, cars, or what have you—passing in one direction only; you just plug a suitable counter into either *J1* or *J2* (depending on whether you want to count them "coming" or "going"), and your problem is solved. Or you can use the gadget to trigger a tape recorder, set up so that it will give one greeting to people coming in and a different message to those going out. Regardless of your specific requirements, one thing is certain: thanks to this little photoelectric "sensor," you'll never again have to wonder whether someone is *coming or going!* —30—

You probably thought top quality electronic test instruments were too expensive*...didn't you?*

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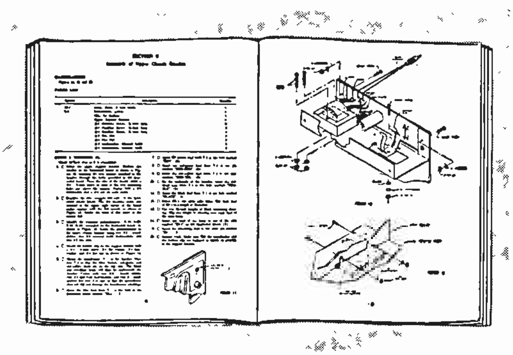
Ease of assembly is one thing. Parts are clearly identified. Each assembly diagram appears on the same page as the step-by-step instructions for that section of assembly. There's no need to refer back constantly to other pages, which consumes time and increases the chance of error.

Ease of alignment is another thing. Each kit contains complete instructions for accurate calibration or alignment of the instrument. Where necessary, precision calibrating resistors are provided for this purpose.

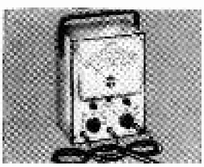
What does it mean? It means that with RCA kits you can get a professional V-O-M or VTVM for as little as $29.95*. Or you can get a good oscilloscope (one of the most useful—but normally one of the most expensive—test instruments) for only $79.50*.

Specialized instruments such as an AC VTVM or an RF Signal Generator, are also available as kits for far less than they would cost otherwise. In every case, RCA kits, when completed, are identical with RCA factory assembled instruments.



Each sub-assembly is described in a separate section with illustrations applying to that sub-assembly available at a glance. No cross referencing necessary.

LOOK WHAT'S AVAILABLE TO YOU IN KIT FORM:



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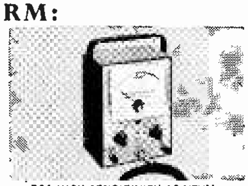

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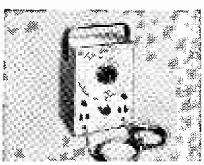

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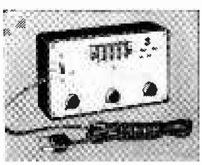
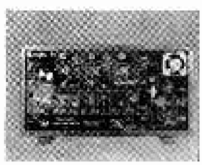
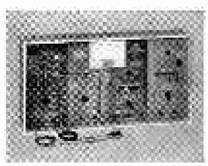


RCA TV BIAS SUPPLY. For RF, IF alignment in TV sets. WG-307B(K). Kit price: $11.95*



RCA TRANSISTOR-RADIO DYNAMIC DEMONSTRATOR. For schools. WE-93A(K). Kit price: $39.95*



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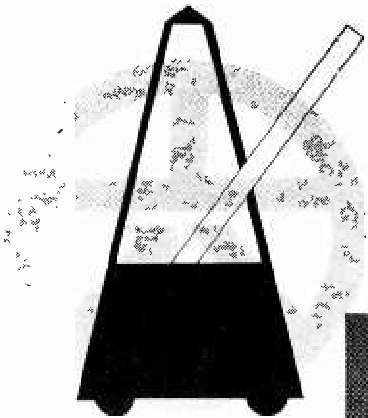
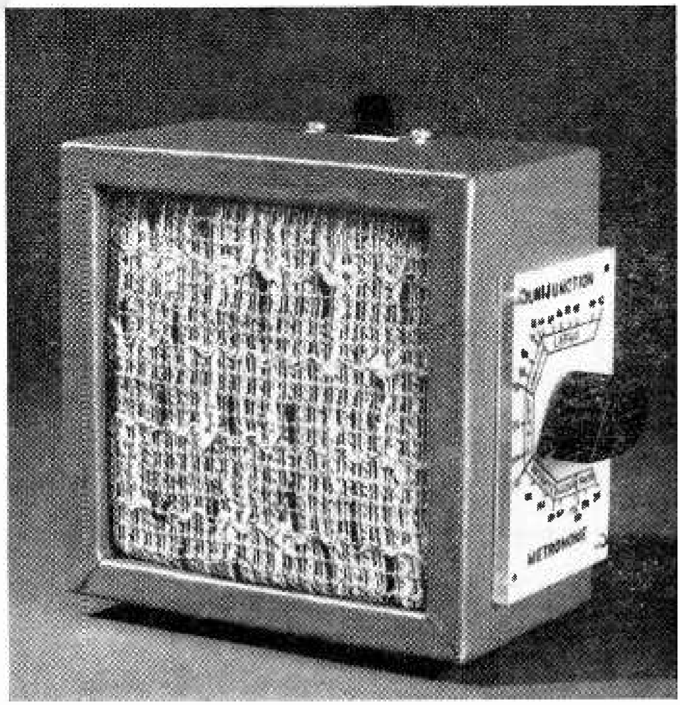


Largo to Presto Metronome



Single-transistor metronome operates from house current

By JOHN F. CLEARY*

A METRONOME can be any contrivance for marking time as an aid to musical study and performance. The metronome to be described here is one of the simpler electronic "contrivances" in that it uses the unique unijunction transistor to generate precision timing pulses. In fact, this is the only transistor used—or for that matter needed—in order to generate a distinct "metronomic tick" at the loudspeaker. An advantage of using the unijunction, or UJT as it is often called, is that the loudspeaker can be driven directly. No output transformer is needed.

The circuit can be powered either by a transformerless supply as shown or by a battery. Beat rate is adjustable from below 42 beats per minute, a low *largo,* to slightly over 208 beats per minute, a high *presto.* Both limits can be extended simply by changing the emitter component values.

Circuit operation centers around the 2N2160 (you can substitute a 2N2646 if you wish) in a basic unijunction transistor relaxation circuit. Applying voltage across *R3*, *R4*, *R5*, and *C2* allows *C2* to charge. Since at the beginning of the operating cycle the unijunction emit-

**Applications Engineering, Semiconductor Products Dept., General Electric Company*

ter is reverse-biased and therefore nonconducting, a high impedance exists across *C2*. As *C2* continues to charge, the emitter voltage increases exponentially and approaches the supply voltage level. At a point determined by the unijunction and called the "emitter peak point voltage," the emitter becomes forward-biased and presents a low impedance across *C2*, causing it to "dump" its charge into base 1 (B1) through the speaker voice coil. This results in a distinct "tick" from the speaker.

"Rate" pot *R4* provides for a slow or fast beat rate by controlling the charging time of *C2*. Frequency is thus determined by the combination of *R4*, *C2*, and the supply voltage across the UJT. Resistor *R3* is selected to set the high beat rate limit while *R5* sets the low limit. By using a log-taper potentiometer for *R4*, a well-proportioned "rate" scale can be adjusted to any range desired. The photograph on page 47 shows a typical 42-208 beats-per-minute metronome scale spread over almost the total 270° range of *R4*. The number of beats for the various tempi employed as calibration for the author's metronome are as follows:

BEATS/MINUTE	TEMPO	BEATS/MINUTE	TEMPO
42-69	Largo	125-154	Andante
69-98	Larghetto	154-180	Allegro
98-125	Adagio	180-208	Presto

Four 1N1692 silicon rectifiers in a bridge-rectifier configuration and a 100-μf. filter capacitor make up the power supply. Fed directly from the a.c. line, this arrangement supplies the required 25 volts at 4 ma. with sufficient regulation for good metronome stability. Resistors *R1* and *R2* act as voltage-dropping resistors and add some degree of safety by limiting the total current drain to approximately 5 ma. under direct short-circuit conditions. By housing the circuit in an insulated box, additional protection is obtained against electric shock.

Naturally, other power supply arrangements can be used. A 22½-volt battery can replace the supply shown. Lower voltages can be used with decreased output and increased calibration error; in fact the UJT will continue to operate with as low as 3 volts applied in many instances.

Construction. The photos show how the unit is constructed with the exception of the line resistors and three of the 1N1692 rectifiers, which are all hidden behind the speaker "U" frame. Two rectifiers are located on either side of the perforated insulation board for ease of mounting and wiring. The back of the speaker frame, as shown, protrudes through the square hole cut from the board and rides on the surrounding lip of the speaker frame. After cutting the board to size (slightly smaller than the over-all speaker measurement), measuring and cutting out the center opening, and mounting all components, the completed board is slipped onto the speaker frame and secured in place with contact cement. The bracket-supported *R4* is then soldered to the speaker frame for increased rigidity, as can be seen in the photo showing the inside view of the unit.

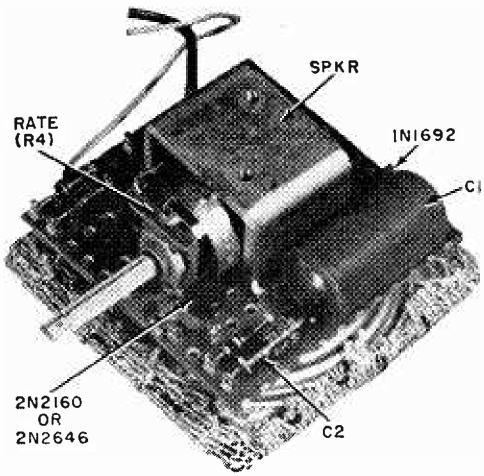
A square of grille cloth and a square of aluminum window screening are cut about 1" larger than the speaker frame. Place the grille cloth on a flat surface, the screen on top of it, and the speaker —cone down—on top of the screen. By wrapping the excess material around the edge of the speaker frame, the cone will be protected from damage. This method of covering the speaker requires no hardware and is self-supporting.

The cabinet shown is made from ⅜" plywood and measures 2½" deep x 4⁵⁄₁₆" square. The back is cut from ¼" hardboard and is glued in place. A shaft hole about ¾" in diameter—large enough to accommodate the shaft and allow the completed unit to be placed in the box snugly—is then carefully drilled in the side of the box. An additional power switch hole is made in the top of the cabinet and a power-line cord hole in the back.

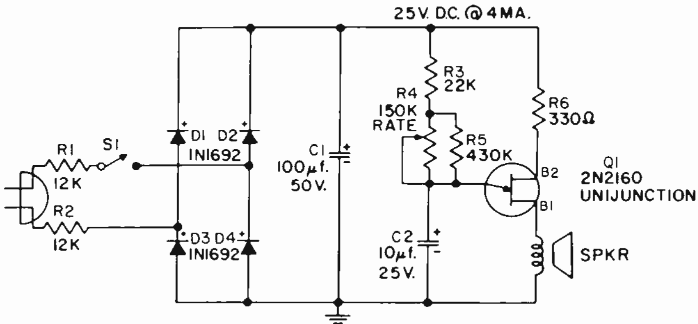
In the photo showing the internal view of the metronome, note the two threaded holes located on the back of the speaker "U" frame. Two additional holes are carefully drilled in the cabinet

PARTS LIST

C1—100-µf., 50-volt miniature electrolytic capacitor
C2—10-µf., 25-volt miniature electrolytic capacitor
D1, D2, D3, D4—1N1692 silicon diode
Q1—2N2160 or 2N2646 unijunction transistor
R1, R2—12,000-ohm, ½-watt resistor
R3—22,000-ohm, ½-watt resistor
R4—150,000-ohm potentiometer
R5—430,000-ohm, ½-watt resistor
R6—330-ohm, ½-watt resistor
S1—S.p.s.t. switch
Misc.—Small speaker and cabinet—see text, perforated phenolic board, flea clips, a.c. cap, wire, solder, etc.



Components of the metronome are mounted on a perforated circuit board. The speaker is a square-framed 3½" Utah SP358 3-4 ohm unit containing a 1-ounce magnet. Any speaker can be used, however; the higher its efficiency, the louder the tick.



back to match these holes which are then used to hold the speaker securely in place.

Should a battery be used to power the unit rather than a permanent power supply, cabinet dimensions must be changed accordingly. Since wiring is in no way critical, any type of cabinet or component arrangement can be employed.

Calibration. Fairly accurate rate calibration will result by counting "ticks" against time. Using a stopwatch or a wristwatch sweep second hand, counting the number of ticks per 15 seconds and multiplying by 4 to obtain the "beat rate" per minute, will result in accurate dial calibration. This method works well for slow to medium beat rates but is more difficult at the faster rates. A second method is to compare the uncalibrated metronome with a calibrated metronome of known accuracy. Both methods are sufficiently accurate for musical purposes.

Should a louder "tick" be desired, the unijunction metronome will easily drive an audio amplifier. By replacing the loudspeaker with a 20- or 30-ohm resistor, positive driving pulses may be taken from base 1 (B1). Negative pulses can be taken directly from base 2 (B2) simultaneously, if needed.

Pulse rate can be changed widely simply by replacing *R4* and *C2*. Two to three minutes, and more, are possible between pulses. —30—

Beef up the sound of your phone bell and put it where you can hear it when you're out at the barbecue pit or in the garage

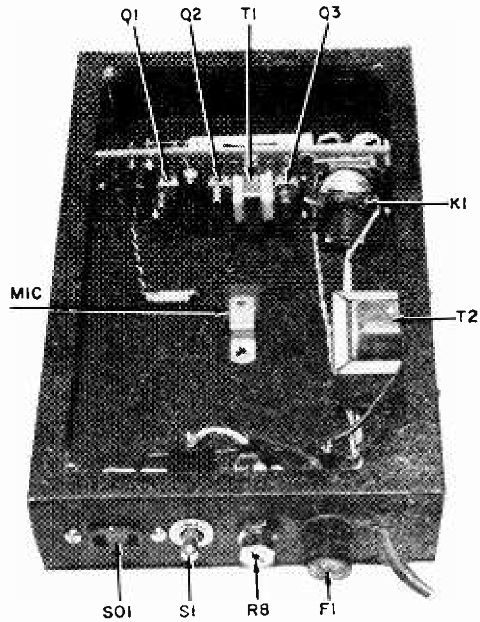
DID YOU ever miss an important telephone call because you were working outdoors or in the garage, or lounging on the patio or porch, where you couldn't hear the bell? Most of us have had this frustrating experience at least once or twice. One way to avoid it is to have the phone company install a loud outside bell. This is fine, *if* you need the outside bell all year round, and *if* it won't disturb the neighbors, and *if* you're always in an area where the bell can be heard readily.

But that's a lot of "ifs," which for many families just don't add up to placement of an order with the phone company. Nevertheless, when the lady of our house was heard to remark to a friend, "We heard *Radio Australia* last

"LOUD-HAILER" for the TELEPHONE

By DONALD L. WILCOX

You can duplicate the author's layout by following the parts placement shown here. Holes in chassis allow bell sound to reach bracket-mounted microphone.



night on the short-wave set, but we can't hear the phone ring out at the barbecue pit," it was clear that something had to be done. It was, and the alternative solution to the remote telephone signal problem described here is the result.

It involves no monthly service charge at any time—let alone for those months when you don't need the bell, doesn't require any connection to telephone company equipment, permits you to put the bell where you need it, and allows you to relocate it at any time without inconvenience. Furthermore, you can build the "Loud-Hailer" in a couple of evenings, at a nominal cost of about $18.00, even using all new parts, and you can probably halve that by raiding the trusty junk box.

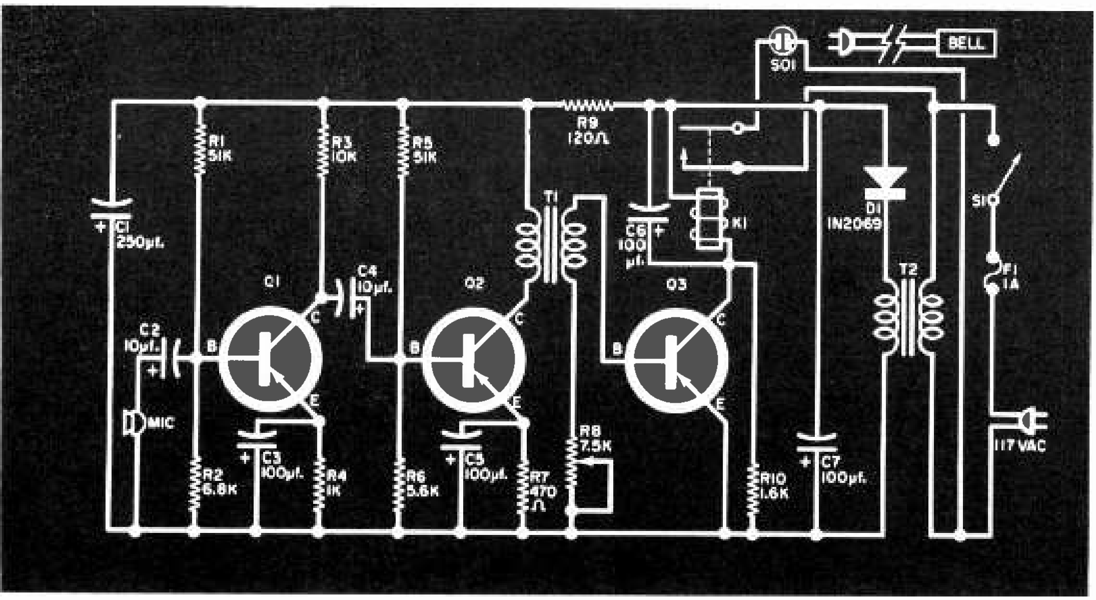
How It Works. The Loud-Hailer is a simple device, made up essentially of a microphone, audio amplifier, and a relay, energized by a small power supply that plugs into the house a.c. line. With the unit in operation, the sound of the telephone bell is picked up by a microphone, the output from which is amplified to a level capable of closing a relay. The remote bell is energized by a.c. from the line, applied through contacts of the relay. The remote bell can be mounted outside the house at any suitable point, or moved about from garden to garage to pool, wherever its extension cord will reach.

A look at the schematic diagram will clarify details of the circuit function. The first two transistors, *Q1* and *Q2*, operate as Class A amplifiers, boosting the microwatt output of the microphone to a level great enough to drive transistor *Q3*, which operates as a Class B power detector.

With no sound at the microphone, *Q3* is practically cut off, since there is no base current; and the emitter-to-collector current is therefore no more than a few microamperes leakage. When the phone bell rings, the amplified microphone signal drives the base of *Q3* negative once each cycle, causing the *Q3* collector current to flow in a series of d.c. pulses. This output, smoothed by capacitor *C6*, energizes relay *K1*, applying a.c. power to the remote bell.

Construction. Since the circuit is extremely non-critical, parts placement and other mechanical details can be varied to suit the constructor's preference. In the author's unit, most of the circuit parts are mounted on a strip of Vectorbord, as shown in the photograph. The controls are grouped at one end of the metal box. The microphone is mounted in the middle of the box, facing a group of drilled holes which permit easy entry for the sound of the phone bell. Wiring is simple and straightforward, and requires only the normal caution about use of a heat sink when soldering transistor leads.

Operation. In use, the Loud-Hailer is placed under the phone with the controls at the rear, so the cords to the a.c. line and the remote bell can be dressed out of the way. This brings the microphone of the Loud-Hailer directly under the bell of the usual desk-type telephone



Schematic diagram shows basic simplicity of the Loud-Hailer circuit.

PARTS LIST

C1—250-µf., 12-volt electrolytic capacitor
C2, C4—10-µf., 6-volt electrolytic capacitor
C3, C5—100 µf., 6 volt electrolytic capacitor
C6, C7—100-µf., 15-volt electrolytic capacitor
D1—1N2069 silicon diode
K1—S.p.s.t. relay, 6-volt, 335-ohm coil (Potter & Brumfield RS5D or equivalent)
Q1, Q2, Q3—2N1274 germanium transistor
R1, R5—51,000 ohms
R2—6800 ohms
R3—10,000 ohms
R4—1000 ohms
R6—5600 ohms
(All resistors ½-watt carbon unless otherwise specified)
R7—470 ohms
R8—7500-ohm potentiometer, with shaft lock
R9—120 ohms
R10—1600 ohms
S1—S.p.s.t. toggle switch
SO1—A.c. convenience outlet socket
T1—Transistor driver transformer, 10,000-ohm primary, 2000-ohm secondary (Lafayette 99 G 6126 or equivalent)
T2—Filament transformer, 6.3-volt secondary (Lafayette 33 G 3702 or equivalent)
1—Alarm-type bell, 115-volt a.c. (Lafayette 99 G 9023 or equivalent)
1—5½" x 9½" x 1½" pan-type chassis
1—600-ohm dynamic microphone (Lafayette 99 G 4527 or equivalent)
Misc.—Vectorbord, fuse holder, transistor sockets, solder, wire, hardware, etc.

TYPICAL D.C. VOLTAGES

	Q1	Q2	Q3
Ve	–0.90	–0.75	0
Vb	–1.00	–0.85	0
Vc	–1.30	–10.00	–9.6

All voltages are measured to + side of C7 with high-impedance voltmeter, no input signal to microphone.

where sound pickup will be strongest.

The extension cord leading to the remote bell is plugged into a.c. outlet *SO1*, and gain control potentiometer *R8* is adjusted so that an incoming ring causes reliable ringing of the remote bell. This setting can be tested by asking one of your neighbors to dial your number. When correct operation has been obtained, locate the remote bell where you'll be sure to hear it when it rings.

If you want to use the Loud-Hailer only occasionally, and in different locations, such as the garden, attic, garage, or barbecue pit, you may want to keep the extension cord free, to be rerouted as necessary. However, if you intend to use the Loud-Hailer for just one or two remote locations, you may prefer to install permanent remote lines and outlets. Either way, you'll stop missing those important calls. –30–

CAR BATTERY SAVER

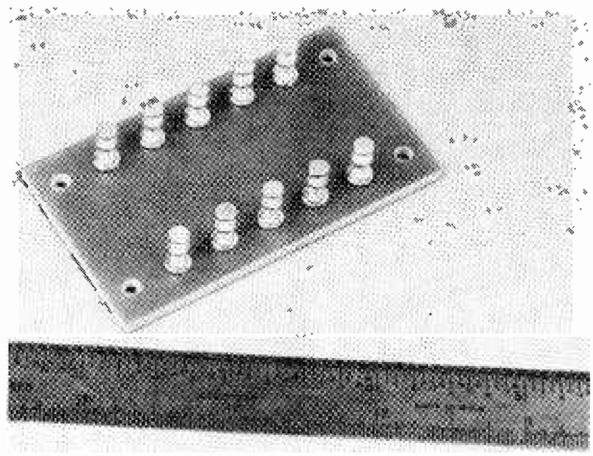
By R. C. APPERSON, JR.

Never again will your wife leave the lights on and kill the battery—this little "computerized" gadget makes forgetting an impossibility

ONE MISERABLE RAINY MORNING, we climbed into our car and headed to work, picking up riders along the way. In order to let fellow drivers know we were on the highway, the headlights were flicked on, and conversation engulfed the group. The rest of the drive was just sufficient to let the stimulating conversation sweep all thoughts of headlights from the driver's mind. Once in the company parking lot, the ignition switch was quickly cut off, and all passengers made a mad, splashing dash for the front door. Two high candle-power lamps remained on, doing no useful work, but sapping those ampere-hours from the car's battery. The weather was clear when quitting time rolled around. All loaded aboard the car, and—urrr, urrr—then nothing. The language that followed was much stronger than the battery, and a vow was made to find a way to remedy the problem. Here is the device that has eliminated many trips to the battery charger; it's yours for a very few dollars and a little time.

How It Works. As in computer logic circuitry, certain conditions must be present before the device generates a signal. When the stage is set properly, the little gadget comes alive with a raucous 100-cycle squawk that won't allow you to leave your lights on. In fact, when this thing sounds off, you'll wish for a second that you never heard of headlights!

The signal is generated only when the headlights are on and the ignition is off. If the ignition is on, nothing happens. Headlight and ignition voltages cause no disturbance either, but the removal of the ignition voltage if headlight voltage is applied starts the action. A look at the circuit will explain why.



Terminal board was used for the prototype, but layout is noncritical; terminal strips can be used.

Computer Logic: The Battery Saver

The circuit used in this project follows computer logic to an extent. The desired action does not fit either "AND" or "OR" gate conditions. "AND" gates operate with both inputs present, and "OR" gates with either one input or the other. The design of the Car Battery Saver is similar to that of an "INHIBIT" gate, to use computer terminology. When the headlights are left on, there is an output unless the ignition is also on. The output is in the form of a raucous warning signal that emanates from the loudspeaker. It doesn't let you forget the lights! If the ignition switch is on, the output is "INHIBITED."

INHIBIT Gate, Generator. If you have a resistor and capacitor in series with a car battery, the capacitor will charge through the resistor to the full battery potential. If you have a resistor and capacitor connected in series and then to sources of like potential (both to the positive terminal of the car battery, for example), the capacitor cannot charge as no current flows from the battery. This, basically, is the INHIBIT principle.

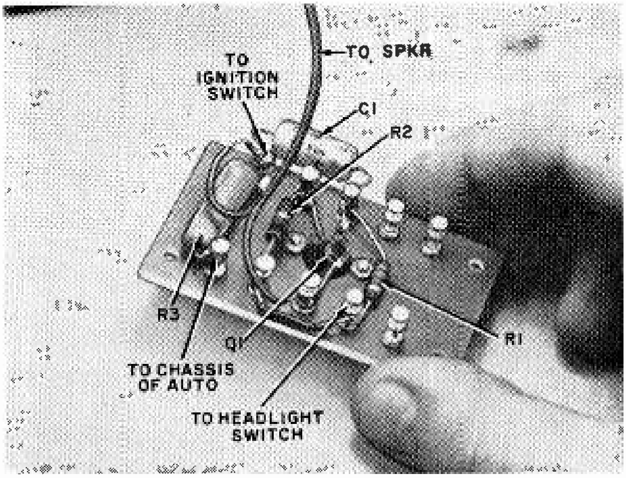
How do we apply this in the car? We have two controls that switch voltages from the same source. Let the headlight voltage be the supply, and the ignition the hold-off signal. Since a reference point is required for the supply, a resistor is placed between the normally-grounded circuit element and the ground. The ignition voltage is dropped across it. Only one-half watt is dissipated as hold-off power. This is a negligible load to a battery being charged by a generator.

The signal generator itself is simple. It is a unijunction relaxation oscillator delivering pulsed energy to a speaker at a 100-cycle rate as determined by the *R1*, *C1* time constant.

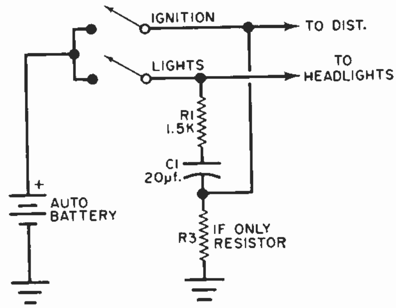
Unijunction *Q1* does not conduct until *C1* charges through *R1* to a potential determined by the unijunction characteristics and the supply voltage. When this potential is reached, the emitter allows *C1* to discharge into base number 1. This turns on the unijunction and a current pulse is drawn through the speaker, producing an audible tone.

Protective resistance for the unijunction is provided by *R2*, and *R3* is the resistor logic. Obviously, *C1* won't charge if a voltage at the top of *R3* is equal to the voltage at the top of *R1*. When the voltage at the top of *R3* disappears, *C1* charges, and the circuit emits the warning.

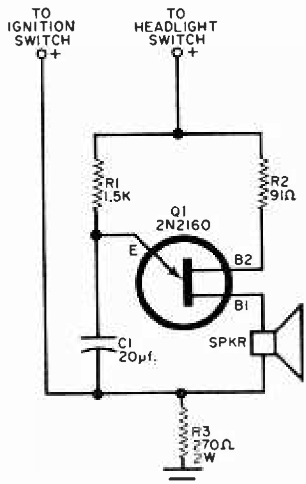
The "Battery Saver" is flexible. Move the location of *R3* and the battery saver



Parts placement is clearly shown above. Connection to the automobile is done as described in the text.



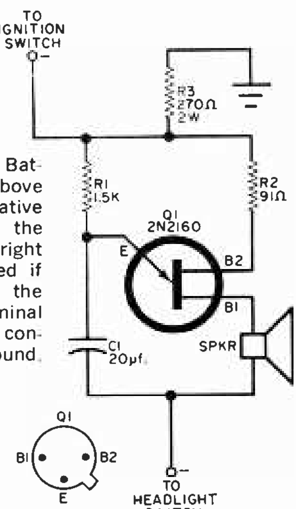
Basic INHIBIT circuit is integrated into auto electrical system as above. This drawing is for illustration only; actually, C1, R2, and R3 are in Battery Saver.



system will operate on a car with either positive or negative ground. Voltage is not critical either. The only difference between a 6- and 12-volt system is a slight volume decrease with the lower voltage.

Building The Unit. Any small container large enough to house the speaker will make a suitable cabinet for the unit. Circuit layout and wiring is not at all critical, but the author's layout is shown for your convenience. Three leads are brought from inside the cabinet which go to the ignition, headlights, and auto chassis ground. The speaker is attached to the case after holes are drilled in the box to let the sound out. Small screws mount the speaker to the cabinet. The speaker terminals also serve as tie points for one base lead and the negative side of the capacitor. The hold-off resistor and the lead that goes to the ignition connect to this capacitor lead. Care must be exercised when soldering to the unijunction, and a heat sink should be used; remember, *it's a transistor.*

(*Continued on page* 153)



Version of the Battery Saver above is for negative ground cars; the schematic at right should be used if your car has the positive terminal of the battery connected to ground.

PARTS LIST

C1—20-µf., 25-d.c.w.v. electrolytic capacitor
Q1—2N2160 unijunction transistor
R1—1500-ohm, ½-watt resistor
R2—91-ohm, ½-watt resistor
R3—270-ohm, 2-watt resistor
1—Miniature speaker, 8 ohms
1—Minibox or other housing
Misc.—Terminal strips or board, wire, etc.

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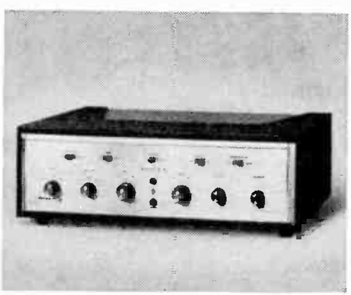

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Chapter 2

Hi-Fi and STEREO

HI-FI speaker enclosures remain a favorite construction project of the died-in-the-wool audiophile. Once again, the ELECTRONIC EXPERIMENTER'S HANDBOOK has utilized the services of Dave Weems to design something out of the ordinary. This year Dave has come up with an enclosure made from a rectangular block of ceramic tile; with the addition of baffling and high-frequency diffusers, Dave has constructed a low-cost stereo system capable of reproducing surprisingly good sound. Author and designer Jim Reid has attacked the enclosure problem from a different angle and describes a clean-cut conventional hi-fi system.

Just in case you don't want to part with that stereo tuner which lacks a multiplex indicator, Chuck Caringella has designed a transistorized gadget to fill the bill. Hi-Fi buffs can regale you with stories about the misadventures of FM multiplex—especially stereo transmissions that are not really broadcast in stereo. An indicator is the only positive way of knowing if an FM station has the necessary multiplex pilot carriers in operation.

Build the reflectoflex SPEAKER ENCLOSURE

By JAMES D. REID

Fill the entire room with realistic, bright, hi-fi sound using this practical reflected-sound system

WHEN STEREO HI-FI first became popular, the ardent audiophile who wanted to show off his gleaming new equipment and fancy speakers would first carefully position a chair at "stereo center" and then ask you to sit down. Needless to say, the illusion—provided by recordings of locomotives, brass bands, and bouncing Ping-pong balls—was amazing, and seemed too good to be true. □ Music lovers quickly recognized that this extravagant separation of channels was, indeed, too good to be true, and as the stereo hi-fi art matured, a number of solutions to the problem, all of which eliminated the "stereo seat," came along. □ One method of getting rid of the center "gap" between the two channels is, of course, to use a center speaker. Another less expensive, simpler method, the one recommended here, is to use two speaker systems having good dispersion—systems that radiate the sound in all directions rather than in a narrow beam. The "Reflectoflex" speaker enclosure which you can easily build—one for monophonic use and two for stereo—is such a system. □ By aiming the speaker upward and "spraying" the sound off the inclined lid (or adjacent walls and ceiling if the lid is not used), it achieves a high degree of dispersion. The result is hi-fi sound with an airiness, an openness that must be heard to be appreciated. □ Some care should be taken in selecting a speaker for this cabinet. Because more high-frequency energy is absorbed when the sound is reflected rather than directed at the listener, a coaxial speaker with a highly efficient tweeter is recommended. Even so, some treble boost at the amplifier may be desirable. □ An alternative would be to use a woofer or full-range speaker with a separate horn tweeter and the crossover network recommended by the manufacturer. The tweeter could

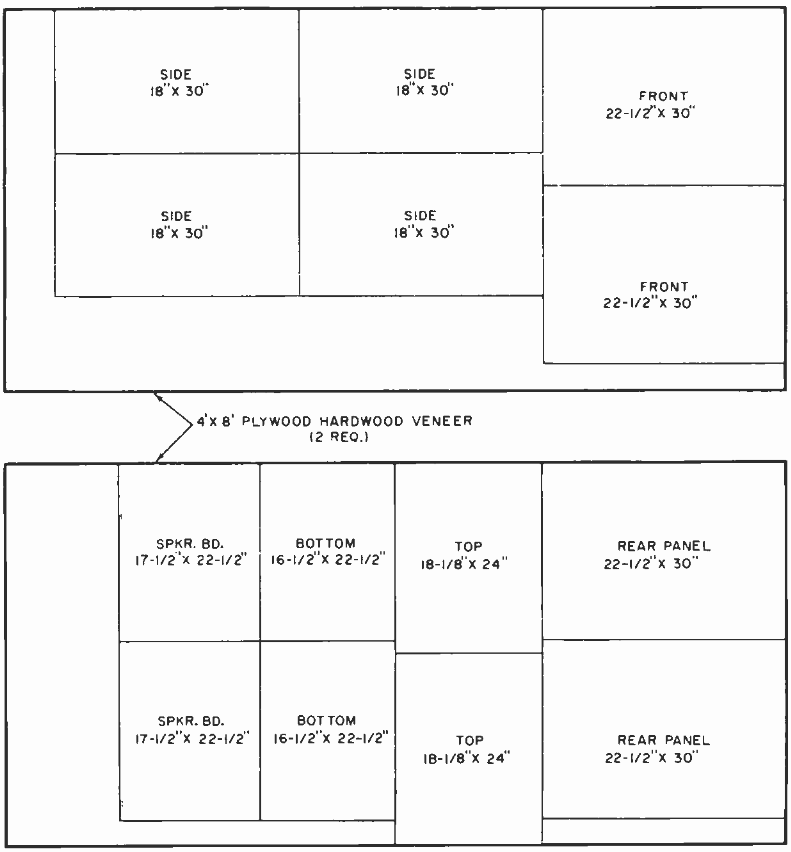
Light, airy sound fills the room when it's dispersed by reflection from cabinet lid (as above). Two enclosures can be constructed for use with stereo setup.

be mounted between the holes shown for the "brilliance" control and the port.

Ports and Port Sizes. Whether or not you need a port depends on the free-air resonance of the speaker you use. If a low resonant frequency speaker (below 35 cps) is available, the port is not cut, and the Reflectoflex is then a sealed box or "infinite baffle" system. If the resonant point is higher, the speaker is positioned off-center on the speaker mounting board, and a circular port cut to match the resonance of the cabinet to that of the speaker (the bass reflex principle).

If the cone resonance of the speaker is 50 cps, the port should be 5½ inches in diameter; for a resonance of 45 cps, 4½ inches; for 40 cps, 3½ inches. The manufacturer of the speaker should be able to furnish information as to its free-air resonance point.

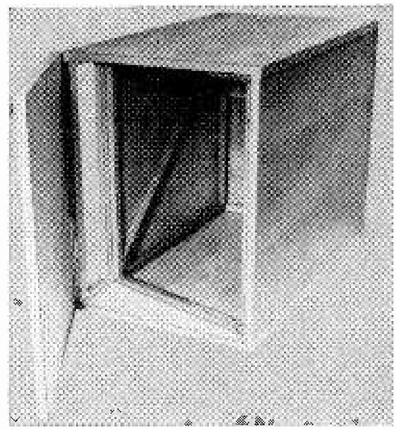
Building the Reflectoflex involves little more than making a rigid box from sheets of ¾" plywood or Novoply as



All sections for two enclosures can be cut from two 4' x 8' sheets of plywood as shown at right. Ordinary, interior grade plywood can be used instead of the veneered type. Other materials include hardwood strips for inside bracing and outside trim, a piano hinge, glue, and wood screws.

shown in the drawings below. The author used hardwood surfaced plywood for good appearance. Hardwood cleats (strips), 1″ x 1″, are glued and screwed to the side panels, and the front and rear panels secured to them with glue and 1½″ #8 screws countersunk from the outside. The resulting holes are covered with 1″ x 1⅛″ strips of hardwood. If a port is used, staple a 2″ layer of fiberglass padding to the interior surfaces. If built as an infinite baffle (no port), fill the enclosure with large (12″ to a side) pieces of fiberglass, leaving room for the speaker magnet assembly.

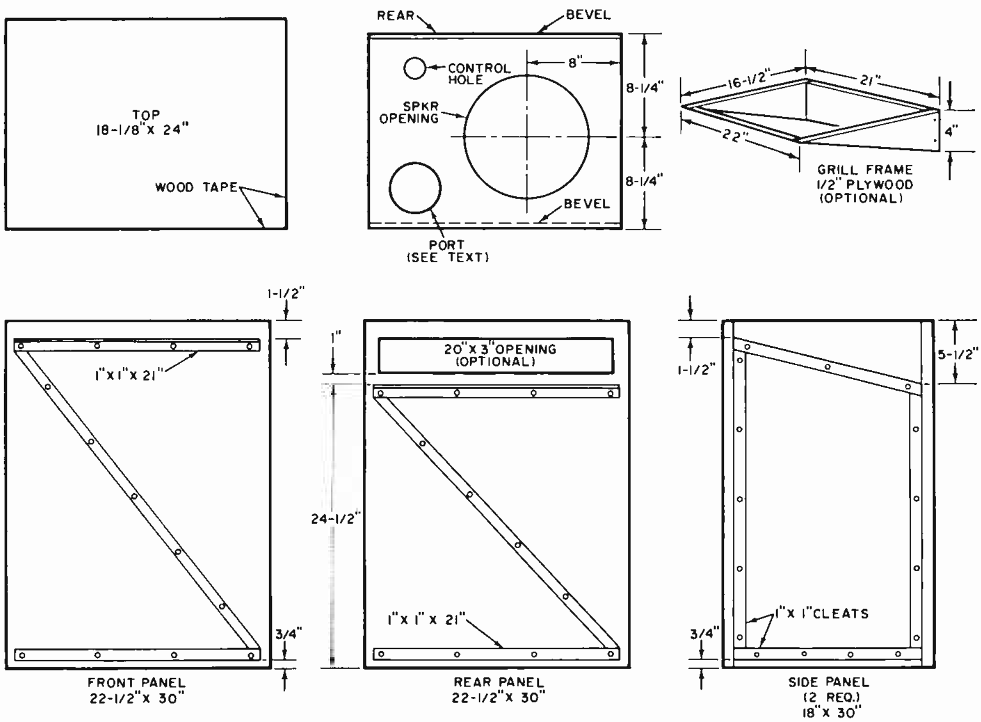
The enclosure lid is attached to the rear panel with a 22″ length of brass piano hinge, and is held open with a simple prop made from a ½″-square piece of hardwood rounded at one end. Shallow holes drilled in the underside of the lid provide for alternate positions so that the lid can be adjusted for best sound reflection. The lid shoud be given a "hard" finish, several coats of shellac, varnish, etc., or a thin sheet of metal should be attached to the underside of the lid to increase its sound reflecting properties.

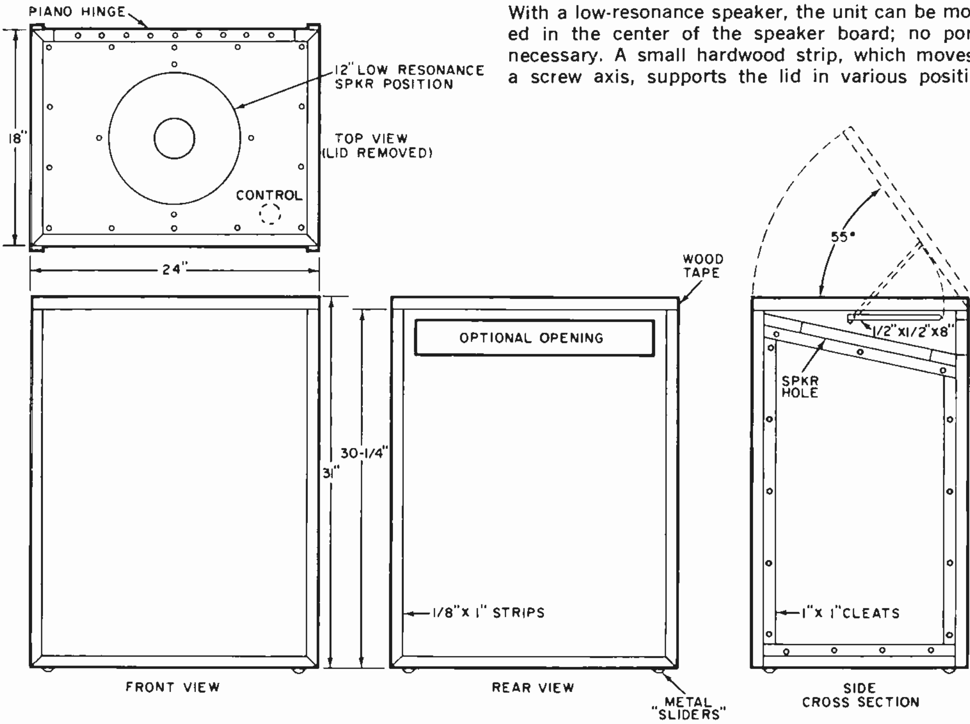


Interior view of Reflectoflex enclosure.

The speaker board is beveled at front

Interior panel details for the enclosure are shown below. The control hole is for a "brilliance" control if used. The 1″ x 1″ cleats are hardwood strips used for bracing, and are glued and screwed from the inside. The front and rear panels are set in between the two side panels, and screwed from the front and back. The screw holes can be filled or covered with hardwood strips.

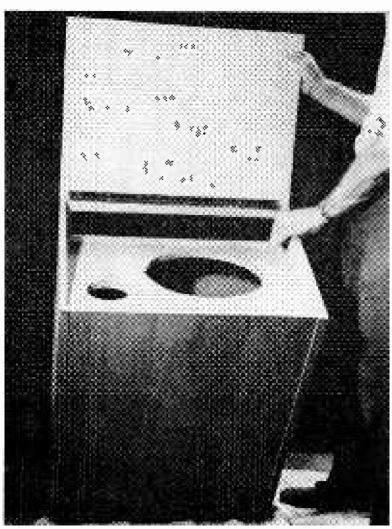




With a low-resonance speaker, the unit can be mounted in the center of the speaker board; no port is necessary. A small hardwood strip, which moves on a screw axis, supports the lid in various positions.

and rear, and the underside lined with a strip of sponge rubber to provide an airtight joint when screwed in place. While a grille is not needed, the speaker can be attractively covered and protected by stapling a grille cloth to a simple frame that fits into the top (see drawing on the preceding page). The completed frame simply rests on the speaker mounting board and is easily removed.

Enclosure with speaker board in position.



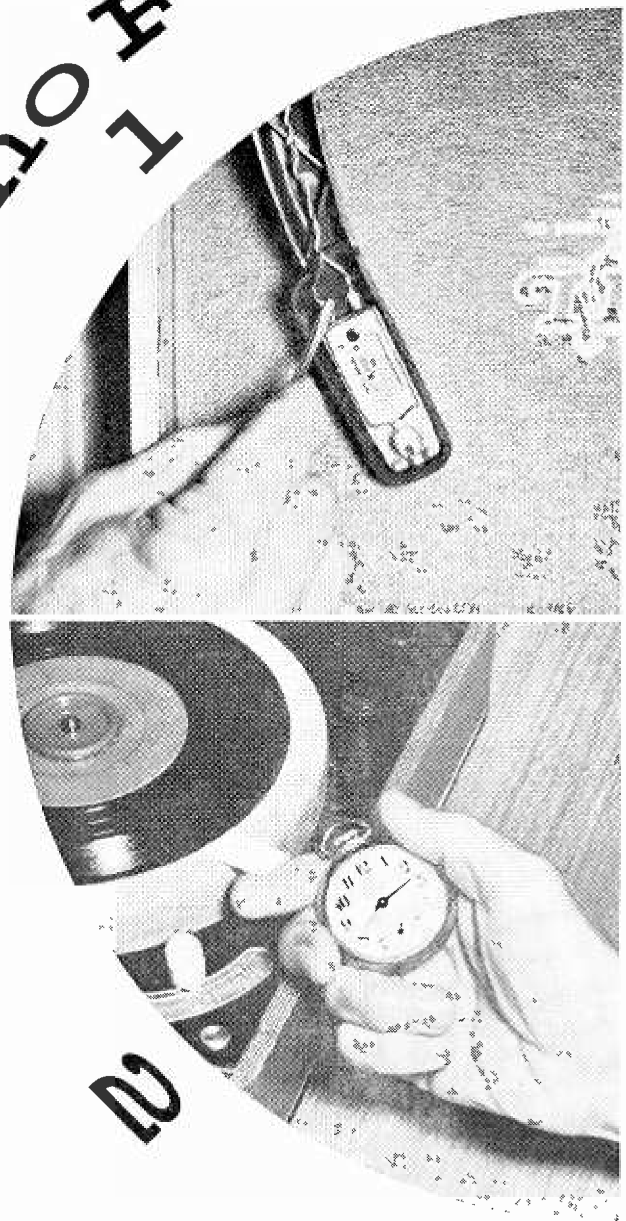
The Reflectoflex, or a pair of them, can be used in upright position, or on the side; the bottom of one unit can be butted against the bottom of another if two units are used with sides down. As previously noted, it is quite possible to use the walls or ceiling as reflecting surfaces instead of the enclosure lid. Simply position the enclosure or enclosures for best results.

The wire from the amplifier enters the cabinet through a hole in the bottom or rear panel if you choose to use the cabinet on its side. Metal "sliders" are fastened to the bottom; alternatively, a simple rectangular base can be built from left-over plywood to lift the enclosure off the floor.

Finishing. The author used stain and several coats of varnish over hardwood veneer plywood to produce professional-looking cabinets. Even ordinary plywood can be quite pleasing to the eye, however, if care is taken in finishing it. In any case, your Reflectoflex enclosure can be counted on to provide a definite improvement in the realism of your living room "concert hall." -30-

Phono Fillips

Got an inexpensive record player that's gathering dust? Here are five easy ways to cure five common problems



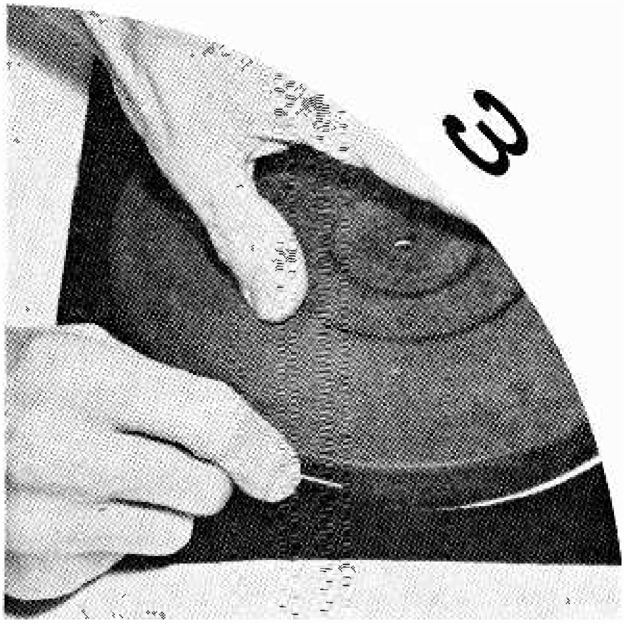
1

QUICK CHECK FOR RECORD PLAYERS—When a teen-ager's record player goes bad, it's the cartridge or amplifier 99 per cent of the time. Before going to the trouble of taking the player apart, simply turn it on, adjust volume to maximum, grasp a screwdriver blade, and touch it to the lugs of the cartridge. A loud a.c. hum at one lug indicates the amplifier is working; if the hum is weak or absent, take the player apart. Good hum indicates a new cartridge, but you can double-check by disconnecting the amplifier leads and connecting a high-impedance magnetic earphone. A good, clear signal when you play a record shows that the cartridge is O.K. Note: Do NOT make these tests while standing on a damp basement floor, or while touching a "ground" such as a radiator.

2

SIMPLE TURNTABLE TIMING—A stroboscopic disc and a fluorescent lamp, if you happen to have them handy, will tell you if your turntable is fast or slow, but not by how much. The photo shows a simple, exact, timing method. Place a strip of paper between a record and the turntable, allowing a little to stick out so it will brush against your finger tip. In this way, you can feel and count each revolution for one minute while watching the second hand of a watch or clock. An accurate count gives you exact turntable rpm. You might also be interested to find out how much the drag of the record player pickup arm reduces the speed of the turntable. Count the rpm's again with the pickup arm in place on the record, and compare.

By ART TRAUFFER

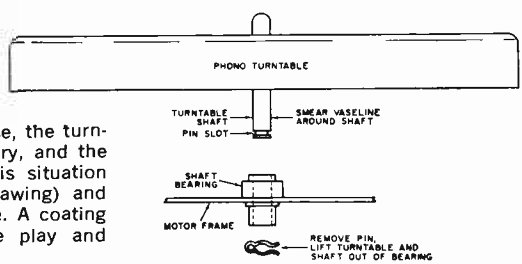


3

NEW FELT FOR PHONOS—When the flocking on top of low-priced phono turntables wears off, it's a good idea to glue on a disc of felt or other material. Such a covering improves appearance and makes things easier on your records at the same time. Having turntables reflocked is more expensive, and small particles of fiber will sometimes adhere to your records. As shown in the photo, remove the turntable (in most cases it's held in place by a "C" washer that fits in a groove on the shaft), lay it over the felt, and cut around the edge with a razor blade. Before removing the turntable, mark the center of the felt disc by inserting a sharp, pointed instrument through the center hole. Punch out a ¼"-diameter hole in the felt for the center shaft. Spread glue (LePage's wood glue, Goodyear Pliobond, or a similar adhesive) over the turntable and position the new felt disc.

4

A "SAVE" FOR CENTERING DISCS—The recess in the center of some turntables is so low that plastic 45-rpm centering discs don't come up high enough to engage the center hole of 45-rpm records. Note in the photo that the top surface of the centering disc is about flush with the top surface of the record. The problem is easily solved by buying another plastic disc (about 25 cents), and cementing it on top of the old one, but the method used here was to grab a 1⅜"-O.D. iron washer from the junk box (a rubber washer can also be used) and cement it to the bottom of the centering disc. The thickness of the washer was enough to raise the disc to the required height.

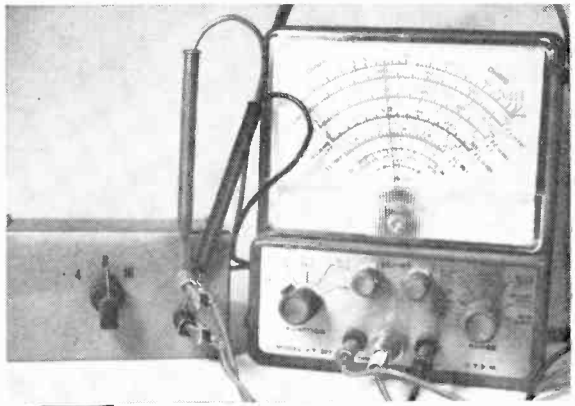


5

IMPROVING WORN BEARINGS—After long use, the turntable shaft and bearing become worn and dry, and the turntable teeters due to increased play. This situation can be improved by disassembling (see drawing) and cleaning the shaft and bearing with gasoline. A coating of Vaseline on the shaft will both reduce play and lubricate it.

RESISTIVE LOAD

If you're tired of using makeshift resistive loads when testing audio amplifier projects, this adjustable unit is for you. The cost is low, and it can be built in two hours



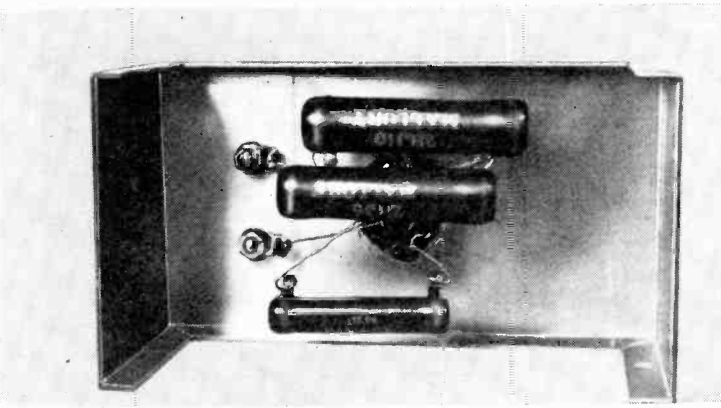
When testing hi-fi amplifiers, a load of the rated resistive impedance that will not shatter the eardrums is a must. Such a test load should also have a negligible reactance over the frequency range of interest, and should be capable of dissipating a reasonable amount of power, at least for short periods. Most of us go along for years haywiring the test load with clip leads, which short out or let go while we're setting the bias or adjusting the feedback, with disastrous results.

The writer finally got fed up with haywire and makeshifts and built this adjustable load unit, which you can duplicate quickly at nominal cost. It is so simple that it can be wired merely by following the schematic diagram and the pictures, without special construction data. Power-handling ability is 15 watts on the 4-ohm, 30 watts on the 8-ohm, and 40 watts on the 16-ohm switch position, if adequate ventilation is provided. Higher-wattage resistors can be used if desired, but will require a larger box and better ventilation.

As a bonus, use of the load permits you to read power output by connecting your VTVM or wide-band multimeter across the load, and choosing the appropriate a.c. scale. Just read the voltage and convert it to watts by means of the graph. The dashed lines show sample measurements of 6.0 volts across the 4-ohm load and 9.0 volts across the 16-ohm load. And if you're worried by the inductance of wire-wound resistors, forget it. Up to well above 100 kc., the inductance of even the 16-ohm resistor is negligible.

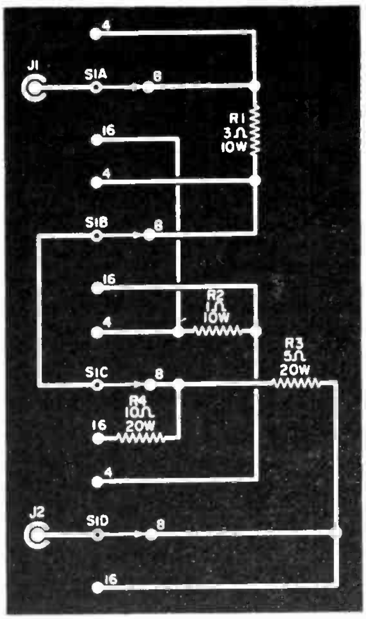
FOR HI-FI TEST

By WALTER TEMCOR

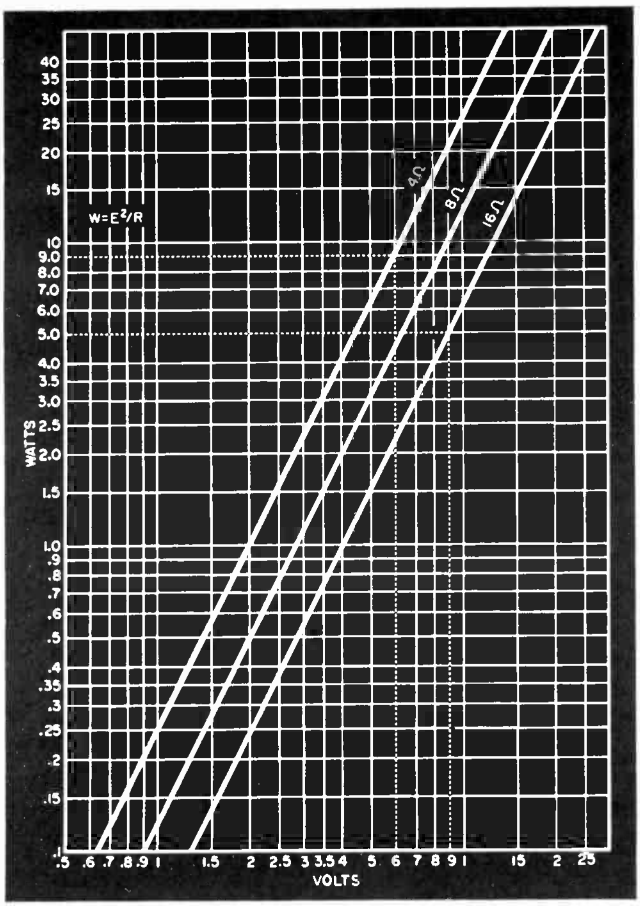


Resistors making up the adjustable load are mounted directly on the switch terminals for wiring ease.

Switching connections are easily followed in the schematic diagram. Don't forget wire lead between S1b and S1c arms.

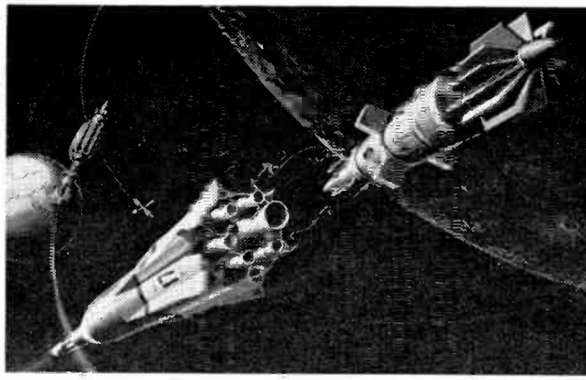


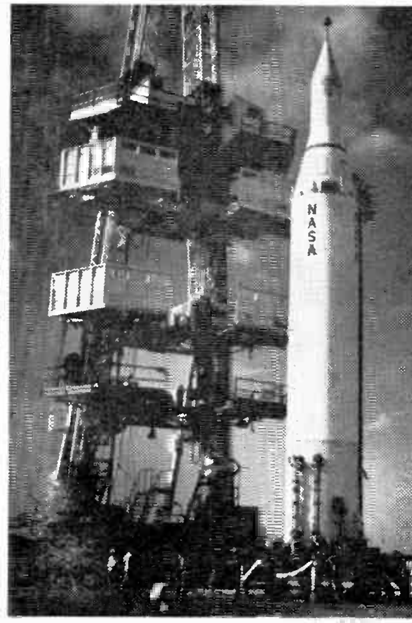
Straightedge and voltmeter are all you need to read watts output from power graph.



PARTS LIST

R1—3-ohm, 10-watt wire-wound resistor (Mallory 1HJ3 or equivalent)
R2—1-ohm, 10-watt wire-wound resistor (Mallory 1HJ1 or equivalent)
R3—5-ohm, 20-watt wire-wound resistor (Mallory 2HJ5 or equivalent)
R4—10-ohm, 20-watt wire-wound resistor (Mallory 2HJ10 or equivalent)
S1—3-position, 4-pole rotary switch (Lafayette 99-6156 or equivalent)
2—Binding posts
1—5¼" x 3" x 2⅛" aluminum box (Premier PMC 1006 or equivalent)
1—Pointer knob
Misc.—Hookup wire, solder, etc.





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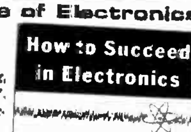

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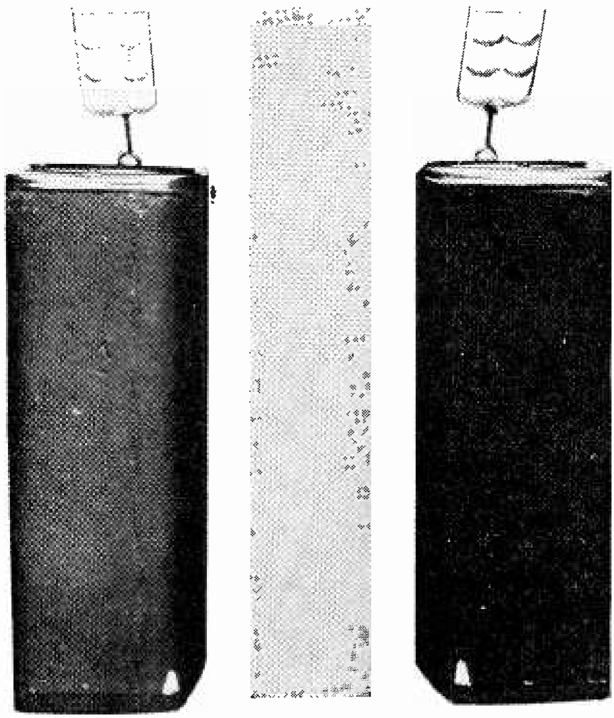


ANOTHER CERAMIC TILE ENCLOSURE

A ducted-port bass reflex for 8" speakers, this system is nonvibrant, inexpensive, and exceedingly compact

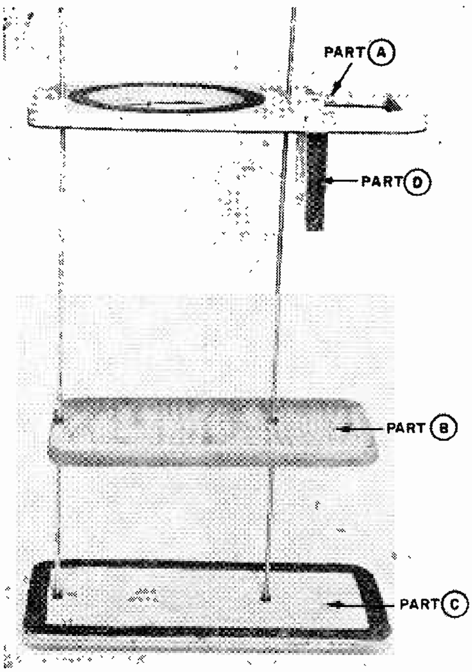
By DAVID B. WEEMS

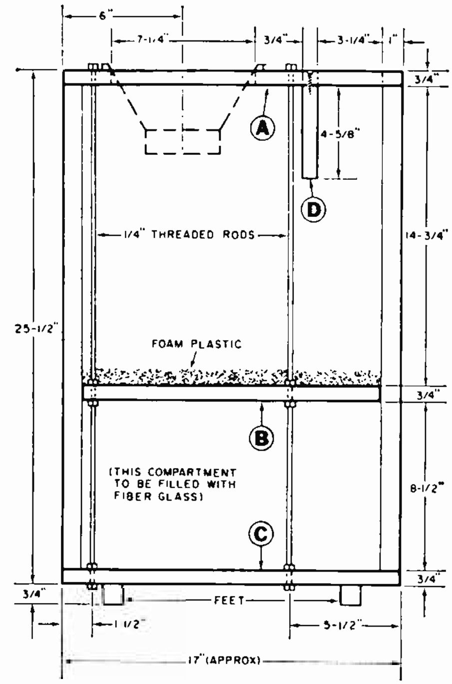
SOME speaker enclosures are small, some enormous; some are cheap, some cost dearly. But all speaker enclosures fall into one of two categories—good or bad. Actually, it makes little sense to house a good speaker in a poor enclosure, no matter whether the reason is to save money, space, or both. On the other hand, with a quality enclosure that also happens to be low in cost, the savings can be applied on a better speaker, or on other components.

In the stereo age the space problem is usually with us, so we can always hope for something compact. The system described here *is* compact, yet it sacrifices little in quality. What's more, each basic enclosure costs only about $6.00, so two enclosures for a stereo setup would run you only about $12.00. Soundwise, almost all the advantages of this enclosure stem from its tile construction.

Tile for Density? The important argument for the use of tile can be found in any complete "Density of Materials" chart. For example, the chart published in Briggs' *Sound Reproduction*[1] lists plywood, the usual material for speaker enclosures, at a density of 0.67. This is admittedly rather good, at least when compared with other forms of wood

[1]Sound Reproduction, *by G. A. Briggs, Third Edition, p. 102*





General design of enclosure is evident in photo and drawing above. Parts A and C form top and bottom, respectively, and are held securely in place against tile by two threaded bolts. Gaskets made from 1/8" foam plastic insure airtight fit between plywood parts and the ceramic tile.

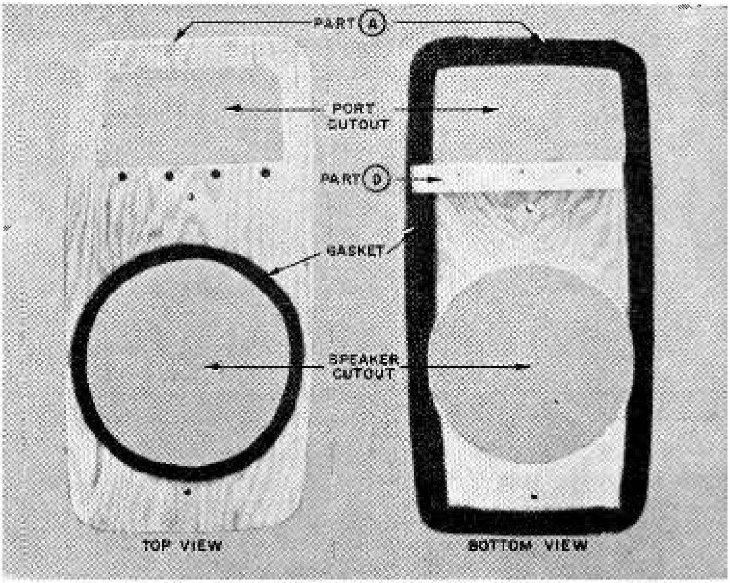
(walnut, for example, is only 0.56). But tile boasts a figure of 2.0, or just about three times that of plywood. In addition, the tile used here has a thickness of a full inch, compared to the usual 3/4" for plywood.

To quote Mr. Briggs again, "All will agree on the necessity of overcoming vibration and resonance at low frequencies, and this is achieved by adequate density." When Mr. Briggs says "All," he surely means all hi-fi and stereo fans who are conscious of what true bass sounds like. People still talk about the beautiful "tone" of a wooden cabinet, forgetting that the speaker system isn't a musical instrument, but a reproducer of an endless variety of instruments and tones. Any energy used up in panel vibrations is lost so far as true bass response is concerned. Even worse, it comes back to us in the form of hangover.

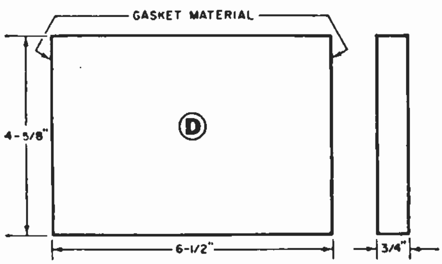
The speaker system shown here uses some plywood, but only at the ends. Furthermore, the plywood end pieces are held securely by two threaded rods, which adds considerably to their rigidity. The bulk of the enclosure is made of non-vibrating tile, sold by lumber yards as "flue tile."

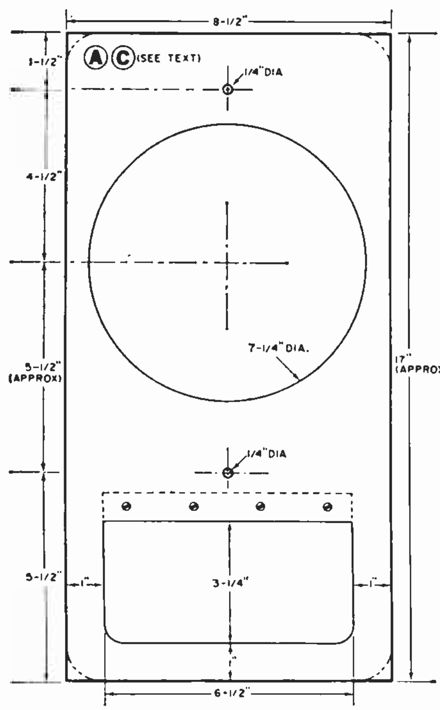
Port with Padding. The basic design of this system is simply a ducted port bass reflex, and any *good* 8" speaker can be used. The only unusual feature is the resonant chamber at the bottom which cancels out a tendency toward a peak or boom at one point in the bass range. Most compact enclosures show such a peak, and the elimination of this peak is probably more important than precise matching of port and speaker.

Best results are obtained with this chamber completely but loosely filled with fiberglass. Several materials were tested, and fiberglass was found to work best. Cotton batting was almost as good, but rug padding and foam plastic were less effective. Interestingly enough, a change of material was evident in the impedance curve of the speaker as well as in the actual sound of the system.



Top and bottom views of Part A appear at left; drawings of Parts D, A, and C have been reproduced below. Parts A and C are identical, with the exception that Part C requires no port or speaker cutouts. Gasket surrounding speaker cutout on top of Part A is for speaker flange which is on top of (rather than underneath) Part A in the finished enclosure.

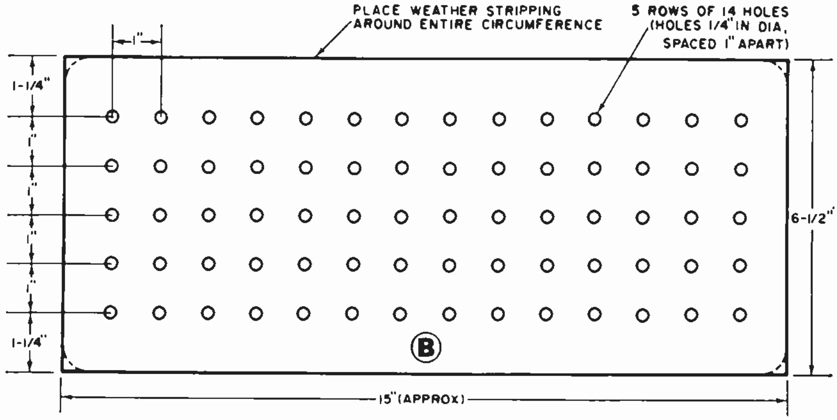




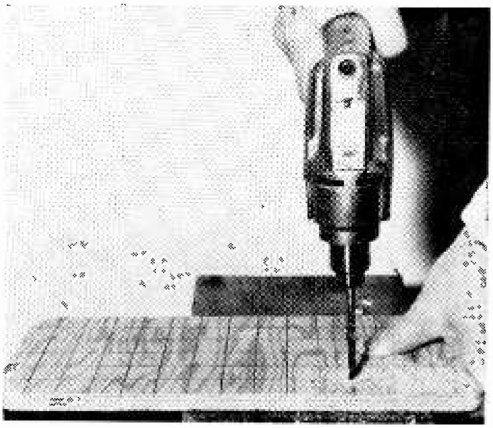
The kind of padding you use in the speaker compartment is another matter. Here personal taste is the best guide. Fiberglass will probably give you the most level response, but the sound will be "livelier" with foam plastic. However, fiberglass could damage some speakers if it is placed too close to them. If you do choose to use it, you'll be wise to cover it with cheesecloth.

Building the Enclosure. This is a rather easy system to construct if you take a few precautions. The plywood parts can be marked out by using each tile as a pattern. Of course, you should label each part, not only as to location, but as to which side is "up" and which is "down." This is necessary because some tiles are asymmetrical. Reverse the speaker board, for example, and it may fit like a left shoe on a right foot.

When the parts are sawed to fit and the gasket materials are glued in place, you can begin putting the enclosure together. Note that a 1/8" foam plastic gasket is used to insure a tight fit between the top and bottom boards (Parts



Partition (Part B) must be drilled as shown here before mounting; you'll also have to drill two holes for rods (see photo and drawing on page 68).



BILL OF MATERIALS

1—24" length of 8½" x 17" flue or fireplace tile for basic enclosure (this is called "18-inch tile" by some dealers)
1—18" x 24" sheet of ¾" fir plywood (for Parts A, B, and C)
1—4⅝" x 6½" sheet of ¾" wood (for Part D)
2—36" lengths of ¼" threaded steel rods
10—¼" hex nuts
4—¼" washers
1—4' length of weather stripping, foam plastic or foam rubber (for edges of Part B)
1—12" x 36" sheet of ⅛" "Art Foam" foam plastic (for gaskets on Parts A, C, and D)
1—36" length of ½" to 1" foam plastic (damping material for top of Part B and speaker compartment walls—see text)
1—8" PM hi-fi speaker
Misc.—Wood and machine screws, nuts, fiberglass, glue, grille cloth, etc.

Optional (see text)

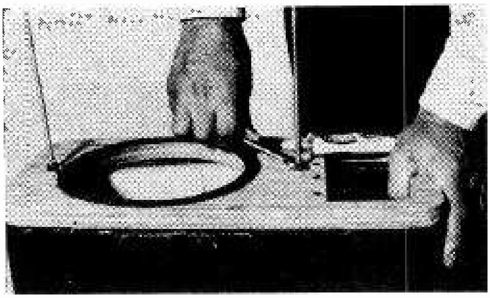
1—8½" x 17" sheet of ¼" fir plywood (for mask)
1—Plastic egg tray
1—5/16" x 4" eye bolt
1—Cable strap
Window screen wire (for mask)

A and *C*) and the tile, between the speaker and Part *A*, and between the sides of Part *D* and the tile itself. Weather stripping is best for gasketing the partition (Part *B*).

Drill the holes for the threaded rod in the top speaker board (Part *A*) as shown on p. 69. Then, using the speaker board as a pattern, drill holes for the rods in the bottom (Part *C*) and middle partition (Part *B*). One way to properly locate the holes in the partition is to place it just inside the tile and lay the top or bottom over it. The duct wall (Part *D*) can now be glued and screwed to the speaker board.

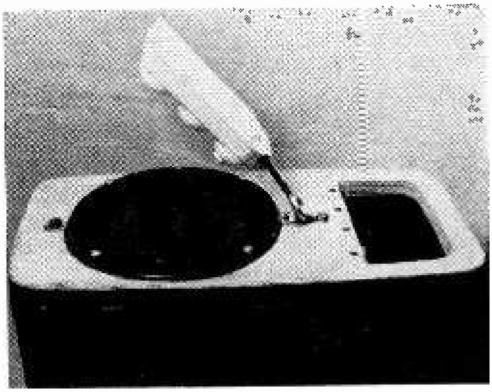
Next, locate the partition (Part *B*) 9½" from one end of the two rods by running nuts down tightly on each side and using bolt-and-nut sealant or lock washers. Now add a nut to each rod at the end, turning it on far enough to allow the bottom board (Part *C*) to go in place. Use a washer under the nut on the bottom side, and tighten both nuts securely on each rod, again using sealant.

The assembly can now be slid into the bottom of the tile, but don't forget to fill the space between the bottom and the partition (Part *B*) with fiberglass. Then line the top of the partition with foam plastic, and pad the walls around the speaker. Drop the speaker board down over the threaded rods and add a



Top (Part A) and bottom (Part C) are the two pieces of "bread" in this flue tile "sandwich." A hacksaw can be used to trim off protruding portion of the threaded rods after the nuts have been tightened securely.

Plastic egg-tray treble diffuser (in photo below) aids in dispersing the "high's" throughout listening room.



If space is really at a premium, the enclosure can be placed between two pieces of furniture, as it is here.

washer and a nut from the top. Tighten the nut as firmly as possible, but don't overdo the job—you may strip the threads if you use a long wrench and apply too much force.

Placement Possibilities. There are many ways of using this system, depending upon the space you have available. One builder succeeded in stowing away the flue tile enclosures in room corners and placing small tweeter baffles on table tops. With the tiles more or less out of view, there was no decorating problem.

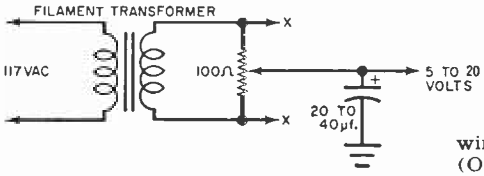
Perhaps the next best solution, with regard to saving space, is that shown at right. The enclosures lie on edge with the speakers toward the upper front. This is especially useful if you must keep the enclosure as low as possible but don't want to go to the woofer/tweeter arrangement.

The projections of the speaker and the bolts on the speaker board require setting the grille cloth out a short distance from the board. One practical way of solving this problem is with a "mask." The mask is made from ¼" plywood with cutouts for the speaker and bolts. To stiffen the grille cloth and protect the speakers, wire can be glued to the mask and the edges trimmed to fit with old scissors. Then the grille cloth can be folded over the edge of the mask and glued in place. Finally, to hide the edge of the speaker board, a coat of paint can be applied (ideally to match the color of the tile).

Some purists may object to having the high frequencies produced from a point about a foot above the floor. If you happen to like your highs "elevated," the enclosure can be stood on end with the speaker facing up and some kind of

(Continued on page 158)

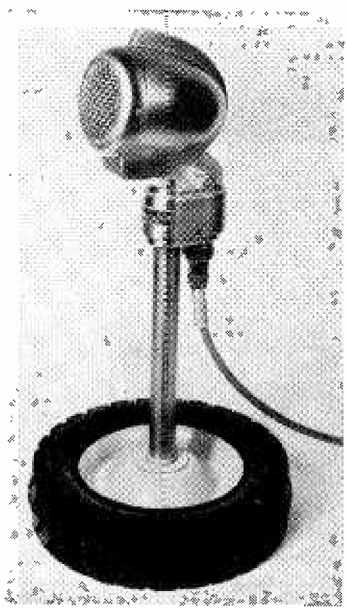
Audio Aids



POSITIVE BIASED HEATERS

If you're experimenting with high-gain preamp stages, hum and noise problems can be considerably reduced by means of the "positive heater bias" trick used by audio engineers. Don't connect the transformer heater winding to ground. Instead, wire a 100-ohm, 10-watt (Ohmite Dividohm) adjustable resistor across the heater winding, and run a lead from the tap to a source of 5-to-20 volt positive bias, such as a tap on a voltage divider from the B-plus line to ground. Bypass the tap with a 20-40 μf. electrolytic capacitor, and adjust the tap point for minimum hum. You'll be surprised at the improvement.

—Kenneth Bohn

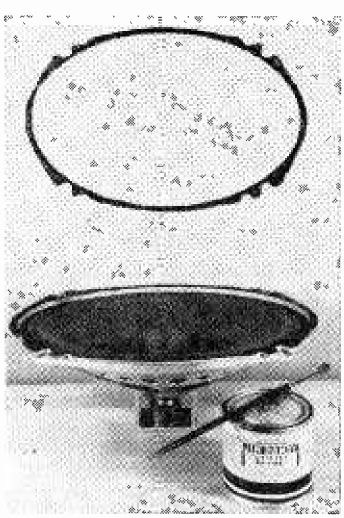


SPORTS CAR MIKE STAND

Do you have a friend with a taste for sports cars as well as ham radio or tape recordings? Tell him to make one of the mike stands shown at left. Sears-Roebuck sells a rubber-tired wheel (recently catalogued as #8732 and selling for $1.49) that makes an ideal base. A regular Atlas AD-8 extension tube is used to support the mike. Since the AD-8 has threads on both ends of the tube, saw off those that will be closest to the wheel. To fit the AD-8 to the hub of the wheel, force-fit a 4" wood dowel into the AD-8 tube, leaving half the length to pass through the hub. Snug the dowel into the hub and cement in place with epoxy resin. *—Art Trauffer*

RECORD DUST REMOVAL

When your hi-fi stereo records get dusty (from lint, hair, cigarette ashes, etc.), there is a simple way to clean them. Go into the kitchen and "borrow" your wife's box of thin-sheet Saran Wrap plastic. Tear off sheet about 6" wide and crinkle it in your fingers while holding it about 1" above the record. Start the turntable and let it revolve slowly. The static electricity generated in the Saran Wrap will attract almost all of the loose dirt and dust. *—Phil Manley*

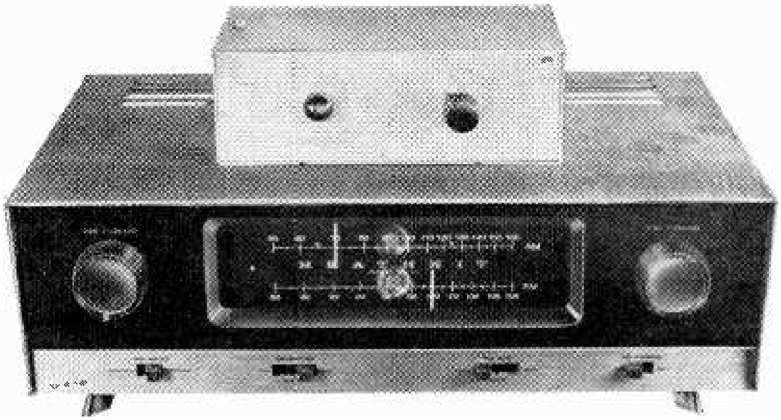


OVAL SPEAKER CUTOUT

There's no trick to accurately cutting out a circular speaker opening using the intersecting line method —from the mounting holes—but an oval or elliptical speaker is something else again. The following practice is somewhat obvious, but maybe you've forgotten about it. Turn the speaker up and carefully paint the cardboard gasket—black is a good color. Press the gasket against the baffle and you have an outline of the speaker opening that can be used as a sawing line. (See photo.) The paint won't hurt the cardboard gasket, but be sure to let it dry before mounting—it might otherwise hold the speaker gasket permanently in place!

—Carl Dunant

Build a
STEREO INDICATOR



Stereo multiplex FM programs are becoming more and more common. This indicator lets you know when you have tuned in a stereo transmission

By CHARLES CARINGELLA

A STEREO INDICATOR of some sort (usually a panel lamp) is now a standard feature of most commercial multiplex adapters and FM-multiplex receivers. Such an indicator helps the user find FM-stereo signals when tuning, and eliminates any doubt as to whether the transmission is stereo or not.

If your equipment does not have one of these stereo indicators, don't despair; the low-cost unit described here can be added to any multiplex adapter or FM receiver. In fact, the transistorized device can easily be tucked away inside most multiplex adapter or FM receiver enclosures. Or, if desired, the unit can be built into a separate enclosure as shown.

How It Works. The transmitted stereo signal contains, along with other modulation components, a 19-kc. pilot subcarrier. The multiplex information, including the 19-kc. signal, appears at the output of the FM receiver. This 19-kc. signal is constant in amplitude and, when present, constitutes the signal that turns on the stereo indicator light.

Multiplex signal output from the FM tuner is fed into jack *J1* (see Fig. 1) and then out again through jack *J2* to the multiplex adapter. If your FM tuner has a built-in multiplex circuit, then it is only necessary to bring out one shielded line from the tuner to *J1*, the input of the indicator circuit. This will necessitate an internal connection in the tuner at the detector output, or at the input of the multiplex circuit in the receiver.

The tuned circuit made up of coil *L1* and capacitor *C1* resonates at 19 kc. This allows only the 19-kc. signal to pass, and all the other components present in the complete multiplex signal are greatly attenuated. The 19-kc. signal is

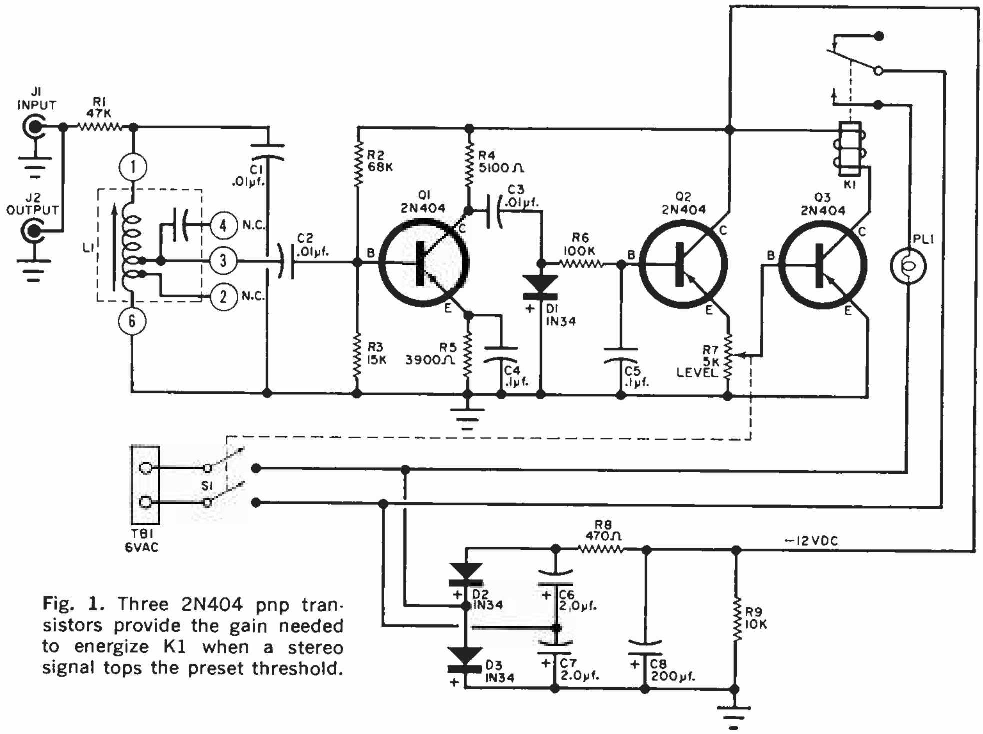


Fig. 1. Three 2N404 pnp transistors provide the gain needed to energize K1 when a stereo signal tops the preset threshold.

then amplified by transistor *Q1,* which is a conventional Class A amplifier.

The amplified 19-kc. signal is then rectified by diode *D1,* and the output is smoothed by resistor *R6* and capacitor *C5.* Transistors *Q2* and *Q3* amplify this d.c. signal, and the final output controls a sensitive relay (*K1*). The relay controls a pilot lamp (*I1*), which is lighted whenever the 19-kc. signal is present.

The only primary power required for the unit is 6-volt a.c. CAUTION! The source of this 6-volt supply must *not* be grounded! The voltage can be taken from the power transformer of the tuner, multiplex adapter, or hi-fi amplifier *only* if the winding supplying the 6-volt a.c. is *known* to be ungrounded. If you can't be perfectly sure that it is, use a separate, small, 6-volt filament transformer for power. This precaution is necessary because of the voltage doubler circuit in the power supply of the indicator unit.

The 6-volt a.c. is applied directly to the voltage doubler circuit, and through normally open contacts of *K1* to the indicator lamp. The output of the voltage doubler circuit is smoothed by resistor

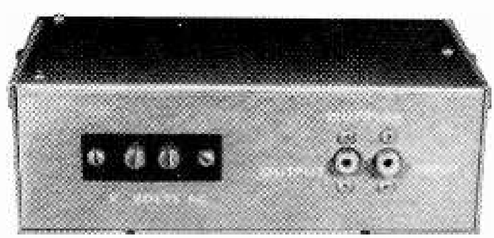


Fig. 2. In the self-contained unit, all connections are made on the rear panel. The name "Multiplex" refers to a function that no longer applies.

R8 and capacitor *C8,* and provides about 12 volts d.c. negative to ground across bleeder *R9.* Since the total current drain is only about 3 ma., inexpensive 1N34 (or equivalent) diodes are satisfactory as rectifiers.

Construction and Adjustment. The entire circuit is constructed on a piece of 6" x 3" Vectorbord. The placement of parts is not critical; however, the layout shown in Figs. 3 and 4 will provide a handy guide. The relay is mounted on the Vectorbord also, since the arma-

(*Continued on page* 164)

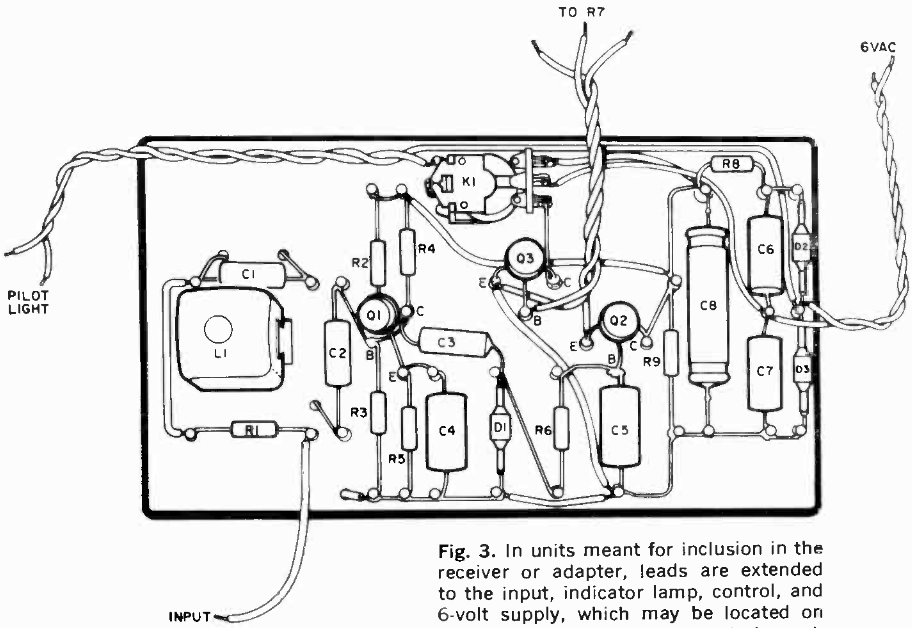
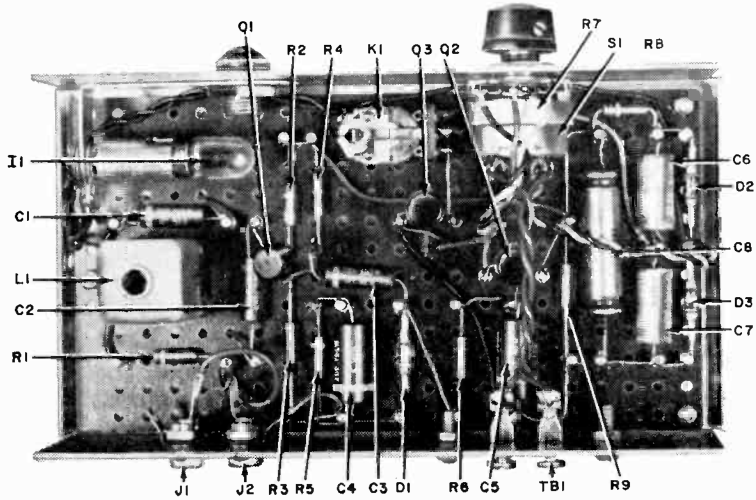


Fig. 3. In units meant for inclusion in the receiver or adapter, leads are extended to the input, indicator lamp, control, and 6-volt supply, which may be located on the main receiving unit, or control panel.

PARTS LIST

C1, C2, C3—0.01-µf., 200-volt d.c., paper capacitor
C4, C5—0.1-µf., 200-volt d.c., paper capacitor
C6, C7—2-µf., 15-volt d.c., electrolytic capacitor
C8—200-µf., 15-volt d.c., electrolytic capacitor
D1, D2, D3—1N34 germanium diode (or equivalent)
I1—G.E. #47 6-volt lamp (or equivalent)
J1, J2—Phono jack
K1—Relay, 5,000-ohm coil (Lafayette 99-6091 or equivalent)
L1—19-kc. multiplex coil (Miller 1354)
Q1, Q2, Q3—GE 2N404 transistor (or equiv.)
R1—47,000 ohms
R2—68,000 ohms
R3—15,000 ohms
R4—5100 ohms
R5—3900 ohms
R6—100,000 ohms
All resistors ½ watt, ± 10%
R7—5000-ohm potentiometer, linear taper, with d.p.s.t. switch S1
R8—470 ohms
R9—10,000 ohms
S1—D.p.s.t. switch (part of R7)
1—6" x 3" Vectorbord
1—6¼" x 3½" x 2⅛" aluminum box chassis
Misc.—Pilot lamp socket assembly, knob, 2-lug terminal board

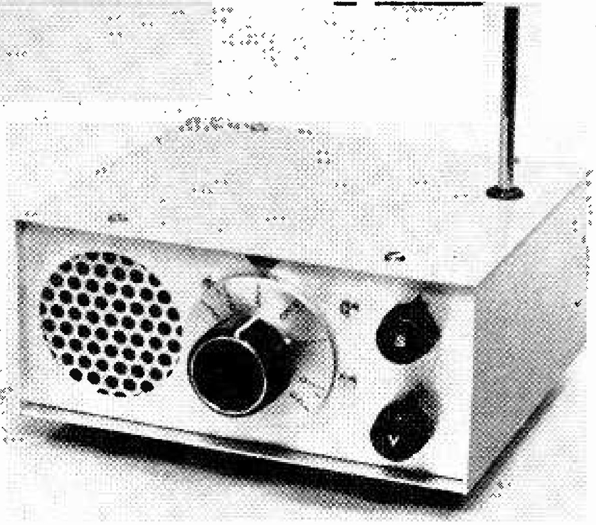
Fig. 4. The layout of parts lends itself to ease of assembly and trouble-shooting. Make sure you do not ground the relay while you're mounting or wiring it.



Chapter 3

COMMUNICATIONS for the HOBBYIST

ONE of our ELECTRONIC EXPERIMENTER'S HANDBOOK contributors has a knack of developing very workable but simple receivers. He is Charlie Green, and in this issue your Editors direct your attention to his 80-meter and 2-meter ham band superhets. Another receiver sure to attract its share of attention is the "VHF Listener"—a superregenerative unit incorporating a squelch circuit. Hams and SWL's will find the outboard accessories (the "SSB Product Detector," "Code Bander," weather station converter, etc.) excellent construction projects for one of those quiet weekends. If you don't have a 100-kc. calibrator, we urge you to seriously consider the special printed circuit board and circuit developed by author Scheidel; this transistorized unit produces harmonics that are perfectly readable well into the VHF part of the spectrum.



THERE'S a large and growing group made up of SWL's and other radio enthusiasts who like to eavesdrop on the goings-on in the 30-54 mc. and 108-148 mc. bands, but who find the receiver problem a tough one. A good commercial receiver for a part of this region of the VHF spectrum can cost from one-tenth to one-third of a kilo-buck, a non-trivial sum for most of us.

In addition, home construction of a good superhet, such as the "VHF Adventurer" (POPULAR ELECTRONICS, October, 1963) requires a rather uncommon amount of test gear and experience. The usual alternative, the very simple superregen receiver, has serious shortcomings. It tends to be unstable, seldom gives equally good results all across its tuning range, causes interference in other receivers, and hisses like a nest of angry copperheads when there's no signal input.

If these obstacles have kept you from the VHF listening ranks in the past, the "VHF Listener" is the answer to your prayers. For sensitivity, simplicity, and low cost, the superregen circuit has been retained, but with modifications that cure its major ills.

The actual unit described here covers the 108-130 mc. aircraft communications band, but the basic circuit can be built to cover other bands between 10 and 170 mc. with very little change other than the use of different values of inductance and capacitance in the tuned circuits. Required departures from the values used in the unit are given later in this article for similar receivers to cover the Citizens Band and 2-meter ham band.

About The Circuit. Signals picked up by the extendible whip antenna are applied via *C2* to a tap on *L1,* shown in Fig. 1. Capacitor *C1* resonates *L1* at the center of the band covered, and once set, does not need retuning. Coil *L2* is a single turn of wire which acts as a low-impedance secondary to *L1,* to match *Q1*'s input impedance.

Transistor *Q1* is the r.f. amplifier, operating in a grounded-base circuit. Power is shunt-fed to the collector via *L3,* which has relatively high impedance across the band covered. Resistors *R1, R2,* and *R3* set *Q1*'s operating bias.

The *Q1* output is applied to the *Q2* detector stage via *C5,* shown in Fig. 2. Tuning capacitor *C6* and coil *L4* make up the oscillator tuned circuit which is connected to the *Q2* collector. Capacitor *C7* is the feedback path for superregeneration. The 60-kc. quench frequency is determined mainly by the values of *C8, C9,* and resistor *R7.*

This detector differs from most superregens by providing, in addition to the audio signal, a d.c. output proportional to the r.f. input. This d.c. component controls the squelch circuit, which silences the set when there is no input.

The audio signal and d.c. squelch control voltage are taken from the detector through a filter made up of *C10, C11,* and *R8.* This prevents the 60-kc. quench frequency from reaching and overloading the audio amplifier input.

The squelch circuit is a d.c. amplifier

VHF LISTENER

There's exciting listening in the VHF bands. Here's a potent transistor receiver that will let you in on it for under $30

By WALT HENRY

that controls diode *D1*, which acts as a gate. The audio signal reaches *D1* via *C13*, but cannot pass through when the diode is reverse-biased. When a signal is received, the d.c. level at the junction of *L4* and *R4* rises. This rise is amplified through *Q3* and *Q4*, overcoming the reverse bias on the *D1* diode gate. This permits the audio signal to pass to the audio amplifier input. If the incoming r.f. signal is cut off, *D1* is again reverse-biased by the voltage at the junction of *R17* and *R18*, and the detector hiss cannot pass through.

The audio amplifier shown in Fig. 5

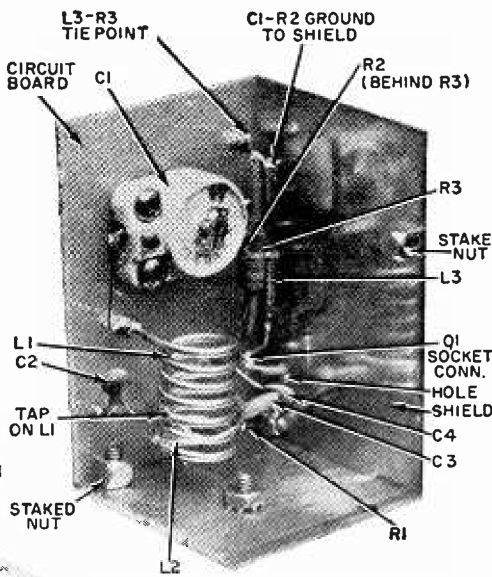


Fig. 2. Follow layout of Q1 r.f. stage closely. Ground ends of L1 and L2 are soldered to circuit board tie point (hidden behind coils) and C3-R1 junction.

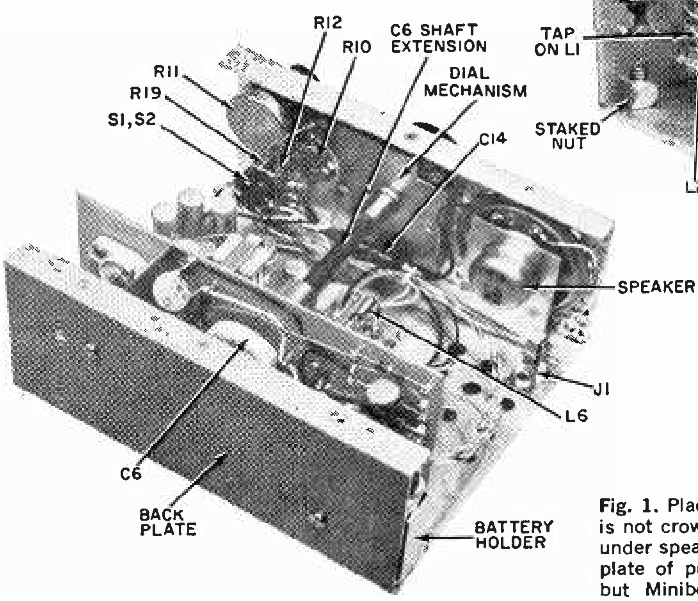


Fig. 1. Placement of major parts is not crowded. Holes in chassis under speaker are optional. Back plate of prototype is removable but Minibox assembly is O.K.

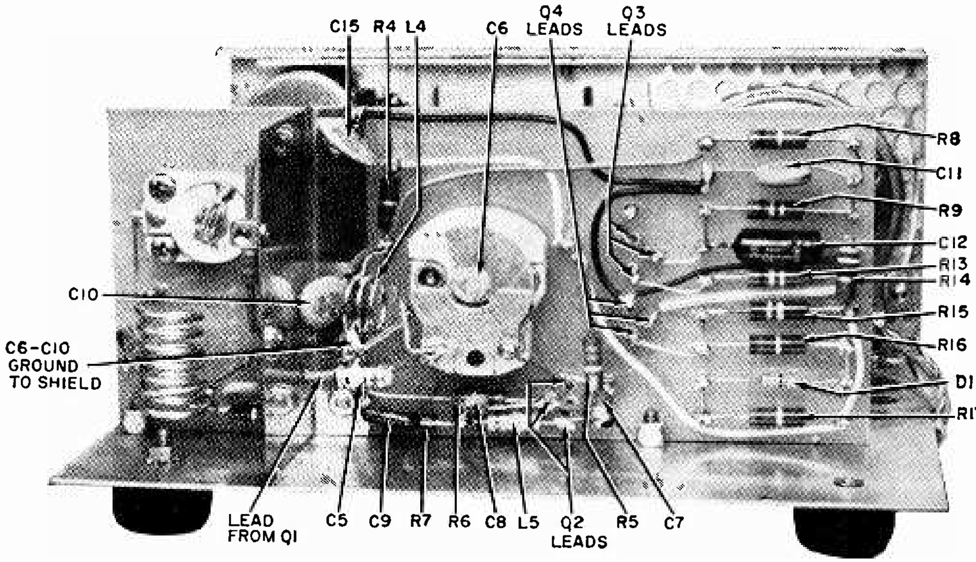


Fig. 3. Signal from Q1 stage left of shield is coupled to detector by wire through hole in shield. R.f. and squelch circuit transistors mount in sockets on front face of circuit board.

was made by the author, but the manufactured units given in the Parts List are equally good, and require less work.

Separate batteries are used to power the r.f. and audio sections. Use of a single battery tends to cause some motorboating due to interaction between the squelch circuit and the audio amplifier when the battery internal impedance increases with age and use.

Construction. The mechanical construction of the author's unit includes staked nuts for holding the circuit board and shield in the case. These are not readily available to most home constructors, but the small angle brackets sold in the "five-and-ten-cent" stores will serve just as well. Alternatively, short lengths of aluminum or brass angle bracket can be used with either self-tapping or machine screws.

The r.f. and squelch circuits are assembled on a 2½" x 5½" piece of insulated circuit board. The author used a non-perforated board and drilled 1/16" holes for small push-in terminals for solder connections. However, a piece of pre-punched Vectorbord and the "flea-clip" terminals made for it are ideal, and are called for in the Parts List.

The only part of the circuit that must be laid out with care is the r.f. amplifier shown in Fig. 2. Such a grounded-base amplifier stage works very well at VHF, but is inherently slightly regenerative and may tend to oscillate if leads are not kept short and direct. The 2N1517 transistor has an internal shield which should be grounded. This may be done by connecting the shield lead directly to ground, or by connecting it to the base lead, which is, in turn, effectively grounded by *C4*. The metal shield between r.f. and detector stages provides a convenient ground for both.

The detector stage may be laid out almost any convenient way as long as the leads are kept reasonably short, as shown in Fig. 3. During construction, omit *R5* temporarily, as its optimum value will be determined by experiment. It probably will be approximately 22,000 ohms. The shield lead of *Q2* can be wired to ground, but this step is not vital.

In case you have some high-frequency transistors in the spare parts box, any of the following types will work quite well in either the r.f. or the detector stage. Tested examples include Philco's 2N502, 2N1742, 2N1743, and 2N1744, the Amperex 2N2084, and Texas Instruments' 2N797. Silicon *npn* types 2N743 and 2N744 will also give excellent performance. If *npn* transistors are used in your version of the "Listener," however, the polarities of *B1, C12, C14,* and *D1* must be reversed, *R6* must be 3300 ohms, and *Q3* and *Q4* must be interchanged.

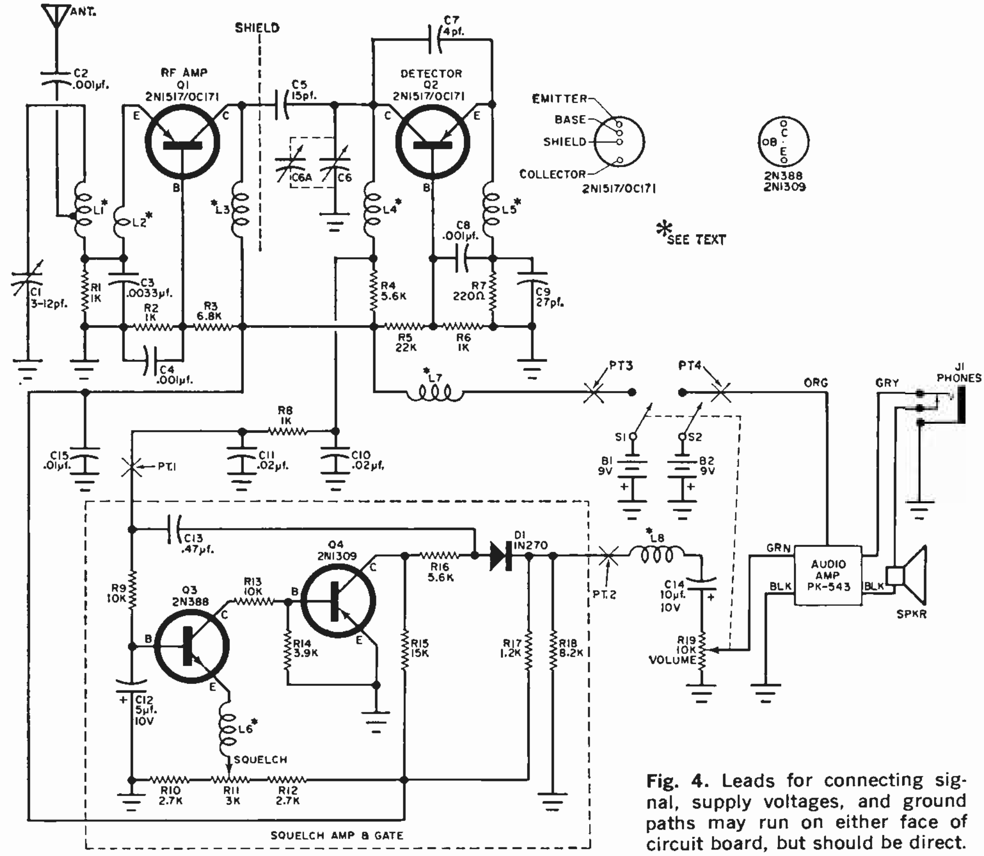


Fig. 4. Leads for connecting signal, supply voltages, and ground paths may run on either face of circuit board, but should be direct.

PARTS LIST

B1—9-volt manganese transistor battery (Burgess 2MN6 or equivalent)
B2—9-volt transistor battery (Eveready 216 or equivalent)
C1—3-12 pf. ceramic trimmer capacitor
C2, C4, C8—0.001-μf., 100-volt disc cer. cap.
C3—0.0033-μf., 100-volt disc cer. capacitor
C5—15-pf. tubular ceramic capacitor
C6—2.8-17 pf. variable capacitor (Hammarlund APC-15B or equivalent, modified as per text)
C7—4-pf. tubular ceramic capacitor
C9—27-pf. silver mica capacitor
C10, C11—0.02-μf., 100-volt disc cer. capacitor
C12—5-μf., 10-volt electrolytic capacitor
C13—0.47-μf., 100-volt tubular paper capacitor
C14—10-μf., 10-volt electrolytic capacitor
C15—0.01-μf., 100-volt disc cer. capacitor
D1—1N270 germanium diode
J1—Subminiature phone jack, shorting type
L1, L2, L4—See text
L3, L5, L6, L7, L8—4.7 μh.—see text
Q1, Q2—2N1517/0C171 Amperex transistor (available from Newark Electronics Corp., 223 W. Madison St., Chicago, Ill., stock nr. 21FX2612—see text)
Q3—2N388 germanium transistor
Q4—2N1309 germanium transistor
R1, R2, R6, R8—1000 ohms
R3—6800 ohms
R4, R16—5600 ohms
R5—See text
R7—220 ohms
R9, R13—10,000 ohms
(all resistors ½-watt carbon unless otherwise specified)
R10, R12—2700 ohms
R11—3000-ohm potentiometer (IRC Q11-112 or equivalent)
R14—3900 ohms
R15—15,000 ohms
R17—1200 ohms
R18—8200 ohms
R19—10,000-ohm potentiometer, with switch (Mallory U-20, with US-27, or equivalent)
S1, S2—D.p.s.t. switch, on R19 (Mallory US-27 or equivalent)
1—7" x 5" x 3" Minibox (Bud 80P350 or equivalent)
1—Transistor audio amplifier (Lafayette 99-9039 or equivalent)
1—Vernier dial mechanism (Lafayette 99-2516 or equivalent)
1—Shaft coupler (Lafayette 32-6412 or equiv.)
1—Extension shaft (Lafayette 32-6409 or equiv.)
1—Telescoping whip antenna (Lafayette 99-3005 or equivalent)
1—2-inch speaker (Lafayette 99-6036 or equiv.)
1—2½" x 5½" preperforated Vectorbord
Misc.—3-lug terminal strip, hookup and coil winding wire, transistor sockets, knobs, screws, etc.
Note: *For CB, R7 is 680 ohms, C5 is 51 pf., C7 is 10 pf., C9 is 62 pf., Q2 is a 2N370*

VHF LISTENER

The specified tuning capacitor *(C6)* should be modified for use in the 108-132 mc. aircraft or 2-meter amateur bands. Remove all but one of the rotor plates, and all but two of the stator plates, the rotor plate meshing between the two remaining stator plates.

Coil *L1* is made by winding 6½ turns of #14 tinned copper wire on a ½" rod, spaced ¾" long. After removing the forming rod, solder the tap at a point 2½ turns from the ground end of *L1*.

Coil *L2* is ¾ of a full turn of #18 around the ground end of *L1*. It should be grounded at the same point as *L1*, but should not contact *L1* elsewhere. Coil *L4* is 3 turns of #18 wound on a ⅜" rod, in a ¼" length.

For the Citizens Band, *L1* requires 23 turns of #28 enameled copper wire on a J. W. Miller 20A000RBI form, tapped 8 turns from the ground end. Coil *L2* is 2½ turns of the same wire close-wound over the ground end of *L1*. Coil *L4* is 17 turns of the same wire on the same type of coil form. Change *Q2* to a 2N370.

Chokes *L3* and *L5* are 23-μh. units, Miller 9310-44 or equivalent, and *L6, L7,* and *L8* are omitted. Also, *C6a* must be added in parallel with *C6,* which is not modified for the Citizens Band.

If you decide to build the unit for the 2-meter band, simply use one less turn in making both *L1* and *L4,* and tap *L1* two turns from the ground end. Also reduce the value of *C7* from 4 pf. to 3 pf.

R.f. chokes *L3, L5, L6, L7,* and *L8* may be commercial 4.7-μh. units, but cheaper ones that work just as well can be made by winding 36-gauge copper wire on one-megohm resistors. Wind the turns closely and cover the full length of a half-watt resistor. Strip the enamel off the ends of the wire with fine sandpaper, wind around the resistor leads, and solder. Note that different choke values are required for the Citizens Band.

Layout is not important in the squelch circuitry, but the construction shown in Fig. 3 is compact and neat. If you are leaving out the squelch feature, omit all circuitry in the dotted rectangle on the schematic, and connect point 1 directly to point 2. Also connect point 3 directly to point 4 and eliminate battery *B1* and switch *S1*.

The color coding on the schematic is for some Lafayette 99-9039 preassembled audio amplifiers. They come with two orange leads which are meant to be connected to a volume control on-off switch. Since a different arrangement is used, cut off the orange lead running to one of the (now disconnected) battery leads and leave the other one intact. Save the battery clip for connecting to the battery leads later on. The other needed battery clip may be salvaged from a worn-out battery of the same type.

The phone jack is connected so that the speaker is turned off when the phones are plugged in.

The case shown in the photographs was handmade in an effort to give the "Listener" a professional appearance. However, the Minibox specified in the Parts List is quite satisfactory, and saves much work.

The dial is a 2" aluminum disc cut from sheet material, but heavy artist's board or stiff sheet plastic is equally good. If you use metal, sand the surface with very fine sandpaper and put the calibration marks on with India ink. A light priming coat of clear Krylon spray will make the ink flow on perfectly. After the ink has dried, spray several coats on the dial to protect the markings.

Testing and Calibration. Temporarily connect a 0.1-μf. capacitor between point 1 and 2 on the schematic. This will bypass the squelch circuit while the detector is being tested. Connect a 10,000-ohm resistor in series with a 100,000-ohm potentiometer and temporarily substitute this combination for bias resistor *R5*. Attach the fixed resistor end of the combination to the base of *Q2*. Turn *C6* to minimum capacitance and connect the antenna. With the audio volume turned up full, vary the 100,000-ohm test bias potentiometer. At some point a loud hiss will indicate correct detector operation.

With the temporary bias potentiometer still in place, calibrate the dial. If a grid dip meter is used, keep the signal

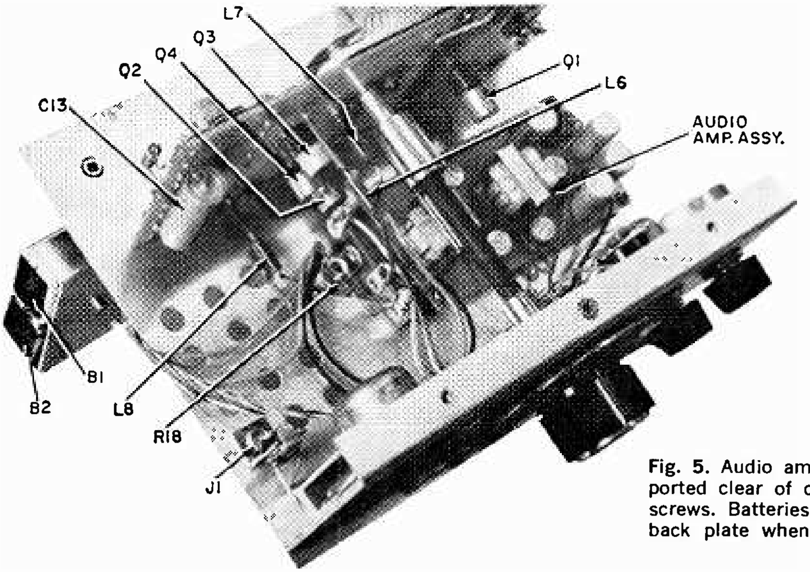


Fig. 5. Audio amplifier board is supported clear of chassis on four long screws. Batteries in holder attach to back plate when unit is assembled.

weak by keeping dipper and Listener well separated. With a generator, a short antenna plugged into the output may be needed. When the signal source is tuned to the detector frequency, the audio hiss will drop noticeably in volume. The frequency range tuned by the detector may be adjusted by squeezing or stretching *L4* slightly to change its inductance. You may also need to readjust the bias on *Q2* with the temporary bias potentiometer. For the Citizens Band version, set the frequency range covered by adjusting *L4* and *C6a* in alternate steps.

Tune near the center of the band, and adjust antenna capacitor *C1* for loudest volume (or lowest hiss level if your signal source is not modulated). It will not be necessary to change this setting when tuning other parts of the band.

Now measure the total resistance of the temporary resistor-potentiometer bias combination, and install a fixed resistor *(R5)* of the nearest standard value. The optimum value for *R5* depends slightly on the voltage of battery *B1*, and the detector may fail to operate near the high end of the band when the voltage of an aging battery begins to drop.

If this happens with a relatively fresh battery, lower the value of *R5* slightly. The current drain on both batteries is only about 5 ma., so they will give many hours of service. A manganese-alkaline battery such as the Burgess 2MN6 is ideal for *B1* since it holds an almost constant voltage until the end of its long life.

When the detector is working satisfactorily, remove the temporary capacitor between points 1 and 2. With squelch control *R11* fully counterclockwise, the detector hiss should be heard. When fully clockwise, the audio output should be silent. Check squelch operation over the entire tuning range. If it does not operate properly over the full range, a slight adjustment in the value of *R12* may be necessary.

For most sensitive receiver operation, the squelch control should be set as close as possible to the turn-on point. If the receiver is left on for extended periods of time, check the squelch setting periodically.

Thanks to the relatively broad tuned circuits of the Listener, tuning to a given channel is not critical. Also, the broad tuning and very low warm-up drift make the set stay "put" on a selected channel without constant retuning.

If you have built the unit for the aircraft band, here's a word of caution. Even though the r.f. stage cuts detector radiation to a relatively low value, very sensitive aircraft receivers may still pick it up and experience troublesome interference when they are very close. For this reason you should never operate the VHF Listener while in a commercial airliner, or closer than several hundred feet to a control tower or airport. -30-

SSB PRODUCT DETECTOR

By R. M. MENDELSON, W2OKO

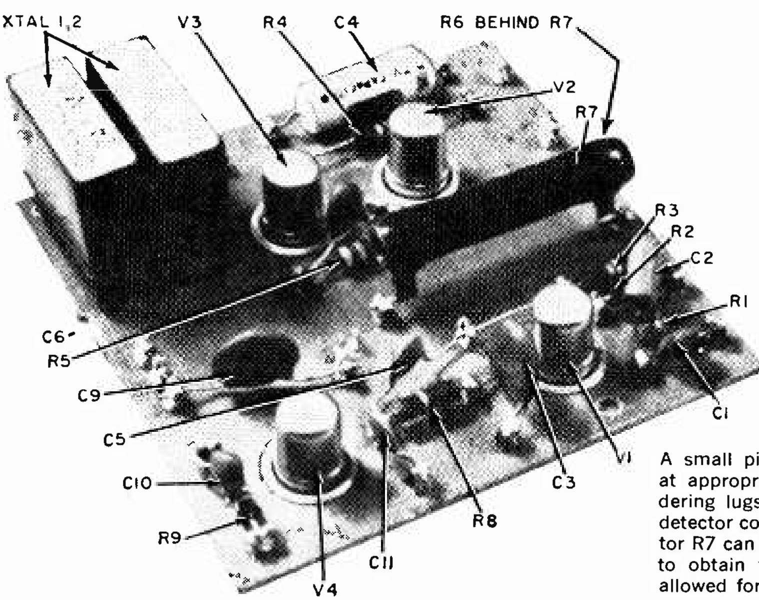
Compact nuvistor detector unravels SSB signals

NUVISTORS have been described in r.f. converter and preamplifier circuits but little has been published about other uses for this component in amateur radio, especially where small size is paramount.

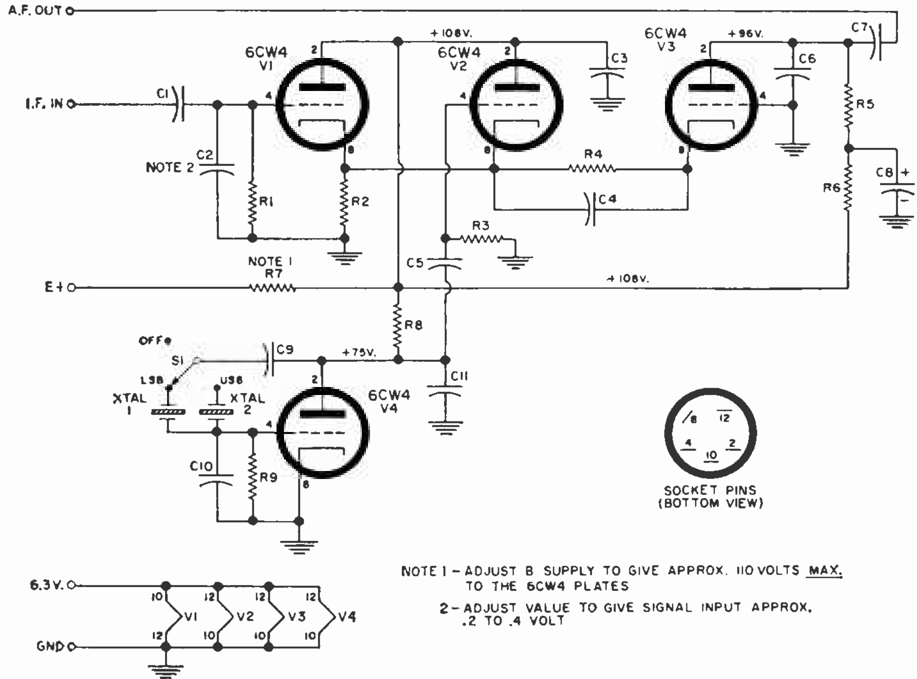
An excellent application for the RCA 6CW4 nuvistor is in a miniature product detector that can be added to any communications receiver—commercial, home-built, or surplus. The size of conventional tubes has often made it difficult to construct an adapter small enough to fit into a compact chassis.

Advantages of Product Detector. When a conventional diode detector is used for single-sideband reception, the beat-frequency oscillator must also be used to supply the carrier. Under these conditions, distortion usually results. It is necessary to reduce the r.f. signal input to the detector and raise the audio gain all the way to help reduce this distortion. The beat-frequency-oscillator injection voltage must also be changed from that used for continuous-wave reception. In lower-priced receivers, running the audio at full gain often introduces hum. The receiver a.v.c. cannot be used, but rather the r.f. gain must be continuously adjusted manually according to the strength of each signal received. In a multistation round table, this adjustment is quite a chore. Many of the weaker signals may be lost altogether.

The best solution to the problem of good single-sideband reception is the use of the product detector, so named because the output voltage equals the algebraic product of the input signal and the local oscillator voltages. It al-



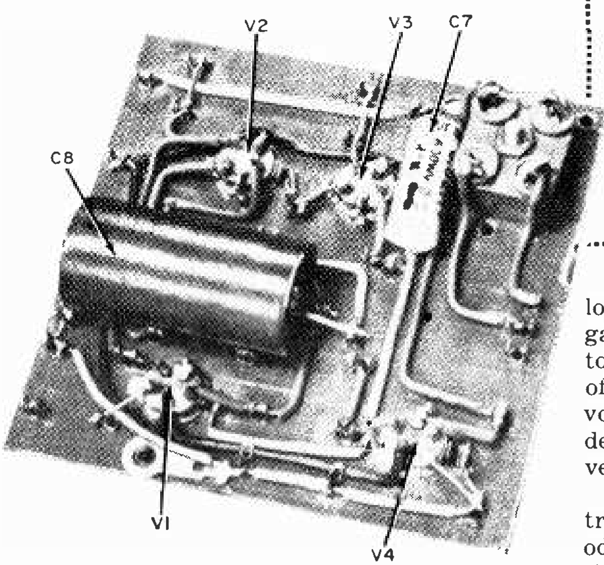
A small piece of fiberboard drilled at appropriate spots for Alden soldering lugs was used to mount the detector components. Ten-watt resistor R7 can be a fixed or a slider type to obtain the 110 volts maximum allowed for proper 6CW4 operation.



A product detector is an absolute necessity for good SSB reception. This uncomplicated circuit features a crystal-controlled BFO.

PARTS LIST

C1, C10—10-pf. disc ceramic capacitor
C2—82-pf. disc ceramic capacitor
C3, C9—0.01-µf. disc ceramic capacitor
C4, C7—0.02-µf. plastic tubular capacitor
C5—100-pf. disc ceramic capacitor
C6—1000-pf. disc ceramic capacitor
C8—20-µf., 250-volt electrolytic capacitor
C11—250-pf. disc ceramic capacitor
R1—500,000-ohm, ½-watt resistor
R2—820-ohm, ½-watt resistor
R3—82,000-ohm, ½-watt resistor
R4—680-ohm, ½-watt resistor
R5—47,000-ohm, ½-watt resistor
R6—1000-ohm, ½-watt resistor
R7—10,000-ohm, 10-watt wire-wound resistor
R8—10,000-ohm, ½-watt resistor
R9—120,000-ohm, ½-watt resistor
S1—3-position selector switch
V1, V2, V3, V4—6CW4 nuvistor triode (RCA)
Xtal 1, Xtal 2—See accompanying table



Bottom view of the circuit board shows the various interconnections.

lows operation of the r.f. control at full gain with use of the receiver a.v.c., distortion-free reception, and a low value of beat-frequency-oscillator insertion voltage for good reception. The product detector will also greatly improve conventional code reception.

The circuit itself consists of three triodes (*V1*, *V2*, and *V3*). The first triode is a cathode-follower for coupling the signal from the i.f. stage of the receiver to *V3*, which serves as a mixer

SSB PRODUCT DETECTOR

stage. Triode *V2* is a cathode coupler between the local oscillator (*V4*) and mixer tube *V3*. In the mixer, the received signal and the local oscillator heterodyne to produce the audio output. The undesired heterodynes are filtered out of this stage, leaving a clean audio signal not dependent on the strength of the input signal.

In the unit described here, the local oscillator is crystal-controlled to overcome the problems of stability that would be encountered from the beat-frequency-oscillator stage of the many different ham receivers. It also provides the proper injection voltage; thus, even low-priced receivers can be used for single-sideband reception without trouble in keeping tuned to a station.

The nuvistor product detector shown in the photos uses four 6CW4 nuvistors and yet is only 3½" square by 2¼" high. If it were not for the crystals, the total height would be only half as much. The nuvistor model works as well as the older models using conventional tubes, but is less than one-quarter the size. All power is obtained from the receiver; only 0.52 ampere at 6.3 volts and approximately 15 ma. at around 100 volts are required.

Construction. In constructing the circuit, a piece of fiberboard is used with mounting lugs for all components. To eliminate wiring errors, Alden No. 651T lugs have been used in the model, but in their absence several preperforated boards and lugs are available in the ham market as substitutes. As a last resort, conventional solder lugs can be screwed to the board; the particular type of lug is not important, nor is the exact layout.

CRYSTALS REQUIRED FOR VARIOUS I.F.'S

Receiver I.F. (kc.)	Upper Sideband Crystal (kc.)	Lower Sideband Crystal (kc.)
455	453.7 (Ch. 45)	456.9 (Ch. 329)
915	913.5 (Ch. 87.7)	916.7 (Ch. 88)
500	498.1 (Ch. 69)	501.8 (Ch. 71)
456	451.166 (Ch. 327)	457.4 (Ch. 47)
1600	1598.5	1601.5

Mounting of the nuvistor sockets requires a little care because the sockets are too small to be bolted on and must be held to the mounting board by two bent lugs. It is best to drill a 31/64"-diameter hole and then hand-file two notches for the lugs. At least one lug on each socket must be soldered to the ground lead to insure a ground for the nuvistor shell when it is plugged in.

The switch used to select the desired crystal is best mounted on the receiver panel, but should not be too far from the terminals. The choice of crystal frequencies is set by the receiver's i.f. One crystal should be above and one below the center frequency of the i.f. by about 1.5 kc. For the common 455-kc. i.f., surplus crystals for channel 45 and channel 329 are suitable. Other i.f. frequencies and their proper surplus crystals are shown in the accompanying table.

Operation. With no tuned circuits, potentiometers, or other adjustable components, this product detector is ready to operate as soon as it is wired up. The only precaution necessary is not to exceed the 6CW4's maximum plate-voltage rating of 110 volts. Actually, the detector works best at about 90 volts, and various values of *R7* can be tried after the unit is in operation.

In some receivers, the value of capacitor *C2* may have to be changed to prevent application of too strong an input signal. The value should be adjusted to provide an input signal of between 0.2 and 0.4 volt at the grid of *V1*. With the oscillator disabled by removal of *V4*, no audio signal should be heard leaking through the cathode-followers.

Sideband is here to stay. Let's convert those receivers over to receive it properly and at the same time get better continuous-wave and radioteletypewriter reception. —30—

CRYSTAL SUPER CALIBRATOR

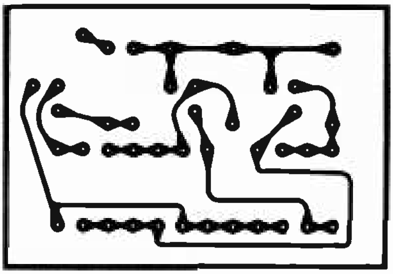
By R. A. SCHEIDEL

Like port and starboard channel buoys for the navigator, crystal calibrator harmonics mark the band edges for hams and others

NEXT TO MONEY, hardly anything serves certain needs of the ham, the SWL, and the set builder better than a good crystal calibrator. For the ham, those stable signals precisely 100 kc. apart mark the band edges of most of the amateur bands with an accuracy that removes the gnawing fear of an unwanted FCC QSL for out-of-band operation. For the SWL, the rather sketchy calibration of many short-wave receiver dials no longer causes such exasperating difficulties when trying to identify an unknown station. And the set builder and experimenter can calibrate the dial of the new receiver, oscillator, or other tunable device with some assurance that the figures they put down on the scale mean something definite.

Crystal calibrator kits are available from several companies, and many receivers feature a plug-in socket for a calibrator, or have a calibrator built in at the factory. Even so, the unit described here has several solid advantages that more than justify its moderate cost and the time required to build it.

First of all, the "super" calibrator is small, rugged, and can be constructed as a completely self-contained unit if you wish. This makes it a natural choice for field day, portable, or mobile use. It also means you don't need to cut into other equipment to steal power, although of course you can power the unit

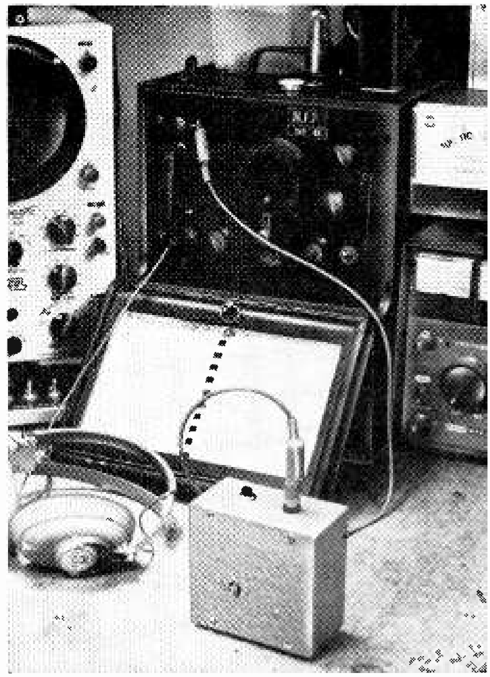


this way if you choose, and a circuit for this construction scheme is provided. Next, crystal current is very low, even if you elect to use the highest battery voltage the design permits, and all other sources of thermal frequency drift are weak. For these reasons, stability is significantly better than is usual for units not operating in a temperature-controlled oven.

Third, the super calibrator is so easy to build, thanks to a high-quality printed-circuit board, that you can choose just about any final assembly form that suits your own needs. This can range from building the unit into an existing receiver to making it the basis for an elaborate home lab signal source, with additional multivibrators to provide outputs at multiples and submultiples of the basic 100-kc. frequency. Because of the "foolproofness" of the design, constructors are encouraged to adapt the unit to their own requirements, although the version described here can be duplicated exactly if desired. And even for this completely self-contained model, certain optional choices are given in the Parts List.

And as the final clincher, the super calibrator provides usable harmonic output to well beyond 100 mc., thanks to an output amplifier stage of optimum design. This last feature alone should perk up the interest of 6-meter hams, and DX'ers who comb the mobile bands above 30 mc., for this is where many calibrators get feeble, and receiver gain also begins to droop.

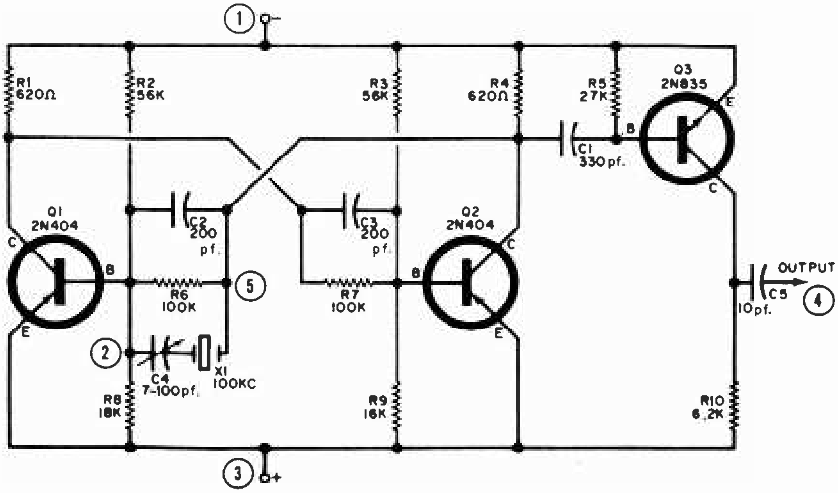
How It Works. The oscillating circuit of the super calibrator is essentially a multivibrator, with the crystal connected in the feedback path from the collector of transistor *Q2* to the base of transistor *Q1*. The crystal operates in this circuit at its series-resonant frequency; that is, it presents a relatively low series impedance at 100 kc., and a relatively high impedance at all other frequencies near 100 kc. As a result, the circuit made up of *Q1*, *Q2*, and associated resistors and capacitors oscillates at 100 kc., since this is the only frequency at which there can be enough positive feedback to sustain oscillation. The exact frequency of oscillation can be adjusted over a small range by means of padder capacitor *C4*, making it possible to adjust the calibrator to zero beat (of a harmonic) with WWV, or another standard frequency signal source.

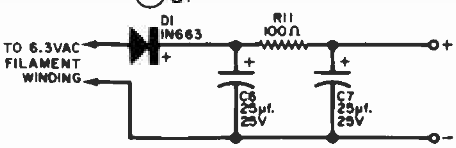


Where accurate frequency check points are a must, as when checking a BC-221 at 100-kc. points, the super calibrator speeds and eases the operation.

The base of output transistor *Q3* is coupled to the collector of *Q2* by capacitor *C1*. Transistor *Q3* is an *npn* type (2N835), and is capable of being switched from cutoff to fully conducting condition in about 10 nanoseconds. This high switching speed is just another way of saying that it can handle very high frequencies.

Since the input waveform from the oscillator circuit is substantially a 100-kc. square wave, *Q3* amplifies this wave and all harmonics to at least 100 mc.,



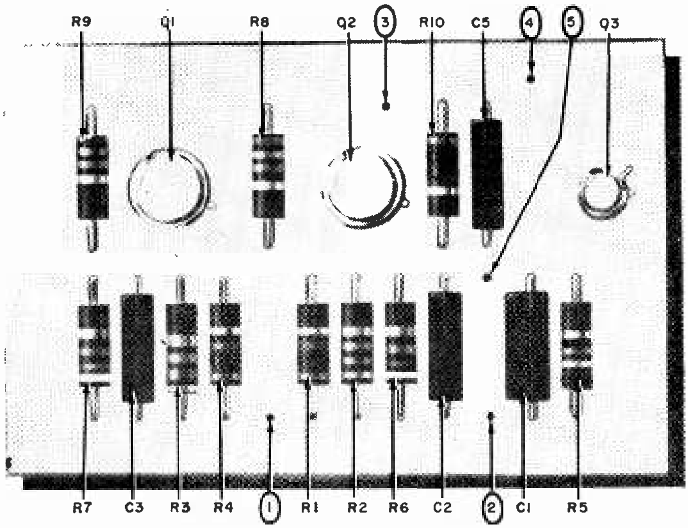


All parts shown in the main schematic diagram mount on the circuit board, except the crystal (X1) and padder capacitor (C4) which mount separately on the box cover. Six-volt power supply circuit is optional.

PARTS LIST

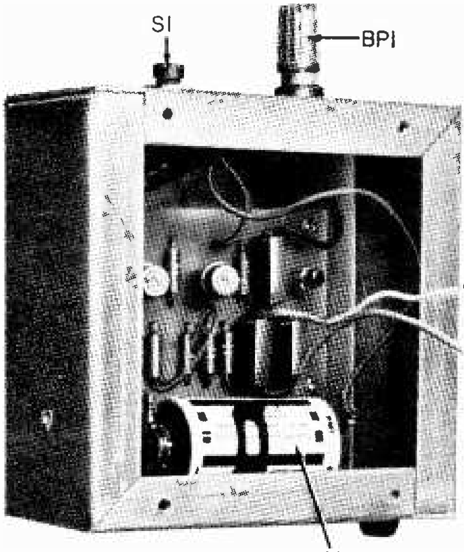
B1—1.5-volt to 10-volt battery to supply 4- to 12-ma. drain—see text*
C1—330-pf. silver mica capacitor, voltage rating not important
C2, C3—200-pf. silver mica capacitor, voltage rating not important
C4—7-to-100 pf. air dielectric variable capacitor, ceramic insulation (alternate for easier fine adjustment; 7-to-24 pf. size)
C5—10-pf. silver mica capacitor, voltage rating not important
J1—Crystal jack, to suit 100-kc. crystal used—see text*
Q1, Q2—2N404 pnp transistor
Q3—2N835 npn transistor
R1, R4—620 ohms
R2, R3—56,000 ohms
R5—27,000 ohms
R6, R7—100,000 ohms { *all resistors carbon, ½ watt*
R8—18,000 ohms
R9—16,000 ohms
R10—6200 ohms
S1—Any small on-off switch—see text*
X1—100-kc. standard type crystal (Petersen Z-6A or equivalent)
1—Printed circuit board (available from R. A. Scheidel, 22 W. Elm, Fremont, Mich., $3.00, three-week delivery)
1—Small aluminum box (4" x 4" x 2" used here)
Misc.—Binding post (BP1) or pin jack for outputs, screws and spacers for mounting board, hookup wire, solder, rubber feet for box, etc.

**Not shown in schematic, constructor's option*

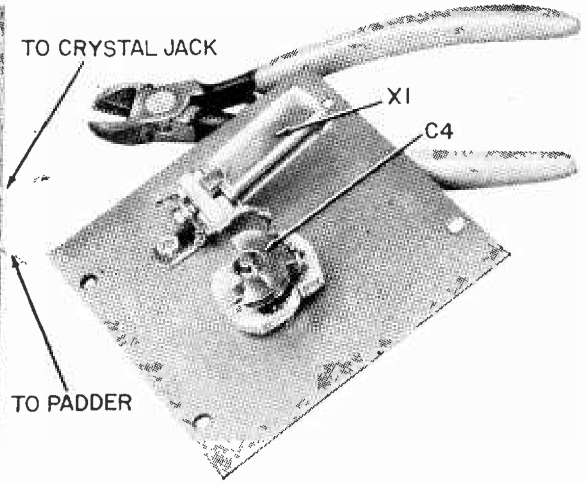


1 POWER CONNECTION (−)
2 PADDER CONNECTION
3 POWER CONNECTION (+)
4 OUTPUT CONNECTION
5 CRYSTAL CONNECTION

Parts placement is set by circuit board layout. Note orientation of the transistor locating lugs when inserting leads in circuit board openings.



Physical location of components in final assembly of version shown is not critical.



and delivers the amplified version to the output terminal through *C5*. The output stage is of relatively low impedance, so that moderate loading such as by the input circuit of a receiver under test will not seriously reduce the output or alter the unit's frequency stability.

Construction. The type of box chosen to enclose the unit does not affect the construction greatly, since almost all of the parts are mounted on the printed-circuit board. However, the type of switch chosen, and the type and size of the battery used to power the unit do affect the choice of the box, so it is well to select these components before you buy the box.

If you choose to duplicate the construction illustrated, begin by drilling holes for 4 x 32 machine screws in the three corners of the printed-circuit board that are clear of printed conductors. By drilling before the parts are mounted on the board, the chance of damaging anything is greatly reduced. With the holes in the board drilled, use the board as a template to locate the mounting holes to be drilled in one of the box covers. In doing this, be sure to spot the holes so the board will clear the lip of the box when it is mounted on the cover, noting that the board will be supported far enough from the cover to allow ample clearance for the solder side.

With this done, mount the padder capacitor, *C4*, and the crystal jack (if one is used) on the other box cover, as shown in the illustration. The crystal can be soldered into the circuit if desired, but most constructors may prefer to mount a ceramic crystal jack as shown, and insure the crystal against accidental removal due to jarring by securing a rubber band around the holder and crystal can.

Mount the output binding post and the on-off switch on one side of the box frame, and the battery holder on the opposite side.

Wire the circuit parts on the printed-circuit board in the positions shown. Use normal care in soldering, and be sure to use a heat sink (such as a copper alligator clip or pair of long-nose pliers) when soldering the transistor leads.

When all parts have been soldered in place and the ends of the leads have been trimmed close to the solder surface, connect five pieces of insulated hookup wire to the points on the board numbered *1* through *5* in the photograph showing the mounted parts. If you use a different color for each wire, it will help prevent errors when you make the final hookup. Leave these wires long enough to permit completion of the wiring when the board and other components are mounted in their final positions.

At this point you can either "go for

(*Continued on page* 151)

2-TUBE SUPERHET FOR 80 METERS

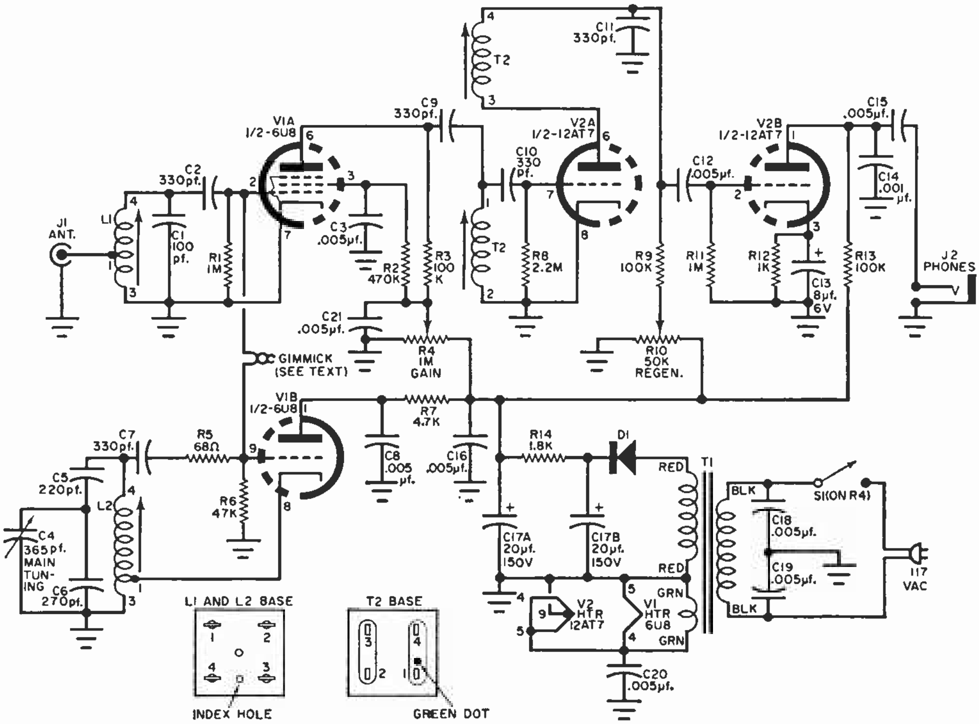
The 80-meter band remains a perennial favorite. Here's a receiver that will let you in on the fun with little outlay of hours and dollars

By **CHARLES GREEN,** W3IKH

HERE'S a simple, easy-to-build receiver for the 80-meter band that can do a real job for the novice, or as a standby receiver for the experienced old-timer. Costing less than $30 to build, even with all-new parts, it uses only two tubes in a superhet circuit, yet provides remarkable sensitivity and fully adequate headphone output, thanks to a regenerative second detector.

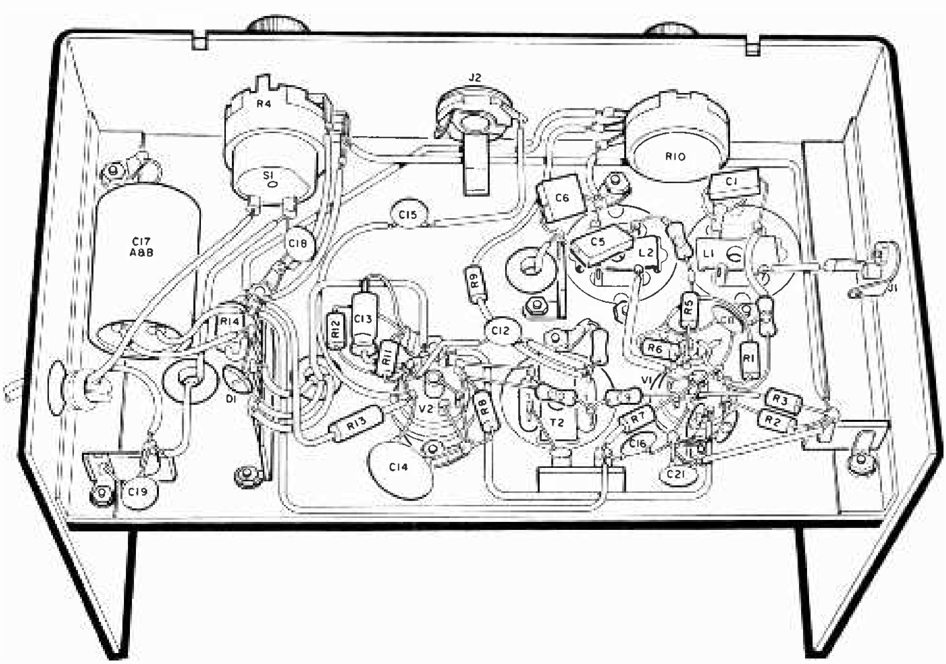
Use of regeneration with panel control also makes the receiver usable on either phone or c.w. signals, and the built-in power supply makes it unnecessary to "steal" power from other sets in the shack. Sharp-eyed EEH readers will note a family resemblance to the 6-meter superhet which appeared in the 1964 HANDBOOK and the 2-meter superhet in this edition. This is far from accidental, for the basic circuit is sound, and lends itself to construction by experimenters not blessed with a shop full of test equipment.

ABOUT THE CIRCUIT. Eighty-meter signals from the antenna enter via jack J2, and are fed to the fixed-tuned circuit made up of L1 and C1, and to the grid



Values of capacitors C5 and C6 affect the bandspread. Reducing the value of C5 increases the arc of the dial occupied by the 80-meter band; increasing C5 reduces the bandspread.

Point-to-point wiring permits mounting most small parts on lugs of major parts as shown.



PARTS LIST

C1—100-pf., 500-volt silver mica capacitor
C2, C7, C9, C10, C11—330-pf., 600-volt ceramic tubular capacitor
C3, C8, C12, C15, C16, C18, C19, C20, C21—0.005-µf., 600-volt ceramic disc capacitor
C4—365-pf. variable tuning capacitor (Lafayette 32-1103 or equivalent)
C5—220-pf., 500-volt silver mica capacitor
C6—270-pf., 500-volt silver mica capacitor
C13—8-µf., 6-volt miniature electrolytic capacitor
C14—0.001-µf., 600-volt ceramic disc capacitor
C17—Dual 20-µf., 150-volt electrolytic capacitor
D1—400-PIV, 450-ma. silicon rectifier (International Rectifier Type 5E4 or equivalent)
J1—Phono jack, chassis type
J2—Earphone jack (to match your phones)
L1—Antenna coil (Stancor RTC-8762 or equivalent)
L2—Oscillator coil (Stancor RTC-8764 or equivalent)
R1, R11—1 megohm
R2—470,000 ohms
R3, R9, R13—100,000 ohms
(All fixed resistors ½ watt, 10%, carbon unless otherwise noted)
R4—1-megohm linear taper potentiometer (with switch S1)
R5—68 ohms
R6—47,000 ohms
R7—4700 ohms
R10—50,000-ohm linear taper potentiometer
R12—1000 ohms
R14—1800-ohm, 2-watt, 10% carbon resistor
S1—S.p.s.t. switch (part of R4)
T1—Power transformer: primary, 117 volts, a.c.; secondary 1, 125 volts, 15 ma.; secondary 2, 6.3 volts, 0.6 ampere (Knight 61G410 or equivalent)
T2—455-kc. slug-tuned i.f. amplifier input transformer (Meissner 16-6758 or equivalent)
V1—6U8A tube
V2—12AT7 tube
1—Dial (Eddystone #598)
1—Shaft coupling (National TX-10)
1—8" x 6" x 4½" aluminum utility box (LMB 146 or equivalent)
1—8" x 4⅜" aluminum sheet (for chassis shelf)
Misc.—"K Tran" mounting plates (Miller 181 or equivalent), tube sockets, angle brackets, grommets, terminal strips, knobs, ⅜" metal spacers, line cord and plug, wire, etc.)

of mixer tube *V1a*. Main tuning capacitor *C4* is connected in parallel with *C6*, and the combination is in series with *C5* to make up the total capacity that tunes oscillator coil *L2*. This arrangement gives a good spread of the 80-meter band over practically the whole dial arc.

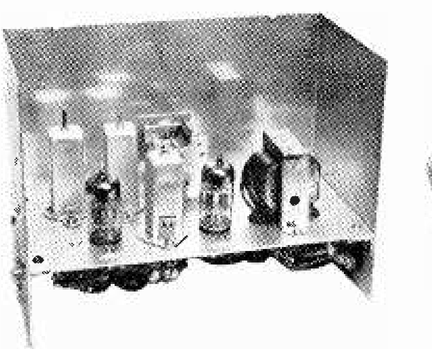
The "gimmick" capacitor made of two twisted insulated wires couples the output of oscillator *V1b* to the grid of *V1a*, and the resultant 455-kc. difference-frequency signals are connected by *C9* from the plate of *V1a* to *T2*. *GAIN* control *R4* varies the conversion gain of the mixer stage so the signal will not overload *V2a*, the detector stage. Coil *T2* is fixed-tuned by its adjustable core to 455 kc., and *REGEN* control *R10* varies the regenerative action of the detector stage.

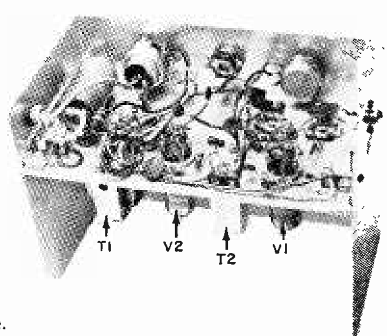
The detected audio signals are fed through capacitor *C12* to *V2b* and amplified. Capacitor *C15* couples the amplified signals to phone jack *J2*. Power transformer *T1*, rectifier *D1*, and the filter circuit made up of resistor *R14* and capacitor *C17* provide the operating voltages for the receiver.

Construction. A metal 8" x 6" x 4½" utility box and a 8" x 4⅜" chassis shelf of aluminum sheet are used to house the components. The chassis shelf is mounted by a pair of angle brackets 10¾" from the base of the utility box.

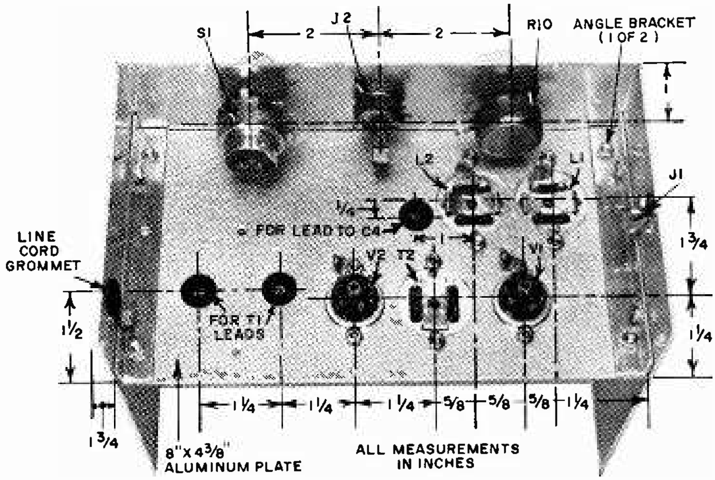
The parts placement shown in the photographs is fairly critical, especially in the mixer-oscillator circuits of *V1*. Begin construction by mounting the chassis shelf and components as indicated.

Coils *L1* and *L2* are supplied with





Position of tuning capacitor C4 is shown above. Other major parts placement is given at right.



Dimensions and orientation of parts should be followed closely to duplicate the author's results. All holes should be deburred before final assembly.

mounting clips only. The author used "K Tran" mounting plates, similar to the plate supplied with *T2*. If these mounting plates cannot be procured, duplicates of the *T2* plate can be made or spaced holes can be drilled in the chassis to mount the coils by their clips.

Short pieces of insulated sleeving should be placed over the coil terminals of *L1* and *T2* to prevent accidental shorting to the chassis, since the plates are not an exact fit and also may move a bit. The author enlarged the shield can clip holes to fit "K Tran" type mounting clips, but the clips supplied with the coils can be used as well.

Two *6-32* machine screws with spacers made of seven metal washers for each were used to mount tuning capacitor *C4* to the chassis. The spacing of the tuning capacitor, the shaft coupling, and the vernier dial must be fairly accurate, so use care in mounting these parts.

After wiring the mixer-oscillator stages of *V1*, form the "gimmick" capacitor by soldering two short pieces of insulated wire to pins 2 and 7 of *V1* and twisting the ends together two turns.

Make sure that you drill a series of holes in the back of the rear box cover, to provide a means of ventilation for the receiver.

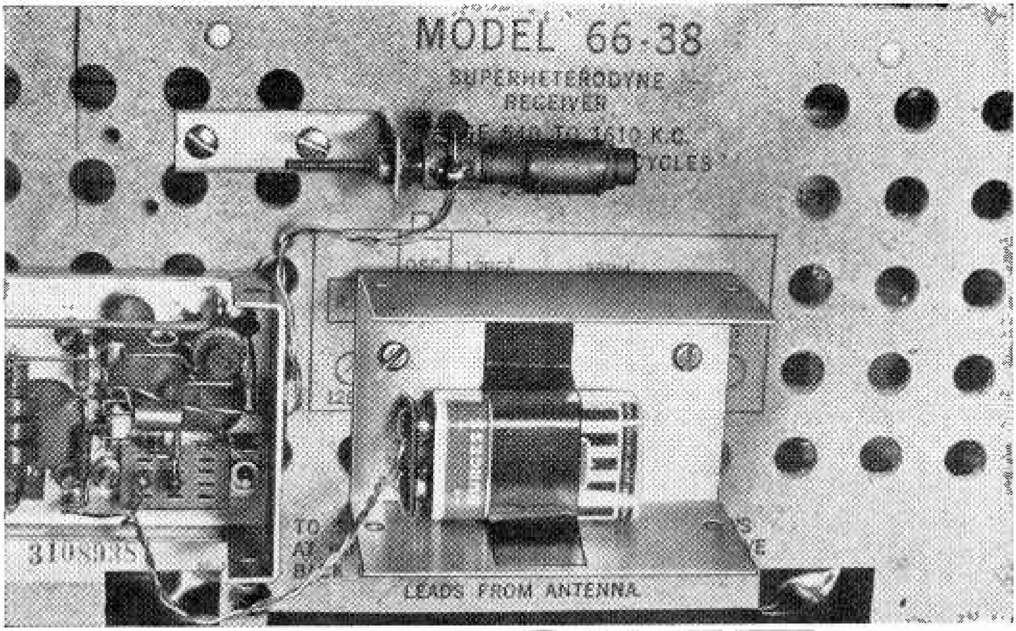
Testing and Calibration. After the construction is finished, adjust the bottom iron core of coil *T2* all the way out, as far as it will go. This is necessary to limit the maximum regenerative feedback of the circuit of *V2a*. Install the tubes and connect the receiver to the a.c. line. Insert a pair of high-impedance earphones into *J2*, and warm up the receiver for a while.

Then turn up the *REGEN* control until you hear the typical regenerative hiss. Set the *TUNING* control to full capacity and the *GAIN* about midway. Connect a signal generator or other source with an output of 3.5 mc. to *J1*. Loosen the locking nut on the slug of coil *L2* and rotate the tuning slug downwards until it is almost flush with the nut; then adjust the slug upwards until you hear the test signal, and tighten the locking nut. In a pinch, you can use a signal you know is at the low end of the 80-meter band for this adjustment.

Disconnect the signal generator and connect a 15′ insulated wire to *J1*. Loosely couple the signal generator to the wire by twisting a small piece of insulated wire around it and connecting the end to the signal generator. Reset the signal generator to 3.75 mc., and rotate the *TUNING* control until the signal is heard. Loosen the locking nut on the slug of coil *L1* and adjust the slug for maximum signal, decreasing the *GAIN* control as necessary to prevent overloading the detector. Now reset the generator to 3.5 mc., and proceed with the calibration of the dial. The author calibrated the dial every 10 kc. to 4 mc.

A transmitter VFO or GDO can also be used for alignment and calibration. If *no* equipment is available, set the tun-

(*Continued on page* 161)



THE WXCVR

If weather is important to you in your work or leisure, get the best information Uncle Sam can provide by tuning in the airline forecasts. The WXCVR lets you do it the easy way.

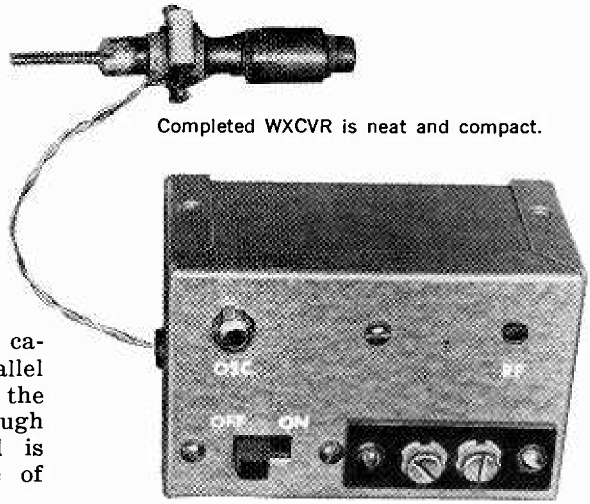
By HARTLAND B. SMITH, W8VVD

TIRED of being rained out at ball games, drowned out at picnics, and snowed in on trips? Thanks to the Federal Aviation Authority's continuously repeated weathercasts, you can now usually avoid disappointing and inconvenient happenings of this kind.

Twenty-four hours a day, seven days a week, the stations listed in the accompanying table transmit up-to-the-minute taped forecasts, and report the current temperature, humidity, barometric pressure, wind velocity and direction for major cities within a radius of several hundred miles. A few moments of eavesdropping on these transmissions will not only inform you of what to expect, locally, within the next twelve hours, but will also give you an excellent idea of the state of the weather in surrounding areas and neighboring states. Armed with this data, you'll be able to do a better job of planning both recreational and business activities.

These aeronautical weathercasts are transmitted in the low-frequency aviation band between 200 and 400 kc., and therefore cannot be picked up by ordinary broadcast-band or short-wave receivers. However, the WXCVR (radioese for "weather-receiver") described here provides an inexpensive answer to this reception problem. It converts low-frequency weather signals to an unused channel near the middle of the broadcast band for easy detection by any home or portable radio. Costing less than $7, the device can be assembled in a single evening and will receive FAA stations as far as 250 miles away.

How It Works. As an example, suppose you want to hear the Denver forecast transmitted on 379 kc. Radio energy at this frequency intercepted by the antenna causes r.f. current to flow through coil *L1* and the primary of transformer *T1*. Inductive coupling between the transformer windings induces a signal in the secondary of *T1* which, together with the combined capacities of *CA* and *C2*, forms a parallel circuit resonant at 379 kc. From the tap on *T1*, the signal flows through the feedback winding of *L2* and is then applied, via *C1*, to the base of transistor *Q1*.



Completed WXCVR is neat and compact.

When switch *S1* is closed, *Q1* operates as an oscillating detector, due to positive feedback through oscillator coil *L2*. The exact frequency of oscillation is determined by the capacity of *C4* and the setting of *L2*'s variable slug. In this case, oscillation at 1529 kc. is desired.

The 379-kc. and 1529-kc. signals present at *Q1*'s base are mixed in the transistor to produce additional signals at the sum of the two frequencies, 1908 kc., and the difference frequency, 1150 kc. Loopstick *L3* and capacitor *C3* are resonated at 1150 kc. Direct connection between converter and broadcast receiver is normally unnecessary, since the strong 1150-kc. field surrounding *L3* can be readily picked up by the receiver's loop antenna.

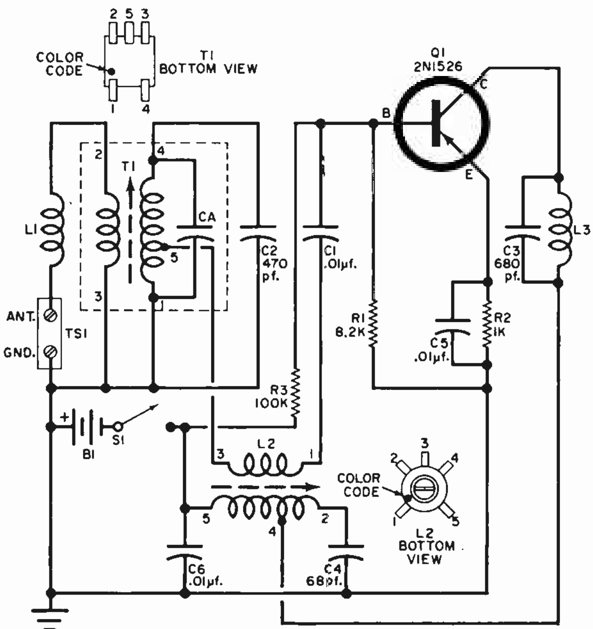
The high impedance of *L1* to frequencies above 1 mc. minimizes such unwanted signals before they reach the base of *Q1*, where they might cause interference to a desired weathercast.

Construction. All parts, with the exception of *C3*, *L3* and *B1* are housed inside the cover of a 3¼" x 2⅛" x 1⅝" Minibox. Miniature components and a simple circuit result in plenty of working space inside the box, despite the small size. Parts layout is not critical although it is best to follow, in a general way, the arrangement shown.

Most capacitor and resistor leads go either to the coil and switch terminals, or to ground lugs. A three-terminal miniature insulated tie strip mounted near the center of the cover supports *Q1* and its associated components. When

FAA AUTOMATIC RADIO WEATHER BROADCASTS

Locality	Kc.	Locality	Kc.	Locality	Kc.	Locality	Kc.
Albuquerque, N. M.	230	Duluth, Minn.	379	Millinocket, Me.	344	Redmond, Ore.	368
Amarillo, Tex.	251	Elmira, N. Y.	375	Milwaukee, Wis.	242	Roanoke, Va.	371
Atlanta, Ga.	266	El Paso, Tex.	242	Minneapolis, Minn.	266	Rock Springs, Wyo.	290
Big Spring, Tex.	326	Elko, Nev.	391	Missoula, Mont.	308	St. Louis, Mo.	338
Billings, Mont.	400	Ft. Worth, Tex.	365	Newark, N. J.	379	San Antonio, Tex.	254
Birmingham, Ala.	224	Fresno, Calif.	344	New Orleans, La.	338	S. Ste. Marie, Mich.	400
Blythe, Calif.	251	Garden City, Kans.	257	North Platte, Nebr.	224	Seattle, Wash.	260
Boise, Idaho	359	Great Falls, Mont.	371	Oakland, Calif.	362	Spartanburg, S. C.	248
Boston, Mass.	382	Houghton, Mich.	227	Oklahoma City,		Spokane, Wash.	365
Bozeman, Mont.	329	Houston, Tex.	332	Okla.	350	Tampa, Fla.	388
Burlington, Vt.	323	Idaho Falls, Idaho	350	Ogden, Utah	263	Texarkana, Ark.	329
Casper, Wyo.	269	Indianapolis, Ind.	266	Omaha, Nebr.	320	Tonopah, Nev.	221
Charleston, S. C.	329	Jacksonville, Fla.	344	Pendleton, Ore.	341	Traverse City, Mich.	365
Chicago, Ill.	350	Kansas City, Mo.	359	Pensacola, Fla.	326	Trinidad, Colo.	329
Cincinnati, Ohio	335	Knoxville, Tenn.	257	Pittsburgh, Pa.	254	Tucson, Ariz.	338
Cleveland, Ohio	344	Las Vegas, Nev.	206	Portland, Ore.	332	Tulsa, Okla.	245
Delta, Utah	212	Los Angeles, Calif.	332	Raleigh, N. C.	350	Washington, D. C.	332
Denver, Colo.	379	Miami, Fla.	365	Rapid City, S. D.	254	Wichita, Kans.	332
Detroit, Mich.	388	Miles City, Mont.	320	Red Bluff, Calif.	338	Winslow, Ariz.	266

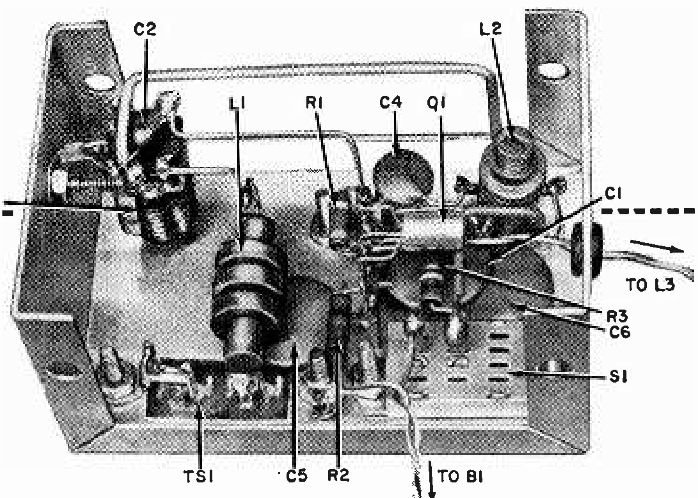


PARTS LIST

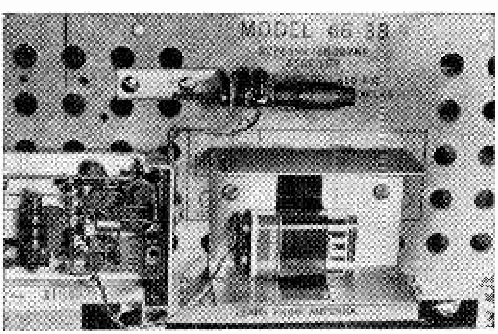
B1—9-volt transistor battery
C1, C5, C6—0.01-µf. ceramic disc capacitor
C2—470-pf. ceramic capacitor
C3—680-pf. ceramic capacitor
C4—68-pf. ceramic capacitor
L1—1-mh. r.f. choke (National R-50 or equivalent)
L2—455-kc. transistor oscillator coil (Miller 2020)
L3—Superex Vari-Loopstick (or Meissner 14-9015 coil)
Q1—2N1526 transistor
R1—8200 ohms } *All resistors ½-watt, 10% carbon*
R2—1000 ohms
R3—100,000 ohms
S1—S.p.s.t. slide switch
T1—455-kc. transistor input i.f. transformer (Miller 2041)*
TS1—Antenna-ground terminal strip
1—3¼" x 2⅛" x 1⅝" aluminum box (Bud CU-2101-A or equivalent)
Misc.—3-terminal miniature tie strip, battery connector, 4-36 machine screws and nuts, wire, solder, etc.

**Capacitor CA shown on the schematic diagram inside the shield can of T1 is part of the manufactured T1 assembly*

One-transistor converter circuit of WXCVR is simple and easy to get into operation.



Parts placement is uncritical, but layout shown leaves room for easy assembly and wiring.

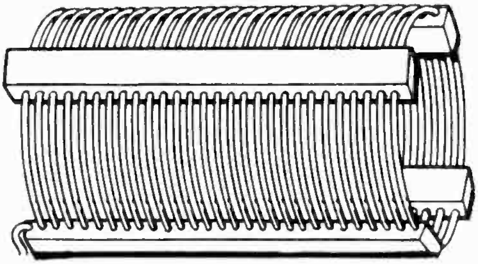


Find optimum position for L3 before mounting WXCVR permanently on back of BC set.

soldering the transistor in place, be sure to use a heat sink between the iron and the transistor body. A copper alligator clip or long-nosed pliers will do the job.

Carefully remove and discard the square aluminum can surrounding *T1*. Position the transformer as shown. Make certain that the slot in its tuning slug is directly behind the 3/16" "RF" tuning hole. Solder terminal 3 to a

(*Continued on page* 154)



R.F. Coil

No more hit-or-miss coil

WHILE there's nothing wrong with the time-honored cut-and-try technique of winding coils for a receiver or transmitter, you can save yourself a lot of time and trouble by building this simple "R.F. Coil Frequency-Finder" for use with an external signal source such as an r.f. signal generator, a VFO, or a grid dipper.

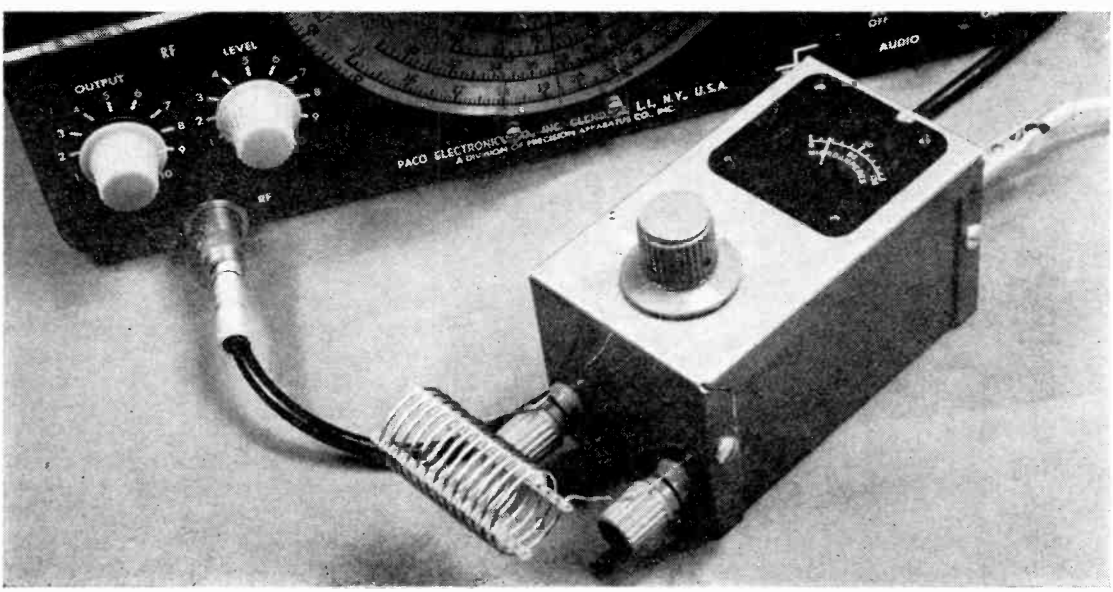
The design of the unit is straightforward. The unknown coil is connected in parallel with *C2*, a midget 140-pf. variable capacitor, through *J2* and *J3*. The only power required is the r.f. furnished by the signal source through *J1-C1*. When the coil and *C2* resonate with the external r.f. source, energy is absorbed by the circuit and rectified by *D1*, giving a reading on the 50- or 100-μa. meter, *M1*.

Construction. Cut a hole for *M1* near one end of the 2¼" x 2¼" x 4" Minibox. Drill a hole to mount *C2* close to the other end of the box. Locate holes for the coil jacks, *J2* and *J3*, in the end of the box near *C2*. Terminal *J1* is mounted at the opposite end near the meter. Both *J1* and *J2* must be insulated from the metal box. Wiring is done point-to-point, keeping leads as short as possible; use a heat sink when soldering *D1*.

Although a 100-μa. meter was used in the author's model, a 50-μa. movement will give better sensitivity (although possibly at greater cost). In any case, a miniature meter of the relatively inexpensive imported variety should prove perfectly satisfactory.

Install a knob with a pointer on *C2*'s shaft, and calibrate *C2*, marking the minimum point (*C2* fully open) 10 pf. and the maximum point 150 pf. (*C2* fully closed). From these two points, estimate the 75- and 100-pf. points

External r.f. source—signal generator or VFO—is the only power required to operate the unit.



Frequency-Finder

winding—all it takes is a meter, a few parts, and r.f. source

By LEON A. WORTMAN

and mark them on the panel. Decals, if available, will make a professional-looking scale. The markings (slightly greater than *C2*'s maximum and minimum capacities to compensate for the unit's internal capacity) will be only roughly accurate, but quite adequate in this application.

Operation. To use the Frequency-Finder with an r.f. generator, simply connect the center conductor of the output cable to *J1*, leaving the shield unconnected. Connect the unknown coil to *J2-J3*, keeping leads as short as possible. If the coil is to be used with a capacitor of any type, set *C2* to that value; otherwise, at minimum.

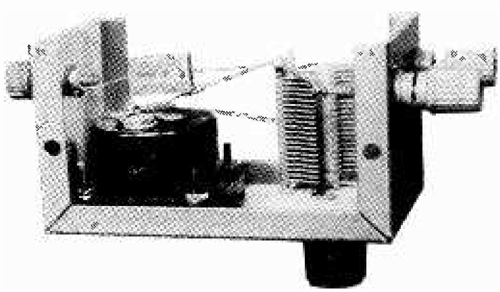
Sweep across the desired frequency range with the r.f. signal generator until you find the resonant point indicated by a maximum reading on *M1*. The resonant frequency of the coil and *C2* can then be read directly on the dial of the r.f. generator. Keep the output low, consistent with a readable indication on *M1*. A VFO can be used in the same manner. If the r.f. source is poorly calibrated, you can double-check by tuning its signal in on an accurate receiver.

To use the Frequency-Finder with a grid-dip oscillator, plug the appropriate coil into the dipper, set it in the oscillating mode, and bring it to within a few inches of the unknown coil. Adjust the tuning dial of the grid dipper for peak indication on *M1*. Read the resonant frequency from the dial of the grid dipper, ignoring, for this test, the dipper's own meter and sensitivity control.

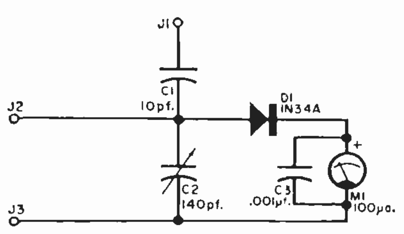
Other Uses. Another method of using the Frequency-Finder is to set the r.f. source at a predetermined frequency, and adjust *C2* to determine how much capacitance is required to make the unknown coil resonate.

The value of a small capacitor can be estimated with the unit. Connect a coil to *J2-J3*, set *C2* at 150 pf., and tune the r.f. source for maximum indication. Connect the unknown capacitor in parallel with the coil at *J2-J3*, and reset *C2* for maximum indication. The value of the unknown capacitor is approximately equal to the maximum value of *C2* (150 pf.) minus the new setting of *C2* that restores *M1* to maximum reading.

Coils are easy to add to, or subtract from, if you use the Frequency-Finder first—try it. -30-



Frequency-Finder is mounted in small Minibox; all wiring is done point-to-point to keep leads short.



PARTS LIST

C1—10-pf. mica or ceramic capacitor
C2—140-pf. midget variable capacitor
C3—0.001-µf. ceramic disc capacitor
D1—1N34A diode or equivalent
J1, J2, J3—Insulated binding posts or jacks
M1—50 or 100 µa. d.c. microammeter
1—2¼" x 2¼" x 4" aluminum box
1—Knob with pointer

THE CODE BANDER

This stable "front-end" BFO makes CW and SSB sets out of marginal receivers

By HARTLAND B. SMITH, W8VVD

Despite the well-deserved popularity of c.w. and single-sideband among radio amateurs, both modes of operation—and especially sideband (SSB)—can create some annoying problems on the receiving end. They can't be copied on a receiver which lacks a beat frequency oscillator (BFO). Without some means for generating a stable local carrier (the function of a BFO), the prospective Novice finds it impossible to practice code reception, and the curious SWL has a hard time deciphering sideband QSO's. Furthermore, many inexpensive or elderly ham receivers, even when equipped with BFO's, drift so badly that the operator must constantly retune to keep from losing the desired signal.

Luckily, there is now a simple answer to these problems—an amazingly stable, simple gadget called the "Code Bander." This easily constructed receiver accessory will enable you to copy code and sideband on any receiver

THE CODE BANDER

that covers the amateur frequencies. If you're presently DX'ing with a broadcast/short-wave combination that lacks a BFO, or if you're struggling along with a simple regenerative set or a communications receiver that drifts badly, this useful little device will greatly improve your receiving capabilities.

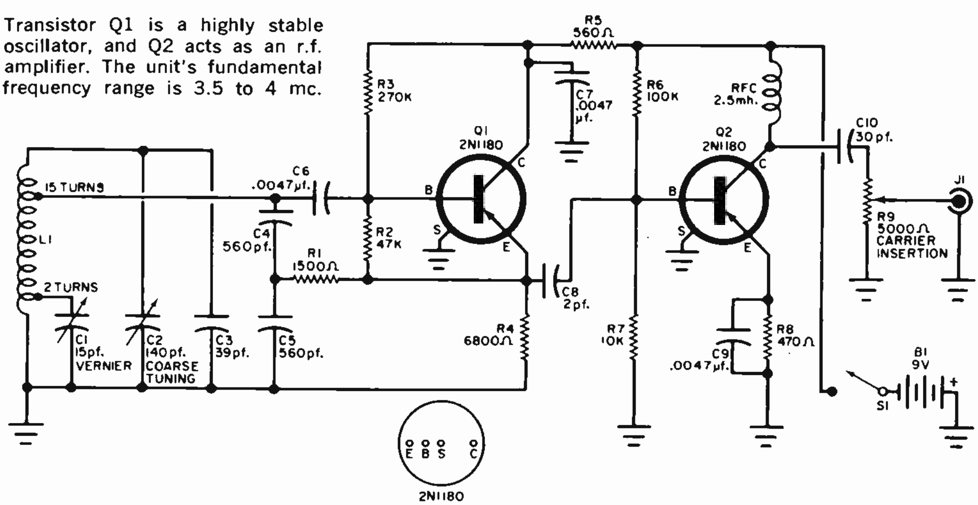
How It Works. Unlike ordinary BFO's, the Code Bander does not operate at the receiver's intermediate frequency. Instead, it produces r.f. energy on or near the frequency of the desired station. It will turn a quacking sideband signal into easily understood AM phone, and will also supply a beat note for effective code reception. Designed for connection to the set's antenna terminals, it can be installed without tearing into your receiver's vitals.

The Code Bander contains two inexpensive transistors: *Q1*, which serves as a highly stable oscillator, and *Q2*, which acts as an r.f. amplifier. The oscillator can be tuned to any frequency in the 3.5 to 4 mc. amateur band by adjusting the coarse tuning capacitor, *C2*. Vernier capacitor *C1* provides the extreme bandspread required to accurately zero on a specific signal.

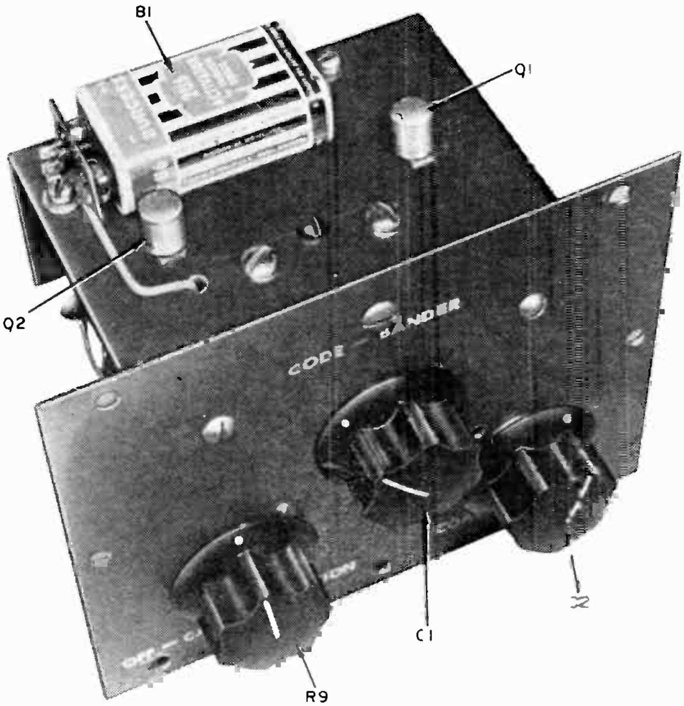
Both the fundamental and harmonics of the oscillator frequency are present at jack *J1*. Thus, the Code Bander can be used not only on 80 meters, but on 40,

PARTS LIST

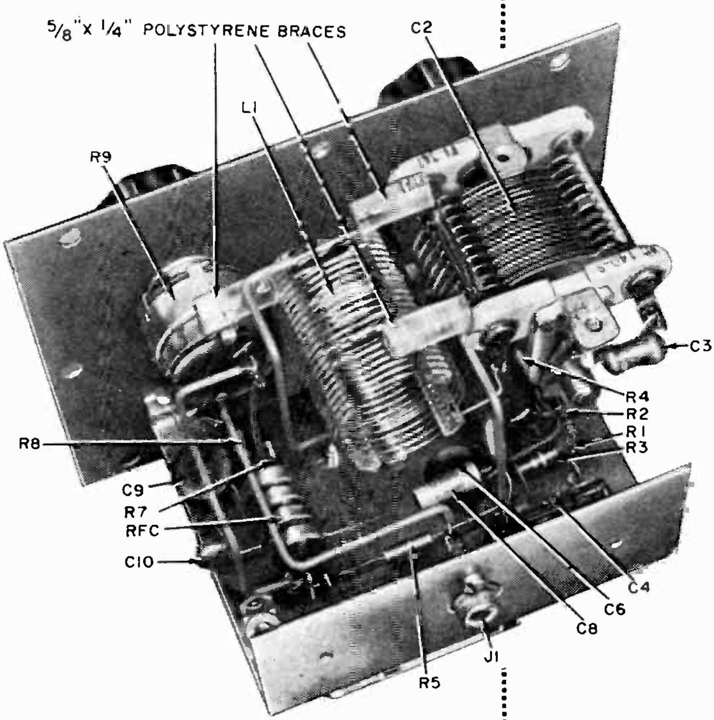
B1—9-volt transistor battery (Burgess 2U6 or equivalent)
C1—15-pf. variable capacitor (Hammarlund HF-15-X or equivalent)
C2—140-pf. variable capacitor (Hammarlund MC-140-S or equivalent)
C3—39-pf. NPO ceramic capacitor (Centralab TCZ-39 or equivalent)
C4, C5—560-pf. silver mica capacitor (Elmenco CM-20-D-561J or equivalent)
C6, C7, C9—.0047-µf. disc capacitor
C8—2-pf. tubular ceramic capacitor (Erie CC20-CK-020C or equivalent)
C10—30-pf. disc ceramic capacitor (Centralab DD-300 or equivalent)
J1—Shielded phono jack
L1—22 turns of Barker and Williamson 3011 coil stock tapped 2 turns and 15 turns from the ground end
Q1, Q2—2N1180 transistor
R1—1500 ohms
R2—47,000 ohms
R3—270,000 ohms
R4—6800 ohms
R5—560 ohms
R6—100,000 ohms
R7—10,000 ohms
R8—470 ohms
(*All resistors ½-watt, 10%*)
R9—5000-ohm potentiometer with switch S1
RFC—2.5-mh. r.f. choke
S1—S.p.d.t. switch (part of R9)
2—Transistor sockets
1—3" x 5" x 4" aluminum utility cabinet (Bud AU-1028-H.G. or equivalent)
1—3" x 3¼" x 1½" (approx.) aluminum chassis
1—Transistor battery connector—see text
Misc.—One- and two-terminal tie strips, solder lugs, wire, hardware, knobs, etc.



Transistor Q1 is a highly stable oscillator, and Q2 acts as an r.f. amplifier. The unit's fundamental frequency range is 3.5 to 4 mc.



This top and front view of the Code Bander shows the general mechanical arrangement with the small chassis mounted to the front panel. Note that the transistors and battery are mounted on top of the chassis.



The small parts are mounted under the chassis, and tuning capacitors and insertion control to the front panel. Solid support for L1 is provided by cementing pieces of polystyrene rod in the places shown.

20, and 15 as well. Control *R9* adjusts the output so that optimum balance between the received signal and locally generated carrier can be achieved.

Oscillator stability is enhanced by tapping the base connection of *Q1* down from the top of *L1*, and by using high capacity at *C4* and *C5* to swamp out capacitance changes in *Q1*. A very low value coupling capacitor, *C8*, minimizes instability resulting from amplifier loading.

Construction. Putting the Code Bander together will be easier if you install *C1, C2, C3, L1,* and *R9* after wiring the other parts. A one-terminal tie strip supports the junction of *R5, R6,* and the r.f. choke (*RFC*). A two-terminal strip supports *C4* and one end of *C5*.

Most chassis grounds are made to solder lugs located under the nuts which hold the chassis to the front panel. Exceptions are the grounded end of *C5* which goes to the ground terminal of *J1*, and the cold ends of *L1* and *R9* which go to a lug bolted to the front panel midway between *R9* and *C1*. (The head of this bolt is visible in the top photo on page 103 behind *R9*'s knob.) Trim resistor and capacitor leads so they are just long enough to connect to the terminals.

The connector for *B1* was salvaged from the top of a discarded 9-volt transistor battery. Solder one terminal of this connector to a ground lug and run a wire from the other terminal, through a hole in the chassis, to switch *S1* (a part of *R9*). Since the drain is less than 2 ma., the battery will last indefinitely.

Mechanical Stability. A number of precautions must be observed to insure ruggedness. Beef up the 3" x 5" x 4" aluminum utility cabinet by installing extra sheet metal screws around the edges of both front and rear panels. Most components are mounted on a small aluminum chassis which is bolted to the front panel and, after installation in the cabinet, fastened to the rear panel with two sheet metal screws.

Solid support must be provided for *L1*. Cut three ⅝" lengths of ¼"-diameter polystyrene rod and cement them between the coil and the bodies of *C2* and *R9*. These plastic braces are visible in the bottom photo on page 103.

Code Bander Operation. To copy c.w., tune the receiver until you come across the familiar thump and hiss which denotes a code signal. Turn *R9* to mid-range, and adjust *C2* until the Code Bander's carrier beats against the signal to produce a whistle each time code is sent. You can vary the pitch of the beat note by tuning *C1*. Finally, adjust *R9* for the best ratio between the signal and the locally generated carrier.

If *R9* is set too high, the c.w. station will be smothered. On the other hand, to low a setting of the injection control will cause the beat note to weaken or disappear entirely.

Copying Sideband. For sideband reception, tune the receiver until the incoming garbled speech is loudest. If you're using a regenerative set, turn down its regeneration to drop the detector out of oscillation. Run *C2* back and forth until the local carrier can be heard on top of the incoming signal. Slowly tune *C1* for normal sounding speech. Set *R9* just above the point where the signal tends to distort.

Although at first glance these instructions may appear complicated, once you're accustomed to operating the Code Bander, you'll find it easy to quickly tune in either a c.w. or sideband signal. If there is too much output with *R9* at minimum, connect a twisted wire gimmick in the lead to the receiver (a gimmick is two short pieces of insulated wire twisted together to form a small capacitance). The gimmick arrangement may be needed with some receivers on 80 meters.

One final tip: if *Q1* should refuse to oscillate, move the base tap on *L1* up a turn or two. —30—

SINGLE SIDEBAND

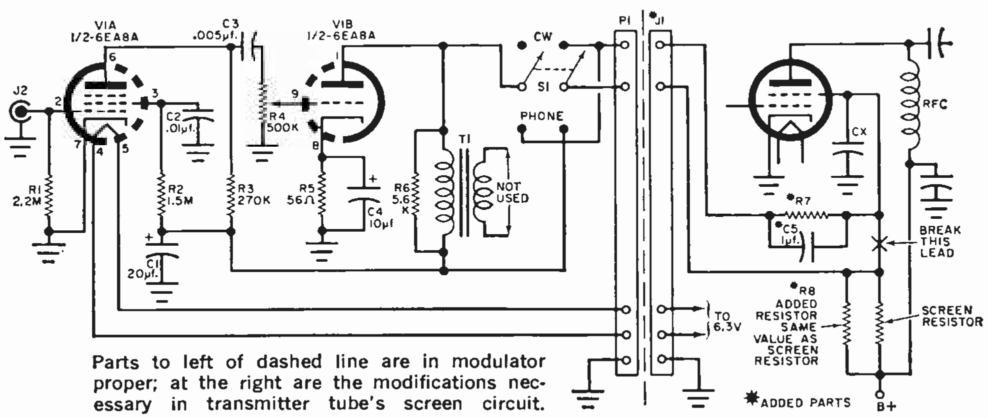
Single sideband (SSB) is basically a way of reducing the bandwidth an AM signal occupies, and increasing its effectiveness per watt of power radiated. A conventional AM signal has 66 percent of the power in the carrier and 16 percent in each sideband when 100 percent modulated. An SSB signal has all the radiated power in one sideband. Since a carrier of the correct frequency and amplitude is required for recovery of the modulation signal at the receiving end, it must be supplied in the receiver. The Code Bander is a low-cost device for providing this carrier to receivers lacking an adequate BFO or any BFO whatsoever for receiving both c.w. and SSB.

SELECTED PROJECTS from W9EGQ

ONE-TUBE SCREEN MODULATOR

The simple modulator shown here will convert any of the currently available, low-power c.w. transmitters into low-power phone transmitters. Referring to the diagram, the signal from the microphone is amplified in the pentode section of the 6EA8 tube and drives the triode section as the modulator, which is choke-coupled to the r.f. amplifier tube's screen circuit. Operating the modulator at a higher voltage than the screen assures adequate audio modulation voltage without excessive distortion. Resistor *R6* across the coupling "choke" (the primary of transformer *T1*) helps to present a relatively constant load to the modulator during the entire modulation cycle, thereby improving audio quality. It also eliminated an audio squeal that developed when the gain control was advanced too far.

Construction. A 2¼" x 2¼" x 5" aluminum box easily accommodates the modulator. Following the general parts layout shown on the next page will keep the input and output separated and minimize feedback problems. Modulation "choke" *T1* is the primary winding of a small, replacement-type, speaker output transformer (Stancor A-3856).



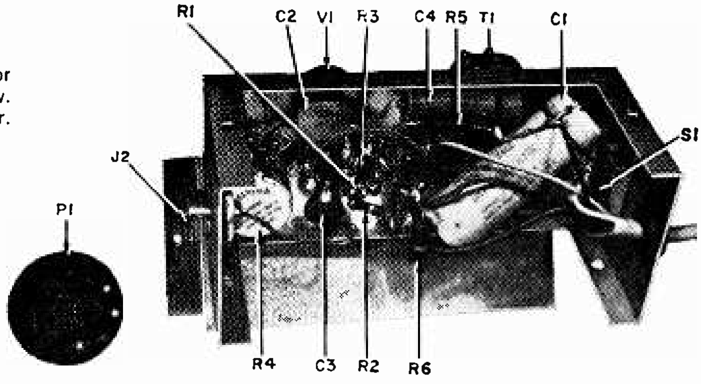
Parts to left of dashed line are in modulator proper; at the right are the modifications necessary in transmitter tube's screen circuit.

PARTS LIST

C1—20-μf., 450-volt electrolytic capacitor
C2—0.01-μf., 600-volt ceramic capacitor
C3—0.005-μf., 600-volt ceramic capacitor
C4—10-μf., 10-volt electrolytic capacitor
C5—1-μf., 200-volt paper capacitor*
J1—Accessory socket on transmitter*
J2—Single-contact microphone connector (Amphenol 75PC1M or equivalent)
P1—Plug to match accessory socket on transmitter
R1—2.2-megohm, ½-watt resistor
R2—1.5-megohm, ½-watt resistor
R3—270,000-ohm, ½-watt resistor
R4—500,000-ohm potentiometer with audio taper
R5—56-ohm, ½-watt resistor
R6—5600-ohm, 1-watt resistor
R7—2-watt resistor having one-half the resistance value of r.f. amplifier screen-dropping resistor*
R8—2-watt resistor equal in value to original screen resistor*
S1—D.p.d.t. toggle or slide switch
T1—Modulation choke; primary winding of 4-watt, replacement-type speaker output transformer (Stancor A-3856 or equivalent)
V1—6EA8A triode-tetrode vacuum tube
1—2¼" x 2¼" x 5" aluminum box
Misc.—High-impedance crystal or ceramic microphone, 5-conductor cable, tube socket and shield, hardware, etc.

**Components installed in transmitter proper*

Simple screen modulator converts low power c.w. into phone transmitter.



Refer to your transmitter instruction manual and the diagram (on the previous page) while carrying out the following steps. If necessary, it is an easy matter to add an accessory socket at a convenient spot on the rear chassis lip of the transmitter to accommodate the modulator plug. You'll need five terminals.

Disconnect the screen-dropping resistor from the r.f. amplifier tube's terminal and connect a 1-watt resistor (*R7*) of half the resistance of the screen resistor between the tube socket screen terminal and the accessory socket; also connect capacitor *C5* across the resistor. Connect the free end of the screen resistor to another terminal on the accessory; at the same time, connect another resistor of the same value across the screen resistor. Check the value of screen bypass capacitor C*x*; if it is greater than .002 μf., replace it with a .002-μf., 1200-volt mica or ceramic unit. (You might check the operation of the transmitter on phone before making this change. If the quality is not too bassy and the modulation percentage is adequate, do not disturb the original screen bypass capacitor, no matter what its value is.) Also connect a pair of wires from the transmitter's 6.3-volt heater circuit to the accessory socket, and ground its fifth terminal to the transmitter chassis. Finally, wire the plug from the modulator to match these connections, and insert the plug in the socket.

Operation. Tune up the transmitter in the normal manner with switch *S1* in the c.w. position. Then put the switch in the phone position; this should cause the amplifier plate current to drop approximately 50 per cent. Now, advance the audio gain control (*R4*) while talking into the microphone until the amplifier plate current increases slightly on voice peaks.

You can check your phone quality and depth of modulation by listening to your signal on your own receiver using headphones. Short the receiver's antenna input terminals to reduce the strength of the incoming signal. Careful adjustment of the r.f. amplifier's grid current and possible experimental adjustment of *R7* will produce the best-sounding signal.

PLUG-IN TRANSMITTER CRYSTAL SWITCH

A sharp Novice operator soon recognizes the advantages of changing his transmitter crystal to get out from under a strong interfering signal, or to move closer in frequency to a station he wishes to work. Unfortunately, even when the crystal socket is mounted on the transmitter front panel, it is not always easy to change crystals in a hurry, and when the crystal socket is recessed inside the transmitter, it is practically impossible. But by adding crystal switching to your transmitter, you can change crystals effortlessly.

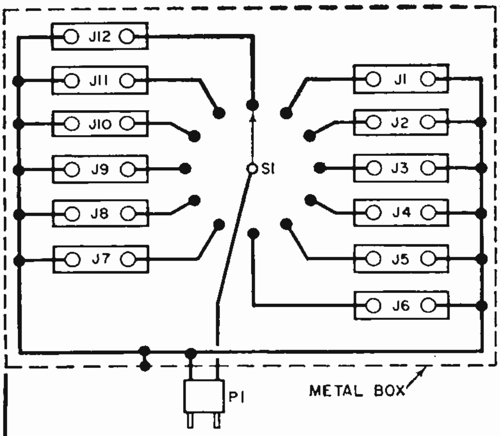
The plug-in unit in the photograph at right will accommodate up to eight crystals, and by using the larger box specified in the Parts List and adding four more crystal sockets, 12 crystals can be accommodated.

Construction. Clearances are quite limited (unless you decide to mount the crystal sockets externally); therefore, be extra careful to mount switch *S1* in the *exact* center of the box. Position the sockets flush with the rear of the box, and space them about 9/16" apart, center to center. The 1/8" mounting holes are 13/32" apart, and the 5/16" holes to accommodate the crystal holder prongs are centered 5/16" from the adjacent mounting hole. Place an extra panel nut on the switch bushing before mounting the selector switch; adjust this nut to position the switch wafer between terminals on the crystal sockets.

Wiring. Connect together the front terminals of all crystal sockets, and connect the rear terminal of each socket to the corresponding fixed terminal of the selector switch. Use a length of standard 300-ohm TV *lead-in* for the connection to plug *P1*. Solder one conductor to the common crystal socket terminals, and connect the other conductor to the terminal for the switch rotor. Make the lead long enough to permit you to insert plug *P1* into the transmitter crystal socket when the unit is conveniently placed near the transmitter. Don't make the lead excessively long, however. Although length is not critical, too long a lead might make the transmitter operate erratically.

Operation. Transmitter operation should remain essentially the same except for the added convenience of crystal switching. In addition, if you tune the transmitter to a frequency near the center of the 80-, 40-, or 15-meter Novice bands, it probably won't be necessary to retune the buffer and final stages of the transmitter to operate on any other frequency within that Novice band. However, for best keying with some crystals, you may wish to touch up the oscillator tuning.

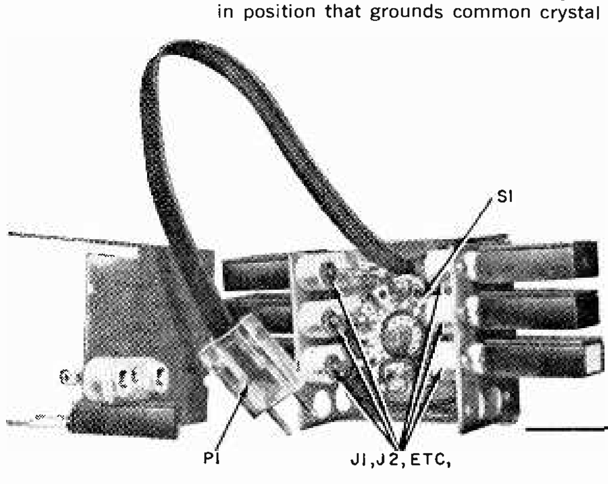
(*Continued on next page*)



PARTS LIST

J1-J12—Jacks for FT-243 type crystal holders, 0.487" pin spacing, 0.095" dia. pins (Millen #33102 or equivalent)
P1—2-terminal plug (Mosley #301 or equivalent)
S1—Multi-position, s.p., ceramic rotary switch (Centralab PA-2000 or equivalent)
Box—For 8-crystal unit: 1⅝" x 2⅛" x 2¾" aluminum (Bud CU-2100A or equivalent); for 12-crystal unit: 1⅝" x 2⅛" x 4" aluminum (Bud CU-2102A or equivalent)
Misc.—18" length of 300-ohm TV lead-in, 4-32 round-head machine screws ⅝" long, etc.

Changing frequency with crystal control is easy with this multi-position switch. Plug P1 must be inserted in transmitter crystal jack in position that grounds common crystal lead.



Two crystal jacks were left out of the unit shown to clarify the construction details.

Warning. The distributed capacitances, etc., of the crystal switch may change the actual oscillating frequency of some crystals as much as 100 cycles or so from their marked values. This possibility is of no importance for normal Novice operation, but it is illegal for a CB operator to make any changes that will affect the output frequency. Therefore, the switch is not suitable for CB use.

ZENER DIODE NOISE LIMITERS

When you are listening to weak c.w. or SSB signals on your receiver, do strong signals appearing suddenly on the same frequency really blast your eardrums? When you use your receiver to monitor your c.w. sending, are you constantly running the audio gain control up and down? Does your receiver's noise limiter work properly for AM phone reception, but become useless for c.w. and SSB? Maybe a couple of inexpensive zener diodes in one of the circuits shown here can solve your problems.

Simple Limiter. Figure 1 is a simplified and modernized version of the "Headphone 'Ear Saver'" originally described in POPULAR ELECTRONICS in July, 1961. At low signal levels, the two zener diodes (*Z1* and *Z2*) act like a very high resistance, and the circuit performs normally. But when a signal voltage exceeds the zener breakdown voltage rating of the diodes, they act like a virtual short circuit. As a result, strong noise and signal peaks are effectively clipped down to size.

The two zener diodes connected back to back are required to clip the positive and negative peaks of the a.c. signal equally, and their voltage rating determines the clipping level. For a fairly loud signal in the phones, 6.8-volt zener diodes (such as the Motorola 1N957 specified in the Parts List) are recommended; for a moderate signal level, try 3.3-volt units (such as the Motorola 1N746).

The "ear saver" can be built in any small box that may be available. When you wire the diodes, join the two negative leads (or the two positive leads)

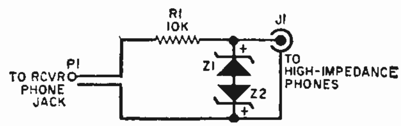


Fig. 1. Simple "ear saver" noise limiter should be inserted between the receiver phone jack and a pair of headphones.

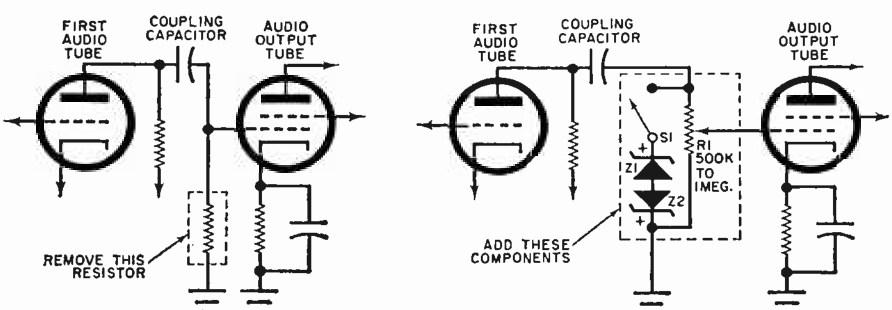
PARTS LIST

J1—Single-circuit phone jack
P1—Phone plug
R1—½-watt, 10,000-ohm resistor
Z1, Z2—6.8-volt, 400-mw. zener diode (Motorola 1N957 or equivalent—see text)
Misc.—Short length of insulated wire, insulated tie point, hookup wire, small box, etc.

PARTS LIST

R1—500,000-ohm to 1-megohm potentiometer—see text
S1—S.p.s.t. switch
Z1, Z2—6.8-volt, 400-mw. zener diode (Motorola 1N957 or equivalent)
Misc.—Short length of shielded hookup wire

Fig. 2. To add more versatile noise limiter to a communications receiver, just make the changes shown in these "before" and "after" circuit diagrams.



together, and connect the two remaining leads across phone jack *J1*. To prevent heat damage to the diodes while soldering, grasp their leads between the diode body and the connection with long-nose pliers.

Versatile Limiter. The limiter of Fig. 2 works on AM, c.w., and SSB signals. Its installation requires replacing the 470,000-ohm to 1-megohm fixed resistor normally connected between the receiver's output tube control grid and ground (consult your receiver's instruction manual to identfy the resistor) with a small potentiometer (*R1*) of the same resistance connected as shown. The zener diodes are connected across the potentiometer through s.p.s.t. switch *S1*. If you use shielded leads, the components can be grouped together at any convenient point on the receiver chassis.

After you finish wiring this unit, close switch *S1* and set potentiometer *R1* to an arbitrary position—say, half scale. Then slowly advance the regular receiver audio volume control to the point where further increase causes *no* further increase in volume from your loudspeaker or phones; simultaneously adjust *R1* for the desired output level.

When these adjustments have been made, no signal or noise pulse can exceed this preset level unless switch *S1* is opened or potentiometer *R1* is readjusted. (With the switch open and the potentiometer turned to the maximum-signal position, the receiver will perform exactly as before.)

Pi-NETWORK TANK CIRCUIT

Have you ever tried to visualize what modern band-switching amateur transmitters would be like if the universally used *pi*-network tank circuit had never been developed? Without it, they certainly would be bulkier, more complicated and more expensive. In addition, they would probably be slightly more difficult to tune; and—other things being equal—their emitted signals would contain just a bit more undesired harmonic energy.

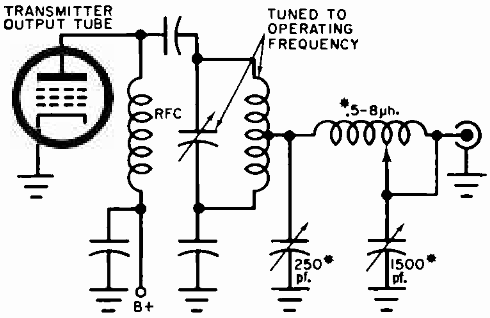
Original Arrangement. Probably the first use of the *pi*-network in amateur transmitters was described in the article "A Universal Antenna Coupling System for Modern Transmitters," by Arthur A. Collins, W9CXX, in *QST*, February, 1934, page 15. Art claimed that the new circuit (see top diagram on the next page) would feed power into virtually any antenna, with increased transmitter efficiency and decreased harmonic output.

For some months after the publication of the article, almost every ham seemed to be building a "Collins Coupler," and they were loading up all sorts of unlikely metallic articles like bedsprings and window screens as antennas. But after its novelty wore off, the Collins Coupler was soon forgotten by the average ham.

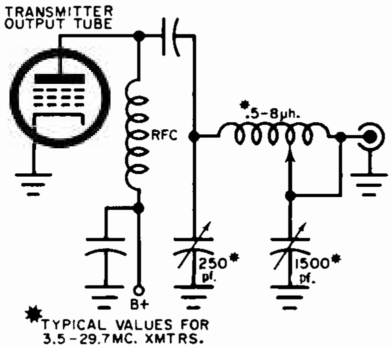
Some time later, Frank C. Jones, W6AJF, described a low-power, portable transmitter which used a *pi*-network combination output tank circuit and antenna-matching network in the *Jones Amateur Radio Handbook*, the predecessor of the *Radio Handbook*. W6AJF's circuit (see bottom diagram on next page) was identical to that used in many transmitters today.

In spite of its claimed advantages, however, the *pi*-net tank circuit did not gain much popularity up to the start of World War II. But during the war practically every ham was involved in defense electronics work, or was in the Armed Services, and many were directly concerned with mobile and portable communications transmitters. Such equipment was more useful if it could feed r.f. energy into almost any random length of wire in an emergency. It also had to be light and compact, without sacrificing efficiency and reliability. Many of these military transmitters used *pi*-network output tank circuits.

As a result of their wartime experience, these hams came home convinced that an amateur transmitter, even the "full-gallon" size, did not have to be a rack-and-panel monster, forever condemned to inhabit the attic or basement. The idea of the compact, table-top-cabinet transmitter caught on strongly, stimulated by the early appearance in surplus of the Collins-designed AN/ART-13 and similar transmitters. And the *pi*-network speedily took over as *the* final



The diagram above shows how the classic pi-network circuit was first used in amateur transmitters in conjunction with a parallel-tuned tank circuit as an antenna-matching network. The modern, simplified arrangement below employs a pi-network combination plate tank circuit and antenna-matching network.



tank circuit, for no other configuration known could be made so compact for the amount of power handled, and still provide front-panel bandswitching, harmonic suppression, reasonable efficiency, and the ability to drive a considerable range of load impedances.

De-Bugging the Pi-Network. Unfortunately, the performance of many transmitters did little to bolster the reputation of the *pi*-network. While many users had no trouble, others battled high harmonic output, and replaced numerous final tank components. Some technical Sherlocking soon pinned down the trouble. A lot of transmitter designers, both amateur and professional, had gone overboard in claiming that the *pi*-net was able to drive any and all impedances, and people expected far too much of it. Theory was one thing, but in practical equipment results were far better when the standard *pi*-network was not required to feed loads greater than 100 ohms or so.

Oddly enough, the Collins Radio Company, whose president, Art Collins, first brought the *pi*-network to the attention of radio amateurs as a "wide-range" coupler, was among the first to recognize the practical limitations of the circuit. Consequently, all post-WW-II Collins amateur transmitters have been designed to work into nominal 50- to 75-ohm loads and are not guaranteed to give satisfactory results with appreciably different load impedances.

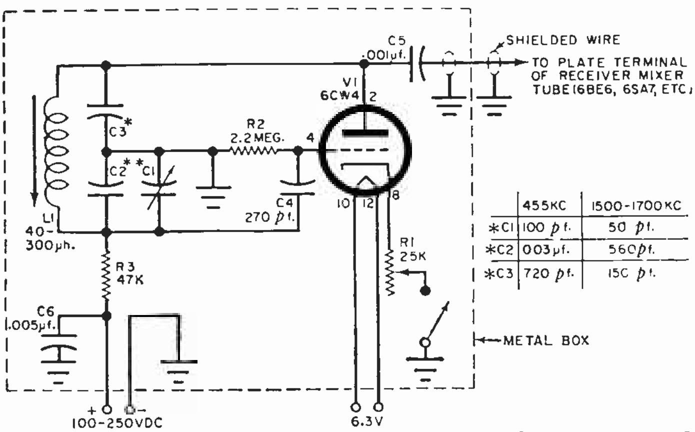
Some manufacturers were a little slow to restrict the range of load impedances they claimed that their transmitters would match. However, most of today's amateur transmitters are designed to work into 50- to 75-ohm loads (with the exception of some low-power beginners' transmitters). All of those we have had the opportunity of testing—which has been most of them—work well when fed into their rated load impedance.

Thus, after a sometimes painful "growing-up" period, the *pi*-network transmitter output tank circuit finally redeemed its early promise.

NUVISTOR Q-MULTIPLIER

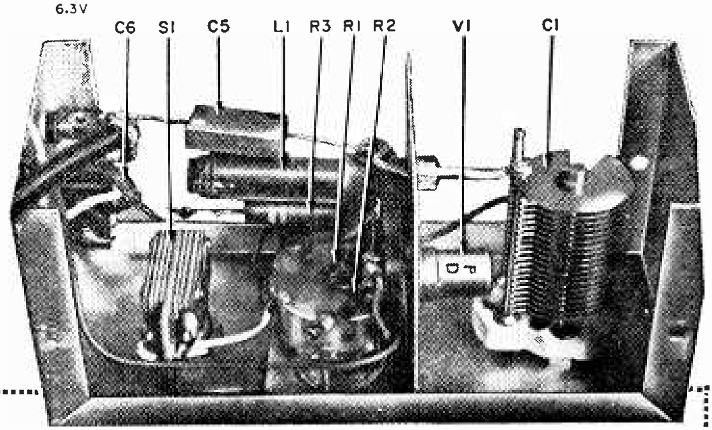
Regular readers of "News and Views" in POPULAR ELECTRONICS have undoubtedly noticed that many equipment descriptions go something like "He uses a 'you-name-it' receiver, *plus* a Q-multiplier for additional selectivity." A Q-multiplier is a regenerative circuit connected to the i.f. amplifier of a superheterodyne receiver to modify its selectivity characteristics. The simple Q-multiplier described here, which utilizes a nuvistor, will increase the ability of an inexpensive communications receiver to separate signals up to 10 times.

Construction Notes. The frequency range of the Q-multiplier must match the receiver intermediate frequency; therefore, part values are included in the parts list for units to operate in both the 455-kc. and 1600-kc. i.f. ranges. The unit is built in a 5" x 2¼" x 2¼" aluminum utility box; the small size of the nuvistor permits uncrowded construction. Although parts placement is not critical, the gen-



As with other Q-multipliers, the nuvistor version makes use of controlled regeneration to boost selectivity.

Construction in the type of box shown permits parts layout for good electronic function and easy assembly.



PARTS LIST

**C1—100-pf. (50pf.) midget variable capacitor*
**C2—0.003-µf. (560-pf.) mica or silver mica capacitor*
**C3—720-pf. (150-pf.) mica or silver mica capacitor*
C4—270-pf. mica or paper capacitor
C5—0.001-µf. mica or paper capacitor
C6—0.005-µf. mica or paper capacitor
L1—40-300 µh. slug-tuned coil (Miller #2002 ferrite rod loop antenna or equivalent)
R1—25,000-ohm potentiometer, linear taper
R2—2.2-megohm, ½-watt resistor
R3—47,000-ohm, ½-watt resistor
P1—Single-contact "phono" plug or equivalent
S1—S.p.s.t. switch
V1—6CW4 nuvistor
1—2¼" x 2¼" x 5" aluminum box (Bud #2104A or equivalent)
Misc.—Insulated tie points, shielded wire (RG-59U or equivalent), etc.

**First values are given for 455-kc. i.f. amplifiers; values in parentheses are for i.f.'s in the 1600-kc. range.*

eral arrangement shown in the photograph is recommended.

Refer to your receiver instruction manual in connection with the following step. The 6.3 volts at 0.135 amperes and 100-250 volts, d.c., at a few milliamperes required to power the Q-multiplier can be obtained from the receiver's accessory socket (if it has one), or from a convenient spot in the receiver, such as the heater and screen terminals of the output tube socket. The power may also be obtained from a small external power supply. In fact, with an a.c./d.c. type of receiver, an external supply is required; a Q-multiplier may not give completely satisfactory results on c.w., however, when used with inexpensive a.c./d.c. receivers.

Install a shielded wire between the plate terminal of the receiver's mixer tube (6BE6, 6SA7, etc.) and a connector on the rear of the receiver chassis or to an unused terminal on the receiver accessory socket, to accommodate the output terminal (*P1*) of the Q-multiplier. After the lead is installed, tune in a steady signal on the receiver, and carefully retune the primary winding of the first i.f. transformer for maximum signal strength. This must be done to compensate for the capacity added to the primary tuned circuit of the i.f. transformer by the shielded lead.

Then plug in the Q-multiplier, adjust capacitor *C1* and resistor *R1*, and adjust coil slug *L1* for maximum signal strength. Retard control *R1* as necessary during this operation to prevent the Q-multiplier from breaking into sustained oscillation (indicated by a steady squeal from the loudspeaker or by the receiver suddenly going dead). Also, the value of resistor *R3* may be increased or decreased if necessary to give resistor *R1* full control.

Operation. In operation, receiver selectivity is maximum when resistor *R1* is adjusted just below the oscillation point. Capacitor *C1* acts as a vernier tuning control, permitting the desired signal to be picked out of a mess of interference.

40-METER ANTENNA FOR SMALL ROOF

Are you one of those people who claim that they don't have room on the roof for an efficient transmitting antenna? Actually, if you have an outside TV antenna, you probably do have room for an effective 40-meter (7-mc.) antenna which will also work on 15 meters. The secret is to use a pair of the TV antenna guy wires as the radiating portion of an "inverted-V" transmitting antenna as shown in the diagram.

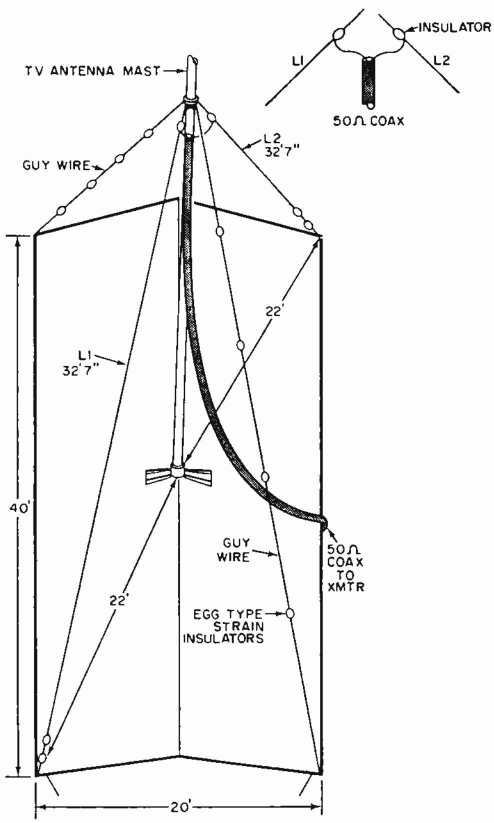
Let's work out the details for installing a 40-meter dipole which has an overall length of approximately 66 feet on a 20′ x 40′ roof—a *very* small roof, incidentally. You'll need a few "egg" type strain insulators (approximately 1¾″ x ¾″) and some 50-ohm coaxial feedline to do the job. Use RG-8/U coaxial cable if you can; RG-58/U will be okay if the length is not excessive.

Design Details. Assuming that the TV antenna is mounted in the center of the roof, we first determine the distance from its base to the corners of the roof, where the guy wires are undoubtedly anchored.

Using the Pythagorean theorem (*the square of the hypotenuse of a right triangle is equal to the sum of the squares of the other two sides*, or $Z^2=X^2+Y^2$), and substituting the distances from the TV antenna base to one side and to the front (or back) of the roof in the formula, we come up with $10^2 + 20^2 = 500$. From a table of roots and squares in a high-school math book, the square root of 500 is something over 22 feet.

Allowing a foot at each end of the dipole for insulators means that approximately 34 feet will be required to accommodate each half of the antenna. Substituting 34 feet for Z and 22 feet for X in the formula gives: $500 + Y^2 = 1152$. Solving for Y, we get $Y = 26$ feet, approximately. Consequently, the apex of the "V" will have to be 26 feet

(*Continued on page* 163)

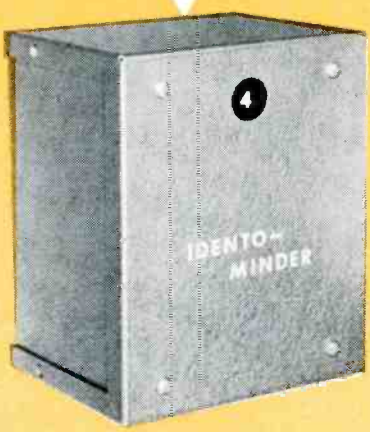


Where roof space is at a minimum, a pair of guy wires supporting a TV antenna installation can be used as the radiating portions of a 7-mc. (and 21-mc.) "inverted-V" transmitting antenna.

HOW ABOUT IT, OM, what precautions have you taken to make sure you comply with the FCC's ten-minute identification rule? Do you rely on the tumbling sand grains of an egg timer to alert you for an ID? Or have you placed your faith in one of those gadgets that ticks like a time bomb and, every now and then, gives out with a nerve-shattering bong—provided you go to the trouble of resetting it every ten minutes. Probably you trust to luck and memory to stay legal.

The "Idento-Minder" overcomes the inconvenience of

THE IDENTO-MINDER



Ten-minute ID's? You'll never forget with a gadget for the ham shack that times QSO's

By HARTLAND B. SMITH, W8VVD

other timing gadgets, and the uncertainty of depending on memory. Housed in a 3" x 4" x 5" Minibox, it tells you not only when to identify, but also lets you know at a glance how many minutes have elapsed since the previous ID has been given. Its quiet electric movement requires no winding, and its flashing neon indicator, while an effective reminder, will neither startle nor annoy you with unnecessary in-shack QRM.

The heart of the Idento-Minder is a small synchronous timing motor that drives a 3½"-diameter disc at a speed

THE IDENTO-MINDER

of 1/10th rpm. At ten-minute intervals, a 9/16" hole, cut ½" from the edge of the disc, uncovers a blinking neon bulb to alert the operator in time for proper station identification.

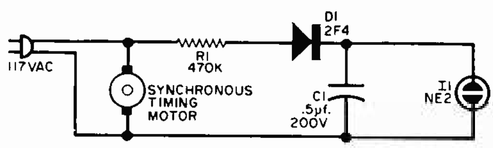
The Blinker Circuit. A relaxation oscillator circuit is formed by *R1, D1, C1,* and *I1.* When the direct current passed by *D1* charges *C1* to the bulb's striking voltage, *I1* lights up and discharges the capacitor. As soon as the capacitor voltage drops to a low level, the bulb goes out and remains extinguished until *C1* recharges. The amount of resistance at *R1* governs capacitor *C1's* charging time. The higher the resistance, the longer the intervals between flashes. When a 470,000-ohm resistor is employed, the neon bulb blinks approximately four times per second.

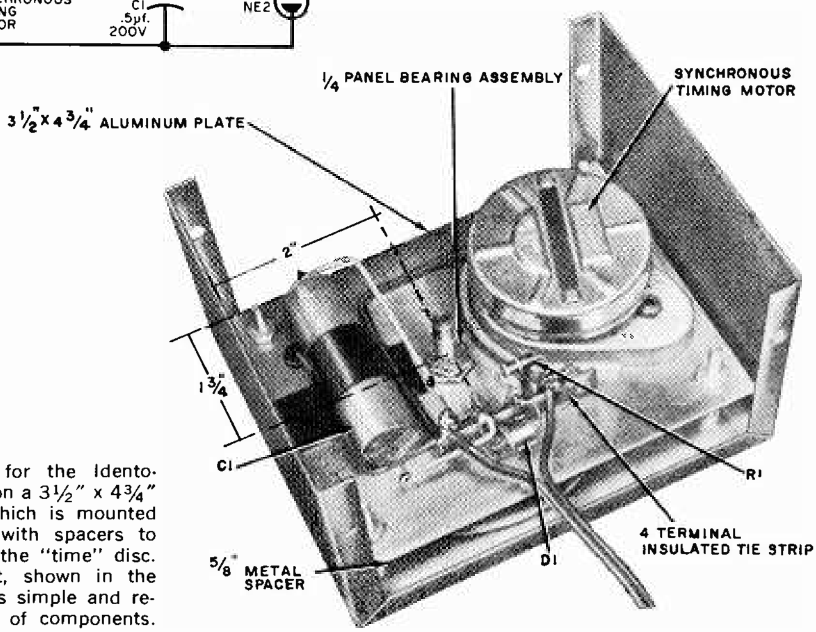
Although synchronous timing motors are listed in many radio catalogs and bargain bulletins, you undoubtedly *won't* be able to find one rated at exactly 1/10th rpm. The solution to this problem is to use a pulley and belt arrangement like that shown in the photos below to achieve the proper disc speed.

Making the Pulleys. The motor in the prototype is a ¼th-rpm type which requires a pulley diameter ratio of 1:2.5. A suitable motor pulley was fashioned from a ½" length of ½"-diameter polystyrene rod. After cutting a fairly deep groove around the rod with a small rat-tail file, the pulley was drilled at the center and pressed on the motor shaft.

A larger pulley, slightly more than 1" in diameter, was then scroll-sawed from a piece of ¼" plywood and also grooved with a file. After drilling a ¼" hole at its center, the wooden pulley was pushed onto the shaft of the ¼" panel bearing assembly visible in the first two photos and fastened in place with epoxy cement. An ordinary rubber band serves as the belt which transfers power from one pulley to the other.

The exact pulley diameters you use will, of course, depend on the speed of your particular motor. The motor suggested in the Parts List, for example, turns at only 1/15th rpm. Therefore, it requires a ½" *disc pulley* and *a* ¾" *motor pulley* to bring the disc speed up





All of the parts for the Idento-Minder are bolted on a 3½" x 4¾" aluminum panel which is mounted inside a Minibox with spacers to permit rotation of the "time" disc. The blinker circuit, shown in the schematic above, is simple and requires a minimum of components.

to 1/10th rpm. If you use a motor with a different speed, vary the pulley size accordingly.

All of the parts for the Idento-Minder are mounted on the 3½" x 4¾" aluminum plate. Approximate the parts layout, and then drill holes for the timing motor, the panel bearing assembly, and the four-terminal tie strip. Drill four mounting holes for the bolts with spacers which hold the panel to the front of the Minibox. While you're at it, drill a hole 9/16" in diameter centered 13/16" from the top of the front panel of the Minibox for the "time" window, and another hole (line with a grommet) in the back for the a.c. line cord.

Assembly. Mount all of the components on the aluminum panel. The tie strip supports *D1, R1,* and the leads of *C1*. You can prevent the capacitor from flopping around inside the case by taping it tightly to the panel as shown in the first photo.

After fabricating and installing the pulleys, cut a 3½"-diameter disc from stiff cardboard or other suitable material, and make a 9/16" hole centered ½" from the edge for the warning light to shine through. Spray the disc with black paint and apply equally-spaced number decals. To install it, simply cement it to the disc pulley.

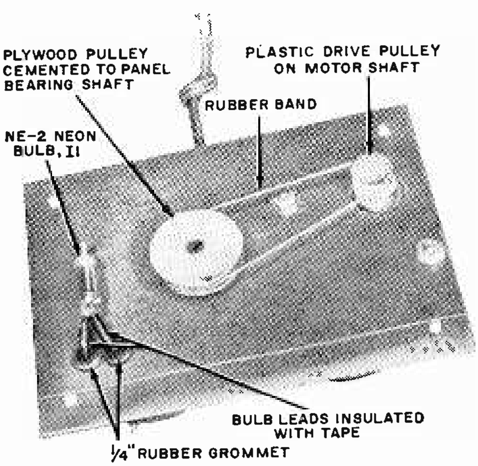
To finish the job, insert bolts through the front of the Minibox, slip ⅝" metal spacers over them to provide clearance between the panel and the box for the rotating disc, and bolt the panel in place. Screw on the back of the Minibox, and you're ready to go.

Install the Idento-Minder where it will be in your line of vision when you're on the air. Don't worry about having to watch the little gadget like a hawk, however, since its flashing neon indicator is so insistent that you'll have a difficult time ignoring it, even when your eyes are focused on an object as much as 90 degrees away from it. Due to the disc's slow rotation, the bulb is visible for almost a minute as the hole passes by, and you're bound to notice the winking light. The numbers also keep you alert because they indicate how many minutes have gone by since the previous ID. -30-

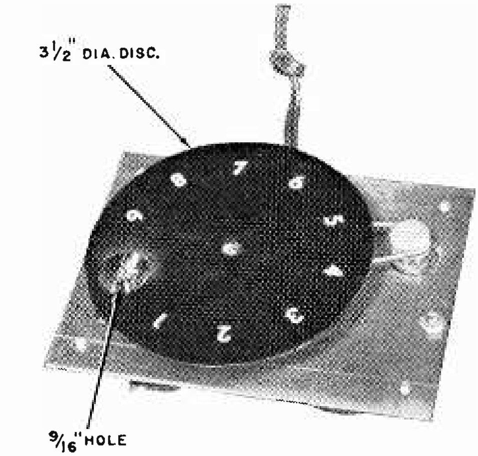
PARTS LIST

C1—0.5-µf., 200-volt paper capacitor
D1—200-ma., 400-PIV silicon rectifier (Sarkes Tarzian 2F4 or equivalent)
I1—NE-2 neon bulb
R1—470,000-ohm, ½-watt resistor
1—120-volt, 60-cycle synchronous timing motor (Allied Radio, 78B-497, $2.40)
1—½" disc pulley for use with above motor—see text
1—¾" motor pulley for use with above motor—see text
1—3" x 4" x 5" Minibox (Bud CU-2105-A)
1—3½" x 4¾" aluminum plate
1—¼" panel bearing assembly
4—⅝" spacers for #6 machine screws
Misc.—Decals, 4-terminal tie strip, hookup wire, hardware, 3½" cardboard disc, black spray paint

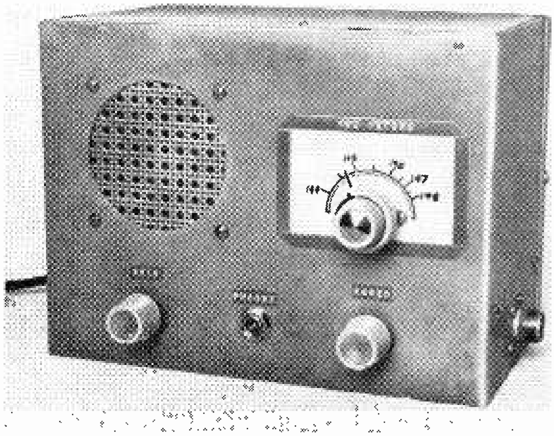
Pulleys are mounted on front of inside panel and coupled with a rubber band. Mount bulb I1 as shown.



Glue the 3½" disc to the large pulley, and position bulb I1 so it shines through the "ten minute" hole.



Need a receiver for the 2-meter amateur band? You can build this sensitive unit easily, at low cost.



2-METER SIMPLE SUPERHET

By CHARLES GREEN, W3IKH

READERS RESPONDED to the appeal of the "Simple Superhet for 6" (1964 ELECTRONIC EXPERIMENTER'S HANDBOOK) so well that a 2-meter version was quickly assembled. It covers the 144- to 148-mc. amateur band, with enough overlap at the band ends to include MARS and CAP frequencies. Three tubes are used to provide a superhet-type front end and a superregenerative second detector, as in the 6-meter version. This combination provides exceptional performance, considering the number of tubes and the overall simplicity of the circuit.

Most details of design and construction closely follow those of the 6-meter model, with a utility box again serving as the cabinet, which also contains the built-in speaker and power supply. The construction is straightforward and free of tricky assembly problems, so with the careful wiring and attention to detail that all VHF circuits require, you should have little trouble getting it going.

About the Circuit. The coaxial line from the antenna connects to jack *J1*, which is connected internally to the tuned input circuit, made up of *C7* and *L2*. This circuit is adjusted to peak broadly at 145 mc. by means of trimmer capacitor *C7*. The 2-meter signals are coupled to the grid of mixer *V1b* via *C8*.

A "gimmick" capacitor made by twisting two lengths of insulated wire together is used to couple the output of oscillator *V1a* to the grid of *V1b*. The oscillator frequency is basically set by trimmer capacitor *C3* and *L1*. This frequency is variable from about 138 to 142 mc., tuning 6 mc. below the desired signal, which establishes the correct 6-mc. i.f. frequency.

The i.f. output of mixer *V1b* is coupled by *C9* to the tuned circuit of the second detector, which consists of *L3* and *C10*. This circuit is adjusted to 6 mc. by means of the tuning slug in *L3*. The *REGEN* control, potentiometer *R6*, adjusts the screen voltage of *V2*, to control the superregenerative action of the detector stage.

To prevent overdriving the grid of *V3* with the quench frequency output of *V2*, *R8* and *C14* are connected as a low-pass filter section. The detected audio output from *V2* passes via *R8* and *C15* to *GAIN* control *R9*, from which the signal is applied to the grid of *V3*. The amplified output of *V3* is coupled through output transformer *T1* to closed circuit jack *J2* and the loudspeaker. Plugging in a set of headphones disconnects the speaker and provides output to the phones through *C18*.

Power transformer *T2*, rectifier diode *D1*, and the filter made up of *R11* and *C19* provide the necessary B+ voltages.

Construction. An 8" x 6" x 4½" aluminum utility box is used as the receiver cabinet. The chassis shelf is made from an 8" x 4⅜" aluminum sheet. Two pieces of aluminum angle support the chassis shelf about 1¾" from the bottom of the cabinet.

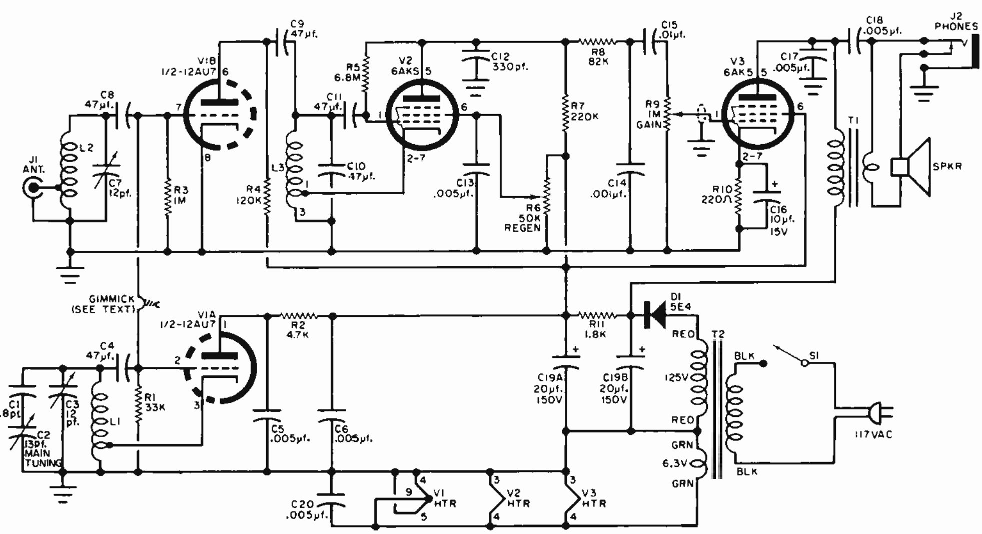
The parts layout is shown in Figs. 2, 4, and 5, and, as we said before, the placement of parts and wiring must be closely followed, as in all VHF devices.

Tuning capacitor *C2* is mounted on three ⅜" metal spacers. A solder lug is screwed to a tapped hole in the frame of *C2*, and soldered to the free end of a second solder lug, which is held to the chassis shelf by one of the screws that secures the socket of *V1*. This provides a short ground path for *C2*, and helps to stiffen the structure mechanically, which improves stability.

A "K-Tran" type of mounting plate was used to mount 6-mc. coil *L3*. Since it is not an exact fit for the Stancor coil specified, care must be taken to avoid shorting the coil terminals. Use short lengths of sleeving over the coil leads or, alternatively, drill holes in the chassis and mount *L3* by its spring clips.

A 3" square of perforated aluminum is used as the speaker grille, and a 1" bracket held by the lower left-hand speaker mounting screw aids in supporting the chassis. The small pointer cemented to the back of the outer tuning knob can be made of stiff cardboard or white plastic. The dial calibration is inked on heavy bond paper and taped to the panel.

Fig. 1. Schematically, the 2-meter set closely resembles the 6-meter unit.



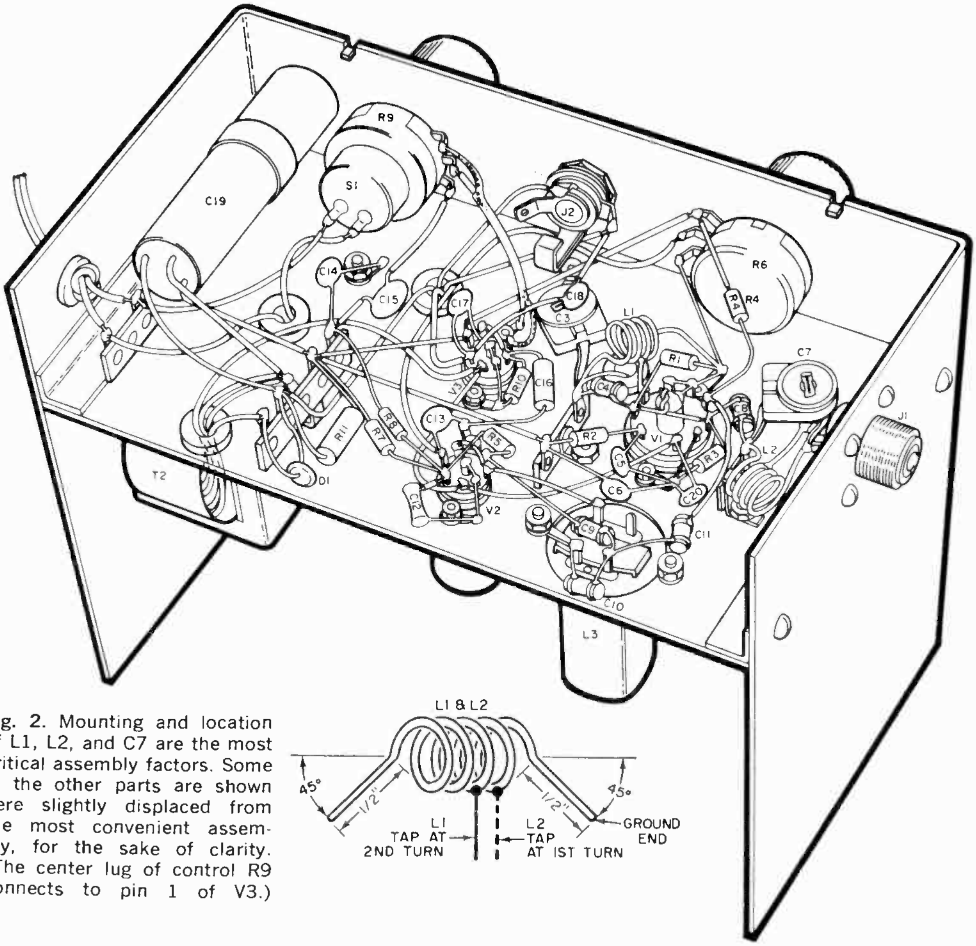


Fig. 2. Mounting and location of L1, L2, and C7 are the most critical assembly factors. Some of the other parts are shown here slightly displaced from the most convenient assembly, for the sake of clarity. (The center lug of control R9 connects to pin 1 of V3.)

PARTS LIST

C1—6.8-pf., 600-volt, NPO ceramic tubular capacitor (5-pf. and 2 pf. units wired in parallel)
C2—13-pf. variable capacitor, with vernier shaft and dual knob assembly (Lafayette 32-0919, 18-79, and 18-77—$1.95)
C3, C7—12-pf., NPO ceramic trimmer capacitor
C4, C8, C9, C10, C11—47-µf., 600-volt ceramic disc capacitor
C5, C6, C13, C17, C18, C20—0.005-µf., 600-volt ceramic disc capacitor
C12—330-pf., 600-volt ceramic tubular
C14—0.001-µf., 600-volt ceramic disc capacitor
C15—0.01-µf., 600-volt ceramic disc capacitor
C16—10-µf., 15-volt miniature electrolytic
C19—Dual 20-µf., 150-volt electrolytic capacitor
D1—400 PIV, 450-ma. silicon rectifier (International Rectifier Corp. 5E4 or equivalent)
J1—Chassis mounting type coaxial receptacle (Amphenol 83-1R or equivalent)
J2—Closed circuit phone jack
L1—4 turns of #16 tinned copper wire, wound ½" long on ¼" diameter; tap at second turn from ground end, leave ½" leads at 45° angle—see Fig. 2
L2—Same as L1 but tap at first turn from ground end—see Fig. 2
L3—Oscillator coil (Stancor RTC 8764)
R1—33,000 ohms
R2—4700 ohms
R3—1 megohm
(All resistors ½-watt, 10% unless otherwise specified)
R4—120,000 ohms
R5—6.8 megohms
R6—50,000-ohm carbon potentiometer
R7—220,000 ohms
R8—82,000 ohms
R9—1-megohm carbon potentiometer (with S1)
R10—220 ohms
R11—1800 ohms, 2 watts
S1—S.p.s.t. switch (on R9)
SPKR—3.2-ohm, 3" speaker (Utah SP3A or equivalent)
T1—Output transformer; primary, 10,000 ohms; secondary, 4 ohms (Stancor A3879 or equiv.)
T2—Power transformer; primary, 117 volts; secondaries, 125 volts @ 15 ma., 6.3 volts @ 0.6 amp. (Stancor PS-8415 or equivalent)
V1—12AU7A tube
V2, V3—6AK5 tube
1—8" x 6" x 4½" aluminum utility box (LMB 146 or equivalent)
1—8" x 4⅜" aluminum plate (for chassis shelf)
Misc.—Line cord and plug, "K-Tran" mounting plate (for L3), tube sockets, aluminum angle stock, grommets, terminal strips, knobs, perforated aluminum for speaker grill, #16 bus wire, insulated hookup wire, shielded wire, etc.

The connection from *L1* to *C1* is made by means of a piece of #16 bus wire, which passes through a grommeted hole in the chassis. The "gimmick" capacitor is formed by soldering two short pieces of insulated hookup wire to pins 2 and 7 of *V1*'s socket, and twisting them together. Trim the pair with your diagonal cutters to leave about two complete twists.

Several 3/8" holes drilled in the back of the cabinet cover will provide ventilation. In addition, two accurately placed holes in the bottom are required to permit adjustment of trimmers *C3* and *C7* with the cover on.

(*Continued on page* 157)

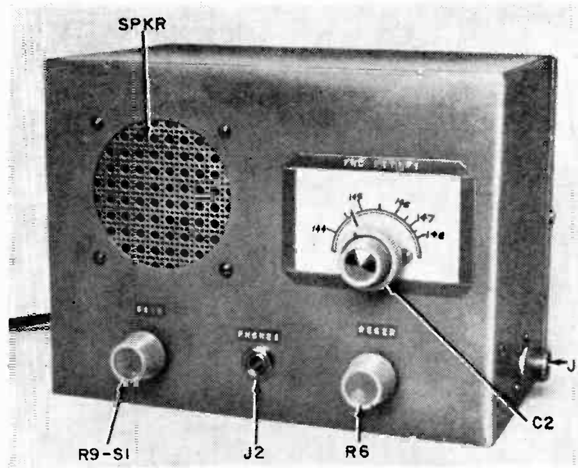


Fig. 3. Panel controls are straightforward and functional, for ease and efficiency of operation.

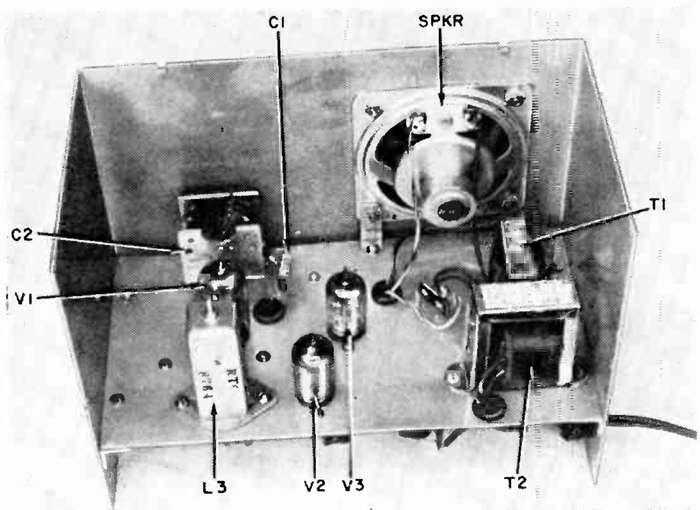


Fig. 4. Rigidity in the mounting of C1 and C2 is important for good tuning stability. This top view shows their relationship.

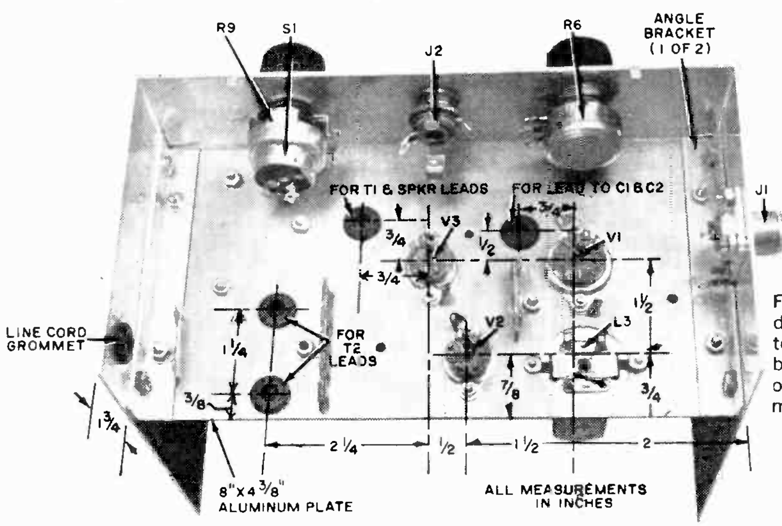


Fig. 5. The spacing and dimensions in this bottom view are important because of the very high operating frequency, and must be followed closely.

Chapter 4

ELECTRONICS for the WORKSHOP

SELECTING material for this chapter always presents a bit of a problem for your Editors. We solve this problem by introducing test equipment that is unusual and not readily available in kit form, or gadgets that can only have a special place in your workshop. The "Electronic Stop Watch" is a good case in point; connected to a 6-digit readout, the stop watch is accurate to a tenth of a second—and because it is all-electronic, it can be remotely controlled and a total of 27 hours can be timed! The "Grid-Dip Meter," "C Bridge," and the "Meterless VTVM" are all low-cost construction projects for the fellow whose workshop budget is at a low ebb.

"Bargains by the Bagful" is a report on the current practice of selling resistors and capacitors sight unseen. You can stockpile your lab or workshop, but be cautious—some bargains are not what they seem.

BARGAINS

BY THE BAGFUL

With a few careful purchases, you can stockpile many of the resistors and capacitors you'll need for project building

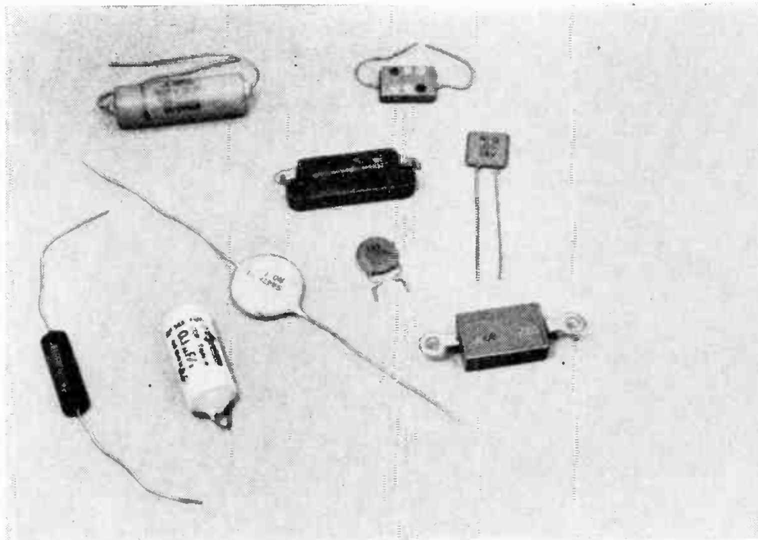
By OLIVER P. FERRELL, Editor

EVERY radio parts store worth its salt these days offers a variety of "poly" bags full of capacitors, resistors, potentiometers, transistors, diodes—everything but the kitchen sink. Mail-order catalogs and flyers are full of assortment offers and several companies specialize in selling nothing but bags of various radio components.

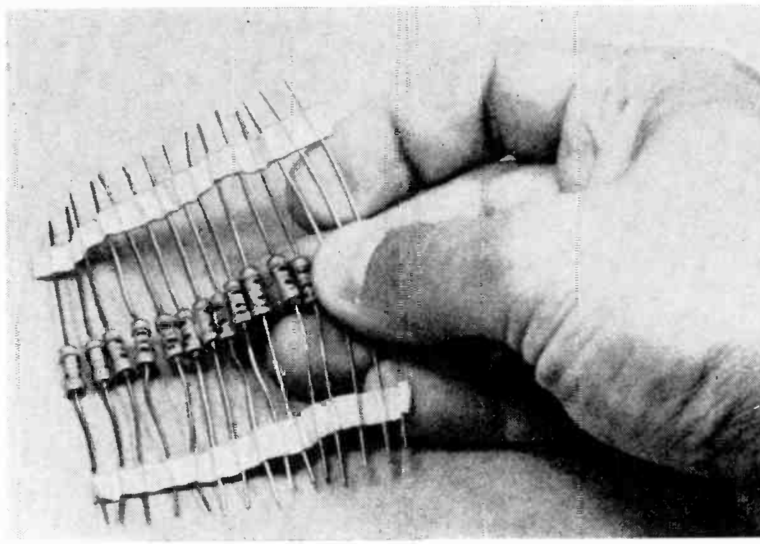
The editorial staff has spent several months quietly investigating poly bag assortments of resistors and capacitors. These two categories of *bargain bags* will be discussed here.

First of all, why buy assortments at all? Inveterate electronic project builders are well aware that there are numerous ways and means of cutting project costs. The so-called "junk box" of re-usable parts is one method. A second is stocking up resistors and capacitors obtained in poly bag assortments. As opposed to buying each resistor or capacitor in a project individually, a stockpile can shave these costs by 70-80 per cent.

We found that poly bag assortments included everything from floor sweepings of some unknown manufacturer to carefully packaged, top-quality merchandise. The buyer has no recourse (*caveat emptor*) but to accept what the poly bag contains without question. The only firm guideline that we could uncover as to the possible worth of a bargain bag is to know with whom you are dealing. Mail-order companies with business reputa-



These are a few of the different types of capacitors (mica, ceramic, molded paper, etc.) culled from poly bag assortments. The two mica capacitors with eyelet leads are over 15 years old. They are not color-coded; values are hot-stamped on bodies of the capacitors.



In disposing of these tubular ceramics, no effort was made to even separate them from an adhesive strip. Obviously, they are all the same value.

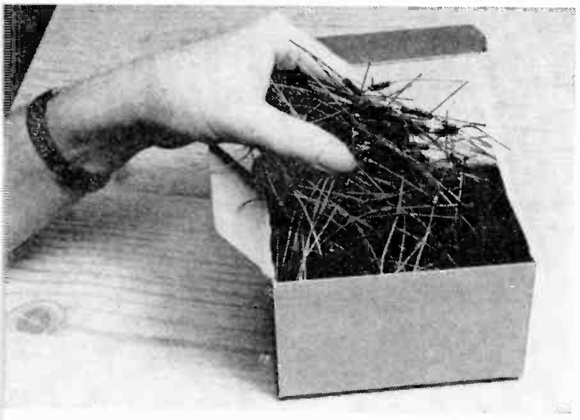
tions at stake and speciality houses dealing in bargain bags will nine times out of ten sell exactly what they advertise.

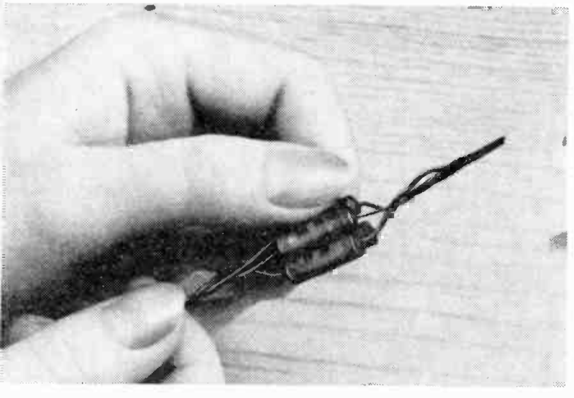
The same cannot be said for at least one-third of surplus or distress equipment mail-order houses, or most of the inhabitants of "radio row" stores in major metropolitan areas. The latter stores—specializing in a walk-in-off-the-street trade—offer very tempting bargains that are difficult to resist. But, resist them you should, even though the investment is almost always under $2. Often as not, you'll be glad you did.

Bargains, Bargains, Bargains? As examples of "radio row" transactions, here are two instances that occurred during our poly bag hunts in lower Manhattan. In one store a sign proclaimed drastic price reductions in resistor assortments from $1.98 to $1.49 to a new final "low-low" of 99¢—an irresistible bargain. A sealed box (poly bag inside) was purchased and from its weight appeared to be packed. It was—with 481 resistors of the same value!

A second store offered precision wire-wound and carbon-film resistors—30 for $1.29. The count was correct and we

This was our prize purchase. All 481 resistors are of the same value although the exterior wrapping of this assortment said it contained 100 different resistors.





In the politest terms, these four resistors can be called "floor sweepings." Twisting the leads together was done by a technician, eliminating the chance that the resistors would be new stock.

"BAD" ASSORTMENT

25 Mica Capacitors for 89¢

4	3.7 μμf.	**2**	68 μμf.
1	7.5 μμf.	**1**	680 μμf.
1	25 μμf.	**1**	800 μμf.
3	27 μμf.	**2**	900 μμf.
8	60 μμf.	**2**	1000 μμf.

Although far from obsolete, this assortment clearly established that mica capacitors are "on their way out." Capacitors from five different manufacturers were represented and all showed distinct signs of aging. Seven capacitors had pre-World War II color coding (nearly invisible) and two of the 27-μμf. capacitors were unmarked. This was a local (New York City) purchase.

"EXCELLENT" ASSORTMENT

50 Tubular Capacitors for 98¢

19	0.001 μf., 60 w.v.d.c.
6	0.0015 μf., 600 w.v.d.c.
1	0.0018 μf., 400 w.v.d.c.
6	0.002 μf., 150 w.v.d.c.
6	0.002 μf., 400 w.v.d.c.
1	0.0022 μf., 400 w.v.d.c.
1	0.0022 μf., 600 w.v.d.c.
4	0.0027 μf., 600 w.v.d.c.
1	0.003 μf., 400 w.v.d.c.
5	0.005 μf., 200 w.v.d.c.
1	0.007 μf., 600 w.v.d.c.
2	0.01 μf., 100 w.v.d.c.
1	0.01 μf., 600 w.v.d.c.
1	0.015 μf., 200 w.v.d.c.
2	0.1 μf., 200 w.v.d.c.
1	0.2 μf., 400 w.v.d.c.
1	0.5 μf., 600 w.v.d.c.

This mail-order assortment contained 59 capacitors instead of the advertised 50. All were in good shape, although obviously "over-runs" from TV set manufacturers. All were clearly imprinted, and all tested "good."

found values ranging from a low of 100 ohms to a high of 3.32 megohms. However, four of the 30 resistors were unmarked and if you can describe a more worthless electronic item than an unmarked "precision" resistor we'd like to hear about it.

Purchases via mail order from any of the five top distributors, plus one speciality mail-order house, were satisfactory. With few exceptions, the components were clean, well-marked, of fairly recent manufacture and of good quality. A sampling of capacitors indicated that only one out of a possible 50 would be leaky, shorted or open on being tested.

Some of the problems that *do* beset bargain capacitors, especially those purchased from doubtful sources, are old, obsolete or indistinguishable color codes and markings. Fortunately, these troubles do not usually affect resistors. Our sampling showed that only one out of every 90 resistors would either be open or have indiscernible markings.

On the other hand, precision resistors are *always* a poor buy in poly bag assortments. The offerings are generally overproduction runs of highly irregular values used in test equipment manufac-

"BAD" ASSORTMENT
50 Resistors for 99¢

- 2 0.33 ohm, ½ watt
- 3 3.3 ohm, ½ watt
- 1 15 ohm, ½ watt
- 2 180 ohm, ½ watt
- 2 390 ohm, 2 watt*
- 1 470 ohm, 3 watt*
- 1 560 ohm, 1 watt
- 1 680 ohm, 1 watt*
- 1 820 ohm, ¼ watt, 20%
- 2 910 ohm, ½ watt, 5%
- 1 2700 ohm, 1 watt
- 1 4700 ohm, 1 watt
- 1 4700 ohm, 4 watt*
- 3 4700 ohm, 2 watt
- 1 6800 ohm, ¼ watt, 20%
- 2 6800 ohm, ½ watt
- 1 6800 ohm, 1 watt
- 1 7500 ohm, 1 watt
- 1 8200 ohm, ½ watt
- 2 8200 ohm, 3 watt*
- 2 10,000 ohm, 1 watt
- 1 10,500 ohm, precision
- 1 18,000 ohm, 2 watt
- 1 68,000 ohm, 2 watt, 20%
- 1 75,000 ohm, ½ watt
- 2 44,000 ohm, 2 watt
- 2 330,000 ohm, 1 watt
- 1 750,000 ohm, 1 watt, 5%
- 1 1.2 meg., 1 watt
- 1 2.2 meg., 1 watt
- 2 20.0 meg., ½ watt

At first glance—while the resistors were still in the poly bag—this looked like a promising purchase. Unfortunately, the assortment was more of a hodge-podge containing all wattage values from ¼ to 4 watts. Particularly bad in this assortment was the absence of values in the range of 75,000 to 330,000 ohms. All resistors identified by the asterisk had no color code. This was a "radio row" purchase.

"EXCELLENT" ASSORTMENT
40 Disc Ceramic Capacitors for $1

- 2 12.0 μμf.
- 1 15.0 μμf.
- 1 18.0 μμf.
- 3 22 μμf.
- 3 27 μμf.
- 2 33 μμf.
- 1 39 μμf.
- 2 47 μμf.
- 1 56 μμf.
- 2 68 μμf.
- 1 82 μμf. (2 kv.)
- 3 100 μμf.
- 1 120 μμf.
- 7 470 μμf.
- 1 390 μμf. (1.5 kv.)
- 1 680 μμf.
- 4 1000 μμf.
- 2 0.005 μf.
- 6 0.01 μf.
- 3 0.02 μf. (1.6 kv.)
- 1 0.05 μf. (25 v.)
- 1 0.047 μf. (50 v.)

Even though this assortment contained a few "seconds" there was a surplus of nine extra capacitors—plus an unusual 27/27 μμf. duo-ceramic not listed above. The distribution of values was remarkable in this poly bag—note the volume of most-used values (470 and 1000 μμf.).

ture. Wattages are rarely indicated (perhaps on one unit out of ten) and you take a chance in using a precision resistor in any circuit that draws more than a watt. Also, the *need* for precision resistors in everyday electronic experimenting is unbelievably small.

What To Buy. There are several rules-of-thumb in buying poly bags. If you can see the bags be sure that component leads are uncut and have not been shortened for use in printed circuit wiring. In the case of resistors, check that the one-half-watters have either a silver or gold tolerance color-coding band. Also, ancient 2-watt resistors were much longer and thinner than present-day units—they are not a good buy.

Capacitors must be watched carefully, although the signs of age are more obvious (see p. 123) than with resistors. Ceramic disc capacitors should be checked for signs of poor dipping—the colored ceramic insulation does not cover all of the capacitor body. Units of this type are "seconds" and are not safe to use.

In the great welter of assortments, special "buys," and "good deals," the average buyer of poly bags has reason to be hopelessly confused when it comes to determining just what he's getting for his money. As this article was being written, the following average prices (cents-per-unit) were computed from our survey.

Resistors:

Top-grade ½-watt	.03
Second grade ½-watt	.015
1- and 2-watt	.035
3-watt, or higher (carbon)	.05
3-watt, or higher (w.w.)	.08
Precision	.07

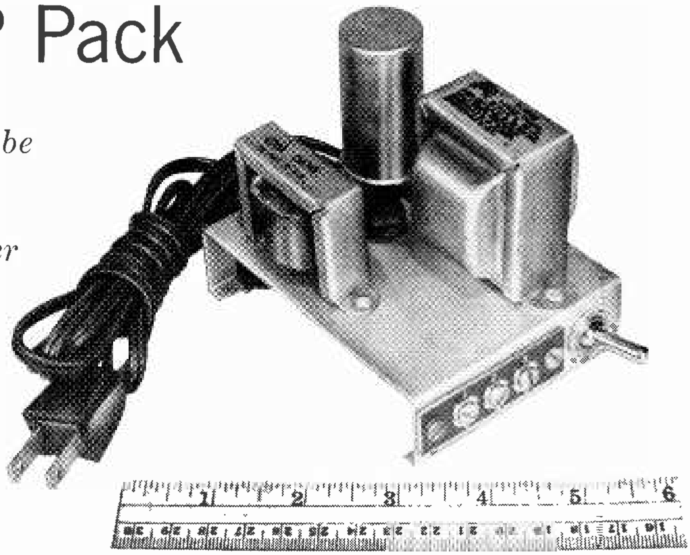
Capacitors:

Ceramic discs	.03
Ceramic tubulars	.02
Top-grade mica	.03
Second grade mica	.02
Paper or molded	.035

The experimenter will find that an $8-$10 investment in poly bag resistor and capacitor assortments will be money well spent. We suggest that the following components be purchased as a start: two good ½-watt resistor assortments, one good 1-watt resistor assortment, one ceramic disc assortment, and two bags of mica or molded capacitors. Unless you need them for some specific purpose, defer buying precision resistors or electrolytic capacitors until a later date. However, if you expect to try out transistor circuits, a good assortment of high-capacitance, low-voltage electrolytics can be added to the above list. —30—

Handy EP Pack

Like to breadboard tube circuits? Here's an Experimenter's Power pack that makes it easy



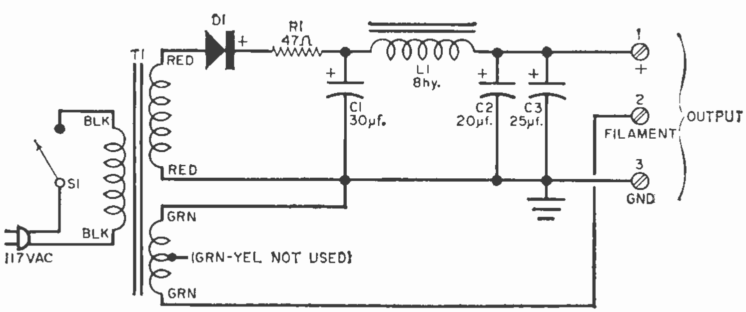
By E. G. LOUIS

ONE OF THE BIG REASONS transistor circuits are popular with experimenters is that the only power supply required is a small battery. Tubes can do a number of jobs better than transistors, however, and if you take an hour or two to assemble this simple supply, your power problems for one- and two-tube circuits will be ended.

Since the EP Pack is a medium-voltage supply, a rather elegant filter section can be used without straining the budget; in any case, the junk box should provide numerous substitutions. Transformer T1 (Merit P-3046 or equivalent) delivers 150 volts at 25 ma., and 6.3 volts at 0.5 ampere. A half-wave rectifier circuit is used with a 50-ma., 300-PIV (or better) silicon rectifier (*D1*). Resistor *R1*—1 watt will suffice—prevents surge damage to *D1* as *C1* charges. The filter capacitors (*C1, C2, C3*) are all in one multi-section can, and should be rated at 250 w.v.d.c. Use an 8-henry choke for *L1* (Stancor C1355). The only other parts required are a small chassis, tie points, a s.p.s.t. toggle switch, and a three-terminal, screw-type terminal strip.

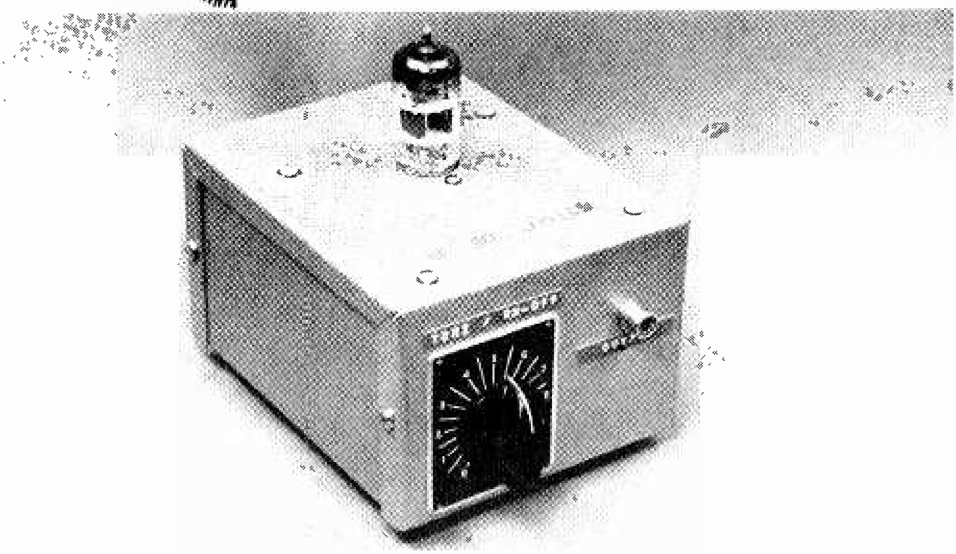
Mount the major components, placing the capacitor can so that it is not in direct contact with the heat-producing transformer. Also, some degree of separation between the choke and transformer should be maintained to prevent hum coupling. The wiring under the chassis is connected to standard tie points. Be sure to observe capacitor and rectifier polarities; use a heat sink when wiring the rectifier.

If the supply will not be connected to a constant load, add a bleeder resistor (60,000 ohms, 2 watts) between terminals 1 and 3 (the B-plus and ground terminals). If isolated filament output is desired, a four-screw terminal strip can be used—five screws if the filament winding of the transformer employed has a center tap. A neon pilot lamp can be connected across *T1*'s primary, and another optional feature would be a ½- or 1-amp fuse connected in one leg of the primary. —30—



Simple power supply for experimenting with tube circuits is cinch to build, and can usually be put together with junk box materials. If you use a higher voltage transformer, you must rate other components accordingly.

THE SQUEALER

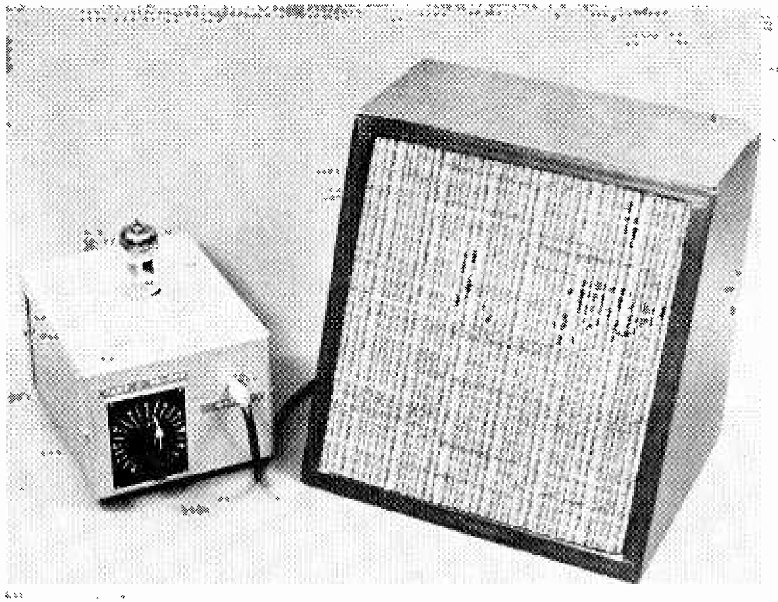


By FRANK A. PARKER

Another starved current circuit application—an audio oscillator

AMAZING AS IT SOUNDS, this starved circuit vacuum-tube audio-note generator has a plate supply of only 5 volts! What's more, the 100-microampere plate current drain beats many transistor circuits. In a unit similar to the "Starved Circuit Amplifier" which appeared in the 1963 ELECTRONIC EXPERIMENTER'S HANDBOOK, the single 12AT7 dual-triode does not need the usual high-voltage plate supply transformer. Plate voltage is taken off the same 6.3-volt winding used for the tube's heater. In the author's model, plate voltage was reduced to an unbelievable 3 volts before the *Squealer* was silenced.

The output of this easy-to-build unit can be varied from 20 cycles to



Coupled to a 3-transistor amplifier in the speaker enclosure, the Squealer had a resounding wallop. If the Squealer's output circuit were broken with a telegraph key, this arrangement could be used for code practice.

about 12,000 cycles with a single control. Audio output voltage is high enough to drive any hi-fi amplifier to full volume. The *Squealer* makes a fine auxiliary audio source in the shack. And, in emergencies, or for mobile use, it can run from a 6-volt battery.

About the Circuit. The *Squealer* uses dual triode *V1* in a modified multivibrator oscillator circuit. Coupling between stages is through the cathode connection, resistor *R2* being common to both triodes. Feedback is maintained by capacitor *C1*, which together with potentiometer *R3* determines the *Squealer's* audio output frequency. The upper frequency limit can be pushed to 15,000 cps or higher by decreasing capacitor *C1* to about 0.01 μf. or lower. Resistor *R1* serves as a plate load for *V1a*; audio output is tapped off the same plate via capacitor *C2*.

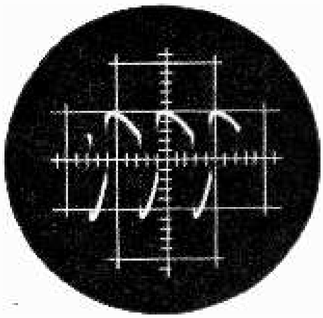
The *Squealer* is isolated from the power line by filament transformer *T1*. The same transformer is also used in a standard half-wave rectifier circuit with diode *D1* and *RC* filter *C3*, *C4*, *R5*. Resistor *R4* protects *D1* against current surges. For battery operation, a 6-volt d.c. source is connected between point *A* and ground. Useful output can be obtained with a d.c. source as low as 3 or 4 volts operating *V1*'s plate and heater.

Experimenters will realize how this circuit differs from the previously mentioned "Starved Circuit Amplifier." The latter circuit produced a high signal gain through the use of a 4.3-megohm plate load resistor. Furthermore, the gain could only be obtained by forcing a voltage drop of several hundred volts across the plate load resistor. This circuit is "starved" in a different sense—deriving its voltage from the heater line (6 vs. 250 volts) and feeding through a small plate load resistor (47,000 ohms vs. 4.3 megohms). The effects are largely the same, however.

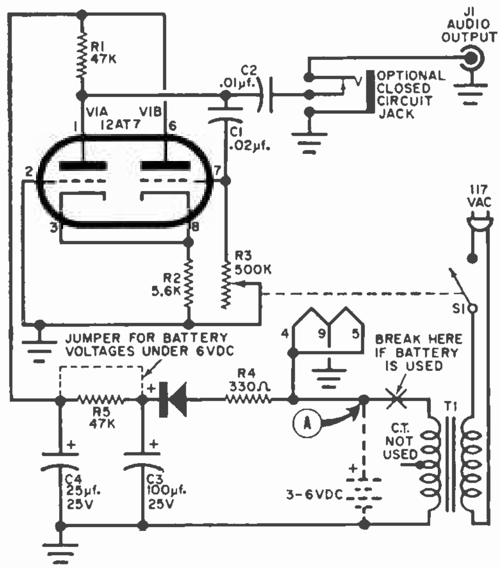
Construction. The *Squealer* fits neatly in a 5″ x 4″ x 3″ aluminum box. Parts placement is not critical but layout might well follow the author's setup for easiest assembly.

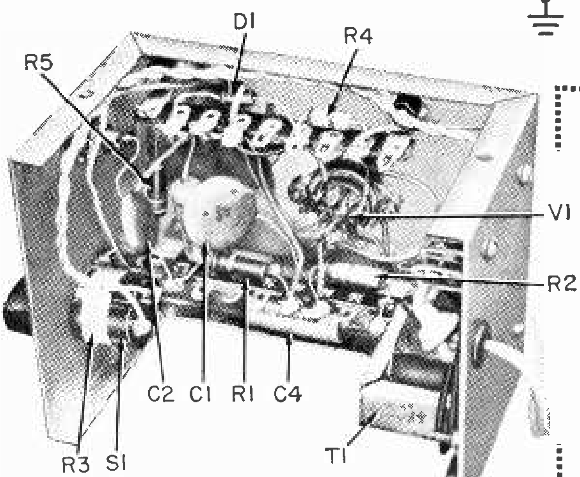
All parts are mounted on the cover half of the box. The tube is mounted topside in the center of the box. If desired, the filament transformer can also be mounted on top of the box but the author chose to mount it at one end as shown.

Most of the resistors and capacitors and the diode are soldered to a pair of 9-lug terminal strips (visible in the photo at right) on either side of the tube socket. Potentiometer *R3* and audio output jack *J1* are mounted on the end of



Waveform of the audio note generated by the Squealer is not a true sine wave. As the diagram at right illustrates, plate voltage is taken from half-wave rectified heater supply.





Parts arrangement is uncritical, although author recommends mounting most of the components in outside wraparound of aluminum box.

PARTS LIST

C1—0.02-µf., 200-volt disc capacitor
C2—0.01-µf., 200-volt disc capacitor
C3—100-µf., 25-volt electrolytic capacitor
C4—25-µf., 25-volt electrolytic capacitor
D1—Silicon diode, 50 PIV, 100 ma., or higher
J1—RCA-type phono jack
R1, R5—47,000-ohm, ½-watt resistor
R2—5600-ohm, ½-watt resistor
R3—500,000-ohm potentiometer (with switch S1)
R4—330-ohm, ½-watt resistor
S1—S.p.s.t. volume control switch (ganged with R3)
T1—Filament transformer: primary, 117 volts a.c.; CT secondary, 6.3 volts @ 0.6 ampere, CT not used (Stancor P6465 or equivalent)
V1—12AT7 tube
1—5" x 4" x 3" aluminum box
Misc.—9-pin miniature tube socket, terminal strips, knob, dial plate, hardware, wire, solder, etc.

the box opposite the transformer. Since no pilot lamp is employed, a dial plate is used with the potentiometer as an on-off indicator and to spot the different output frequencies.

Operation. The *Squealer* works fine with both crystal and medium- to high-impedance dynamic headphones. If it is to be used for code practice, a closed-circuit telephone key jack can be optionally inserted between capacitor *C2* and output jack *J1*. As an audio source for hi-fi amplifiers, an ordinary shielded cable terminated with a pair of RCA-type phono plugs will do.

If desired, the *Squealer* can be operated from a 6-volt battery. Simply connect the battery between point *A* and ground as shown on the schematic. Be sure to disconnect the 6.3-volt secondary of *T1* before connecting the battery since the transformer winding represents a d.c. short for the battery. To increase the audio output with supply voltages under 6 volts, short out resistor *R5* with a wire jumper. —30—

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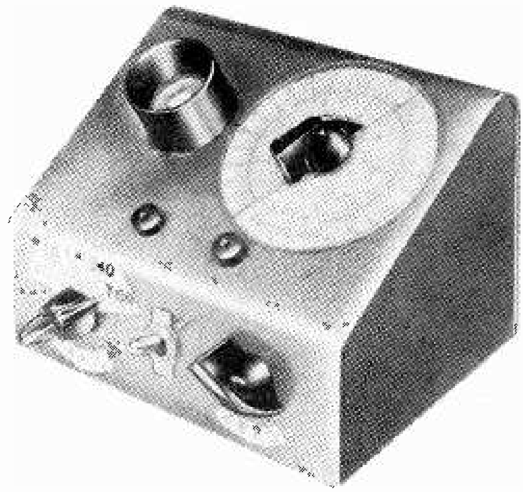


meterless vtvm

By WILLIAM J. MILLARD

When you need a high-impedance voltmeter, you usually need it bad—this one uses no meter, and twelve bucks buys the parts

THE trusty multimeter is generally the first measuring instrument bought for the average home workshop, and often it's the *only* one the experimenter's budget will permit. But what do you do when the voltage to be measured is in a very high impedance circuit? Even if the multimeter is one of the fairly expensive sort having a 20,000-ohm-per-volt movement, the input impedance on a low-voltage range, say 3 volts full scale, is only 60,000 ohms. If you're trying to measure the bias on the oscillator grid of a mixer, or in a low-level audio stage having a 5-megohm (or higher) grid resistor, the multimeter looks pretty much like a dead short circuit to the voltage being measured. In such cases you either give up (unthinkable!), buy a vacuum-tube voltmeter ("unfundable"), or rummage in your junk box and build the "Meterless VTVM."

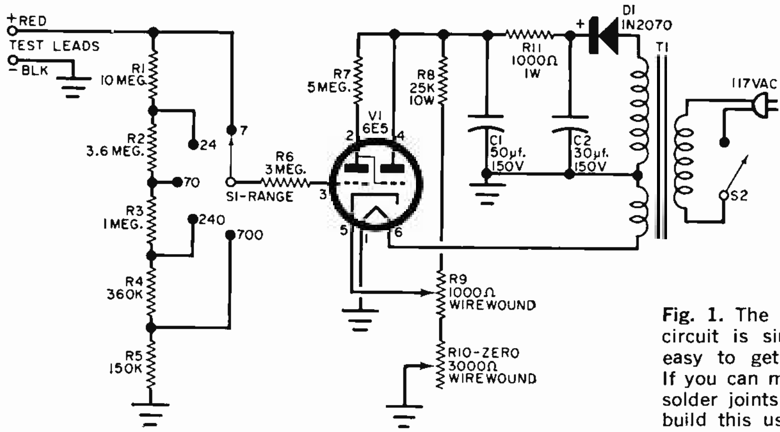
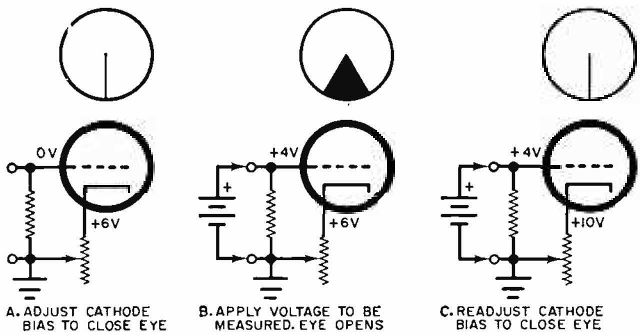


Fig. 1. The slide-back circuit is simple and easy to get working. If you can make good solder joints, you can build this useful unit.



PARTS LIST

C1—50-µf., 150-volt electrolytic capacitor
C2—30-µf., 150-volt electrolytic capacitor
D1—1N2070, 400-PIV silicon diode
R1—10 megohms
R2—3.6 megohms
R3—1.0 megohm
R4—360,000 ohms
R5—150,000 ohms } *½-watt carbon resistor, 5% tolerance*
R6—3.0 megohms
R7—5.0 megohms } *½-watt carbon 10% tolerance*
R8—25,000-ohm, 10-watt, wire-wound resistor
R9—1000-ohm, linear taper, wire-wound potentiometer
R10—3000-ohm, wire-wound potentiometer
R11—1000-ohm, 1-watt carbon resistor
S1—Single-pole, 5-position rotary switch
S2—S.p.s.t. toggle switch
T1—Power transformer; 125 volts @ 15 ma., 6.3 volts @ 0.6 ampere (Stancor PS-8415 or equivalent)
V1—6E5 electron-ray indicator tube
1—Aluminum box, sloping front (Bud AC-1612 or equivalent), or constructor's choice
Misc.—6-prong tube socket, line cord and plug, red and black pin jacks (one each), test prods, solder, hookup wire, hardware, etc.

It's true that the Meterless VTVM won't measure resistance or current, except by indirect methods, but the multimeter can still take care of those chores as before. And the Meterless VTVM will provide a bonus "instrument." You can use it when you're measuring a voltage that may suddenly take a drastic jump as you make adjustments, thereby avoiding the risk of wrapping the pointer of your multimeter around the stop pin! The repair of this all-too-common laboratory ailment (known as Technician Goofitis) will deflate your piggy bank by at least $10, and it *can* cost more. Such transient voltage jumps are taken in stride by the Meterless VTVM.

How do you measure voltage without a meter? By reviving a voltmeter circuit so old and out of use that it has probably been forgotten by many old-timers . . . and maybe never learned by newcomers to the electronics field. It's called the slide-back voltmeter circuit, and it originated back in the 1930's. It doesn't require a meter (although one *can* be used, of course), because all that is needed is a means of indicating when

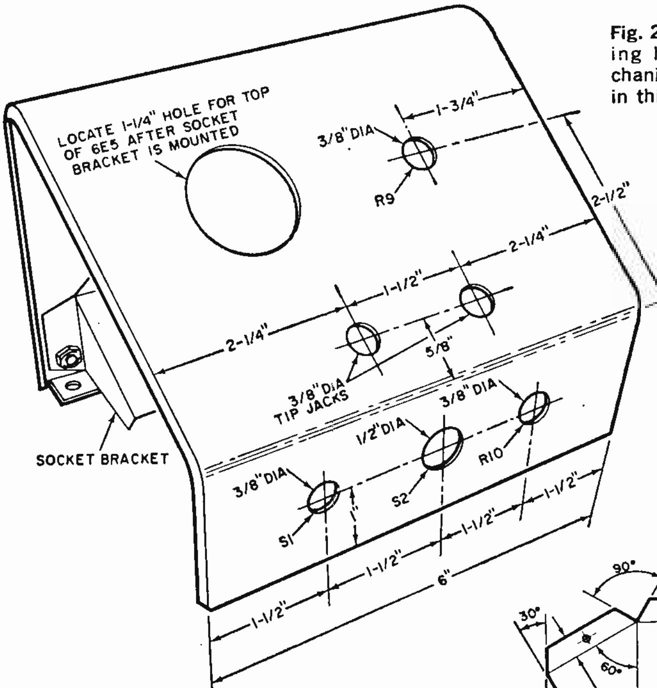


Fig. 2. Details of the mounting holes and other mechanical work are shown in this dimensioned sketch.

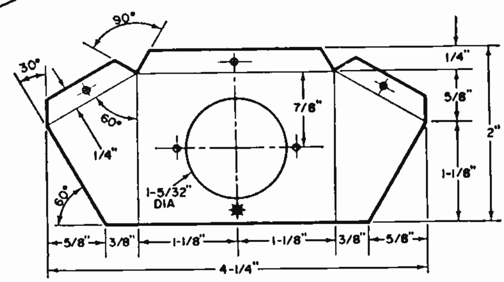


Fig 3. Cut the sheet metal for the bracket as shown before bending to final shape.

*MOUNT TUBE SOCKET SO THAT PIN 5 IS AT THIS POINT. SHADOW WILL THEN BE AT 6 O'CLOCK WHEN TUBE IS INSERTED.

two voltages have been adjusted to be equal, and a tuning indicator ("magic eye") tube can do that very nicely.

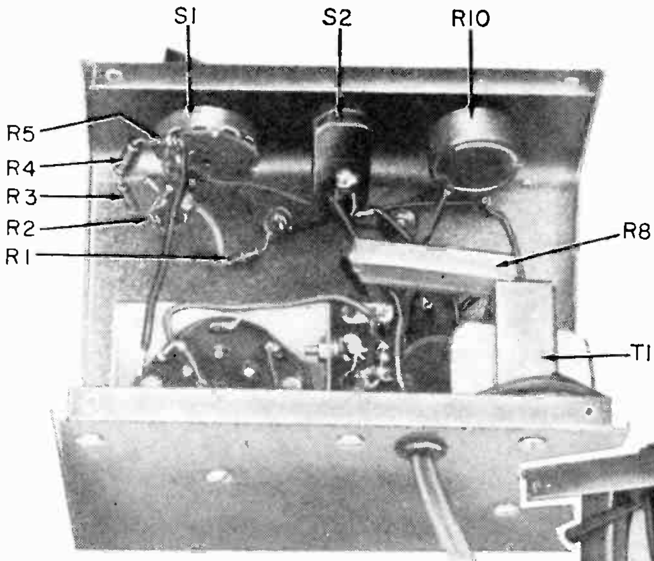
Years ago these miniature cathode-ray tubes were used by the thousands as tuning indicators in broadcast and other receivers. Today, they're still used widely in the less costly tape recorders. Naturally a lot of them are lurking in the junk box waiting to be put into service again, and if you don't have one on hand, the cost of a new one is far below that of a respectable meter.

A 6U5/6G5 may be substituted for the 6E5 tube specified if an additional 1000-ohm resistor is put in series with the lead from the arm of *R10* to ground. The 6U5/6G5 will sharpen up the "tuning" of the VTVM.

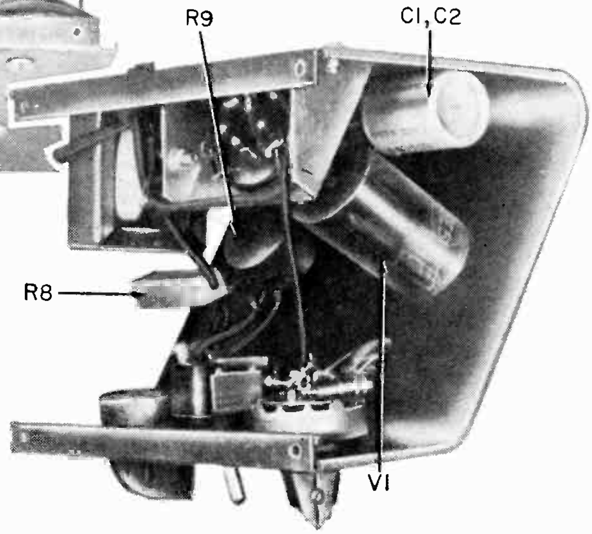
How It Works. Take a look at the schematic diagram in Fig. 1. If you set the arm of potentiometer *R9* to the low-voltage end of the resistance element, and adjust potentiometer *R10* to bias *V1* so that the "eye" just closes, as in Fig. 1(A), application of a d.c. voltage to the input leads will cause the eye to open again—see Fig. 1(B). Now, by readjusting the bias by means of potentiometer *R9*, you can cause the eye to just close again, as in Fig. 1(C). And if you calibrate the position of the arm of *R9* on a suitable dial scale, you can read off the unknown voltage as quickly as the eye-closing adjustment can be made.

How do you calibrate the scale of *R9*? By applying known voltages, such as from combinations of batteries, or by measuring voltages in low-impedance circuits simultaneously with your multimeter and the Meterless VTVM.

Since the range of measurement potentiometer *R9* is limited, the switchable voltage divider network has been included to extend the usefulness of the circuit to higher voltages. For stable operation and ease of calibration, *R9* must be a linear taper wire-wound potentiometer, if you want the voltage scale to be uniform. The 1000-ohm value used by the writer provides a good spread of the dial markings without requiring too many steps of the range switch, but other values can be used to suit the individual constructor's needs. Use of 5% tolerance resistors adds little to the cost of



Layout and wiring are not critical, but assembly is easier if the order given in the text is followed.



the unit, and provides better accuracy and ease of calibration.

Construction. Since the box used to house the writer's unit has no chassis, all controls and associated parts are mounted on the sloping front panel, as shown above. Solder resistors *R1* through *R5* to the terminals of the range switch before you mount it. It's also a good idea to mount *R9*, *R10*, *S1*, *S2*, and the test prod jacks before installing the transformer and indicator tube.

For details of the angle bracket used to support the socket of *V1*, see Fig. 3. When the socket is in place, you can determine the exact location of the 1¼" hole in the front panel for the eye end of the tube. Cut this hole and cement a piece of blackened cardboard mailing tube around it as a light shield.

Fasten the filter capacitor to the rear surface of the box by means of the machine screw in the center hole of the tube socket bracket. A three-lug terminal strip on the side of the tube bracket supports diode *D1* and resistor *R11*. Resistors *R6* and *R7* (not indicated in the photos) are supported by the tube base lugs to which they are soldered.

Calibration. When you have completed and checked the wiring, switch the unit on and let it warm up until the eye pattern stabilizes. Set range switch *S1* to the lowest range and turn *R9* counterclockwise so that the arm is at the end nearest to *R10*. This is zero volts on all ranges. Then short the test leads together and adjust the zero setting control (*R10*) so that the eye of tube *V1* just closes.

Now fasten a piece of paper under the knob of *R9* with Scotch tape, for use as a temporary scale. Apply a known voltage such as from a single flashlight cell, and adjust *R9* until the eye is just closed again. Mark the temporary scale accordingly. Continue with other voltages until the low range is calibrated.

This scale will hold for ranges three and five if you multiply the scale markings by 10 and 100, respectively. Ranges two and four are calibrated in the same way, after which you have only to transfer the temporary markings to a permanent scale for mounting under the knob.

Want to use your unit for a.c. also? Just add a 0.002- to 0.005-μf., 200-volt capacitor from pin 2 of *V1* to ground, and you're in business. —30—

Split-second timing is vital in dozens of operations from firing moon rockets to checking hot rod performance at the local drag strip. Equip yourself to make highly accurate time checks by building the . . .

ELECTRONIC STOP WATCH

By FRED BLECHMAN, K6UGT

FOR YEARS the standard device for accurate elapsed time measurement in sporting events and industrial processes has been the hand-held stop watch. This works well for many purposes, but it has its shortcomings and limitations. For one thing, it can't very well be operated remotely, and most models are limited to a total elapsed time of fifteen minutes, when the hands are again on zero. And you do have to remember to wind it, of course.

Also, pricing a good jeweled-movement stop watch capable of tenth-second accuracy at the local jeweler's will probably get you a quotation of $25.00 or more.

For less than $21.00 you can build this electronic stop watch that will time events in seconds and tenths, up to a total of more than *27 hours*, yet can be reset to zero in seconds. Readout is entirely in Arabic numerals, with no unnumbered dial marks to interpret, and remote control can be added for about $4.00, with safe isolation of the control circuit from the power line.

You can time almost any kind of race or

sporting event, and scores of other things like free-flight model airplane endurance flights, photographic time exposures or developing processes, phone call duration, lab experiments, and . . . but the list of potential uses is endless.

How It Works. The heart of the electronic stop watch is a 600-rpm synchronous motor. The shaft speed of this motor is directly controlled by the *frequency* of the 60-cps a.c. line voltage (not the voltage), which is maintained by the utility company to an accuracy of 0.1 of 1 per cent, or better. At 600 rpm, the motor shaft makes 10 revolutions per second. A plastic cam mounted on the shaft opens and closes a snap-action switch ten times per second. Each switch closure advances an electronic counter one digit, indicating the lapse of 0.1 second.

Since the counter has six digits, 99,999.9 seconds can be counted without interruption—a total of 27.77+ hours. The control switch has a standby position (marked *STDBY*) between the *OFF* and *TIME* positions. In this position, the motor is started and allowed to get up to full synchronous speed, which requires about one second. If this were not done, the timing during the first second would be slow, causing a serious error in measuring duration of events that last no more than a few seconds.

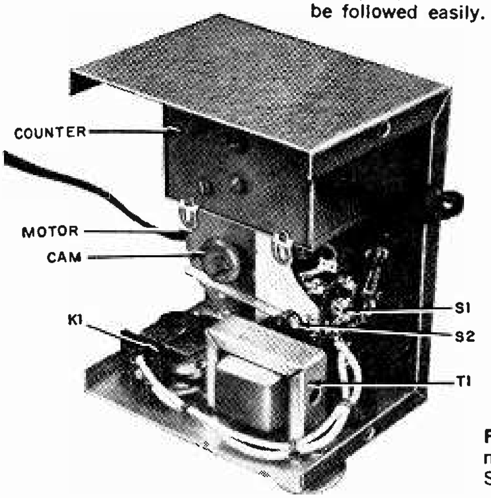
Note also that when the switch is moved from *TIME* to *STDBY* at the end of a timing operation, the motor continues to run, and the unit remains in readiness for the next timing operation.

With the switch at *STDBY*, the timer can also be controlled from a remote point (if you elect to include this feature) by merely closing a switch to initiate a timing period and opening it at the termination. This can be done either manually or automatically by the mechanism of the operation being timed, such as the rise of a starting gate. Since the remote line carries only the current needed to close a relay, it is not necessary to shield it, and it can have several ohms resistance without affecting operation.

The pilot lamp provides a visual alerting signal to let the user know that the unit is standing by, or actually counting. In a noisy environment (such as a drag strip), the muted clicking of the leaf switch can't be heard when the unit is at *STDBY*.

Construction. For correct electromechanical operation, three of the component parts are critical. The motor must be a 600-rpm unit of the *synchronous* type, and it must have sufficient torque to operate the switch. The smallest, lightest, and least expensive motor filling these requirements, and having the added advantage of ready availability, is specified in the Parts List.

Fig. 1. The author's layout of parts is compact, and can be followed easily.



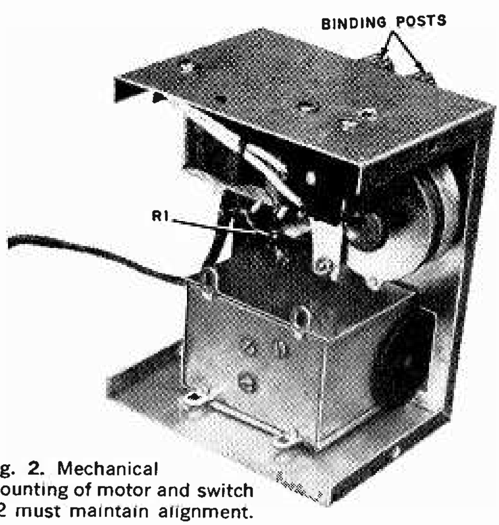


Fig. 2. Mechanical mounting of motor and switch S2 must maintain alignment.

In order to use the motor called for, the operating force required by the snap-action switch must be very small. The switch specified requires an operating force of only four grams, and comes with the necessary leaf actuator already attached.

The 6-digit electrically operated counter has a built-in full-wave bridge rectifier circuit, which serves two important purposes. It converts a.c. line current to d.c., which is required by the counter actuating coil for operation at the ten-counts-per-second rate used. It also provides a conductive path across the coil terminals to dissipate the transient voltage generated when the actuating voltage is interrupted by action of the motor-driven switch. If you want to substitute another counter for the one specified, it *must* have a similar bridge rectifier circuit.

The layout of the author's unit is shown in Figs. 1 and 2. Since wiring is not critical, the layout can be altered to suit the constructor's preferences. However, good mechanical positioning and rigidity between the motor shaft and the snap-action switch is very important. The necessary mechanical relationship between these parts is shown in Fig. 3.

The control switch may be a rotary type if desired, but the lever switch specified allows more precise start-stop control. Another alternative would be to use a push-button switch as a means for starting and stopping the actual timing function, with the lever switch controlling the off and standby conditions. If a push-on, push-off type of switch is used, the Electronic Stop Watch will require less relearning on the part of users who are familiar with the ordinary mechanical stop watch.

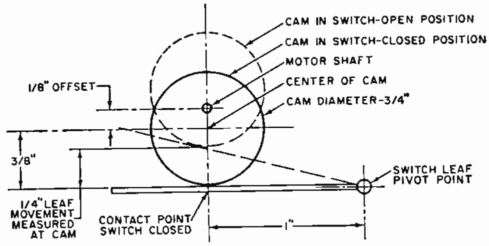


Fig. 3. Dimensions shown must be followed closely to insure correct cam and switch action.

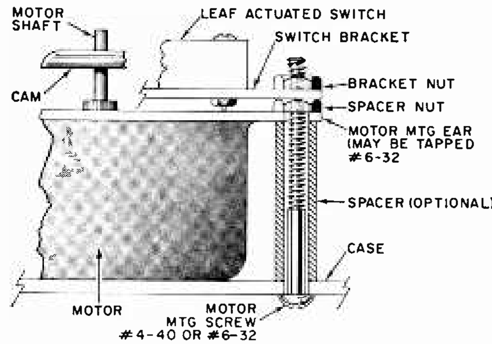
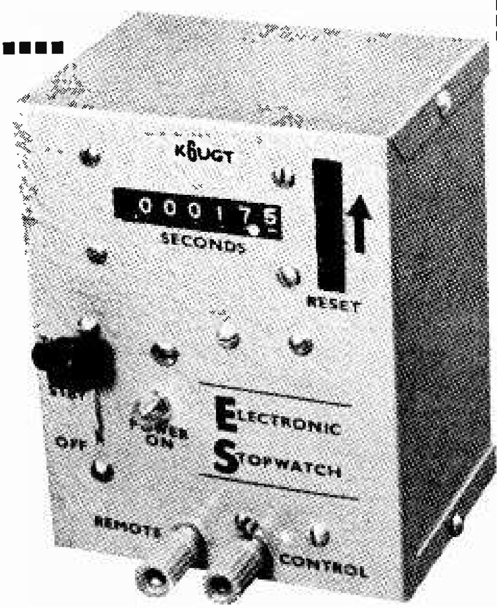


Fig. 4. Use of spacer tube and nut will avoid risk of bending motor case and misaligning cam.



The counter specified comes with a removable escutcheon plate that allows additional mounting flexibility; it was not used in the author's unit. In quiet surroundings, the counter is a bit noisy when it is running. If the sound is undesirable, insulate the counter from the panel with soft rubber grommets, and wrap the counter with a layer of styrofoam or foam rubber.

The filament transformer, relay, and *REMOTE CONTROL* terminals are optional parts, necessary only if you want to use the remote control feature. The

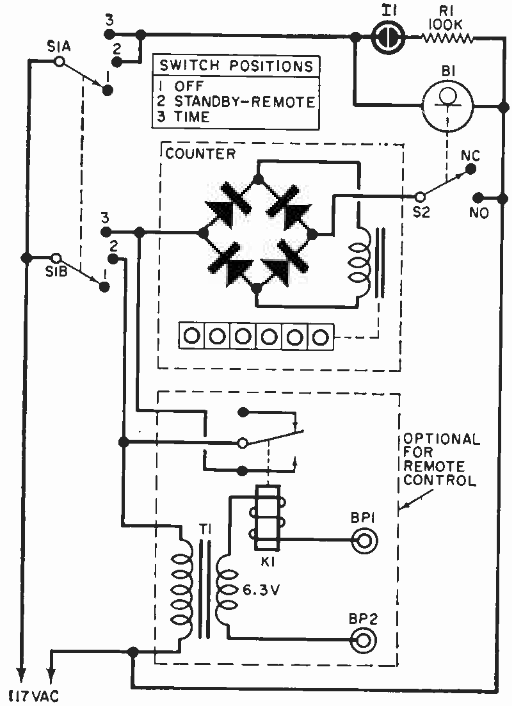


Fig. 5. Wiring is not critical but it must be kept clear of the cam and snap-action switch.

PARTS LIST

B1—600-rpm, 20-inch/ounce synchronous motor (Synchron Model 630, Herbach & Rademan, 1204 Arch St., Philadelphia 7, Pa., Stock No. HI-26, $4.95)*
I1—NE-2 neon panel lamp
R1—100,000-ohm, $\frac{1}{4}$-watt carbon resistor
S1—2-pole, 3-position lever switch, non-shorting (Centralab PA-7001 or equivalent)
S2—Miniature snap-action switch, with integral leaf (Acro 2CMD1-2AXX-A24)*
1—117-volt a.c., 6-digit type counter (Lafayette 99-9511)*
1—5" x 4" x 3" aluminum utility box (Premier PMC-1005 or equivalent)
Misc.—Line cord and plug, panel marking decals, sheet metal screws, machine screws and nuts, terminal strip

Optional for Remote Control

BP1, BP2—Insulated binding post
K1—6.3-volt a.c. relay (Advance GHA-1C-6AC or equivalent)
T1—6.3 volt, 0.75-ampere heater transformer
**Do not substitute for these parts. Equivalent items may be used for all other parts.*

parts are small, and can be added to the basic unit without difficulty. However, be sure to insulate the terminals and the contacts of relay *K1* from the box, if a metal box is used.

The motor may be mounted in any position. The four motor mounting ears can be tapped for *6-32* screws, or *4-40* screws and nuts may be used. Take care not to overtighten the screws as the thin motor case is easily bent. Spacers of aluminum or brass tubing can be used as mounting standoffs, as shown in Fig. 4, if desired.

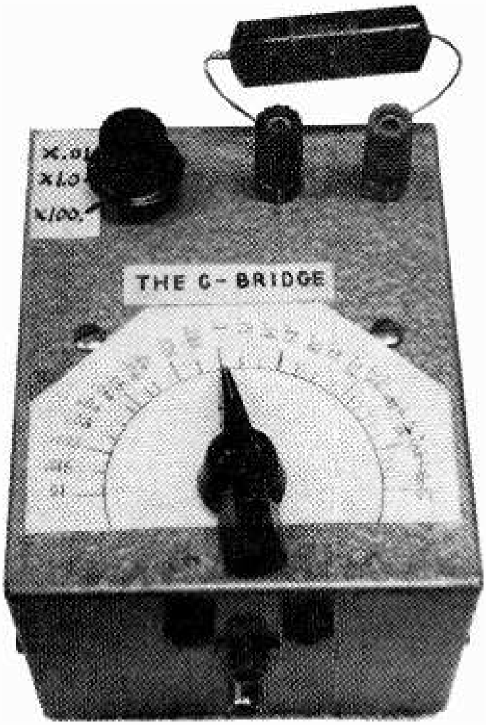
The cam consists of a heavy plastic button with a $\frac{1}{16}$" hole drilled $\frac{1}{8}$" off center. It should make a gentle force-fit on the motor shaft. Cement it permanently in position with epoxy or a similar strong adhesive.

Make a simple sheet-metal bracket to hold the snap-action switch in the required position with respect to the cam, as shown in Figs. 3 and 4. If you make elongated holes in the bracket, they will permit some adjustment of the cam-to-leaf spacing. Don't stray too far from the dimensions shown, or the motor may be stalled by excessive friction or mechanical interference.

Follow the schematic diagram of Fig. 5 when you are ready to wire the unit. There are no critical points, but it is advisable to mechanically anchor the wiring so that it cannot interfere with operation of the motor and snap-action switch.

Operation. The control switch is set to *STDBY* when timing operations are to be started. The motor reaches synchronous speed in about one second, and a rapid, quiet clicking of the snap-action switch will be heard. To start a timing operation, flip the control switch to *TIME* and leave it there until the event nears the finish. At the exact finish, flip the switch back to the *STDBY* position, and read the time in seconds and tenths of a second. To operate from a remote point, leave the unit in *STDBY*, close the remote switch to start, and open it to stop the timing operation. When the time has been read off, the counter is reset to zero by a few strokes on the thumb wheel.

The author's unit has timed events ranging from sprint races to recording time of long-play tapes, but you can undoubtedly come up with plenty of uses not mentioned here. —30—



C BRIDGE

By FRANK A. PARKER

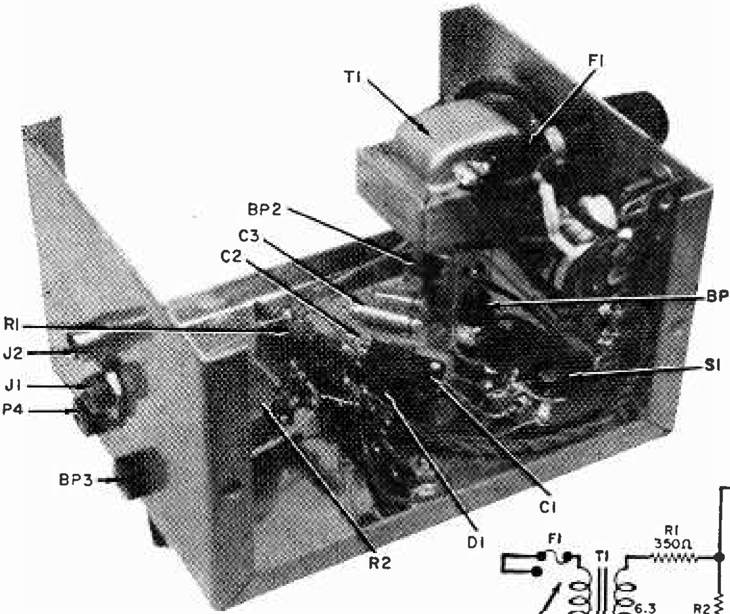
Having trouble reading the markings on your junk box capacitors? The C Bridge will enable you to measure them more accurately than the maker marked them.

MOST OF US have many capacitors gathering dust in the junk box because the markings can't be read. It's easy to measure the values of the unknowns if you have access to a capacitance bridge, but most such instruments come high, due to the wide range, sensitivity, and accuracy that must be provided in a laboratory instrument.

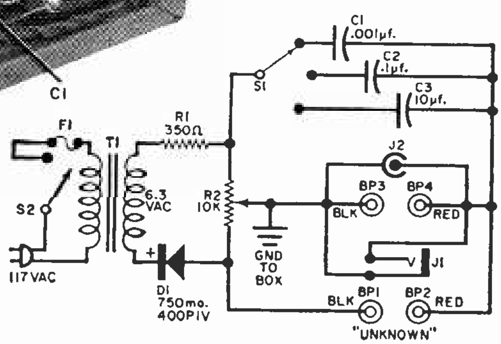
For those who can't afford so much frosting on their technical cake, the "C Bridge" will do the job very well. And you can make the accuracy high enough to yield far closer values than the maker puts on ordinary bypass and coupling capacitors. Best of all, since no sensitive null detector is built in, you can construct the C Bridge for about $12.00, even if you buy all new parts. If your junk box contains a few of the common parts needed, you can easily cut that cost in half.

How It Works. Any bridge works by comparing the signal voltage across the unknown part with the same signal across an adjustable known part that is accurately calibrated. The C Bridge is no exception, but by using a null indicator that you already have on hand, and making the a.c. line provide the bridge signal, a lot of the cost of the precision lab bridge is avoided.

The bridge circuit consists of potentiometer *R2*, the "known" capacitor selected by switch *S1*, and the unknown capacitor connected between binding posts *BP1* and *BP2*. Notice that *R2* actually forms two arms of the bridge



Label positions of range switch S1 "x.01," "x1.0," and "x 10.0." Use capacitors of known value singly and in parallel combinations to calibrate your C Bridge. By borrowing or buying a few 5% capacitors, you can give your scales greater accuracy.



PARTS LIST

BP1, BP2—*Universal binding post (one black, one red)*
BP3, BP4—*Insulated pin jack (one black, one red)*
C1—*0.001-μf., 200-volt silver mica capacitor—see text*
C2—*0.1-μf., 200-volt Mylar or paper capacitor—see text*
C3—*10-μf., 25-volt electrolytic capacitor—see text*
D1—*750-ma., 400-PIV silicon diode*
F1—*3/8-ampere, 250-volt type 3AG fuse*
J1—*Open-circuit phone jack*
J2—*Phono jack, RCA type*
R1—*350-ohm, 1/2-watt carbon resistor*
R2—*10,000-ohm, linear taper, carbon element potentiometer (Ohmite CMU-1031 or equivalent)*
S1—*Single-pole, 3-position rotary switch*
S2—*S.p.s.t. toggle switch*
T1—*6.3-volt, 0.6-ampere filament transformer*
1—*5" x 4" x 3" aluminum utility box*
Misc.—*Hardware, knobs, terminal strips, wire, solder, etc.*
Note: *Four 0.0001-μf. and four 0.01-μf. capacitors for use in calibration may be required if capacitors of known value are not at hand*

circuit, since its moving contact is grounded, and the signal is connected across the whole resistance element of *R2*.

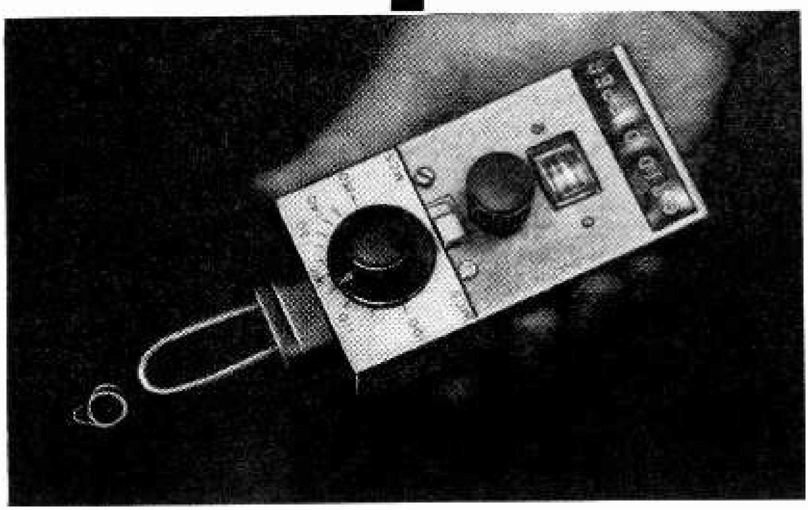
The signal? That's a harmonic of the 60-cycle a.c. line frequency generated by diode *D1*. It's mostly the 180-cycle third harmonic, since diode *D1* acts as a half-wave rectifier, but the exact frequency does not matter very much, as long as it can be heard in headphones or measured with a multimeter or VTVM. (The reason for not using the 60-cycle line frequency from the 6.3-volt secondary of transformer *T1* is that many inexpensive earphones don't reproduce a 60-cycle signal very well.)

The signal voltage across the known and unknown capacitors in series will be divided according to their relative capacities. By adjusting the arm of potentiometer *R2*, a point will be found where the voltage is the same as the voltage at *BP4*, the common point of the known and unknown capacities. In a pair of headphones plugged into *J1*, this will be heard as a "null" point, at which the signal disappears. Once the dial scale of the potentiometer is calibrated, the value of the unknown capacitor can be read from the scale as fast as you find the null point.

Construction. All parts of the circuit mount in the cover portion of the box. There is nothing electronically critical about the parts layout, but potentiometer *R2* should be located so that the calibrated scale can be made relatively large and easy to read. The writer's lay-

(*Continued on page* 152)

VHF GRID-DIP METER



Going to build some gear for working the VHF bands? VHF project construction can be a real pleasure if you build this gadget first—cost is under $10 with all-new parts, and it's a one-evening job

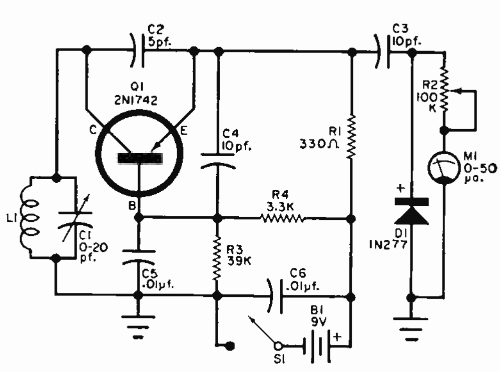
By **E. H. MARRINER,** W6BLZ

MOST OF US would like to build equipment for the VHF part of the spectrum, but find ourselves blocked by lack of a suitable instrument for adjusting tuned circuits to the desired frequency. A good VHF signal generator will do the job, but its cost will cause sharp, shooting pains in the region of the wallet.

The author found a way around this snag with a transistor version of the familiar "grid-dip" oscillator, which, though grid-less, works on the same basic principle.

About the Circuit. The VHF Grid-Dip Meter is a simple, self-excited oscillator, with a diode and microammeter so connected as to give a reading proportional to the emitter-to-base r.f. current. When the tuned collector tank circuit consisting of *L1* and *C1* is coupled to an external tuned circuit that is resonant at the frequency of oscillation, there is a sharp dip in the meter indication, similar to the dip in grid current of the tube version.

Construction. The VHF Grid-Dip Meter is assembled in an aluminum utility box



PARTS LIST

- B1—9-volt transistor battery (RCA VS 323 or equivalent)
- C1—4- to 20-pf. variable capacitor (E. F. Johnson Type 20M11)
- C2—5-pf. NPO tubular ceramic capacitor
- C3—10-pf. silver mica capacitor
- C4—10-pf. NPO tubular ceramic capacitor
- C5, C6—0.01-μf. disc ceramic capacitor
- D1—1N277 VHF semiconductor diode
- L1—VHF tuning inductor—see text
- M1—99-5026 50-μa. tuning meter (Lafayette Radio Electronics, 111 Jericho Turnpike, Syosset, L.I., N.Y.)
- Q1—2N1742 VHF transistor
- R1—330-ohm, ½-watt carbon resistor
- R2—50,000-ohm, linear-taper miniature potentiometer
- R3—39,000-ohm, ½-watt carbon resistor
- R4—3300-ohm, ½-watt carbon resistor
- S1—S.p.s.t. slide switch (Lafayette 99-6189 or equivalent)
- 1—4" x 2¼" x 2¼" aluminum utility box (LMB J-875 or equivalent)
- Misc.—#16 solid copper wire (for L1), hookup wire, ceramic standoffs—see text, etc.

with all parts mounted on the flanged half. This provides complete enclosure and shielding when the box halves are mated, but also permits easy access when a battery change is needed (which isn't often, incidentally).

As in all VHF devices, placement of parts and length of leads is important. Take particular pains to center the hole for tuning capacitor *C1* ¾" from the end of the box, measured on the outside. Take equal care to center the coil socket in the end of the box ⅝" back from the front panel surface (outside measure). If you use the specified part for *C1*, and make the coil as described below, calibration of your unit will closely follow that shown on the dial of the author's unit.

Mount the coil socket, tuning capacitor *C1*, switch *S1*, potentiometer *R2*, and meter *M1* first, since lugs on these parts support many of the other parts.

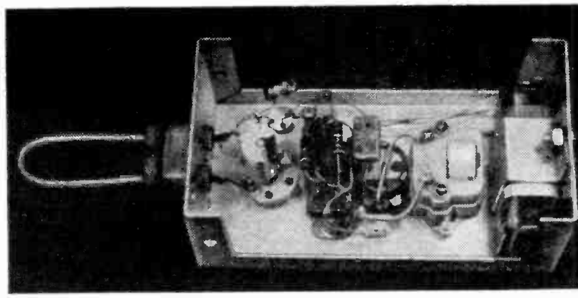
Note that *S1* is held in place by an internally threaded insulated terminal and a binding head machine screw at each end. Wire the small parts according to the pictorial diagram. Be sure to use a heat sink *every* time you heat a transistor lead, either by soldering to it or its supporting lug; a small wad of wet facial tissue gripped around the lead with a small alligator clip is good.

Note that capacitor *C6* is not shown in the pictorial. In practice, the capacity to ground through the ceramic standoff supporting the junction of *R1* and *R4* at one end of *S1* was enough for proper operation in the author's unit. If you use a different insulated terminal, better play safe by using *C6*, as shown in the schematic. It may be wired from the hot end of the standoff terminal to the ground lug.

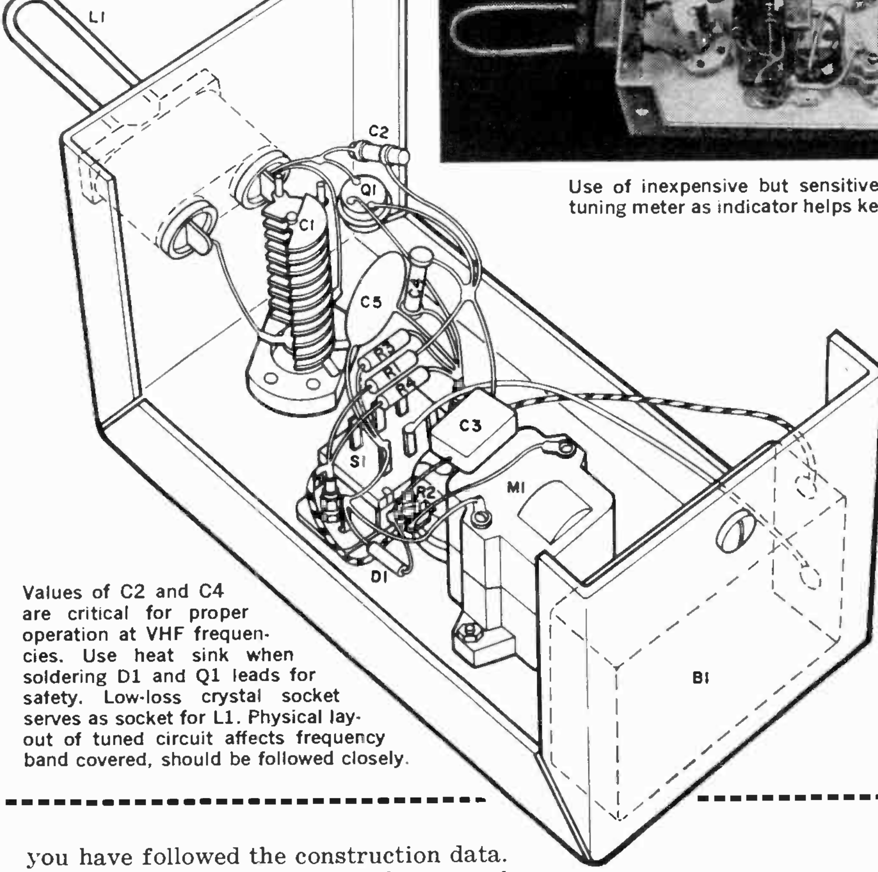
The sawed-off base of an FT-243 crystal holder serves as the base for *L1*, the tuning "coil," which is actually a loop of #16 solid copper wire. Make the loop ½" wide, with parallel sides, and trim the length to just 2" long from the end of the base pins to the end of the loop. Cover the exposed portion with sleeving of Teflon or polyethylene before soldering to the base pins.

Adjustment. Plug in the coil and set switch *S1* to the "on" position. The meter should read up-scale at once, and the amount of the deflection should be controllable with potentiometer *R2*. If this is not so, check for a wiring error, or defective transistor or diode.

Calibration near the low end of the range can be checked against an FM receiver. Tune in an FM station on a channel above 100 mc., hold the grid-dip unit loop close and parallel to one wire of the twin-lead at the FM receiver antenna posts, and tune the dipper slowly through its range. Near full engagement of capacitor *C1*, the output of the meter will be heard interfering with the FM station tuned in. Tune the meter exactly to the FM station signal, and mark the dial with the corresponding frequency. Do the same for other stations of known frequency that your receiver covers. Bear in mind that if your dipper tunes to an FM station on, say, 100.9 mc. with *C1* almost fully meshed, it can't be far from 150 mc. with *C1* fully unmeshed, if



Use of inexpensive but sensitive uncalibrated tuning meter as indicator helps keep cost down.



Values of C2 and C4 are critical for proper operation at VHF frequencies. Use heat sink when soldering D1 and Q1 leads for safety. Low-loss crystal socket serves as socket for L1. Physical layout of tuned circuit affects frequency band covered, should be followed closely.

you have followed the construction data. If you are a 2-meter ham (or have a pal who is), check the dipper against the receiver calibration, and so on.

Operation. Once calibrated, your VHF Grid-Dip Meter serves both as a signal source and means for determining the resonant frequency of tuned circuits in its range. Want to trap out a local FM station on 106.9 mc. so you can receive that distant station on 107.3 mc.? A trap series-resonant at 106.9 mc. across the receiver input will do the job. A short length of small coil stock of the "Airdux" kind and a low-value trimmer capacitor (15- to 20-pf. max.) will do.

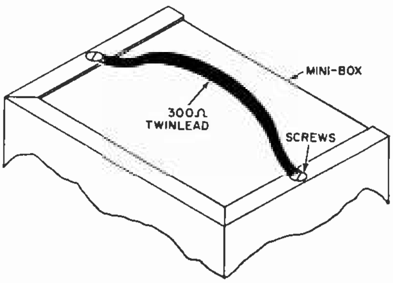
Connect the coil and trimmer directly (no extra leads) in parallel with each other. Couple the loop of the dipper to the trap circuit by holding it near the end of the coil, and watch the meter while tuning the dipper slowly through its range. At the resonant frequency of the trap, the meter will show a sharp dip. Be sure to adjust *R2* as needed to keep the meter indicating nearly full scale, so the dip will show clearly.

When the dip is found, reduce the coupling between the dipper loop and the trap circuit, and carefully find the center of the dip; read the resonant frequency of the trap from the dipper dial. Tune the trap trimmer over its range to resonate the trap at 106.9 mc. if possible. If necessary, trim the coil value, and try again, until you hit the frequency of the unwanted station. Now reconnect the trap coil and capacitor in *series* across the FM receiver input, and make final adjustment for minimum signal from the unwanted station. -30-

The Best of TIPS & TECHNIQUES

HANDLES FOR MINIBOXES

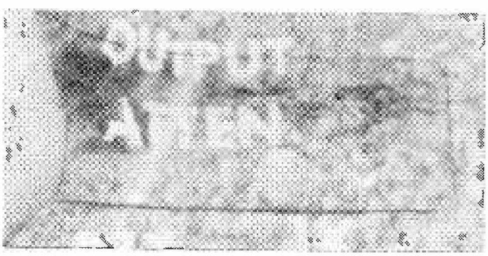
Good-looking, sturdy handles for units built into Miniboxes can be made with pieces of 300-ohm TV twin-lead. Determine how long the handle should be, cut the twin-lead to length, and punch a small hole at each end through the center of the insulation. Fasten



the handle in place with two of the screws that hold the box together. If the unit is rather heavy, a stronger handle can be made by cutting the twin-lead a bit longer than needed, stripping off some insulation at each end, and twisting and soldering the two conductors together. —*Jay Prager*

CHANGING PANEL DECALS WITHOUT TEARS

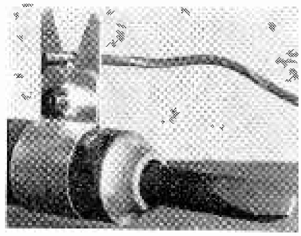
Ever wish you could change some of those decals you put on the panels of your home-brewed electronic masterpieces? It happens to all of us when we modify a unit, or think of a better name. If this is your problem,



place a strip of fresh cellophane tape over the decal and stick it down well, leaving one end free. Then remove the old decal by pulling the tape directly out and away from the panel. It may take two or three pieces of tape to remove stubborn old decals completely. —*Stanley E. Bammel*

WIRE STRIPPER FOR PLASTIC INSULATION

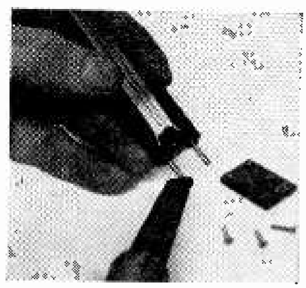
A handy wire stripper for plastic-insulated hookup wire can be made from a strip of sheet copper with a V-shaped slot in one end as shown in the photograph at right. Bolt the copper in place and allow the iron to heat. The insulation to



be removed is laid in the "V" and rotated. The heat will make a clean break in the insulation and permit it to be easily removed by simply sliding it off the wire. —*Milton F. Dickfoss*

PLUG-IN CONNECTOR FOR 300-OHM TWIN-LEAD

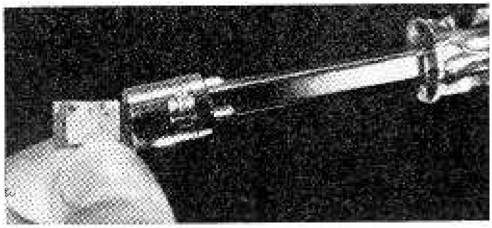
Connectors for 300-ohm ribbon transmission line can be bought at reasonable cost, but there are plenty of times when you need one right away, and the shop shelf is bare. If you have a spare crystal holder of the FT-243 variety, the problem is easily solved. If the crystal is still in the holder, disassemble the unit and remove it. Heat each pin with the soldering iron and shake



or blow out excess solder. Use a file to cut a groove in the Bakelite portion of the holder just wide and deep enough to fit snugly over the twin-lead you are using. Next, strip the conductors of the twin-lead back ⅝" to ¾", clean and pre-tin them. Push them fully home in the crystal holder pins, solder, and reassemble the holder. Any standard crystal socket serves as a female connector on the receiver chassis. —*Waldo T. Boyd*

EMERGENCY OR SPECIAL SCREWDRIVERS

If you carry a screwdriver to fit every width and length of screw-slot you encounter, you'll find that they can crowd other items out of the tool box. Here's a way to obtain those special sizes you need without having them bulge over the sides of your tool kit. Cut some short driver blades from 1/16"

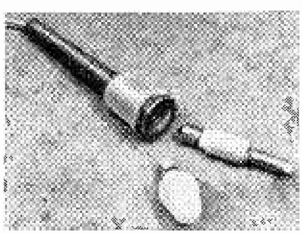


steel and grind the opposite edges parallel so that each blade is a snug push-fit in one of your hex-nut drivers. Then grind the end to leave 1/8" to 3/16" projecting. Finally grind the tip to the thickness you need for those special narrow or broad screw-slots.

—*Ken Murray*

EXTRA "LAMP HANDEE"

Here's an old trick, but one so useful that it's worthwhile rehashing. It's easy to see into those dark chassis corners if you have a spare Ungar "Standard Line" soldering iron. This is the common type of iron that comes equipped with

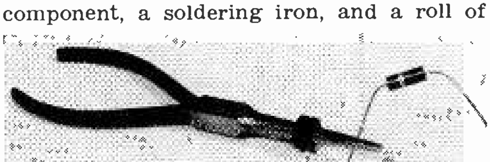


several screw-on heating units of different wattages. The thread is the same as that for the base of a standard 7-watt decorative light bulb. For less eye strain, all you have to do is to screw one of these bulbs into the soldering iron, in place of a heating unit.

—*Steve Brant, K8VII*

ANOTHER KIND OF THIRD HAND

If you're suffering from the same old problem of not having enough hands to hold a component, a soldering iron, and a roll of

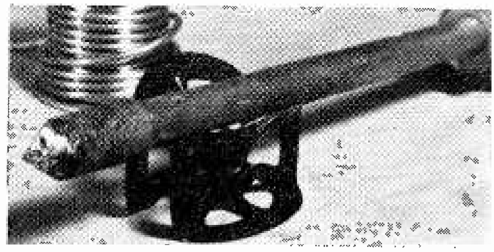


solder (unless, of course, you use your teeth!), try this idea. Slip a small rubber grommet over the end of a pair of needle-nose pliers and use them to hold the component. This "third hand" can also be used when you solder transistors, diodes or other small parts requiring a heat sink.

—Charles Caringella

RIBBON REELS BECOME SOLDERING IRON STANDS

Worn-out typewriter ribbons should be discarded, of course, but you might want to keep the reels they come on. You can make handy holders for soldering irons from this

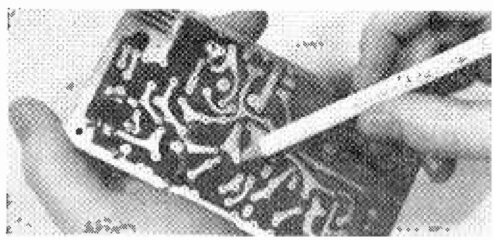


type of reel. All you have to do is bend the reel to resemble the one shown in the photo.

—Wayne Floyd

ERASER CLEANS CIRCUIT BOARDS

If you've ever faced the problem of having the foil separate from a printed-circuit board when you attempt to solder it, this tip is for you. Before you start, carefully clean the copper foil by rubbing it with a typewriter eraser like that shown. The eraser has the correct amount of abrasive, and removes oxidation and dirt so that



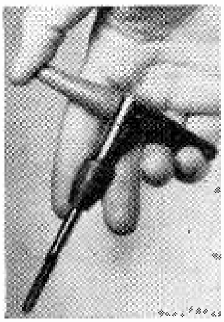
joints can be rapidly tinned and soldered. Incidentally, this technique is recommended by NASA for high-reliability soldering of satellite components.

—Kent A. Mitchell, W3WTO

IDENTIFYING TRANSISTOR TYPES

Painted-on transistor type-numbers often wear off with repeated handling, and many transistors, especially those of the general-purpose variety sold to experimenters, are not marked at all. If you do a lot of breadboarding of circuits, you'll save yourself considerable time and trouble by scratching type numbers and/or other data such as "a.f." or "r.f.," and *"pnp"* or *"npn,"* on the outside of each transistor case with a sharp instrument. —*Stanley E. Bammel*

IMPROVING COMFORT OF TAP WRENCH HANDLE

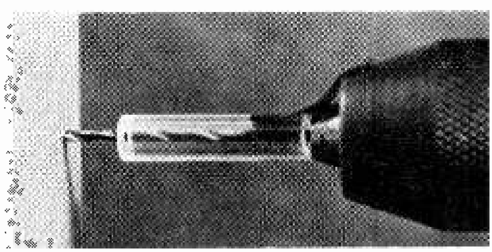


The ordinary tap wrench can be pretty wearing on the hands when many holes must be tapped in hard or tough metal. In a pinch, slide a pair of large rubber battery clip sleeves over the two halves of the wrench handle, as shown. They can be taped or tied in place if desired, and will help prevent the development of blisters when a lot of tapping must be done.

—*Jerome Cunningham*

SLEEVE PROTECTS AGAINST DRILLING DAMAGE

If you find it necessary to drill holes in delicate pieces of electronic equipment, protect them from damage by using a piece of polystyrene tubing over the bit as shown in the photo. The tubing, which can be

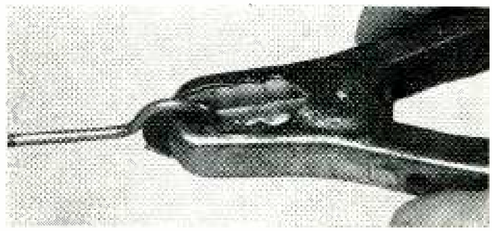


taped to the drill chuck to hold it in place, will keep the bit from plunging through the hole when the metal gives way, and then striking and damaging delicate components on the other side of the panel.

—*Stanley E. Bammel*

BATTERY CLAMP SERVES AS SELF-GRIPPING PLIERS

A large battery clamp can be a handy tool for turning TV lead-in stand-off insulators; as a bonus, it will hang onto the stand-off if you have to let go. Such a clamp can also help in turning wing-nuts and thumbscrews, and in getting those pesky caps off

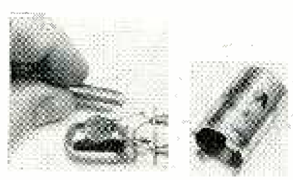


bottles of coil dope and speaker cement. And as a "third hand" for holding together two parts to be soldered, it's hard to beat.

—*Joseph Carroll*

FLUORESCENT STARTER REPAIR

The starters in fluorescent light fixtures seldom outlive the fluorescent tubes. This is almost invariably due to the failure of the poor-grade capacitor used in the starter. When the starter goes, the tube blinks on and off, or doesn't light at all. To repair the starter, open its case by bending back the lugs holding the aluminum shell to the fiber base. Clip out the paper-foil capacitor and discard it. Substitute a 600-volt, .01-μf. ceramic disc capacitor for the original capacitor if the light uses a 15-20 watt fluorescent tube. For a light using a 30-40 watt tube, install a .005-μf., 600-volt ceramic disc capacitor. Then reassemble the starter, making sure that the capacitor leads do not short to the aluminum shell.



—*Bert Isbell, K5IBZ*

FOOT PADS FOR HEADPHONES

Nothing beats a pair of ordinary, inexpensive magnetic headphones for general utility use, but they can become very uncomfortable if you wear them for any length of time. If copying code or trying to snag rare s.w. stations is your meat, get a couple of foam rubber callus cushions to attach to your headphones. Although these pads are intended to ease foot problems, they'll do a good job on your ears, too!

—*John A. Comstock*

Crystal Super Calibrator

(*Continued from page* 90)

broke," and complete the final assembly, or you can hook everything up on the bench with clip leads and make sure it works before assembling the unit in the box. If it doesn't oscillate, recheck everything, particularly the transistors.

When you're ready, mount the circuit board on the inside of the prepared box cover, taking care to space it clear of the cover with quarter-inch spacers, or with extra nuts on the mounting screws. Put the cover on, and complete the wiring to the battery, on-off switch, and the output binding post. Last, connect the two wires going to the crystal and padder capacitor, put on the second cover, and you're ready to fire up.

Adjustment. To adjust for zero beat with WWV, tune in the 10-mc. transmission (or the 5-mc. signal if you can't hear the 10-mc. signal at your location). Couple the output of the calibrator to the receiver antenna, either directly or through a small capacitor, and fully mesh the padder capacitor plates. Then back off on the padder slowly, listening as the beat note gets lower, until zero beat is reached.

When the frequency difference between the calibrator harmonic and the standard signal gets down to a few cycles, a regular oscillation of the receiver signal strength meter will be seen. This indication is more sensitive than the audible one, and permits adjustment to within one cycle per second or better! If you adjust your calibrator this carefully, the harmonic will be within 15 cycles of the correct frequency, even at 150 mc!

Bear in mind that, while the unit will function with a 1.5-volt, one-cell battery supply, it will also operate on higher voltages (safely to at least 10 volts), and will give commensurately greater output, at some small sacrifice in thermal stability. And you can even use an a.c. power supply running off the receiver heater circuit, as shown in the schematic, if the few milliamperes of battery drain worry you. —30—

C Bridge

(*Continued from page* 142)

out is convenient, but need not be followed exactly.

First drill and deburr all the holes needed for mounting the parts. Note that in the unit shown the transformer, line fuse, and a neon pilot lamp (optional) are all mounted in one end of the box, with all connections for the null detector at the opposite end. One of the two terminal strips is mounted near the center of the box lid, and supports *D1*, *R1*, and the common ends of capacitors *C1*, *C2*, and *C3*. Use a heat sink when soldering *D1*.

Standard capacitors *C1* and *C2* can be bought in 10%, 5%, 2%, or even 1% tolerance. The 5% tolerance is recommended for *C1* as the best compromise in price and accuracy. For *C2*, the saving for the 10% tolerance may be enough to be worthwhile. Capacitor *C3* is actually made up of two small 25-w.v.d.c. electrolytics in parallel. This was necessary in order to bring *C3* to within the desired 5% accuracy, since ordinary electrolytics are not made to close tolerances. The writer found that two Sprague Type TE capacitors marked 6 and 2 μf. totaled 10 μf. when paralleled.

An optional neon pilot lamp was included in the writer's unit. If you wish to add this feature, connect a plastic-encased NE-2A (or similar) neon lamp in series with a 200,000-ohm, ½-watt carbon resistor across the primary of transformer *T1*.

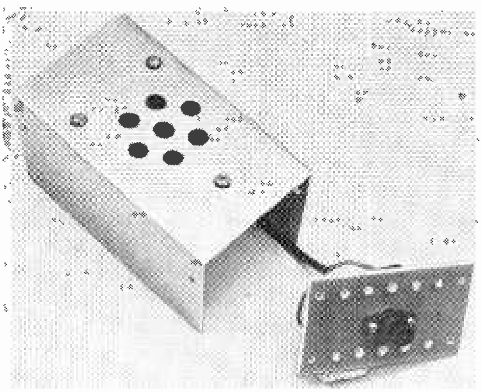
Calibration. The C Bridge is calibrated by connecting known values of capacitance across the "unknown" binding posts, adjusting potentiometer *R2* to the null point, and marking the position of the knob pointer with the value of the known capacitor. To do this, connect the null detector by plugging it into the appropriate jacks (*J1*, *J2*, or *BP3* and *BP4*), and plug the C bridge into the a.c. line.

You can use high-impedance phones, a VTVM, or best of all, an amplifying type a.c. VTVM as null detector. —30—

Car Battery Saver

(*Continued from page* 55)

Mounting the Battery Saver. After determining the polarity of your car's electrical system, choosing the proper circuit and constructing the Battery Saver, the last step is to mount it in the car and hook it up. One self-tapping screw will secure the case in any location you choose. When it is in place, connect the ground lead under a bolt on the dash or to any metal that is in common potential with the frame of the car. Connect the ignition wire to the cold accessory side of the ignition switch. This is the terminal normally used for a radio or other accessories. Turn on the ignition as a test; nothing should happen. Connect the other lead to the headlight switch on the side that goes to the headlights, or again, the "cold" side of the switch. With the switch off, no voltage should be measured. Then, with the ignition switch on, turn on the headlights. Still nothing should occur. However, when you turn off the ignition with the headlights on, your Battery Saver will come to life with a loud blat.



You can mount finished unit in almost anything, even plastic soap dish. This one fits in Minibox.

You have built, tested and installed a device that will save you considerable trouble. Of course, the acid test comes when you trade cars. Which do you pull out first: the Battery Saver or those new tires? —30—

The WXCVR

(Continued from page 97)

ground lug bolted on the left end of the cover. Run a fairly heavy, solid wire from terminal 1 to the grounded mounting foot of the 3-lug tie strip. Use similar wire for the balance of *T1*'s connections to insure adequate support for the transformer. A study of the illustrations will reveal how the rest of the components are mounted and wired.

Antenna Tips. Don't skimp on the skywire if you want topnotch performance from the WXCVR, for long wavelengths need long antennas. Within 50 miles of an FAA station, a 25′ antenna will probably be sufficient. However, if you want to reach out for distance, put up at least 50 feet of wire, and install the antenna as high in the air as possible.

For best results, use a cold water pipe or a rod driven into moist earth for the ground connection. If you can't conveniently do this, simulate a ground by connecting 20 or 30 feet of wire to the ground terminal of *TS1*. Put this wire on the floor under a rug, or run it along the baseboard.

Adjustment. After temporarily taping *L3* to the case of the radio the WXCVR is to work with, adjust the slug until ¾″ of the slug screw extends outside the coil form. Should the receiver have no built-in loop, but, instead, require an external antenna, wrap a couple of turns of insulated wire around *L3*, strip the opposite end of the wire, and connect it to the radio's antenna terminal.

Add 1150 kc. to the frequency of your nearest FAA station as listed in the table. Tune the receiver to the sum of the two frequencies, which will lie somewhere between 1350 and 1550 kc. With antenna, ground and battery connected to the WXCVR, and *S1* switched on, slowly adjust the slug of *L2* until the carrier generated by *Q1* is heard in the radio. If you hear more than one carrier during this adjustment, pick the strongest.

Now retune the receiver dial to 1150 kc. If a strong broadcast station occupies this spot, move over to 1140 kc. or 1160 kc. Adjust the slugs of *T1* and

L3 for maximum noise, hiss, or static. With ordinary luck, you will already be hearing the weathercaster's voice. If not, slowly move *L2*'s slug back and forth until you encounter the desired signal. Touch up *T1* and *L3* for maximum volume.

As you align the converter, you will probably hear what sound like slow speed code stations. These are airways and marine beacons, many of which operate on the low frequencies. You will also hear a Morse code identification signal under the voice of the weathercaster. Tweak the receiver dial slightly to accentuate the voice and discriminate against the beacon tone.

If you want to explore the band from 200 to 400 kc., slowly tune *L2*'s slug through its adjustment range. As you discover interesting signals, repeak *T1* for best reception.

Final Installation. With adjustment on the desired FAA station completed, machine screws can be used to fasten the rear cover of the converter to the back of the receiver. Fasten *L3* in place after finding the position which provides maximum signal transfer to the receiver's loop. To avoid the danger of shock when working with an a.c.-d.c. set, be sure that the converter's mounting screws and other parts do not make contact with any metal parts of the receiver. Apply plastic electrical tape to all screws that protrude from the receiver's case.

Readers located beyond the range of an automatic weathercaster need not despair. Similar information is transmitted at half-hour intervals on many other low-frequency channels. A complete list of all FAA radio facilities is contained in the *Airman's Guide*, available for about 75 cents (the price varies) from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.; since a new issue is published every two weeks, you may be able to wangle a copy for free at the local airport. The station list is also given in *Weather Services For Pilots*, also available from the Superintendent of Documents (for 10 cents), but this pamphlet is not so frequently updated as the *Airman's Guide*. —30—

Pickup Pranks

(*Continued from page* 31)

or other rotating member that can be reached with the pickup. The magnet need not be large—a more sensitive meter can be used if the signal is low. Care should be taken to anchor the magnet firmly as near as practical to the axis of rotation, since the centrifugal force developed at high speed could cause the magnet to break loose with consequent damage. Any clamps used to hold the magnet or pickup should be made from nonmagnetic aluminum.

Calibration. If you're interested in actual rpm rather than relative speed, calibration can be accomplished with an oscilloscope and audio generator hooked up as indicated on page 31. With the motor running at low speed, adjust the frequency of the audio generator until a *single* trace appears on the oscilloscope screen. Read the generator frequency and multiply by 60 to convert to rpm.

Increase engine speed and repeat for several readings: plotting the results should give you a "scatter" of points that fall on both sides of a straight line. The graph thus plotted may be used to convert any meter reading to rpm, or a new meter scale may be made to overlay the existing scale.

Code Practice Oscillator. Oscillation requires positive feedback. By placing the pickup in the inductive field of *its own amplifier,* oscillation will result and can clearly be heard through the speaker. By putting a key in series with the pickup, dots and dashes can be made. Here again, the transistor amplifier with its relatively low impedance requirement does a better job than a typical radio audio amplifier. It may be necessary to couple to the back of the speaker for better sensitivity. Also, changing the position of the pickup will very often change the pitch of the oscillation.

A pickup can also be used as a hum-finder. Simply connect it to a high-gain amplifier and use it to trace a.c.-carrying circuits.

There are, no doubt, many other practical applications for this simple inductive coil, and the price is low! -30-

2-Meter Simple Superhet

(*Continued from page* 119)

As with any other construction job, it is important to do all cutting, drilling, and deburring before beginning assembly. You'll probably find it easier to wire the tuned circuits connecting to *V1* before wiring the other stages.

Testing and Calibration. When assembly and wiring is completed, carefully check all connections against Figs. 3 and 5 before firing up. That done, plug into the a.c. line, turn on the set, and allow a 10-minute warm-up. Set the *GAIN* control to maximum and increase the *REGEN* control setting until you hear the typical superregenerative detector hiss from the speaker.

Before aligning the front end to cover the 2-meter amateur band, it's necessary to align the second detector to the 6-mc. i.f. channel. First, make an approximate adjustment of *L3* by turning the slug screw until about ¼" is exposed above the lock nut on the can. If you have a generator that will provide a 6-mc. signal, apply it to the coax antenna input, back off the *REGEN* control until the hiss just disappears, and adjust the slug in *L3* for maximum output from the speaker. This puts the detector circuit on 6 mc.

To align the front end when no generator covering the 2-meter band is available, set trimmers *C3* and *C7* to about half capacity, and main tuning capacitor *C2* at a little more than half capacity. Connect a good 2-meter antenna to *J1*, and adjust oscillator trimmer *C3* until 2-meter amateur signals are heard. On a medium strength ham signal, adjust *C7* for maximum gain.

If you have a generator covering 2 meters, connect it to *J1* and set it to give a modulated signal at 145 mc. Turn up the *REGEN* control until you hear the hiss, and adjust *C3* with a nonmetallic screwdriver until you hear the generator signal.

Finally, adjust *C7* for maximum signal output while rocking the main tuning capacitor slightly. This adjustment is necessary because changing *C3* affects the oscillator frequency. —30—

Ceramic Tile Enclosure

(Continued from page 71)

treble diffuser added. One method that works well is an inverted plastic funnel (as used in the "Drainpipe 8" enclosure —see the 1963 ELECTRONIC EXPERIMENTER'S HANDBOOK).

Egg Tray Diffuser. Another type of diffuser, shown on p. 71, has the advantage of being adjustable, and the multiple convex surfaces insure wide diffusion. It is made from half of a plastic refrigerator egg tray (sold in dime stores for about 29 cents), an eye bolt, and a strap that electricians use for fastening down electrical cables.

The egg tray is cut in half and a hole drilled in the remaining end to match the size of the eye bolt. A nut is then placed on each side of the plastic tray end to clamp it in place; again, sealant is called for.

The small strap will have to be drilled out on one side to allow it to fit the ¼" threaded rod as shown. If you're planning to use this diffuser, the strap should be installed at the time the speaker board is tightened, substituting it for the washer. After the diffuser is mounted, a screw should be put on the other end of the strap.

If you use this diffuser, you may want to "dress up" the system. Decorator burlap or even grille cloth can be glued directly to the outside of the tile. Alternatively, a light frame could carry the grille cloth up around the diffuser and hide it, or a frame could be built around the entire system which could then be encased in grille cloth.

The Word Is "Crisp." Not everyone will like this speaker system. One listener, for example, said he preferred his own, because it was more "mellow." But it's wise to be suspicious of that word. "Mellow" usually suggests hangover, and this in turn means transient distortion. A poorly braced cabinet can produce it in great quantities.

"Crisp" is the word for the kind of bass produced by this little enclosure. If you like your bass crisp and you aren't flush with either space or money, this system is for you! —30—

The Cloud Sentinel

(*Continued from page* 10)

can be used to power the amplifier and thereby increase amplification.

You can experiment with different values of *R2, R5,* and possibly *R4* for even better results. Because current drain on *B2* is only about 3 ma., smaller batteries can be substituted for *B2*. Possible transistor substitutions include experimenter's *pnp* types such as the 2N107. All switches can readily be changed, as can potentiometer types and values.

Antenna-Ground System. The antenna shown in the photograph on page 10 is made with seven 10″ lengths of #14 bare copper wire filed to points at the top, and soldered together at the bottom. The wires are fitted into a hollow oiled block of wood which insulates them from the mast and supports them so that they point upward. Connect a length of #14 insulated copper wire to this assembly, and bring it down the antenna mast to the base, taping it to the mast at suitable intervals.

A 6′ length of ½″ galvanized steel pipe driven into the ground near the base serves as a ground. Use microphone cable to connect the antenna and ground to the Cloud Sentinel, soldering the antenna lead to the center conductor. Connect galvanized ground wire to the ground pipe, and then to the base of the antenna mast; solder the braid of the microphone cable to this wire.

Be sure that these connections are electrically and mechanically sturdy, then bury the length of microphone cable leading away from the mast in a trench at least 10″ deep for a minimum distance of 30 feet. Finally, bring the end of the cable above ground and connect it to the Sentinel.

Calibration and Use. To calibrate the Sentinel, turn it on, rotate *R4* until the meter is zeroed for ambient temperature, close *S1,* and adjust *R3* until the desired amplification factor is shown on *M1*. Connect the antenna and ground and throw *S3* to *ANT*. If the meter reads down-scale, throw *S3* to the *GND* position. During use it will be noted that the meter will frequently deflect down-scale—this shows a temporary reversal of current flow in the antenna-ground circuit and is in no way unusual.

In operation, it will be found that as an electrical storm approaches the meter pointer will wander—aimlessly at first, then rather animatedly as the storm nears. If the storm is at a distance of 15 miles or more, it will normally be impossible to hear the thunder, but the meter will show lightning discharges as fast drops in readings following rather slower build-ups.

As the storm approaches, the pattern continues, but it will be necessary to shunt the meter because peak currents of several microamperes will flow. Typical lightning flashes will be read as increasingly rapid rises in current followed by very sharp drops—possibly necessitating reversing the *ANT-GND* polarity. With some experience, it will be possible for the operator to predict quite accurately both the instant and intensity of each stroke.

Another interesting phenomenon which will be noted is that variations in the temperature of the surrounding air alter the no-signal (zero) position of the meter—up-scale for warmer, down-scale for colder. Temperatures can change very quickly during thunderstorms, and for this reason, zero and calibration should be checked every few minutes.

The Cloud Sentinel can also be used in clear weather to measure what are known as "fair weather currents." During thunderstorms you will note that electron movement is normally from air to antenna to ground. In fine weather, a reverse flow will be registered, but at considerably reduced readings and with the possible need for extended antenna height.

Safety Precautions. The Sentinel is considerably safer than most installations using an antenna. However, the following rules should be observed for absolute safety:

(1) Limit antenna height to 20 feet for monitoring local thunderstorm activity.

(2) Locate the antenna mast near a building or other tall object so that the antenna is within the object's "cone of protection."

(3) Lead the microphone cable away from the antenna by burying it in a covered trench at least 10" deep and 30" long.

(4) Operate the Sentinel indoors—in a house, garage, or dry shed.

(5) Should lightning begin striking within two miles of your operating position, suspend operations until the storm passes out of this range.

(6) Ground the base of the antenna mast to the nearby ground.

At first glance it may seem that the above precautions go to mollycoddling extremes. This may be true, but it is strongly recommended that they be observed—they could possibly save your life!

Although parts for the Sentinel catalog at about $13 (including $4.95 for the meter), judicious use of junk box parts and substitutions can cut this total down considerably. The completed unit can also be used as a sensitive laboratory instrument for measuring tiny currents. The amplifier will prove to be quite linear for all factors of amplification if the meter has been accurately zeroed and calibrated prior to use. —30—

Two-Tube Superhet

(*Continued from page* 94)

ing slug screw of *L1* to ½" above the shield can, and the slug screw of *L2* ⅜" above the shield can; this should bring the adjustments in the vicinity of 80 meters, and you can readjust on received signals.

A ground connection will probably improve reception, and is also advisable if you use *C18* and *C19* across the power transformer primary, as otherwise the chassis will be slightly "hot" to ground. If you have no trouble with line noise or transmitter r.f. into the receiver, *C18* and *C19* can be omitted. The author used a hank of stranded insulated wire about 20 feet long as an antenna and an inexpensive imported type of crystal headset (Lafayette 99-2550 or equivalent) for reception.

The c.w. signals are received with the detector *REGEN* control set just above the point of oscillation and the *GAIN* control low enough to prevent detector overloading. Phone signals are received by setting the *REGEN* control just below the point of oscillation. With a little trial and error, you'll find you can hear just about any signal on the band that anyone else can hear, and without straining your ears, either. -30-

Telephone Beeper

(*Continued from page* 38)

Any standard potentiometer will do if the box you use has room for it. (If the adjustment of *R2* is too touchy, use alternate 10,000-ohm unit specified.)

The time interval between beeps is controlled mainly by the relative values of capacitors *C1* and *C2*, and resistor *R1*. Increase the resistance of *R1* if the interval is too short, decrease *R1*'s resistance if the interval is too long. If "chirp" is evident, readjust *R2*.

The speaker specified in the Parts List will fit in the plastic box used by the author. If a larger enclosure is used, any 3.2-ohm speaker will be satisfactory.

Construction. The construction of the Beeper may be varied to suit the builder, and wiring placement is not at all critical. The author used a perforated board, with components on top and point-to-point wiring and jumpers underneath. A cutout in the board accommodates the speaker frame. A single screw and spacer support the circuit board in the box. Small holes may be drilled in the box in the area of the speaker, or (as in the author's unit) a piece of perforated aluminum can serve as a grille to cover a cutout opening. The speaker itself is supported by four screws.

A simple retainer clip fashioned from 1/16"-diameter piano or coat-hanger wire is formed to fit around the mouthpiece of the particular telephone you intend to use (since the size of the mouthpiece is different for different-style handsets). A piece of foam rubber or plastic may be shaped with a razor blade to form a cradle for the mouthpiece, as well as to provide a "spring" force holding the phone snugly against the wire clip, which fits into the mouthpiece groove. The ends of the wire clip fit into small holes in the side of the box.

Switch *S1* is mounted with two screws, and wired to two battery connectors (which may be salvaged from discarded 9-volt batteries) in series. The batteries can be wedged into position by the circuit board, or held in the box with a bracket or cement. Spray-painting the box after assembly will improve the appearance, and title decals will add the finishing touch.

Operation. When the Beeper is in use, the first beep will be heard about 30 seconds after the switch is turned on. Thereafter the beeps will be heard at approximately 15-second intervals. To test the Beeper, temporarily connect a 10,000-ohm resistor across *R1*; this should increase the beep rate. Current drain is only about 2½ ma., so the batteries should last over 200 operating hours with normal intermittent phone use.

If you regularly record telephone conversations of technical discussions, business transactions, long-distance family calls or for any other purpose, the Telephone Beeper will be a useful accessory to remind the party at the other end that he is being recorded, and may also prevent you from being charged with unlawful recording. The investment is small, the inconvenience slight, the result worthwhile. —30—

40-Meter Antenna

(*Continued from page* 112)

higher than the ends to fit in the available space. If your TV antenna mast is not high enough for the purpose, you can add a length of mast to it above the TV antenna.

Modifying the Guy Wires. Insert an egg-type strain insulator (which is stronger than ordinary antenna insulators) in the pair of guy wires where they are fastened to the mast. Then determine the exact length of each half of the antenna (*L1* and *L2* in the diagram) for the desired frequency with the formula: $Length_{ft.} = 234/Freq._{mc.}$, which works out to 32′ 7″ for 7.175 mc., the center of the 40-meter Novice band. Both *L1* and *L2* should be cut to this length if you want to operate around this frequency.

Now measure off the desired lengths from the center insulators and insert another strain insulator at each measured point. If your transmitter power is much over 100 watts, it might be wise to use two strain insulators in series at these points for increased insulation.

Finally, solder the inner conductor of your coaxial feedline to one side of the antenna at the apex and the outer shield to the other side. Tightly tape the end of the cable to keep moisture out of it, and drop the cable down the pole, along the roof, and into the radio room.

Don't worry about the guy wires not being copper; they will radiate okay. But you might insert strain insulators in the unused guy wires at 10′ intervals for slightly improved results. -30-

Stereo Indicator

(*Continued from page* 75)

ture is connected to the frame, and in the case of the stereo indicator, it's necessary to keep it off ground.

Connect a multimeter or VTVM across diode *D1*, and tune in a stereo signal. A negative potential of about 0.5 volt d.c. will appear across the diode with respect to ground. If no stereo signal is available at the time, a 19-kc. signal from the audio oscillator can serve as the input. Set the audio oscillator to provide a signal of 0.5 to 1.0 volt or so, and tune coil *L1* for maximum voltage across *D1*. The input sensitivity of the stereo indicator is about 0.03 volt r.m.s. at 19 kc.

Potentiometer *R7* is a level or threshold control. Adjust it to set the threshold high enough to light the lamp when a moderate level FM stereo signal is being received, but not so high that the unit trips on inter-station noise. Stronger bursts of noise between stations will trip the relay. However, careful adjustment of *R7* will eliminate most of the trouble from this source. -30-

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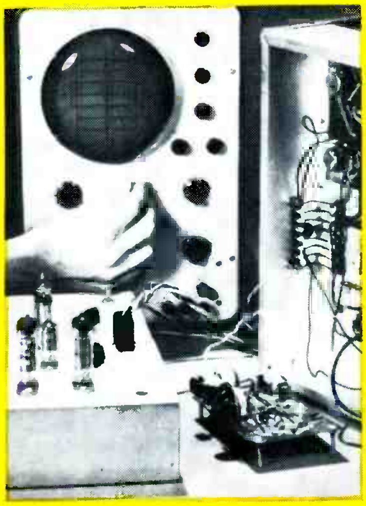

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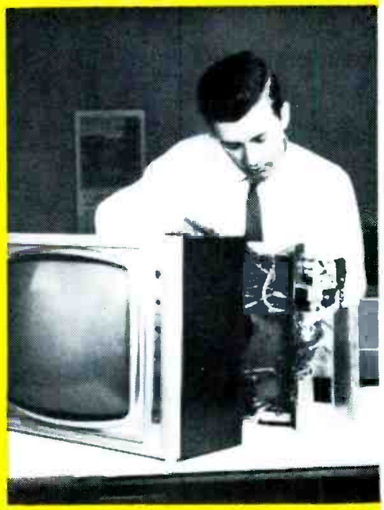

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