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PRACTICAL ELECTRONICS

745

A FAWCETT BOOK

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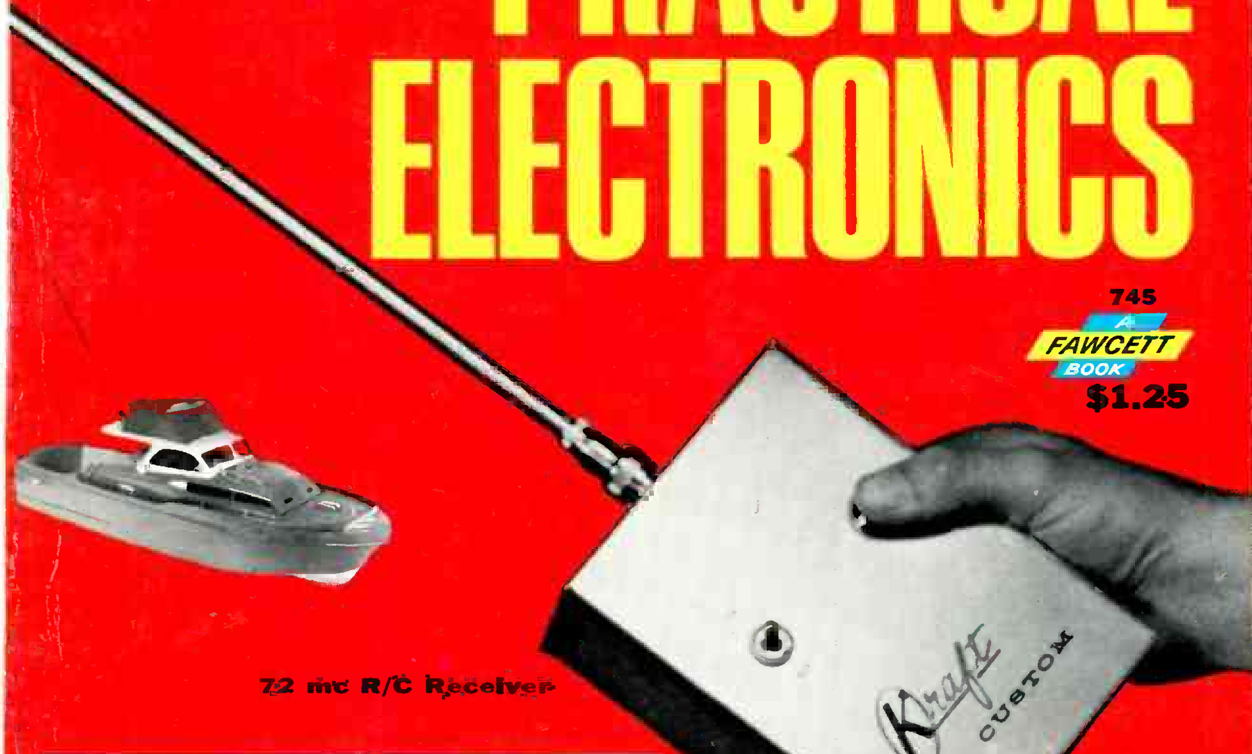
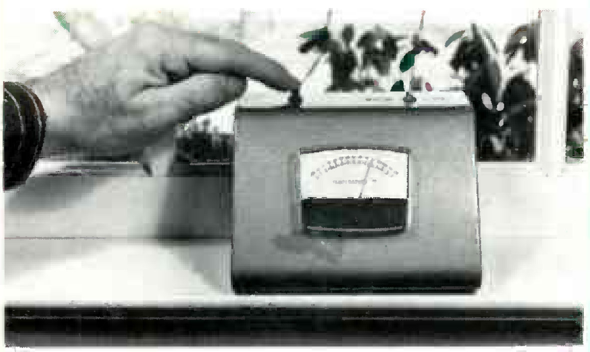


72 mc R/C Receiver



Electronic Indoor-Outdoor Thermometer

Low-Power Transmitter

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PRACTICAL ELECTRONICS

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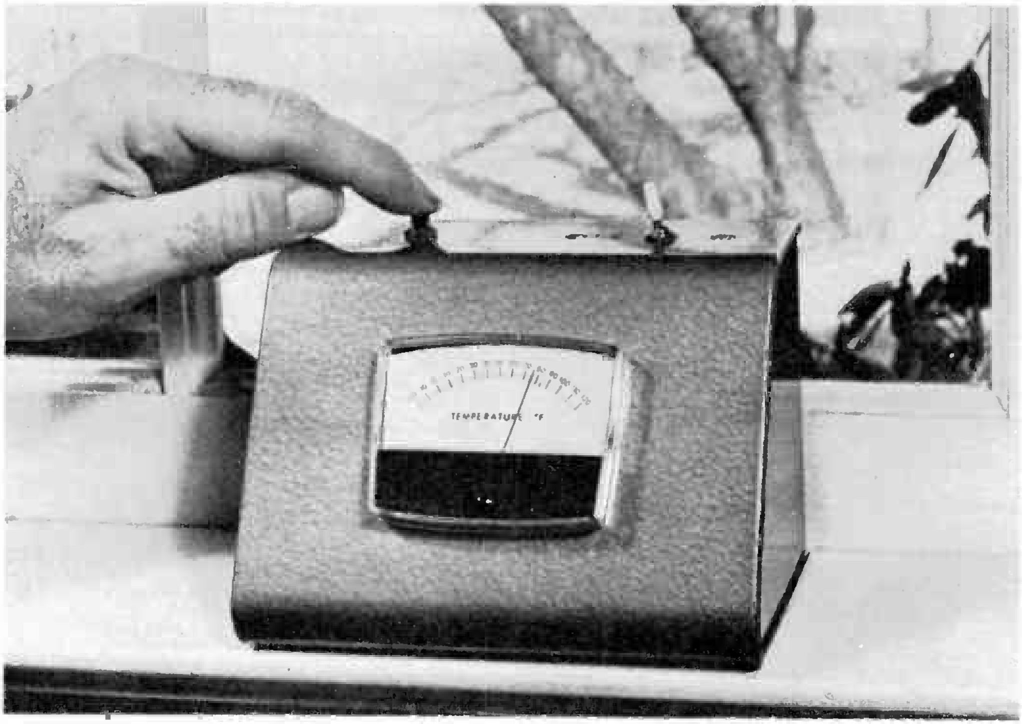


Build an Electronic Indoor-Outdoor Thermometer

By Ron Benrey

THE electronic thermometer is a handy home gadget that never has enjoyed much popularity because of the price of the factory-made kind, especially when compared to the freebies given out by hardware stores and heating-oil companies. So now we're going to tell you how to make your own at fairly modest cost (unless you think of the free ones).

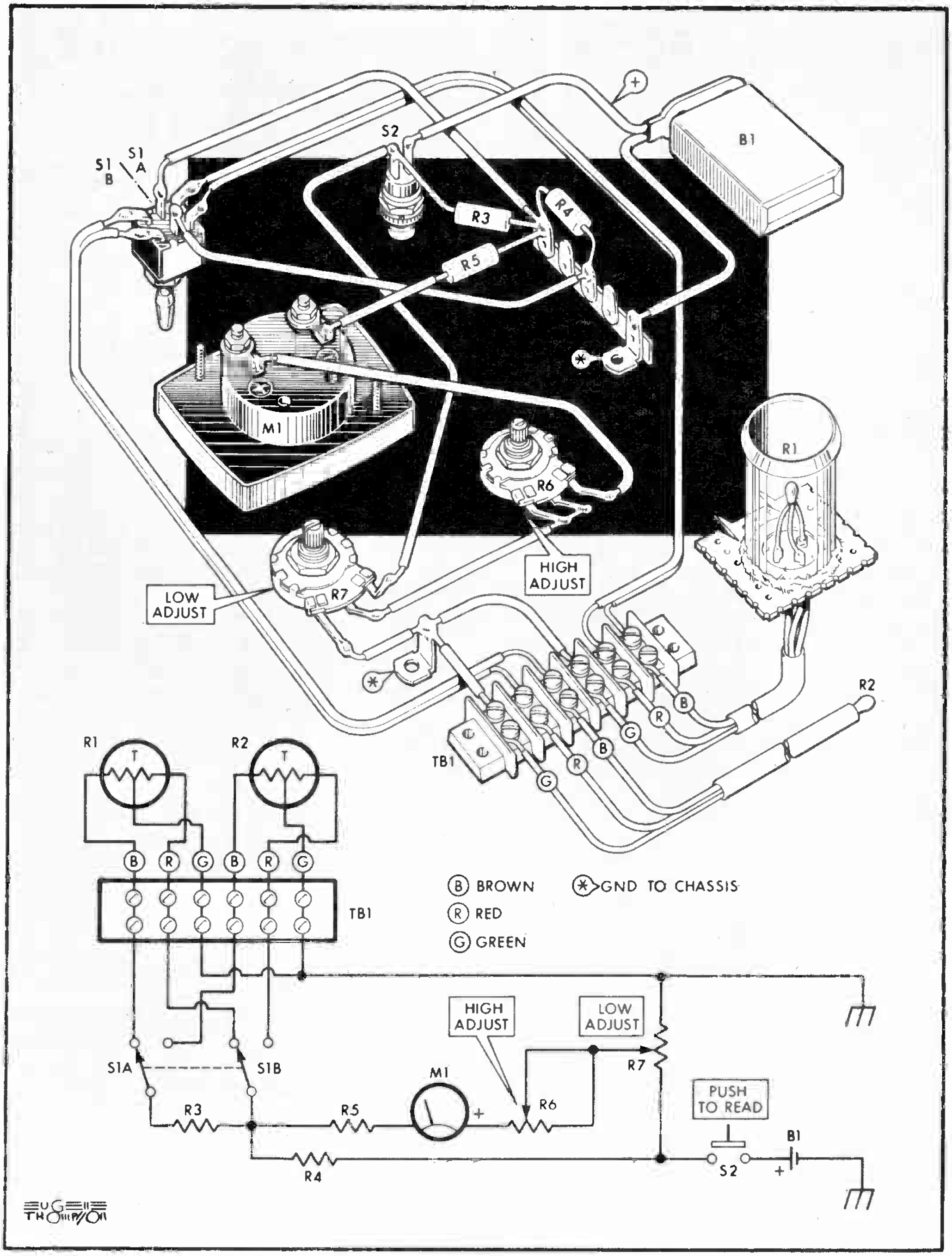
Electronic thermometers are handy for two main reasons. The temperature can be read easily on dials with pointers. But, more than that, they can indicate readings from sensors located at distant points . . . upstairs, downstairs, outside, in the garage and so on. A switch selects the location you desire. We have limited our instrument to one inside and one outside sensor but minor modifications could add an unlimited number of locations.

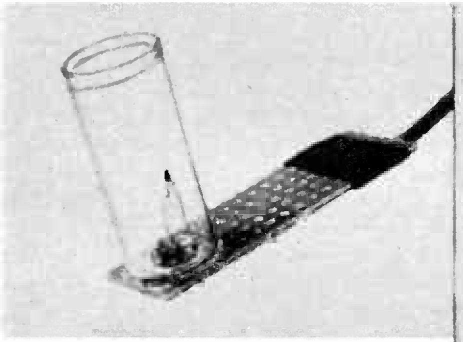
Our indoor-outdoor thermometer covers the range of $-20°$ to $+120°$ Fahrenheit on one easy-to-read scale and can monitor temperature at locations up to 40 ft. from the control box. It can give you the temperature inside and outside the house, for instance, or it can monitor any room in the house, plus your heated garage, greenhouse or sun porch. If you have two-zone heating, it can monitor both zones.

Heart of the electronic thermometer is a solid-state, temperature-sensitive device called a thermistor. As temperature changes, resistance of the thermistor varies and so varies the flow of electric current. The meter reads changes in voltage and the scale translates these into degrees of temperature. One thermistor is used in each of two probes that send voltage/temperature readings back to the control box.

Toggle Switch S1 (*Indoor/Outdoor*) selects thermistor probe assembly R6 or R7. Depress switch S2 (*Push to Read*) to get a reading. Since both thermistor networks are identical, one five-step calibration procedure serves for both probes.

Most of the thermometer circuit is housed in a sloping-front aluminum case. Start construction by cutting a





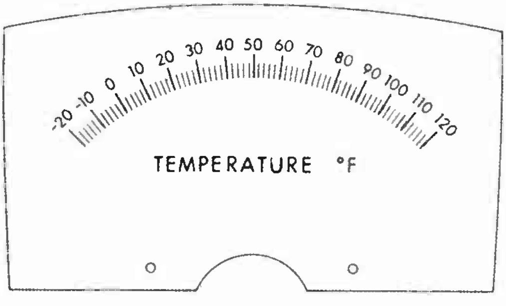

PILL VIAL shields outdoor thermistor from wind, rain. Heat-shrink tubing covers wires of indoor thermistor.

Indoor-Outdoor Thermometer

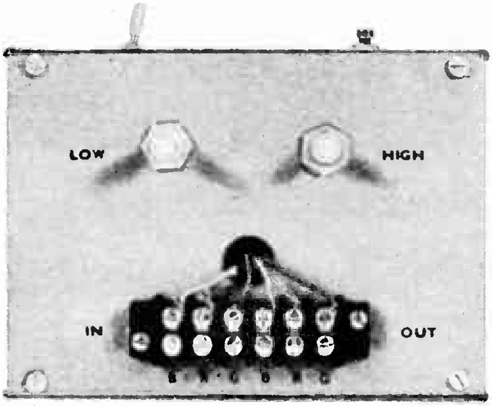
1¾-in.-dia. hole in the front panel for meter M1. Install M1 with supplied hardware and pots R6 (*High Adjust*) and R7 (*Low Adjust*). Also, mount selector switch S1 and momentary contact switch S2.

Mount a 5-lug terminal strip to the front panel, using one of the meter mounting screws. Two lugs are unused. Bolt six-terminal barrier strip TB1 to the rear panel and drill a ½-in. access hole for the leads to pass through. Install a ⅜-in. rubber grommet in the hole.

Wire the circuit by first soldering resistors R3, R4 and R5 to the tabs on TB1. Note that R4 is a precision resistor and is supplied with each thermistor. Obviously you'll end up with an extra one, which you can discard.



PASTE dial scale over M1's original face.



DRY TRANSFER lettering readily identifies parts and terminal lettering on rear of meter case. S1 is at top left; S2 is at right.

PARTS LIST

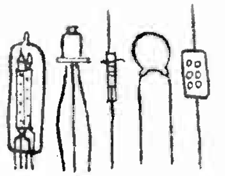
B1—8.4-V mercury battery (Mallory TR-146X)
M1—0-50 microampere DC microammeter (Calectro D1-910 or equiv.)
R4—35,250-ohm precision resistor (see * below)
R3—22,000-ohm, ½-watt carbon resistor
R5—56,000-ohm, ½-watt carbon resistor
R6—50,000-ohm, linear-taper pot
R7—10,000-ohm, linear-taper pot
R1,R2—Thermistor assembly: −30° to +50°C ±0.2°C (Yellow Springs Instrument No. 44203 Available from Allied Industrial Electronics, 2400 W. Washington Blvd., Chicago, Ill. 60612)
S1—DPDT miniature toggle switch
S2—SPST normally open push-button switch
Misc.—4¼x5x4-in. sloping-front aluminum cabinet (Bud AC1611), 6-terminal barrier terminal strip (Calectro F3-238), three-conductor audio cable, 9-Volt battery connector, 5-lug terminal strip (Calectro F3-216).

* R4 supplied with thermistor assembly. Discard one if two thermistors are purchased.

Mercury battery B1 is attached to the prototype front panel with a few dabs of contact cement. Battery B1 must be a mercury cell to supply a steady voltage, which helps to keep calibration accurate.

Meter M1 comes with a 0-50 microampere scale. Replace it with the −20° to +120° temperature scale shown. After M1 is mounted, carefully pry the plastic faceplate off the meter assembly with a sharp, flat screwdriver blade. Cut out (or make an exact copy of) the new scale and cement it over the existing one with rubber cement. Be careful not to bend the meter needle.

(Continued on page 56)



BEGINNER'S CORNER

THE THERMISTOR

MENTION the word thermometer and most people think of a fragile stem of glass filled with mercury or colored alcohol.

But like so many other things these days, thermometers can be replaced by semiconductors—in this case a thermistor. The name is derived from the words *thermal* and *resistor* because the device behaves like a temperature-sensitive resistor.

The thermistor is not a particularly new product, nor is it a device anything like a simple carbon resistor. It contains combinations of manganese, nickel, cobalt and copper—all of which are related to operating range and power-handling needs.

Unlike wire, whose resistance increases with temperature, the thermistor's resistance *decreases* as temperature increases. For this reason it is said to have a negative temperature coefficient of resistance.

Why does it behave this way? Because the metal oxides mentioned above form a molecular lattice. Apply heat and conducting paths are formed which enable current to flow. The higher the temperature, the more conducting paths and the greater the current. Connect a thermistor in a circuit with a battery and a meter, then heat the thermistor and you'll notice the current *increases* because of the decrease in resistance.

In conjunction with a power source, a thermistor controls current flow. The current can be indicated as degrees of temperature or used to control a heat source in the manner of a thermostat.

Thermistors also are used in circuits to offset the effect of components which have a positive temperature coefficient of resistance. In our experiment, we'll make a thermistor electronic thermometer.

Thermistors are classified according to physical shape, which also is a clue to electrical ratings. There are *beads*—pinhead size units known for fast response time and accuracy. Next are *probes*, which are beads installed in thin glass tubes to give them physical ruggedness and mounting simplicity. *Discs* are thicker and capable of handling greater power. *Rods* and *washers* usually are for higher-wattage applications.

In general, you may find the probe type most useful. It's inexpensive and easy to use in temperature-measuring or heat-detecting circuits. The beads are small components with hair-like leads. Larger thermistors usually require heat sinks and sophisticated circuits.

Figure 1 shows how the resistance of a typical thermistor is related to temperature change. The curve begins at the freezing point of water (0° C), at which point resistance is 5,800 ohms. When the thermistor is heated to its maximum safe temperature (300° C), resistance drops to 6 ohms.

An important characteristic of the thermistor is revealed by the shape of the curve. Notice that temperature and resistance do not vary linearly. For example, if you double temperature, say, from 25° to 50° there is a 1,200-ohm drop in resistance. But double temperature again from 50° to 100° and resistance drops only about 600 ohms.

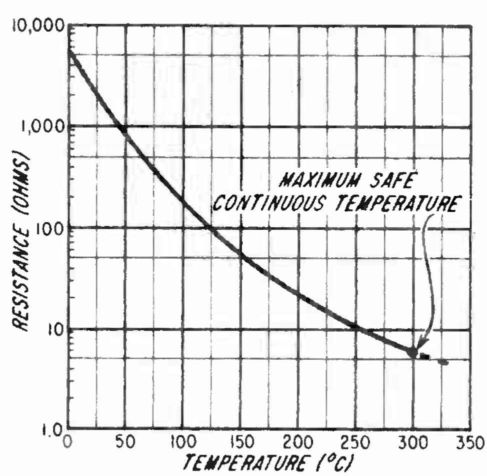


Fig. 1—Curve shows how the resistance of a Fenwal GB32J2 thermistor decreases as the temperature increases from 0° C (32° F) to 300° C (572° F).

THE THERMISTOR

In other words, the thermistor behaves in logarithmic fashion. This creates a problem in a practical application: Let's say you want to use a thermistor with a meter whose linear scale is to be calibrated in degrees of temperature. If the meter is used to indicate a large portion of the thermistor's characteristic curve, the dial markings become crowded and hard to read at each end of the scale. That is, the distance between each degree near freezing or boiling is not the same. This problem can be solved by using only a portion of the thermistor's curve. As our project will show, different meter sensitivities can compensate for this.

An electronic-thermometer is shown in Figs. 3 and 4. The thermistor responds to heat and controls current from the battery to the meter. One valuable feature of this circuit is that the thermistor can be mounted a great distance from the meter and battery.

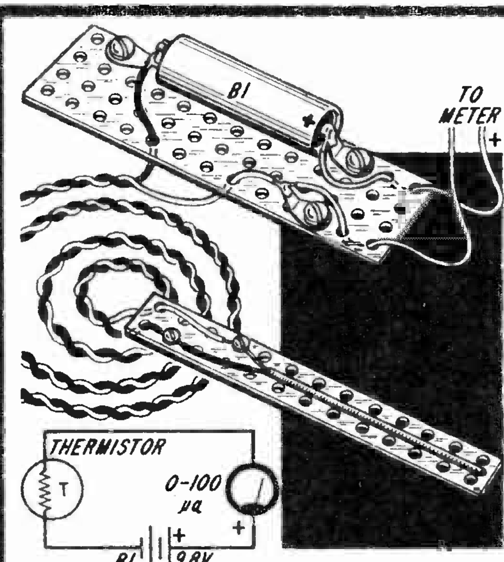
Resistance of the long connecting wire is negligible compared to that of the thermistor; therefore, accuracy will not be affected. Thus, thermistors can be used for temperature sensing at remote locations, such as the inside of a freezer or an oven or on the outside of a space vehicle.

The important temperature rating you'll see in the thermistor specs is resistance at 25° C. This corresponds to a room temperature of 77° F. When measuring thermistor resistance you must observe a precaution: use a high-resistance scale on the VTVM. If you don't the meter might cause a heavy current to flow through the thermistor and cause it to heat up. This heat will lower the resistance further and produce an error.

The self-heating effect, incidentally, is important in some special applications. It permits the device to become an electrical regulator. Rather than respond to outside temperature, the thermistor develops internal heat from large current flow. Resulting changes in resistance then operate current-regulating circuits.

In our thermometer, we must avoid self-heating because this will introduce an error in temperature indications. In a small thermistor, each milliwatt of power developed within the device will raise the internal temperature by 1° C. This will change resistance by about 4 or 5 per cent.

Designing a circuit with thermistors is not simple. As one manufacturer puts it, "Trial and error may be the easiest way!" There is, however, an excellent aid for anyone who wants to begin experimenting with thermistors. It is the *Thermistor Data and Curve Computer* (Fig. 5). Price is $1.50, but it is included in a $4.95 kit (G-700) made by Fenwal Electronics, Inc. The kit (Allied Stock No. 8 U 658) includes the



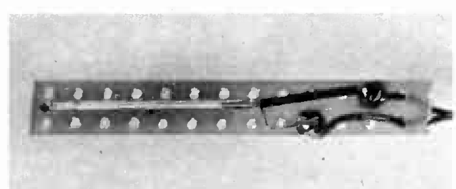


Fig. 2—Probe for our thermometer is made by mounting probe-type thermistor on a ½ x 3½-in. piece of perforated board. Actual thermistor is the black dot on probe tip at the extreme left.

Fig. 3—Complete thermometer (less meter) is at left. Battery is mounted on 1⅛ x 3½-in. piece of perforated board. Schematic shows circuit as a thermistor, battery and meter connected in series.

curve computer, a thermistor-specification manual and four thermistors. The thermistor used in our project is the one marked 135,000 ohms (at 25° C). If you don't wish to purchase the kit, the equivalent thermistor is the Fenwal GA51P8 (Allied 9 U 967) priced at $2.35 plus postage.

Here's how we developed the practical circuit. First consideration was to keep power dissipation low to avoid self-heating. We did this by using a 100-microampere meter. (You can also use the equivalent range on a VOM.) Our voltage source is a standard 9.8-V mercury battery. This combination of voltage and current (9.8V × .0001A) produces a power dissipation in the thermistor of 0.98 milliwatts. Next, we checked the resistance range of the thermistor. You can look this up in a thermistor manual but the curve computer just mentioned will give the information and other pertinent data in seconds. Our thermistor is rated at 135,000 ohms at 25° C (77° F). The specs show that at freezing (32° F) resistance is about 500,000 ohms. At 95° F it is about 80,000 ohms. Since we know the battery voltage is 9.8 it is possible to determine where each current, or temperature, point would fall on the meter scale (dividing voltage by resistance yields current).

Thus, it is possible to make a chart like the one in Fig. 6, which shows temperature at key points on the meter's dial. Calibration also can be made by comparing meter indications with a household thermometer. You can obtain a cold point by placing a thermometer and the thermistor probe in a refrigerator or freezer. A good reference for water's freezing point (32° F) is a glass of water with ice cubes and salt added.

By following these procedures you can derive other temperature scales. Two variables which affect range are battery voltage and meter sensitivity. A simple way to raise the range for higher temperature would be to switch to a higher current range on the meter. You also could add a shunt to reduce meter sensitivity. —*H. B. Morris.*

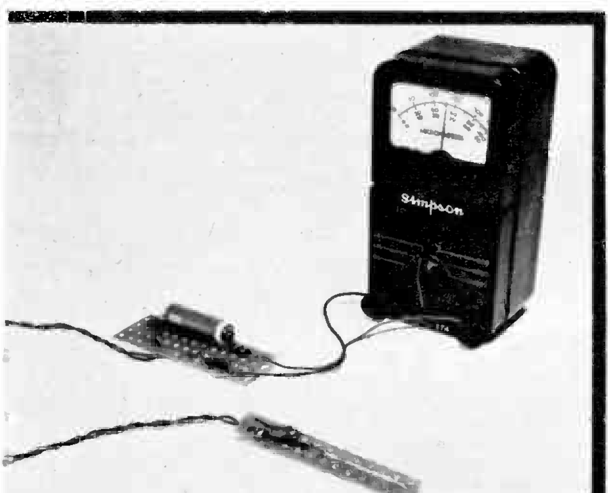


Fig. 4—Complete project. Meter is a Simpson Model 374 DC microammeter. Its full-scale ranges are 50, 100, 250, 500, 1,000 microamps.

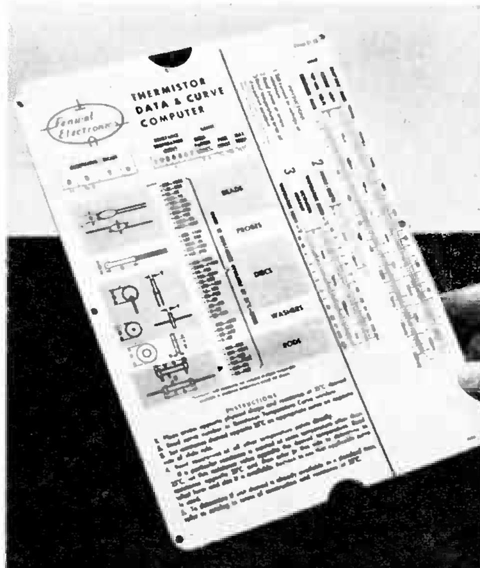


Fig. 5—Cardboard computer by Fenwal quickly solves thermistor problems involving resistance-versus-temperature and power.

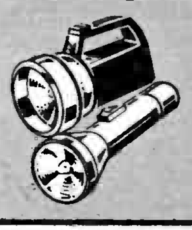
THERMISTOR CALIBRATION CHART

Current (ua)	Temperature (F)
0	—
17	20
22	32
38	50
67	70
100	87
180	110

Fig. 6—To make calibration chart, dip thermistor in glass of water. Freezing point can be obtained by measuring temperature of melting ice in water. Use hot water for temperatures over 70°.

Consumer's Guide to

Flashlights



WANT the best flashlight value for your money? Then there are two key questions you should ask yourself: What do I want the flashlight to do? How long do I expect it to keep doing it? Flashlights vary in size from penlights (which are the size of a pen, naturally) to multicell searchlights. There are several types of lanterns as well.

No matter what kind or size flashlight you buy, it won't work unless you put batteries in it. The two go together like gin 'n vermouth. We'll fill you in on these later.

As for the flashlights themselves, the kind or size you should buy depends almost solely on how you'll use it. Penlight flashlights, because of small size, are good when just a minute amount of light will do and when portability and handiness are important. If you want to see where to insert a key in the dark, then a penlight will do the trick. But you probably wouldn't use the penlight to walk across the room to get to the keyhole—not enough light. A penlight obviously can easily be carried in your pocket, tackle box or glove compartment.

Most common flashlight is the one that uses a couple of D cells. It's the kind you have in your toolbox, glove compartment, kitchen drawer or maybe stuck to the refrigerator by a magnet. On the average, you get a 1,600-ft. beam of about 2,000 candlepower with this size.

These flashlights range in price from less than $1 (59 to 99 cents) to nearly $3, the deciding factor being construction and not amount of light produced. The under-a-buck types generally are made of aluminum and have slide switches. Flashlights made of plastic sell for more and are usually more durable. They often are bump-resistant and waterproof, with slightly better switches. Top of most lines is the all-steel type, featuring solid, long-lasting construction.

Keep in mind, though, that for the most part, all flashlights using the same batteries and comparable bulbs will give roughly the same amount of light. What you pay for when the price is higher is longevity of the flashlight housing and not necessarily a brighter beam.

Next step up from flashlights that use two D cells are those that use more, naturally. Three- and five-cell flashlights give about 2,000- and 3,000-ft. beam lengths, respectively. Brightness is about 3,000 and 6,750 candlepower. Cost of the flashlight housing is higher than that of the two-cells because they tend to be sturdier and there's simply more of it. And you need more batteries to fill it. For most fix-it jobs, though, the two-cell D type is adequate.

If flashlights don't give you a wide enough or strong enough beam and the light has to be set down (that is, if you need both hands for the job you're doing), look to lanterns.

Many lanterns use four or six D cells or a 6-V lantern battery in the case. The 6-V battery is worth the extra expense, even if only because there's less bother in changing batteries. Some lantern batteries (such as Eveready's No. 609) are impact-resistant and waterproof.

Another type of lantern uses an apparatus that screws onto the top of a heavy-duty, steel-clad 6-V battery. It's a bit on the heavy side but this type is designed for long life and arduous use. Most come with a red blinker opposite the beam end for emergency signaling. This is an excellent piece of equipment for car or boat.

So far as flashlight batteries (or cells) are concerned, there is a choice of several types. The one used for two-cell household flashlights is the carbon-zinc type. This is the lowest in price. This type is available with nominal voltages of 1.5 to over 500 V. It comes in many different shapes and sizes, from penlight to a 6-V model suitable for heavy-duty use. The heavy-duty battery naturally costs more because more refined types and grades of chemicals are used to produce varying amounts of chemical activity. These ingredients give much longer service.

The alkaline-manganese dioxide battery is a step up from carbon-zinc. It performs best on continuous drain and shows an excellent advantage over conventional cells on a performance-per-unit-of-cost basis. It differs from the carbon-zinc battery in that the electrolyte is highly alkaline, not ammonium chloride and zinc chloride dissolved in water.

Finally there is the rechargeable battery, usually made of nickel-cadmium and usually built into the flashlight or lantern. There are alkaline rechargeables, too. Cost of this type of battery is much higher than that of the carbon-zinc or alkaline and it makes sense only if the flashlight will be used frequently over a long period of time. The batteries have to be recharged periodically or they don't work at peak effectiveness nor last as long as they should.

Of course, flashlights also come with special attachments and features, such as waterproofing for marine use. Paying extra for these makes sense only if you *really* need them.

Some good buys in flashlights and lanterns (prices without batteries) are:

- Eveready's Skipper plastic flashlight. It uses two D cells, is waterproof and floats. It features a heavy-duty switch designed to last 100,000 cycles. Price is $2.29.
- Ashflash's Chrome 'N Color flashlight. It uses two D cells and retails for 99 cents. Housing is chrome on seamless aluminum.
- Eveready's Commander and Captain spotlights. Both use two D cells. The former, priced at 99 cents, is the company's best-seller. The latter, Eveready's top standard light, is triple-plated—with copper, nickel and chrome over steel. List price is $2.89.
- Ray-O-Vac's J2-K flashlight. This general-purpose model uses two D cells, costs 99 cents.
- Eveready's All American lantern. This $4.29 model is waterproof, floats, resists chemicals and withstands temperature extremes. It's one of the company's sales giants.
- Ashflash's 60 High Intensity Floating 4 Cell Blinker Lantern. Uses four D cells and sells for a low $2.49. It floats and is shock-, dent- and rustproof and impact-resistant. ●

Jet Eavesdropper

SANDWICHED between the FM broadcast band and the 2-meter ham band is a slice of VHF spectrum filled with exciting listening. It's the 108-136 mc aircraft band. Tune in and you'll hear transmissions to and from control towers and commercial and private planes.

Aviation communications have come a long way since the early days when bonfires were used to light up runways and transmissions were via CW. The band is active around the clock—particularly in bad weather when flight and landing-pattern instructions are frequent and terse. You can listen in on the band with this 2-tube superregen receiver which features speaker output and a squelch circuit to eliminate background noise between transmissions.

Construction. The receiver can be built on a 7 x 7 x 2-in. aluminum chassis, as was our model, as shown in the pictorial and the photos. We used a 5 x 5-in. piece of sheet aluminum with a 1-in. mounting foot to hold the dial. Use a flexible coupling (Allied 47 A 2405) to connect tuning capacitor C5's shaft to the dial. Use a ⅜-in. spacer to attach C5's mounting foot to the chassis. Cut the hole for V1's socket about 1 in. to the side of C5. Then cut a ⅜-in.-dia. hole between the two holes for C4. C4 is connected between a 1-lug terminal strip under the chassis and C5, which is on top of the chassis.

Mount the speaker on two ¾ x ¾-in. brackets. To minimize microphonics, isolate the speaker's mounting screws from the brackets with grommets. Before wiring the chassis, cut a 1⅝ x 2¾-in. piece of perforated board and install the squelch-circuit components on it with flea clips. Mount the board in the chassis with spacers to prevent

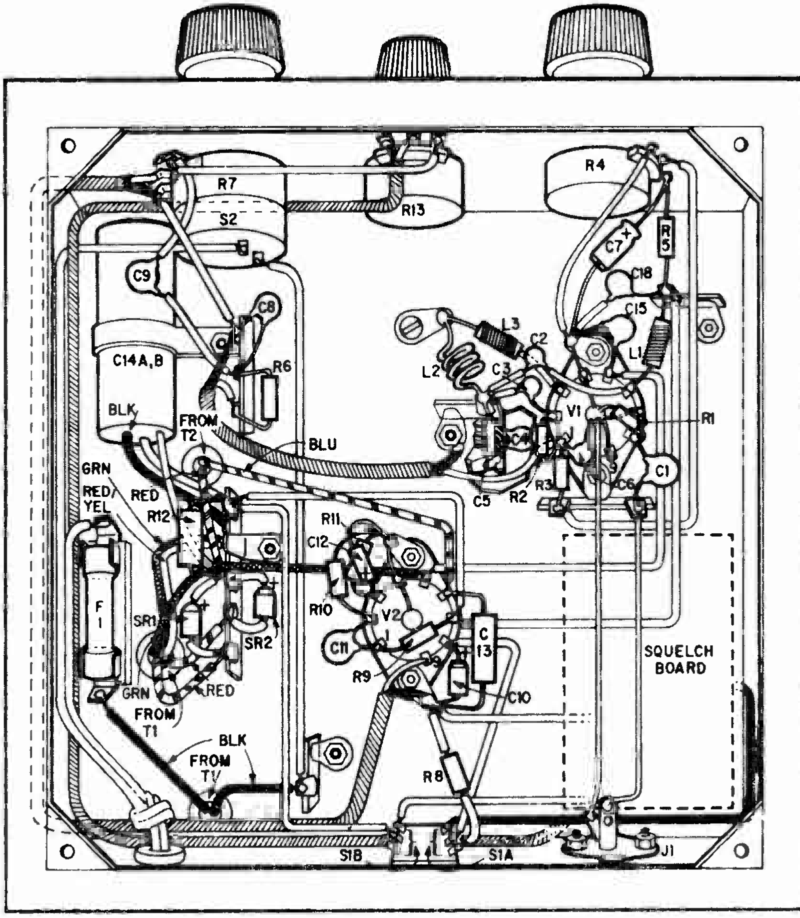


Fig. 1—Most critical part of the circuit is around V1 in upper right corner. Get parts and leads in positions shown or the receiver may not tune whole band.

Jet Eavesdropper

shorts to the chassis. Keep the leads around V1 short and direct.

To make L2, wind three turns of No. 16 wire around a 3/8-in.-dia. twist drill. Space the turns out to a length of 3/8 in. Bend out 3/8-in. leads from the coil.

Mount J1 on the rear of the chassis in line with the center of V1's socket and high enough so its leads will clear the squelch circuit board. Position the leads from J1 to V1 as shown in the pictorial, keeping them approximately 1/8 in. apart. You can use the left-over No. 16 wire used to wind L2 for the leads to J1. Keep L3 away from L2 and the chassis.

Operation. A 6-ft. length of hookup wire is fine for an antenna but for best reception

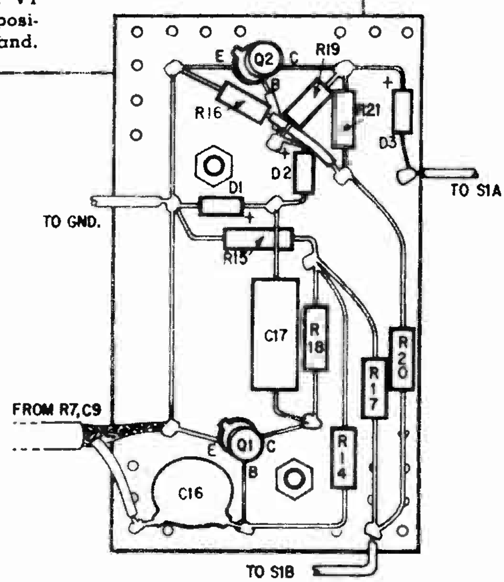


Fig. 2—Squelch board. Install all parts on board before mounting it on main chassis. Board fits in lower right corner of chassis as shown in Fig. 1. Watch the heat when soldering diodes D1,D2.

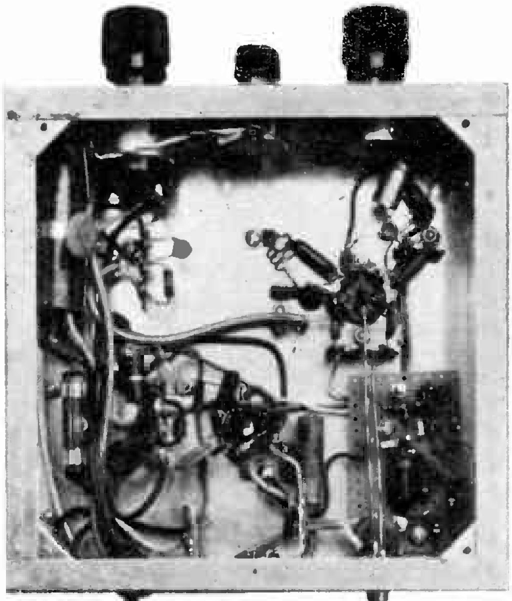


Fig. 3—Receiver underside. Install small components before connecting the shielded wires going from upper left corner to V2 and squelch board.

a vertical antenna, cut to length for the band, is best.

Connect the antenna to J1 and turn on the receiver. Set S1 to off and turn the *volume, squelch* and *regen* controls fully clockwise. If a signal generator is available, set it up to produce a modulated 108-mc output. Couple the generator's output to the antenna lead by wrapping a few turns of the antenna wire around the generator's hot lead.

Tune C5 until you hear the signal. Its plates should be almost fully meshed. If you don't hear the signal, squeeze or spread L2's turns until you do. Then calibrate the dial with the generator.

If a signal generator is not available, try adjusting L2 so you can hear a station at the top of the FM broadcast band (108 mc) with C5's plates almost closed.

The tuning range will depend on your wiring job and component layout. Remove the signal generator and tune the receiver for aircraft calls on an active frequency. Then adjust the *regen* and *volume* controls for best reception.

Set S1 to *on* and adjust the *squelch* control until the background noise level disappears or is low. Transmissions should cause the squelch circuit to open and calls to come through. The *regen* control setting will affect squelch operation.

The Circuit. Take a look at Fig. 4. Signals from *ant.* jack J1 are coupled via C1 to the cathode of grounded-grid RF amplifier V1A. Amplified signals pass through C2 to the

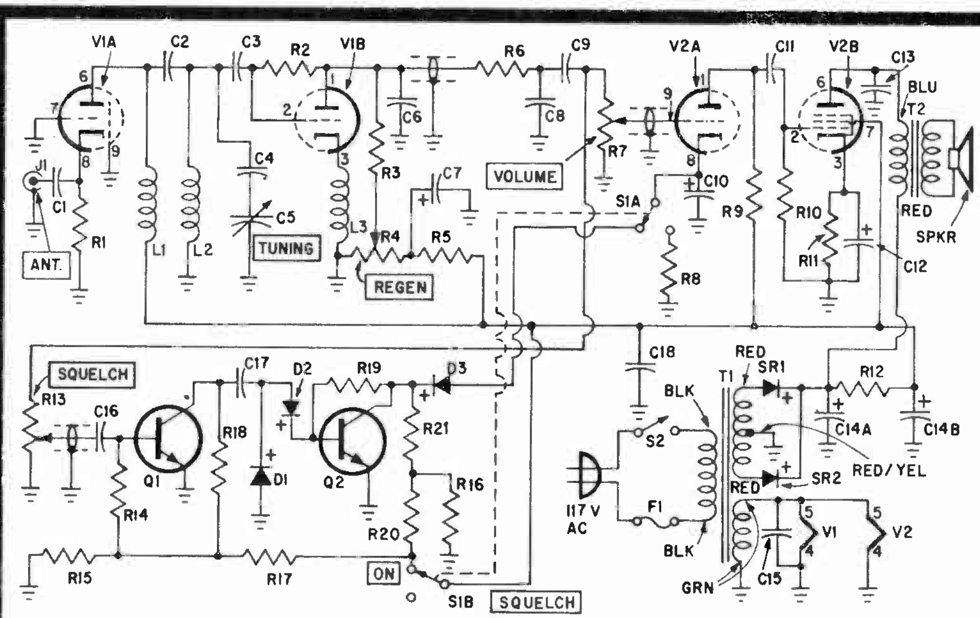


Fig. 4—Incoming signal is coupled by C1 to cathode of grounded-grid RF stage V1A. Tuned signal is fed to superregen detector V1B, whose audio output goes via R7 to audio stages. Part of audio goes to squelch circuit whose output goes to V2A. No signal at J1 causes squelch to bias off V2A.

PARTS LIST

Capacitors: 1,000 V ceramic disc unless otherwise indicated
C1—47 μμf
C2—4.7 μμf
C3,C4—20 μμf
C5—3.2-36 μμf variable capacitor (Hammarlund HF-35. Allied 43 A 3591)
C6—470 μμf
C7—5 μf, 150 V electrolytic
C8—.002 μf
C9,C11,C16—.01 μf
C10,C12—8 μf, 12 V electrolytic
C13—.03 μf, 400 V paper tubular
C14A,C14B—50/30 μf, 150 V dual electrolytic
C15,C18—.001 μf
C17—.25 μf, 200 V paper tubular
D1,D2—1N198 diode
D3—HEP-157 silicon diode (Motorola. Allied HEP-157)
F1—1/4 A fuse and holder
J1—Phono jack
L1,L3—1.72 μh RF choke (J. W. Miller RFC-144. Lafayette 34 C 8973)
L2—Coil: 3 turns No. 16 wire, 3/8-in-dia. x 3/8-in.-long. 3/8 in. leads (see text)
Q1,Q2—HEP-50 transistor (Motorola. Allied HEP-50)
Resistors: 1/2 watt, 10% unless otherwise indicated
R1—220 ohms
R2—6.8 megohms
R3—100,000 ohms
R4—100,000 ohm, linear-taper potentiometer
R5—10,000 ohms, 2 watts
R6—82,000 ohms
R7—1 megohm, audio-taper potentiometer with SPST switch
R8—5,600 ohms
R9—220,000 ohms
R10—1 megohm
R11—120 ohms
R12—1,800 ohms, 2 watts
R13—1 megohm, linear-taper potentiometer
R14—820,000 ohms
R15,R21—15,000 ohms
R16—10,000 ohms
R17—120,000 ohms
R18—4,700 ohms
R19—1.5 megohms
R20—180,000 ohms
S1A,S1B—DPDT slide switch
S2—SPST switch on R7
SPKR—3½-in. 3.2-ohm speaker
SR1,SR2—Silicon rectifier; minimum ratings: 500 ma, 400 PIV
T1—Power transformer; secondaries: 250 V c.t. @ 25 ma, 6.3 V @ 1 A (Allied 54 A 2008 or equiv.)
T-2—Output transformer; primary: 10,000 ohms; secondary: 4 ohms (Allied 54 A 1448 or equiv.)
V1—6JK8 tube
V2—6CM8 tube
Misc.—Vernier dial (Lafayette 99 C 2566), 7 x 7 x 7-in. aluminum chassis, 9-pin tube sockets, perforated board, shielded wire

Jet Eavesdropper

L2/C5 tuned circuit. Variable capacitor C5 tuned our receiver from 106 to 148 mc.

Grid-leak capacitor C3 couples the signal to the grid of superregen detector V1B. Interelectrode capacitances of V1B feed back RF to cause oscillation. The time constant of R2/C3 interrupts the oscillation at an ultrasonic rate. This allows circuit gain to reach high level—hence the name *superregeneration*. Superregeneration is controlled by varying V1B's plate voltage with R5.

The detected audio signal passes through low-pass filter R6/C8 to attenuate the ultrasonic oscillation. The signal continues via C9 to the parallel-connected *volume* (R7) and *squelch* (R13) controls. When S1 is off, V2A amplifies the signals from R7. The signal is then fed via V2 to the speaker.

When S1 is set to *on* the cathode of V2A is connected to the squelch circuit. This circuit cuts V2 off when there's no audio signal at the junction of C9 and R7. The cathode of V2A is connected by D3 to Q2's collector. Normally little current flows between Q2's emitter and collector. This raises Q2's collector voltage high enough to reverse-bias D3.

A received signal sends audio to R13. The audio then is amplified by Q1 and rectified by D1 and D2. The DC bias fed to Q2's base lowers Q2's emitter-to-collector resistance, which in turn forward-biases D3. V2A's cathode now has a path to ground; therefore, V2A amplifies the signal. R13 controls the squelch threshold

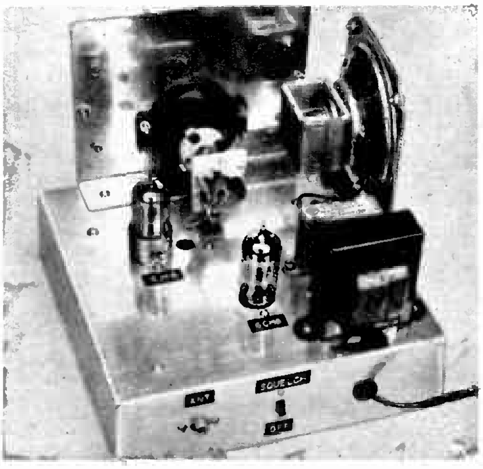
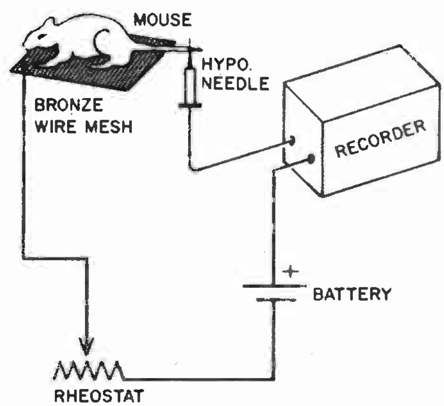


Fig. 5—Plate at front supporting dial assembly is made of scrap aluminum. When mounting the speaker, isolate it from the chassis with grommets.

the curious case of the



MOSQUITO-POWERED BITEMETER

VAMPIRES and other ghouls of the spook world supposedly are at their charming and chilling best during the blackest of witching hours, which just might explain why the lowly mosquito comes round in the cool of the evening. For, small though it may be, the mosquito rightly can be considered a vampire in the sense that it delights to dine on blood. And the mosquito often squares with its host, paying for the blood it has taken. Payment, in this instance, may come in the form of a fatal disease—malaria, say. But precisely how does the mosquito dole out its death-dealing germs?

To find out, a biochemist at Chicago's IIT Research Institute constructed the mosquito-powered bitemeter shown in our photos and drawing (that's the biochemist, Philip Kashin, in the photos). A mouse, anesthetized so he wouldn't mind the needle in his tail and the mosquito bites in his tummy, made like the guinea pig. Resting on top of a wire screen, the mouse actually formed part of an electric circuit, though no current could flow because his fur acted as an insulator. But let a mosquito stand on its legs on the screen and probe through the mouse's hair into his skin and—presto! The mosquito-powered bitemeter swung into action.

A recording instrument connected into the circuit revealed each probe the mosquito made in the mouse's skin. And it also indicated whether the mosquito was probing, salivating or actually engorging on the host's blood (each caused progressively more current to flow).

Since a mosquito transmits diseases primarily when it is probing and salivating rather than engorging, Mr. Kashin hopes his experiments ultimately will lead to more effective mosquito repellents. Reason is that previous studies were chiefly visual and could not distinguish probing and salivation from actual engorgement.—*Robert Levine*

WHAT TV TEST PATTERNS

THOUGH there are dozens of TV test patterns (each station transmits its own version), all are designed to let you know more than what station you're tuned to. Nearly any test pattern will enable you accurately to read off the quality of a) aspect ratio, b) vertical and horizontal linearity, c) line count and interlace, d) video frequency response and line resolution, e) contrast and f) low-frequency phase shift.

A test pattern is composed of a frame, a large dark circle, horizontal and vertical wedges, concentric circles and black-and-white bars. (Our photo shows the test pattern transmitted by New York's WPIX; others are similar.) Let's see what each measures and what can be done to improve picture quality.

Aspect Ratio, Linearity. The frame is transmitted with a height-to-width ratio (technically called an aspect ratio) of 3 to 4. Tied in as a supplementary measurement with the frame is the familiar large dark circle. It is transmitted perfectly round, perfectly centered, with the top and bottom touching the top and bottom center of the frame.

Try to position the picture so the center of the large circle is at screen center, then adjust vertical linearity to vary the top of the circle and vertical height to change the bottom of the circle (these adjustments interact somewhat, so it's best to rock both together for final adjustments). Adjusting horizontal drive, horizontal width and horizontal linearity will vary left and right sides of frame and circle. Properly adjusted, height and width of the frame will have a 3:4 ratio, all circles will be perfectly round and all wedges of equal length. If they are not, test the low- and high-voltage rectifiers, damper, horizontal and vertical output tubes.

Line Count, Interlace. A TV station transmits a picture contained in approximately 490 usable horizontal lines formed by a spot of light less than 1/64th-in. in diameter. The spot starts in the upper left corner of the screen and is drawn across to the right, then retraced over and over.

Unfortunately, a TV set can't make such a tiny spot, which means that the number of lines on the screen ordinarily is less than 490. And the fewer the lines the more picture details will blur.

You can determine the approximate number of lines on your TV by observing the horizontal, pie-slice wedges and noting the point where the individual black and white lines blend. The white dots in the center line indicate the approximate line count (see our drawing—we show only one wedge because both are identical). If interlacing is poor, lines will be blurred and jagged.

To some degree, you can improve line count by decreasing spot size (poor interlace best is left to a serviceman). Test the low- and high-voltage rectifiers, damper, horizontal output and picture tubes. Also, try adjusting the focus, horizontal drive, brightness and contrast controls while viewing the horizontal wedges. Each has some effect on spot size.

Video Frequency Response, Line Resolution. TV pictures are transmitted with a bandwidth of 4.5 mc, though many TVs are incapable of producing the entire range of frequencies. Some cut off as low as 2.5 mc, resulting in a picture with little detail. You can determine response by judging the blend point in the upper vertical wedges of the test pattern. (The lower vertical wedge checks line resolution and can be used as a supplemental guide when checking line count. Ringing at any frequency will be indicated by additional lines in the vertical wedges at that point.)

To increase frequency response, test the RF amplifier, mixer-oscillator, IF, video detector, video amplifier and output tubes. Also, adjust the fine-tuning

Really MEAN

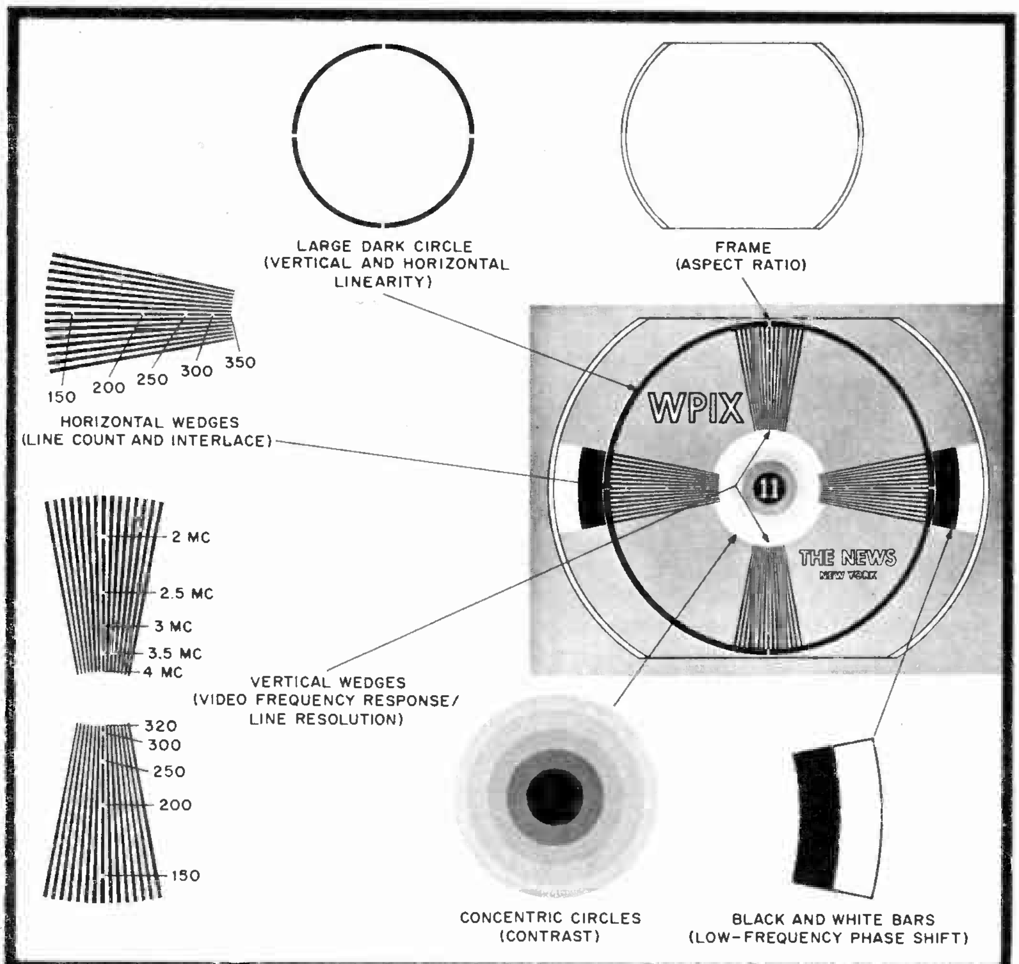
By ART MARGOLIS

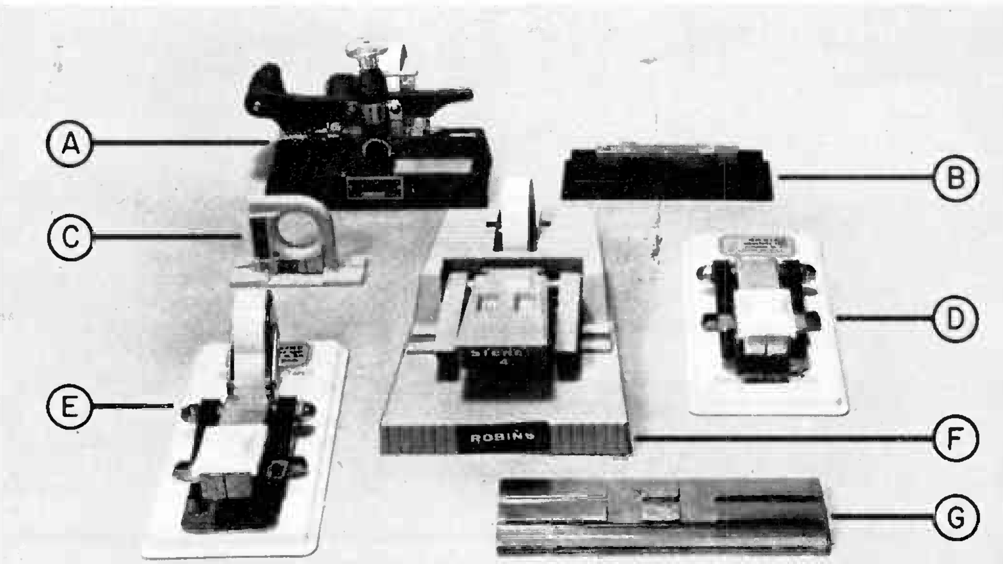
and video-peaking controls (if possible) and finish with a full-dress alignment of the tuner and IF strip.

Contrast. Test patterns contain five shades—white, light gray, medium gray, dark gray and black—in concentric circles or blocks. All five shades should be available at some setting of the contrast control.

If they are not, first check the setting of the AGC control (contrast will be limited if it's set too high). Second, test the AGC tube, the video amplifier or output tubes, the video detector and the picture tube itself (a gassy tube will overload the picture to a degree, causing lack of contrast range).

Low-Frequency Phase Shift. Streaking or smearing of the black and white horizontal bars indicates excessive low-frequency phase shift. This often can be reduced by adjusting the video amplifier and output, video detector, IF stages, mixer-oscillator and RF amplifier.





Tapes splicers come in all shapes and sizes. Represented here are (A) Alonge professional splicer, a heavy-duty, relatively expensive unit; (B) Low-cost editing block equipped with hold-down arms to keep tape ends in place; (C) Gibson Girl at its simplest—SP-4 block and cutter; (D) Gibson Girl TS-4J, a stripped-down version of (E) Gibson Girl TS-4S, with splicing tape holder; (F) TS-8D, fanciest of the Gibson Girl sisters; (G) Robins Cut-N-Splice editing block.

WANTED: A GOOD Tape Splicer

By HERB FRIEDMAN, W2ZLF

BACK in the days when there were still few amateur tape enthusiasts (and few tape brands) the first thing that struck your eye on opening a fresh box of tape was usually a set of instructions for making a tape splice. It all looked very simple. But when you got around to playing back your first splice, what you heard could be discouraging. Those hand-made splices, as you would soon learn, required a good eye, a steady hand—and lots of practice.

Anyone who has acquired sufficient skill can do a pretty good job by that method. But for the all-thumbs duffer there are on the market a number of products claiming to substitute gadgetry for dexterity. Do they make good splices? First we've got to know what makes a good splice good.

Making a Good Splice

First, the ends of the recording tape must butt together perfectly, leaving no exposed adhesive to accumulate dust, dirt and oxide particles. (A bad splice with tape ends that don't meet is illustrated in Example 1 on the third page of this article.)

Also (and most important) the adhesive used for the splice must not *bleed*—it must not flow from the patch to adjacent turns of tape on the reel so that the tape sticks as it unwinds during use, introducing disastrous wow. Adhesive that bleeds to the oxide coating of the tape will cause a sound drop-out as the bleed passes over the heads—and it will gum up the heads.

Bleeding is easily avoided by using standard splicing tapes such as Scotch type 41 which have a special adhesive that will not run or bleed under conditions normally encountered in use or storage. (The adhesive used on standard acetate mending tape runs like a leaky faucet and should never be used to splice tape, even in an emergency.) If the splice protrudes (Examples 2 and 3) exposed adhesive can cause similar problems.

The angle at which the recording tape is cut is not critical as long as the tape is cut on a *diagonal* and both ends are cut at the *same* angle. (Tape cut with a square end invariably makes a noisy splice. It also takes more of a beating as it passes over heads and idlers and is therefore more likely to fail.) Devices that offer an adjustable cutting angle give you no advantage and may introduce mismatch in the tape ends (Example 4).

As long as the tape ends are properly cut and barely touching, most splicing devices will successfully prevent the tape from slipping to one side (Example 5) or falling at an angle (Example 6). Some really cheap splicers that use a pressure-formed tape channel take on an angle where the tape-cutting slot is sliced through the channel.

Perfect *butt* is something else. If the joined tape ends are not absolutely flush, an accumulation of oxide flakes and other foreign matter in the gap will make a noisy, weak splice. In editing blocks, particularly, carelessness in positioning tape ends can easily produce an overlap (Example 7), ready to snag on just about anything.

In extreme cases, poor splicer design can even damage the tape. Ragged edges (in the channel of very, very cheap blocks) can snag and nick tape (Example 8) which soon will part. With thin polyester-base tapes, too, there is the danger that a device with too good a grip—plus a careless user—can yank the tape until it stretches or its edges curl (Example 9).

What's Available

There are three basic types of splicers. The earliest model, one still popular, is the *Editall* type which may be a plastic or metal block with a channel slightly narrower than the recording tape and running the entire length of the block. Cutting across the channel at the center of the block is a thin diagonal groove (usually at 40 or 45 degrees). A razor blade pulled through the groove cuts the tape. The ends are joined either with a piece of splicing tape slightly narrower than the recording tape or with a large piece of splicing tape which must then be trimmed with scissors or a razor. To avoid protruding splicing tape, it is necessary to cut into the edge of the recording tape very slightly. Narrow splicing tape avoids the cutting but requires some practice to keep the splice from going crooked, like the one in Example 2.

The second type of splicer is the *Gibson Girl,* which comes in many styles. They are alike in having two sets of blades which generally position themselves automatically. A diagonal blade cuts the tape, the splicing tape is applied and the trimming blade is pulled into position and pushed down. It automatically trims the splice to a slightly wasp-waisted contour (hence the Gibson Girl name).

The third type is the *Alonge* professional splicer, used by radio stations and recording studios. It is basically similar to the Gibson Girl type but is more rugged and trims the splice flush at the edge.

Testing . . . Testing

To see which is really the best splicer regardless of price we obtained a model of every splicer we ran across and used them in an ordinary, routine manner. At times the test seemed more like an obstacle course.

We had planned to use the professional (and relatively costly) Alonge as the ultimate criterion since it is a beautiful piece of machinery. Unfortunately on all models tested the trimming blade went out of alignment after several cuts, leaving exposed adhesive. While the misalignment was not great we feel that under long-term storage the bleed would result in sticking. (Professional studios like to dub edited tapes immediately.)

Editing blocks (Editall and imitators) either use a slightly narrow channel to hold the tape in place or are equipped with hold-down clamps. All suffer from the same thing: they require a very sharp razor and a certain dexterity in trimming or positioning the splicing tape.

One block, the Robins TS-5, is supplied with self-stick patches that are not only difficult to remove from their protective backing, they were almost impossible to apply. Since the patch is the full width of the tape channel it ended up protruding on every try.

Similar in intent, although more elaborate in design, are the Editabs, made by the Editall people. Their backing runs down the channel beyond the splice to make the patch self-aligning. If you plan on a lot of editing, though, you'll find Editabs a relatively expensive way of doing it.

Also along the same lines are Presstapes, recently announced by Kodak. While they were not available in time to test side-by-side with other products, a quick check using the editing channel formed right into Kodak's tape reels turned up no problems. With editing devices that do not hold tape ends firmly in position or have an extra-deep tape channel (making it difficult to get at the Presstape's backing) they might be harder to use.

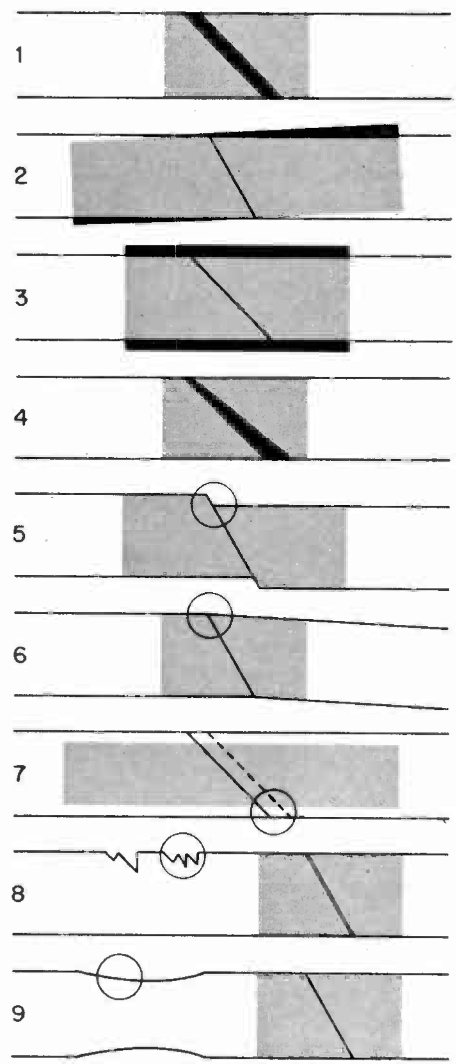
In terms of cutting and trimming, the most effective splicer we tested was the Gibson Girl. Most models are made by Robins but several other brands available from local distributors are almost identical. Their chief advantages are that they make an excellent splice and that the blades are adjustable and replaceable to allow for wear. Unfortunately, in terms of convenience they suffer from *upgraditis.*

Whether a Gibson Girl is advertised as just a plain splicer or a Stereo or a Stereo-4 splicer, it's used for the same job—editing ¼-in. magnetic tape. The basic Gibson Girl priced at about $4 is just a cutter. Add another buck-and-a-half and it comes with a bracket that holds a roll of splicing tape (only the small roll—100 or 150 in. long—unfortunately). Robins recommends ⅜-in. splicing tape for this model but the wider ½-in. roll will fit and makes a stronger splice. Whichever splicing tape you use you'll have to pry it up from the base after each splice. If you do a lot of editing it can be infuriating.

Perhaps the easiest of the Gibson Girls to use is the Robins TS-8D priced at $7.65. This model accommodates splicing tape ½ in. wide in rolls up to 66 ft. long. It has good tape hold-down and cutter systems and never sticks down the splicing tape. Well, hardly ever. Instead, it has a tendency to let the end of the splicing tape pop out of its guide and fall under the base.

Then there's the Robins SP-4 priced at $1.50. This gem consists of a small adhesive-backed plastic block that mounts on the recorder and a hand-held cutter-trimmer. Place the recording tape in the channel of the block, place the cutter on the guide pins, press down and the cut is made. The trim works similarly. Since there is no splicing tape holder to untangle, it turned out to be the fastest and easiest splicer to use.

All in all we may sum up by saying that a difference in price generally represents a convenience which more often than not can turn out to be an inconvenience.



ROGUES' GALLERY OF BAD SPLICES

Whatever splicer model you use, whatever type of splicing tape you prefer, these are the faults to watch for when you're editing tape: (1) Gap between tape ends; (2) Improperly-positioned splicing tape; (3) Improperly-trimmed splicing tape; (4) Mismatch in angle of cut; (5) Tape ends parallel but offset; (6) Tape ends form an angle; (7) Overlap of tape ends; (8) Fraying; (9) Stretching or curling of tape.

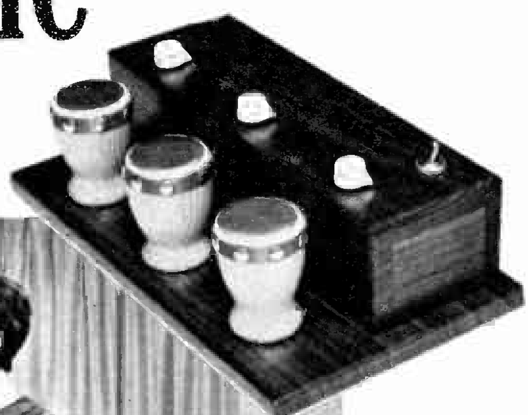
THEY may laugh when you sit down at your pint-size bongos. But when you give them an earful of the wild, authentic sounds they produce, they'll gasp in amazement and grasp their bar stools firmly.

It's amazing what can be done electronically nowadays. Would you believe the percussive sounds of bongos, tom-toms, a bass drum, wood blocks, gongs and claves? It's a fact, and the next time the party's music needs more beat, bring out your miniature electronic bongo set. Used in conjunction with any amplifier, the electronic bongo set will produce the sound of practically any percussive instrument at a cost of about \$3 per instrument.

And Now...

ELECTRONIC BONGOS!!!

By FRED B. MAYNARD



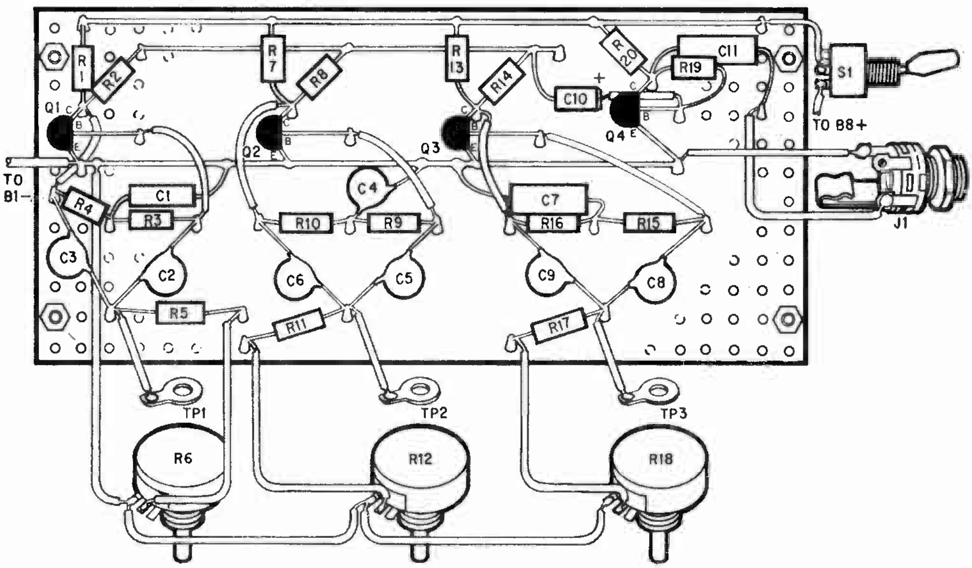


Fig. 1—Our model was built on a 3 x 7-in. piece of perforated board which allowed plenty of space for all parts. Components can be mounted more tightly if you plan to add extra oscillators. If needed, connect hand-clip lead to B1 — buss. The lugs marked TP1, TP2, TP3 go to the touch plates.

ELECTRONIC BONGOS!!!

The sounds are produced with electronic ringing circuits. A ringing circuit is simply an oscillator which is adjusted so it does not run continuously. However, when triggered, or shocked, by a transient, it will break into a short-term oscillation. The bongo set we show here uses three inexpensive, simple twin-T oscillators. If you want additional percussive sounds, simply keep on adding oscillator circuits.

Each oscillator is shocked into oscillation when you touch a sensitive part of its circuit. The actual shock comes from body potential picked up from stray AC fields in the room. Each oscillator can easily be adjusted for best sound with a potentiometer.

There's a possibility that when you tap a touch plate a sound won't be produced. Reason for this is that there may not be enough stray AC around.

The solution is simple. Connect a three or four-ft. length of wire to the negative buss. This is shown in the schematic. It is not shown in the pictorial, but is the wire to which the negative battery lead is connected.

Connect the other end of this lead, on which you should attach a small alligator clip, to *you*. The simplest place is to a wristwatch band. Or, you could hold it between your thumb and third finger. You would naturally use your second, or index, finger to strike the bongo.

How It Works

The circuit shown in Fig. 3 produces sounds of tom-toms, high-pitched bongos and low-pitched bongos. It consists of three twin-T oscillators—associated with transistors Q1, Q2 and Q3. Transistor Q4 is a preamp whose output is coupled by C11 to output jack J1. You connect the output to the high-level input of any amplifier—the larger the better.

Look at the circuit associated with Q1. Resistor R1 is the collector load resistor. Resistor R3, R4 and C1, constitute one of the T-network branches. Components C2, C3, R5 and R6 constitute another T-network branch in parallel with the first branch.

When the values of the resistors and capacitors in the twin-T network are proportioned properly, the circuit will operate as a free-running oscillator or as a ringing circuit, depending on the resistance of R6.

Each oscillator's output, taken from the collector side of the T-network, is fed to a

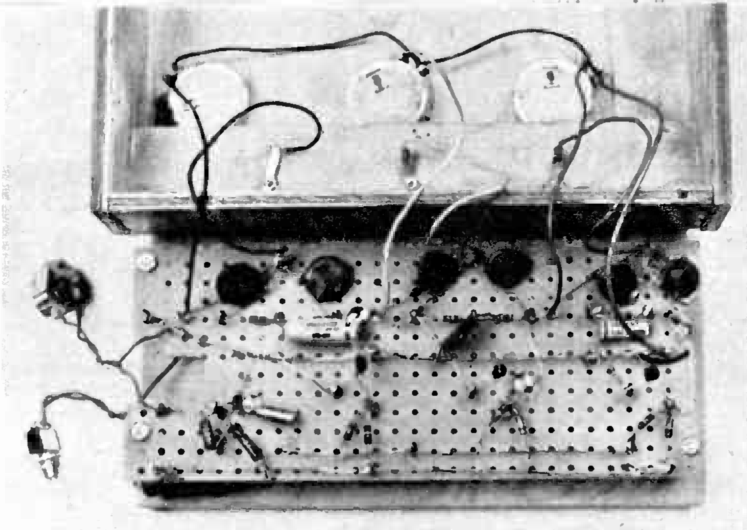


Fig. 2—Inside view of our model. Notice how wide-open the board is. Potentiometers R6, R12 and R18 are installed in top of cabinet directly behind each bongo. The lug under each pot connects to the wire from the touch plate on top of each bongo.

common line through resistors R2, R8, R14 then through C10 to Q4. Transistor Q4 amplifies the signal and feeds it to output jack J1.

Resistor values are the same from one oscillator to the next. Different frequencies are obtained by using different-value capacitors. The capacitor values in our Parts List will produce tones for a tom-tom, low-pitched bongo and high-pitched bongo.

Other tones can be obtained. For bass drums, use larger capacitors. For higher-pitched bongos, wood blocks and claves, etc. use smaller capacitors.

You may try out or add any of these other sounds with other capacitors. When you add

PARTS LIST

B1-B8—1.5 V penlite cell (8 reqd.)
Capacitors: ceramic disc or mylar paper: 75 V minimum unless otherwise indicated
C1—.033 μf C2,C3—.015 μf
C4,C8,C9—.02 μf
C5,C6—.01 μf
C7—.04 μf
C10—1 μf, 50 V electrolytic
C11—.5 μf
J1—Phone jack
Q1-Q4—Motorola MPS6515 transistor (Allied, 64¢ plus postage. Not listed in catalog)
Resistors: ½ watt, 10% unless otherwise indicated
R1,R7,R13—100,000 ohms
R2,R5,R8,R11,R14,R17—10,000 ohms
R3,R4,R9,R10,R15,R16—47,000 ohms
R6,R12,R18—20,000 ohm, linear-taper potentiometer
R19—220,000 ohms R20—5,600 ohms
S1—SPST toggle or slide switch
TP1-TP3—Touch plates (see text)
Misc.—Battery holders, alligator clip for hand clip (optional, see text)

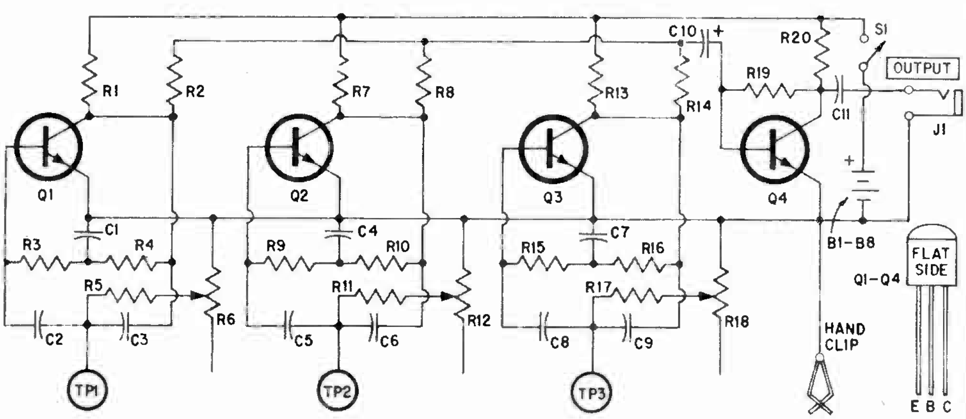


Fig. 3—Circuit for three-bongo set. Basic oscillator for one tone consists of C1,C2,C3,Q1,R1,R2, R3,R4,R5,R6 and TP1. To change tone, change values of C1,C2,C3 only. C2,C3 must be identical; C1 must be twice the value of C2,C3. To lower the tone, increase the capacitance and vice versa.

ELECTRONIC BONGOS!!!

on another oscillator circuit, always remember that (using oscillator Q1 as an example) C2 and C3 must always be equal, and C1 must always be twice the value of either. If the capacitor values are cut in half, the frequency *increases* approximately one octave, and vice versa.

Construction

You may use any type of construction you prefer; it is not critical. We built our bongo's circuit on a 3 x 7-in. piece of perforated circuit board. Not mounted on the board are the batteries, the three control pots (R6, R12, R18), battery switch S1, output jack J1 and touch plates TP1, TP2 and TP3.

A good-looking cabinet is shown in Fig. 5. You can get a better idea of what it looks like on our cover and on the first page of this article. Made of ½-in. walnut, it has a front step on which are mounted the three miniature bongos. On top of each bongo is a touch plate—a 1½-in.-dia. metal disc.

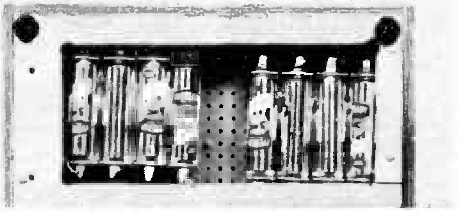
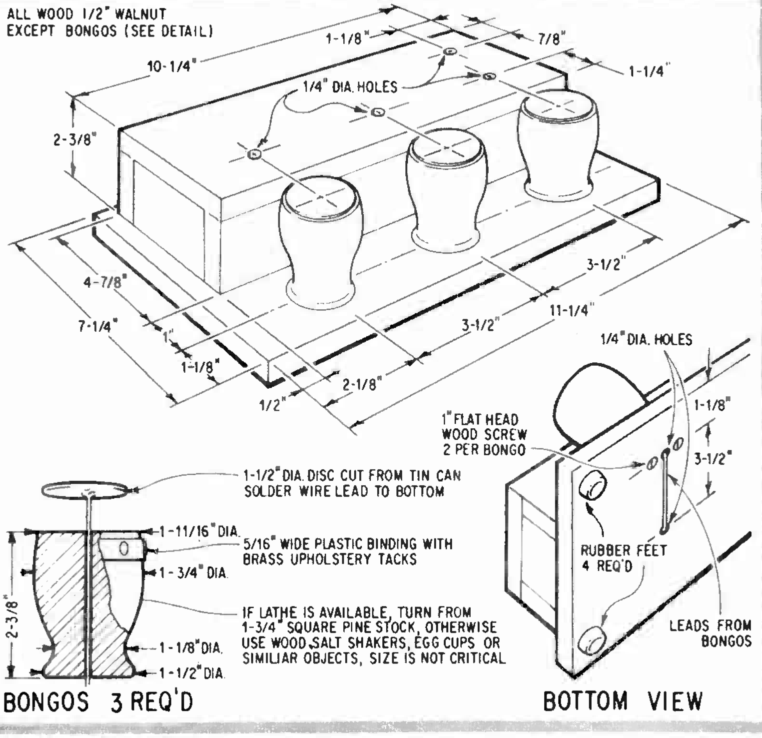


Fig. 4—Underside of our bongo set. Notice how eight penlite cells are mounted in two battery holders. If desired, you could use a 12-V battery.

Adjustment of pots R6, R12 and R18 is very simple and should be made from time to time because of drift due to voltage or temperature changes. Connect the output to an amplifier or earphones. Turn all the pots to their maximum-resistance position (full counterclockwise). One at a time turn each pot clockwise until oscillation starts. Then turn the pot counterclockwise until the oscillation just stops. Tap a touch plate quickly and you'll hear percussion-like sound.

Fig. 5—Here are all of the construction details for the cabinet shown on our cover and on the first page of this article. None of the dimensions are particularly critical. We made our bongos on a lathe; however, you could use wood or plastic salt shakers, egg cups or souvenir bongos.



1-Tube All-Bander

A low-cost, high-performance receiver for the listener on a budget.

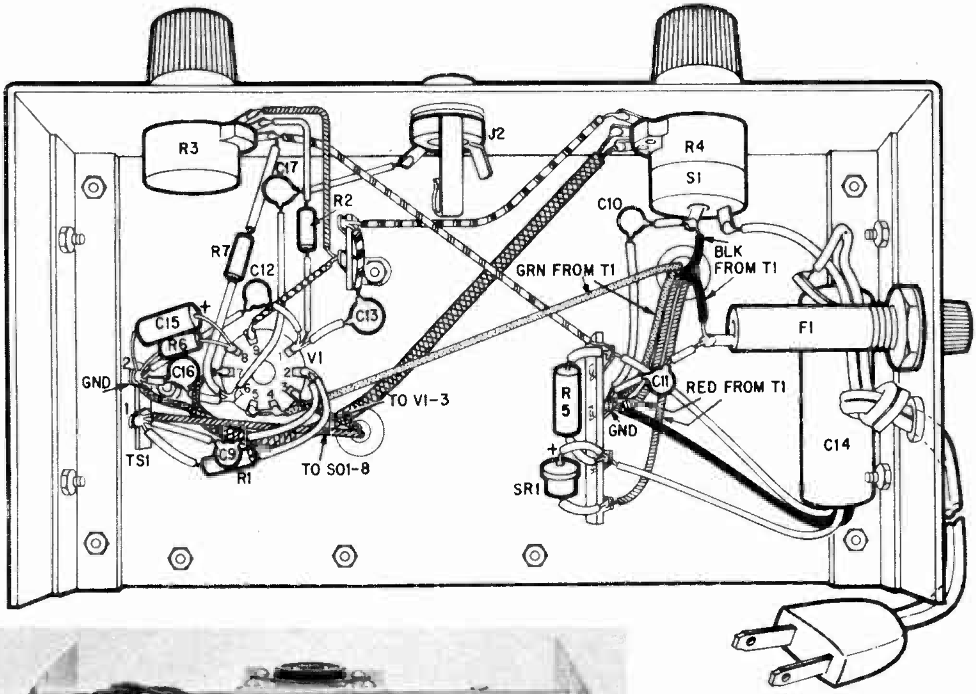
By DAVID J. GREEN, W6FFK

IT'S not just young folk that must crawl before they can walk. Hams-to-be and short-wave listeners must, too. And a good way to get started in either of these activities is with a receiver that is simple, doesn't put a strain on your wallet yet performs well.

If you really get hooked, you'll have a receiver which will hold you in good stead until the time comes when more cash is available for a larger rig.

On the other hand, if after monitoring the bands your interest wanes, you won't kick yourself for having tied up a lot of money in a receiver that ends up sitting on the shelf.

Our receiver is just what you need to start. It uses a dual triode for the detector and the audio-amplifier stage. Operating frequency is changed by simply plugging in a coil for each of the following bands: 15 meters, 20 meters, 31 meters, 40 meters, 80 meters, 160 meters and the broadcast band.



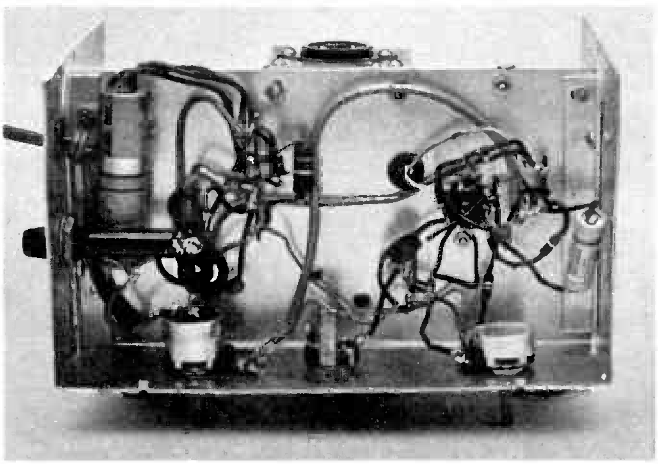


Fig. 1—There is very little under the chassis; therefore, you should have no problems fitting everything in place. Keep all leads to and around V1 short and direct. Note how the chassis is installed in the main section of the Minibox with home-brew brackets. Our chassis was installed 2¼ in. above the bottom of the cabinet. Heavy wire from volume control R4 to pin 7 on V1 is shielded.

1-Tube All-Bander

The Circuit

Signals to antenna jack J1 are coupled via antenna trimmer capacitor C1 to the tuned circuit consisting of coil L1 (or L2 through L7) and tuning capacitor C8. Bias for the detector stage (V1A) is developed by R1 and C9. To provide regenerative feedback, the cathode of V1A is connected to a tap on each coil. Regeneration is controlled by varying V1A's plate voltage with *regen* control R3.

The detected signal across R2 is coupled by C13 to *volume* control R4. The signal is then fed to the grid of audio amplifier V1B. Bias for V1B is provided by R6 and C15. The amplified signal which appears across R7 is coupled by C17 to phone-jack J2. The impedance of your phones should be at least 3,000 ohms, or higher. Operating power is furnished by power transformer T1, rectifier SR1 and the R/C filter circuit consisting of C14A, C14B and R5.

Construction

Mount a 7¾ x 3¼-in. piece of aluminum in main section of a 8 x 6 x 3½-in. Minibox. Support the plate approximately 2 in. from the bottom of the cabinet with brackets mounted on the side of the cabinet. Duplicate our parts layout to insure correct operation.

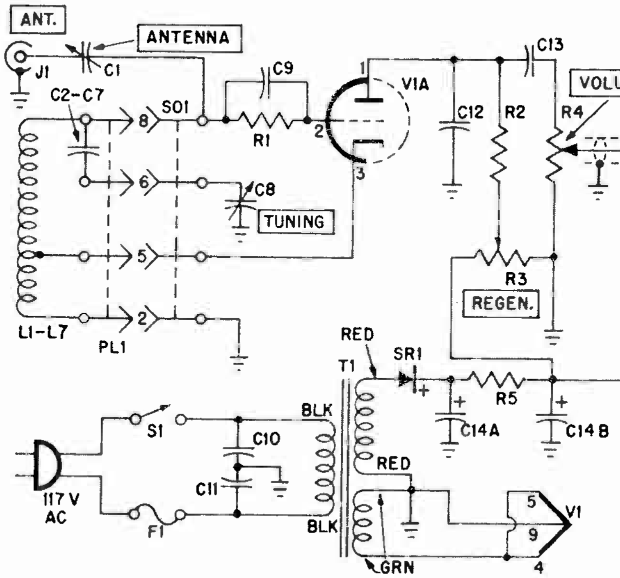


Fig. 2—Schematic. Incoming signals are tuned by C8 and selected coil (L1-L7) and fed to regenerative detector V1A. Audio signal is then fed via C13 and volume control R4 to audio amplifier V1B. Signal is then coupled to phones (high Z) by C17.

PARTS LIST

Capacitors: 1,000 V ceramic disc unless otherwise indicated
C1—4-30 µµf trimmer (Allied 11 U 651 or equiv.)
C2-C7—See coil chart
C8—10-365 µµf variable (Lafayette 99 E 62176)
C9—100 µµf
C10,C11—.005 µf
C12—470 µµf
C13,C17—.01 µf
C14A,C14B—20/20 µf, 150 V electrolytic
C15—10 µf, 25 V electrolytic
C16—.001 µf
F1—½ A fuse and holder
J1—Phono jack
J2—Phone Jack
L1-L7—Coils (see coil chart) wound on octal tube bases
PL1—Octal tube base (7 reqd.)
Resistors: ½ watt, 10% unless otherwise indicated
R1—2.2 megohms
R2—270,000 ohms
R3—50,000 ohm liner-taper potentiometer
R4—1 megohm, audio-taper potentiometer
R5—1,800 ohms, 1 watt
R6—1,000 ohms
R7—100,000 ohms
S1—SPST switch on R4
SO1—Octal tube socket (Amphenol 77MIP8 or equiv.)
SR1—Silicon rectifier: 750 ma, 400 PIV (Lafayette 19 R 5001)
T1—Power transformer; Secondaries: 125 V @ 15 ma, 6.3 V @ 0.6 A (Allied 61 U 410 or equiv.)
V1—12AT7 tube
Misc.—8 x 6 x 3½-in. Minibox, plastic tape kit (Lafayette 99 R 8029), No. 28 enameled wire, 9-pin tube socket, terminal strips, knobs, AC line cord and plug

The octal tube socket (SO1) for the coils should be mounted on a 2½ x 2-in. aluminum bracket. Install the bracket 2¾ in. from the left, and 3 in. from the right sides of the cabinet. The back of the cabinet should have a 1¼-in. hole cut in it in front of SO1. At the top of the coil-socket bracket drill a small hole for a sheet metal screw which should be used to hold the back of the cabinet to the bracket.

Trimmer capacitor C1 should be mounted

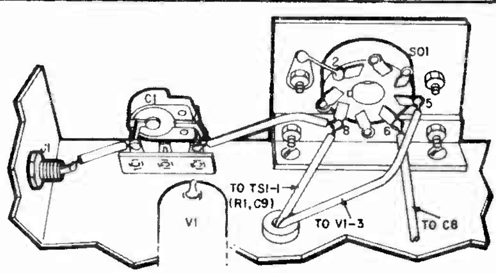
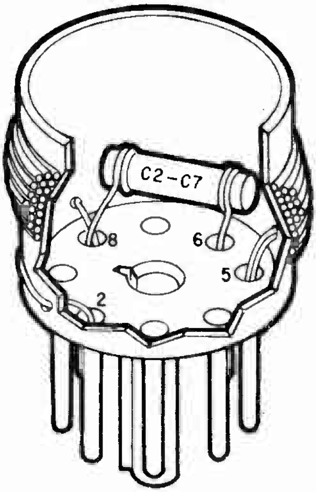


Fig. 3—View of top rear of chassis shows how trimmer capacitor C1 and socket for coils are mounted. Cut holes in back of cabinet for access.



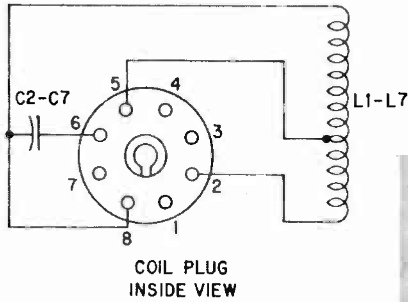
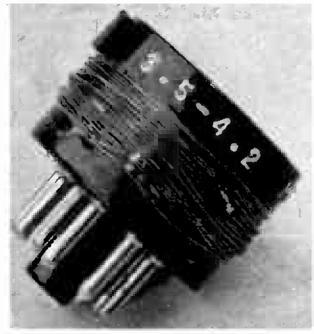


Fig. 4—Coil details. First, drill holes just above pins 2, 5 and 8. Start winding at pin 2, tap goes to pin 5, finish at pin 8. Install capacitor or jumper (see table) before soldering pin 8. An example of scramble winding can be seen in the photo of L3 at the right.



1-Tube All-Bander

by soldering its lugs to a three-lug terminal strip as shown in Fig. 3. C1 should be positioned to line with a hole in the back of the cabinet 1½-in. from the right side.

The Coils

The coils are wound on octal-tube bases. Before winding them, drill holes at the bottom of each base right above pins 2, 5 and 8. Start winding the coil from pin 2, as shown in the coil table. When you reach the number of turns at which you make the tap, break the wire, remove the enamel insulation, push both ends of the wire into pin 5 and solder. Then keep winding the coil the same direction and connect the last turn to pin 8.

Install the capacitor, or a jumper wire in the case of the broadcast-band coil, from pin 8 to pin 6. Keep the wire tight and the capacitor's leads short. After finishing, wrap plastic tape around the coil wire. We used different-colored plastic tape for quick identification of each coil.

Operation

Plug in the broadcast-band coil first. Turn the set on and give it a few moments to warm up. Turn the *volume* control all the way up and adjust the *regen* control until the receiver is just below the point of whistling. Tune for a loud station and then adjust the *regen* control until the station comes in loud and clear. Then adjust the antenna trimmer capacitor for maximum volume.

COIL CHART

Coil	Freq. (mc)	Turns	Capacitor (C2-C7)
L1	.55-1.5 (bdcst.)	80, tap at 20 from gnd.	Jumper
L2	1.65-2 (160 M)	75, tap at 20 from gnd.	47 $\mu\mu f$
L3	3.5-4.2 (80 M)	29, tap at 8 from gnd.	47 $\mu\mu f$
L4	6.5-8.5 (40 M)	13, tap at 3 from gnd.	47 $\mu\mu f$
L5	9.5-9.7 (31 M)	12, tap at 3 from gnd.	27 $\mu\mu f$
L6	14-14.5 (20 M)	8 tap at 4 from gnd.	10 $\mu\mu f$
L7	21-22 (15 M)	5, tap at 2 from gnd.	10 $\mu\mu f$

All capacitors ceramic disc or mica. All coils are scatter wound with No. 28 enameled wire.

Fig. 5—Chart above contains details for all seven coils. Frequency coverage is approximate and depends to a large extent on how coils are wound.

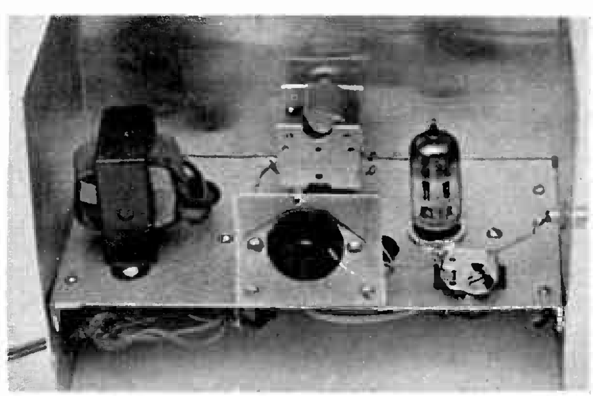


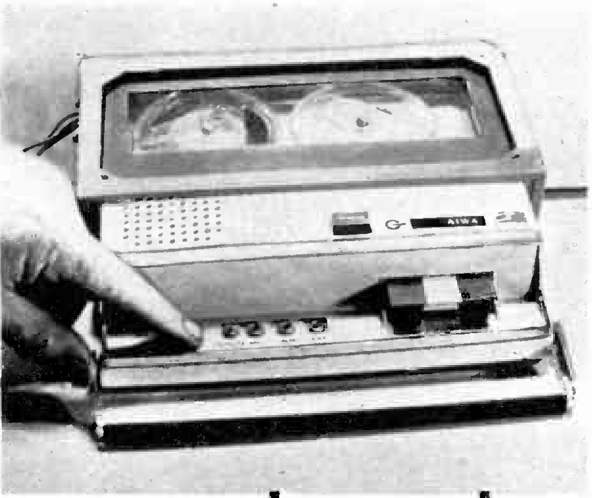
Fig. 6—Note location of antenna jack and trimmer capacitor. Hole above the coil socket is for self-tapping screw installed through back of cabinet.

PUT TAPE IN YOUR CAR

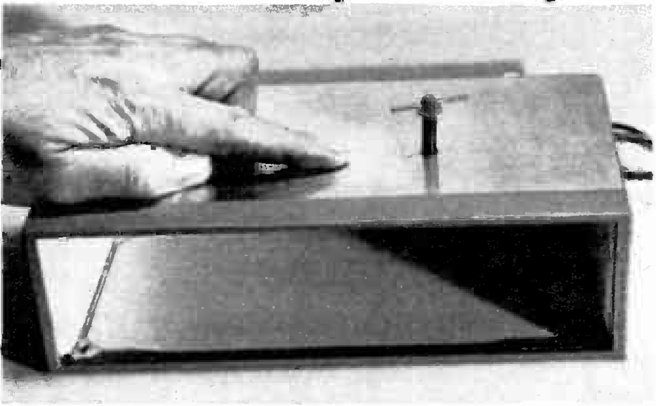
THAT latest rage, the auto tape player, is great if you're willing to listen to prerecorded tapes only. But we'll bet there are many times when you'd like to be able to play a tape you made at home or record a tape on the road.

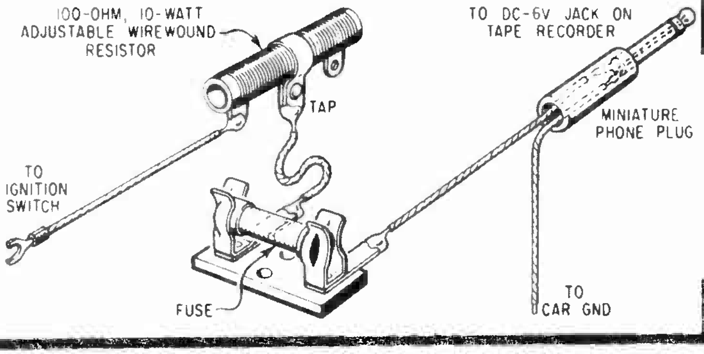
For example, if you're a salesman a recorder in your car will enable you to write orders quickly. Or you could tape reminders to yourself, ball-game scores or important broadcasts. And don't forget the children, who can be entertained by stories taped in advance of a long trip. Here's how we installed a $40 tape recorder in our car.—*Homer L. Davidson*

We installed a Japanese-made Aiwa recorder, which handles 3-in. reels at 1⅞ or 3¾ ips. It operates on 6 V and is push-button controlled. Latest model, TP-706, is available from Allied Radio (stock No. 79 U 970 MX) for $39.95. It has a jack on the front panel into which you feed 6-V power. Push button on mike starts and stops machine. Other jacks are for external speaker and high-level input.



Start by taking a 5 x 10 x 3-in. aluminum chassis (Premier ACH-401 or equiv.) and cut away 10-in. side with nibbling tool. Smooth all edges and cover with tape. Bolt shown is on bottom and is used to hold recorder in place. Drill holes in the top of the chassis to hold it to underside of the dashboard.

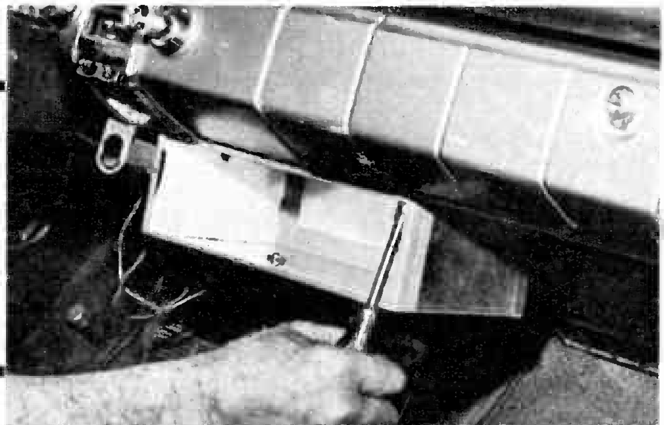


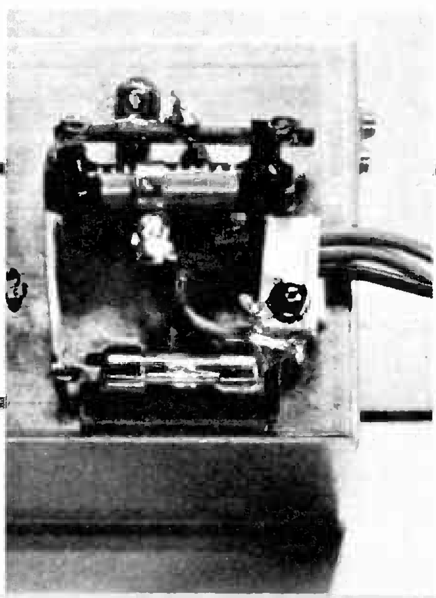


Mount resistor to drop voltage to 6 V on back of chassis. As recorder draws 100 ma, value should be 60 ohms. Use 100-ohm adjustable type and adjust slider with recorder operating to set voltage. Positive lead goes to the sleeve in plug.

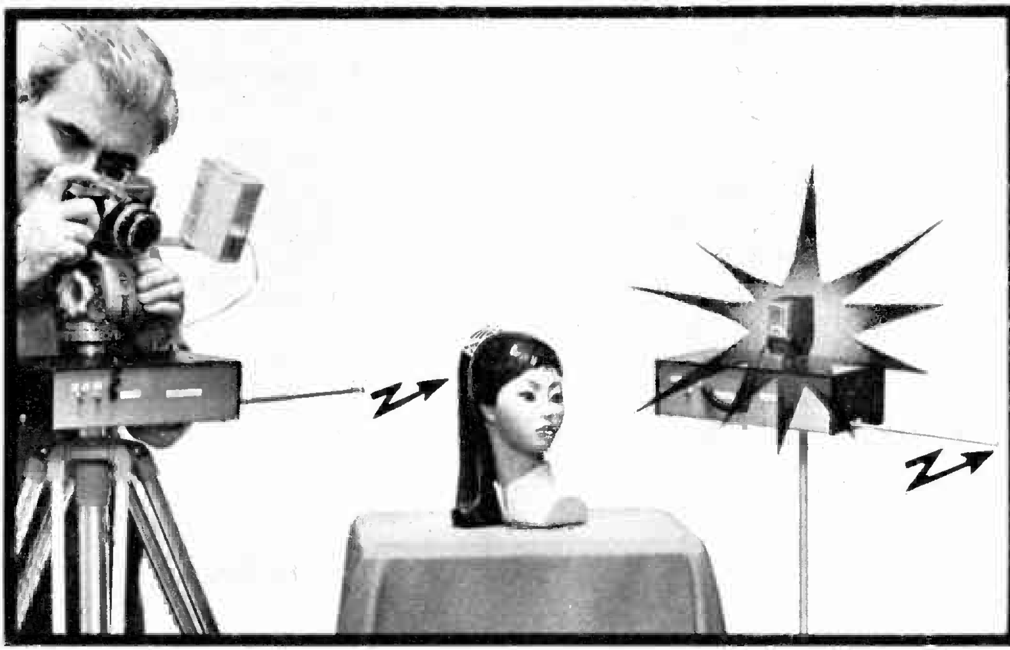
The job is done. The recorder is about 3 in. deeper than the chassis; therefore, operating push buttons, level meter, volume control and speaker will protrude just the right distance. Cement a small magnet on back of mike so it can be held to dash when not in use. To remove recorder for use in home, loosen underchassis screw, disconnect power plug and slide unit out.

After resistor has been adjusted, install the chassis under the dash with self-tapping screws. Connect negative power lead to car chassis and positive lead to cold or accessory lug on ignition switch.





Adjustable wirewound resistor and fuse holder should be mounted on back of chassis. Because resistor will be difficult to get to after unit is mounted, measure the dropped voltage with recorder operating before installing chassis under the dash. Fuse should be a .15 A type 3AG.



An Electronic Slave Flash for Your Camera

By C. R. Lewart

IF YOU'VE sweated through the hassle of stringing out tangled wires for slave flash equipment, your liberation is at hand.

Our little flash pack is not only wireless but also free of the chancey performance of light-triggered slaves. You can use just as many slaves as you wish and up to hundreds of feet away.

The secret is radio—a radio signal that originates at the camera and arrives instantly at the slave to set it off. What's inside the rig includes integrated circuits, light-emitting diodes and an optoelectronic coupler. A budget pair of walkie-talkies along with a handful of resistors, capacitors and other components complete the parts roundup.

Both master and the slave can be wired on 3¾ x 2½-in. pieces of perf board, and then mounted with their walkie-talkies and battery holders inside 3 x 11 x 5-in. metal boxes. Drill a hole in each box for the antenna. Attach the walkie-talkies to the cabinets by gluing in place or by mounting with brackets.

The only connections to the walkie-talkies are to the speaker and battery leads. The battery clips can be removed from the walkie-talkies because power now will come from B1 in the master and B2 in the slave. B1 and B2 are size AA cells mounted in holders.

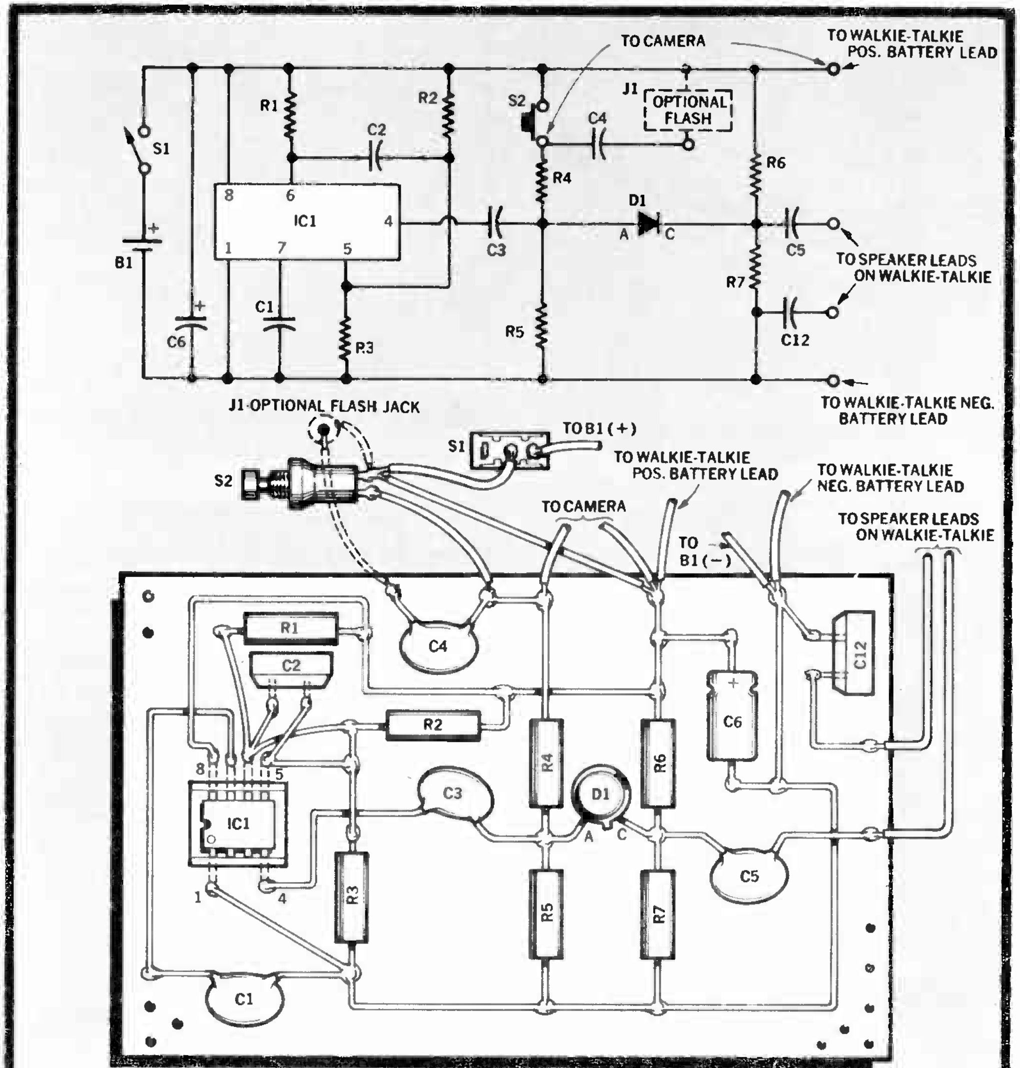
Remove the speaker in the transmitter (master) and connect one lead to C5. The other lead goes to capacitor C12. Since current flow from B1 in the master station is controlled by switch S1, connect the positive (red) to the positive voltage bus at C6 (camera side of S1). The negative or return voltage lead is connected at C12 to the negative side of the battery.

A bracket should be made for the master to lock the push-to-talk button in the transmit position. Or you can just jump the button by soldering in a toggle switch. Otherwise, the bracket will do.

In each slave station the speaker remains connected but two wires are run, one to C13 and the other to C14 on the slave circuit board. The positive battery lead (red) picks up B2 voltage from S2 while the negative wire goes to B2 (—) at the cathode (C) of the SCR. Remote flashes are connected at the SCR in each slave. The positive or center flash conductor goes to the anode (A) while the negative or outer conductor of the cable goes to the cathode (C) of the SCR.

Since you will need two pieces of photographic flash cable, one for the connection to the camera and the other for the remote flash, you can get a flash gun extension cable and cut it in half. The half with the male jack connects to the camera, the other to the gun.

At the master the camera is connected between the R4 side of test switch S2 and the positive B1 battery bus. Positive and negative is not important here.

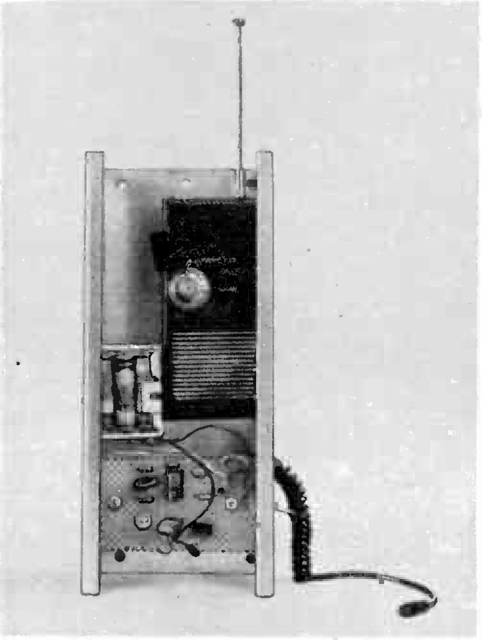


MASTER STATION

An Electronic Slave Flash for Your Camera

While we did not include the jack for the optional flash in our master, it is easy to add and you can connect it between the positive battery bus (camera side of the S1) and capacitor C4.

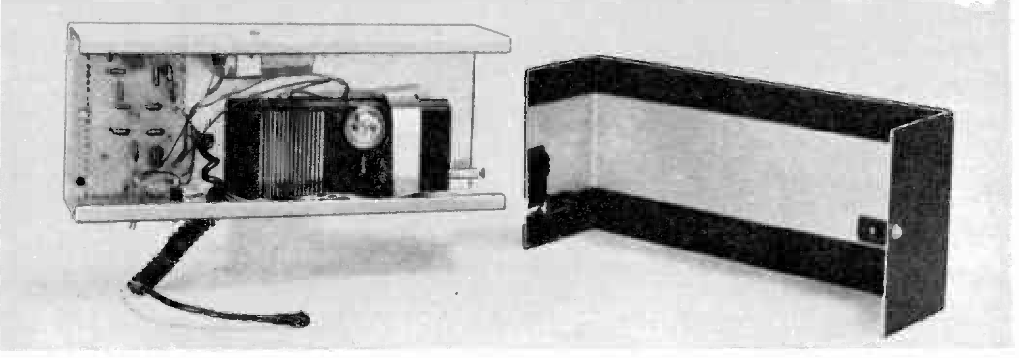
Do not connect either the camera or the flashers until after you have adjusted the system. Put the master station



SLAVE unit is roomy with circuit board, battery bracket and walkie-talkie mounted.

PARTS LIST

Capacitors
C1—.01MF, 10 volt mylar
C2—.001MF miniature mica
C3—.2MF, 10 volt ceramic
C4—.01MF, 250 volt ceramic
C5—.2MF, 10 volt ceramic
C6,C11—10MF, 10 volt miniature electrolytics
C7—.02MF, 100 volt mylar
C8,C10,C12—.5MF miniature micas
C9—.1MF miniature mica
C13,C14—.2MF miniature micas
Resistors: all ½ watt, 10% tolerance unless otherwise noted, K-1000
R1—2.7 kohms
R2—1.8 kohms
R3—12 kohms
R4—2.4 kohms
R5—6.8 kohms
R6,R7—3.3 kohms
R8—5 kohms variable, Allen Bradley BA99382-21
R9—2.2 kohms
R10—240 ohms
R11—1.5 kohms
R12—270 ohms
Semiconductors
IC1—Signetics NE 566 PLL
IC2—Signetics NE 567 PLL
OPT—Motorola MOC 1000 or MOC 1003 opto-electronic coupler also could be equiv. GE, Fairchild or Monsanto
D1—Germanium Diode HEP 134 or equivalent
LED1—Light emitting diode HEP P2000 or equivalent
SCR—HEP R1222 or equivalent
B1,B2—12 AA cells (total)
S1,S3—SPST miniature switches
S2—Momentary, normally open SPST switch
Misc.—Two walkie-talkies with volume control, Lafayette HA-70d or equivalent, integrated circuit sockets, flash gun extension cord; Model 539 aluminum boxes measure 3" x 11" x 5" available from Hazelton Scientific Co., P.O. Box 163, Hazel Park, Mich. 48030 for $3.55 plus postage, Battery holders for each set of six AA cells.

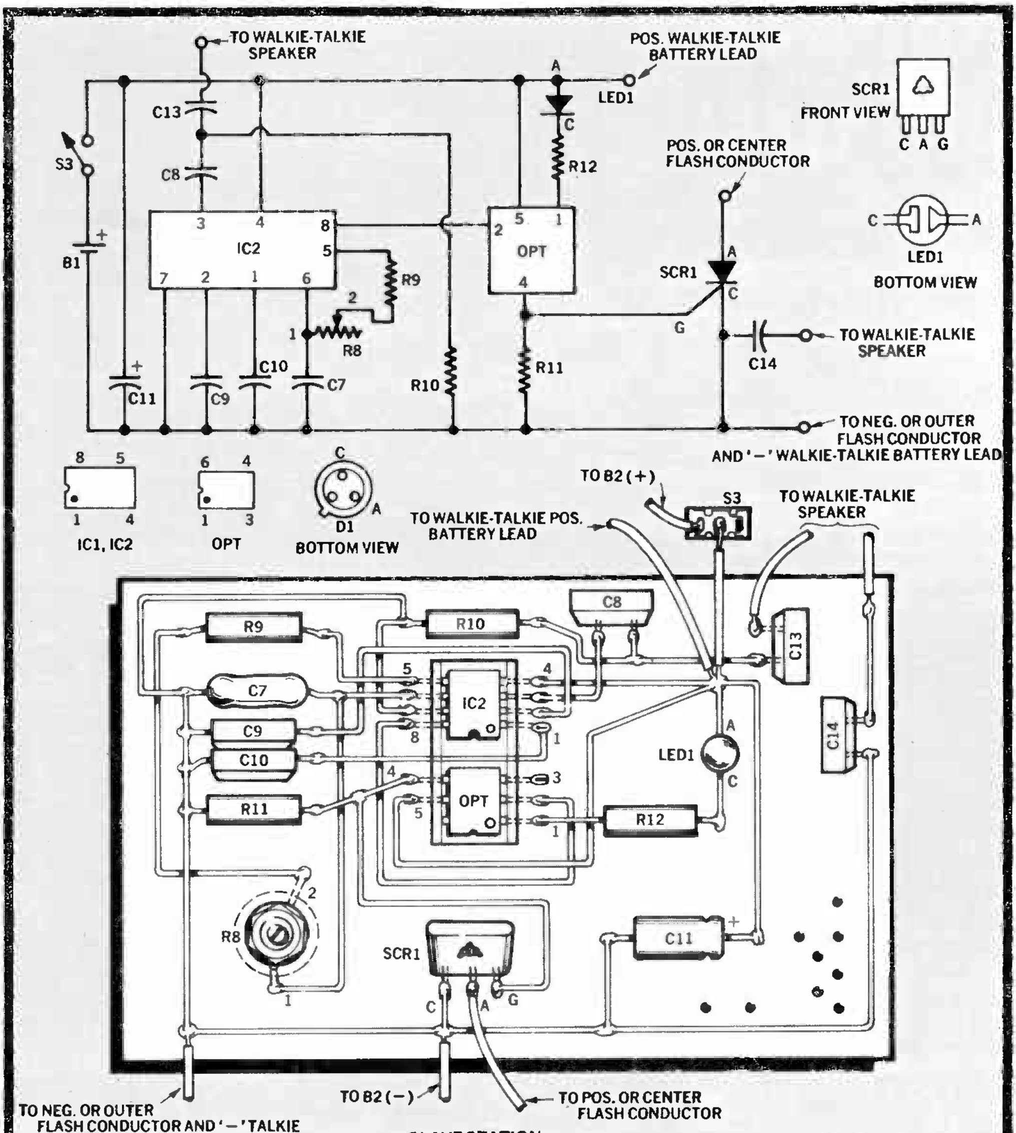


MASTER device has clamp around talkie body to keep it in transmit position.

20-50 ft. away from the slave, turn on S1 and S3 and have a friend push test switch S2. Turn the volume control on the receiving and transmitting walkie-talkies halfway up and leave them in this position. Now turn R8 back and forth to adjust the receiving frequency and leave it in the center of the range in which indicator lamp LED1 lights up.

With both slave and master turned off and the walkie-talkie antennas pulled out, connect the flash to the slave devices and an optional strobe (if you desire) to the master unit. Now you can charge the strobes. After you turn on the the transmitter and receiver, you can test the system by pushing S2. The flash

(Continued on page 56)



SLAVE STATION

NUVISTOR SWL BOOSTER

There's gold in them thar SW bands and this hot preselector will prove it.

By HERB FRIEDMAN, W2ZLF

REVOLUTIONISTS transmitting on a flea-power rig during an uprising in a Latin-American country. Hopeful politicians in a newly independent nation broadcasting fuzzy music from their country to show the world that theirs is a land of importance. Now that's real DX!

But rare is the budget SWL receiver with enough sensitivity to dig those stations out of the mud. While some receivers offer quite a bit for a modest price, their sensitivity on the important SWL frequencies—5 to 15 mc —is likely to be something like 16 microvolts for a 10db signal-to-noise ratio. And that's like not much. To dig out the rare stations you need a sensitivity of 1 μv or better. The best way to get it, short of buying a gold-plated receiver, is with our Nuvistor SWL Booster.

The booster has been designed specifically to give super sensitivity to budget receivers—that is, receivers without a tuned RF stage. Construction has been tailored for the beginner. Even if you're a novice at building projects you should be able to construct the booster with a minimum of problems.

Using a tetrode Nuvistor, the booster has up to 40 db gain from 5 to 15 mc. Theoretically, this would give a receiver with a sensitivity of 16 μv a sensitivity of 0.16 μv. In practice, however, noise and other troubles get in the way and the actual sensitivity will end up being in the neighborhood of 0.5 to 1 μv. In tests with a popular budget receiver that was near dead from 12 mc up, the addition of the booster filled the dial with stations.

Construction

Because of its extremely high gain, the booster may tend to be unstable (will oscillate) unless it is built *exactly* as shown. Follow the pictorial and Parts List to the letter, make no substitutions or changes and there'll be no trouble.

Using the dimensions in Figs. 1 and 2, drill the front and rear panels of the U-section of the Minibox. Then cut and drill the internal shield. The shield can be made from a piece of scrap aluminum or an old Minibox. Start construction by mounting V1's socket on the shield.

Depending on its style (there are two types), the Nuvistor socket may not be the easiest thing to mount. We suggest this pro-

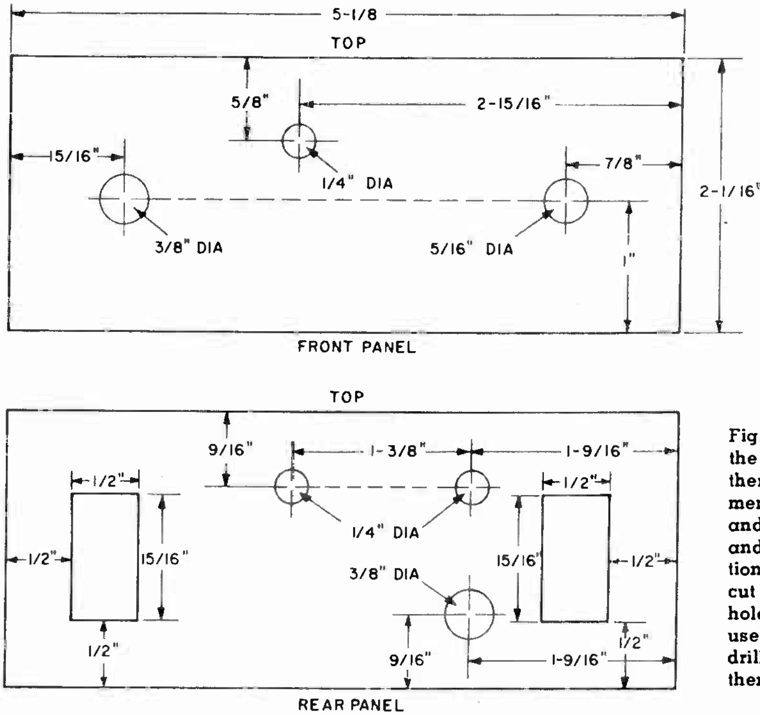


Fig. 1—Position of all the parts is critical; therefore, use these dimensions for cutting and drilling the front and rear of the U-section of the Minibox. To cut the rectangular holes in the rear panel, use a nibbling tool or drill several small holes then file away metal.

cedure: bend out the two mounting straps so they are in the same plane as the top of the socket. Hold the socket in place and fit two screws or rivets through ⅛-in.-dia. holes drilled so they are adjacent to each tab. The screw or rivet heads will secure the straps insuring a solid, well-grounded mounting. Make certain the socket is oriented correctly. If it is turned 180° *do not* cross the leads to it; instead, remove the socket and install it correctly. Put a ¼-in. rubber grommet in the ¼-in.-dia. hole in the shield for R3.

Locate tuning capacitor C5 about ⅛-in. behind the front panel. Using the tapped holes in C5's underside as a guide, mark the hole positions in the bottom of the U-section of the Minibox for C5's mounting screws. Drill the holes but do not mount C5 yet. Next, position the shield so it is centered behind the hole for switch S1. Mark the shield's mounting holes in the bottom of the cabinet. If you prefer, a phono jack can be substituted for the terminal strip TS2. If your antenna transmission line is coax, you also can substitute a phono jack or a coax connector for TS1.

Mount the components in the following order: TS1, TS2, the shield, C5, C1 and S1 (with a jumper across its bottom terminals). Don't forget to mount a terminal strip with the shield (see Fig. 3, bottom). Resistor R3 is mounted in the grommet in the shield. Connect all components associated with V1.

The plate cap for V1 is on the right side of the shield and should be installed last. Note that there are two main ground points. Don't change connections to them or you're likely to have oscillation problems. Finally, mount and wire L1 and then L2. Make certain C7 is mounted as close as possible to L2; C7's ground lead can be long but the lead to L2 must be short.

The coils you receive for L1 and L2 may

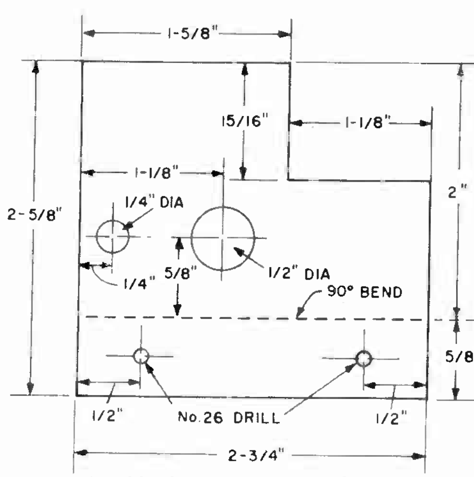


Fig. 2—Shield plate. Nuvistor socket is mounted in ½-in.-dia. hole; resistor R3 fits in grommet in ¼-in.-dia. hole. Bend the bottom toward you.

NUVISTOR SWL BOOSTER

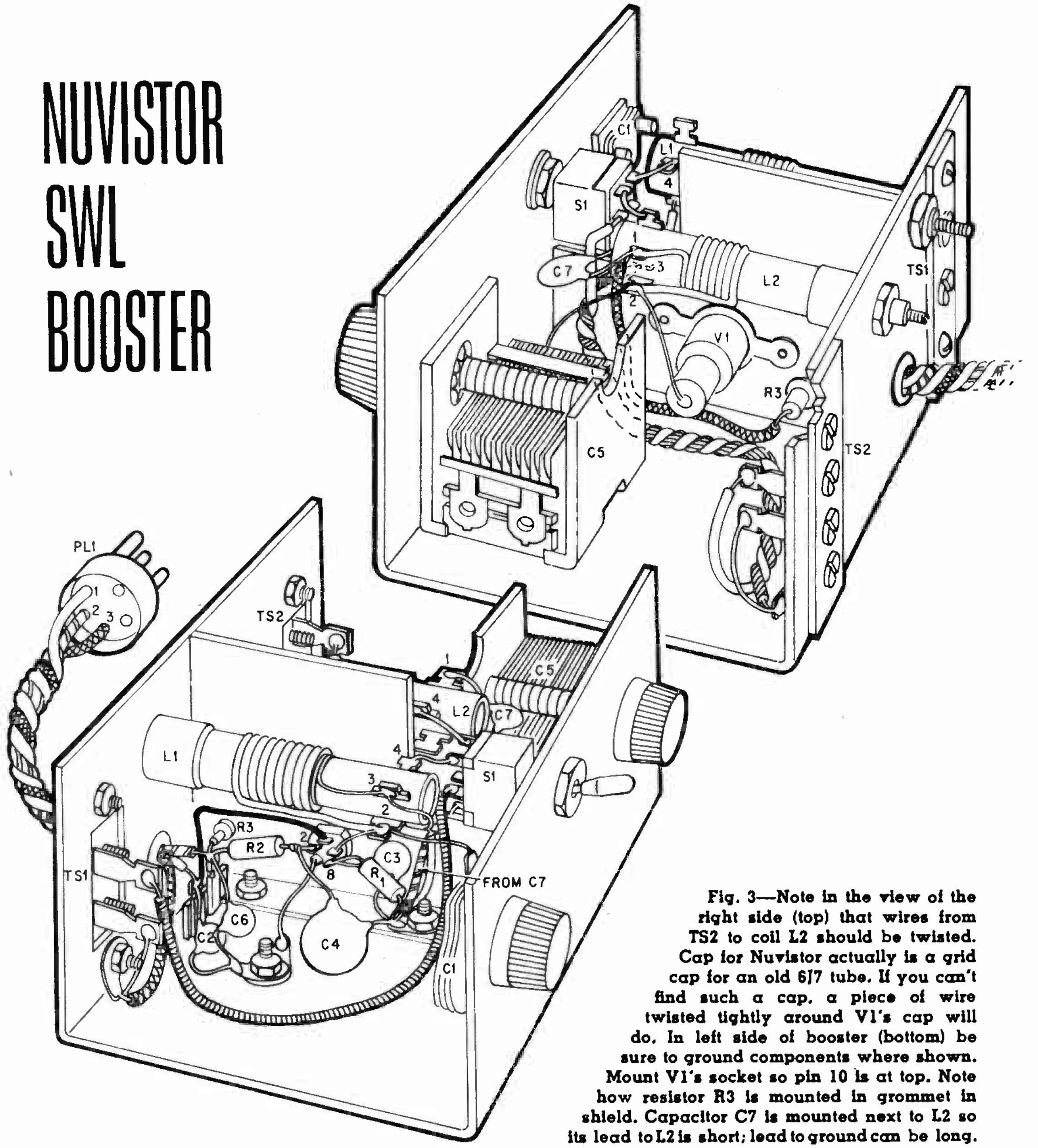


Fig. 3—Note in the view of the right side (top) that wires from TS2 to coil L2 should be twisted. Cap for Nuvistor actually is a grid cap for an old 6J7 tube. If you can't find such a cap, a piece of wire twisted tightly around V1's cap will do. In left side of booster (bottom) be sure to ground components where shown. Mount V1's socket so pin 10 is at top. Note how resistor R3 is mounted in grommet in shield. Capacitor C7 is mounted next to L2 so its lead to L2 is short; lead to ground can be long.

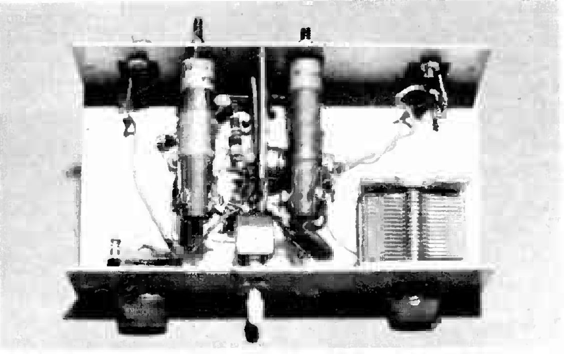


Fig. 4—Top view of completed booster. Although the coils may not look exactly alike, they're electrically identical since the part numbers are the same. Mount L1 (left) so its color dot faces down. Mount L2 (right) so its color dot faces to the right. If you mount coils some other way, improper placement of leads to them may cause oscillation. Be sure to remove the trimmer capacitor mounted on C5's side.

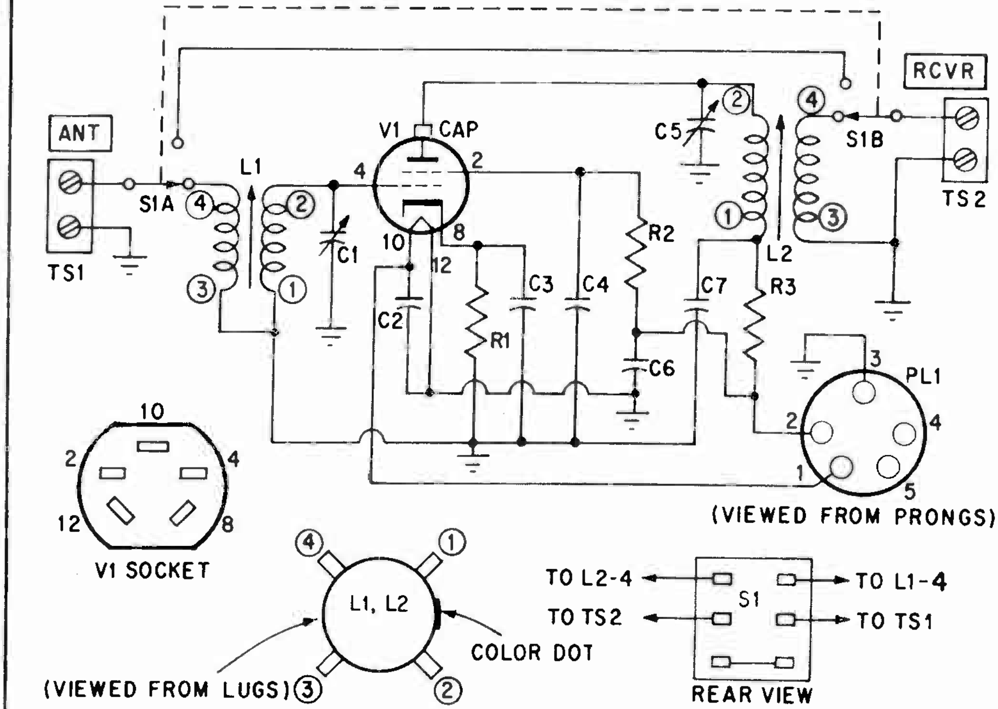


Fig. 5—Schematic of booster. When switch S1 is in position shown signal from antenna goes through booster. When you tune in a strong station, set switch to other position to feed signal directly to receiver to prevent overloading of booster and receiver. Mount V1's socket with pin 10 up as shown.

not look exactly the same even though they have the same part number. The windings may be close together or separated slightly. It doesn't matter which design you get as long as the part number is correct. You identify the coil lugs with respect to the color dot on the form as shown in Fig. 5. One final reminder—keep all leads short.

Construction of the power supply in the main section of a 2⅛ x 3 x 5¼-in. Minibox is straightforward—just duplicate the layout in the photo in Fig. 6. Resistor R5 can be three 22,000-ohm ½-watt resistors in parallel or a single 7,500-ohm 2-watt resistor.

Alignment

Connect the booster (via TS2) to your receiver's antenna terminals with a short length of RG59/U coax. Turn on your set and the booster's power supply and set S1 so the antenna input (TS1) is connected directly to the receiver. Set the receiver to 15 mc; set C1 and C5 to minimum capacity (plates open) and turn L1's and L2's slug-adjustment screws fully clockwise. Then back them out ⅛-in. Connect a signal generator set to 15mc to TS1.

If you don't have a signal generator, con-

PARTS LIST

C1—10-365 μμf miniature variable capacitor (Lafayette 99 R 6217)
C2,C6—.005 μf, 500 V ceramic disc capacitor
C3,C4—.01 μf, 500 V ceramic disc capacitor
C5—10-365 μμf midget TRF variable capacitor (Lafayette 99 E 62176)
C7—.02 μf, 500 V ceramic disc capacitor
C8,C9—.05 μf, 500 V ceramic disc capacitor
C10—20 μf, 250 V electrolytic capacitor
C11—40 μf, 150 V electrolytic capacitor
L1,L2—5.5-18 mc RF coil, J.W. Miller C-5495-RF (Lafayette 34 R 8717)
NL1—NE-2 Neon lamp
PL1—5-prong plug (Amphenol 91-MPM5L)
Resistors: ½ watt, 10% unless otherwise indicated
R1—68 ohms (see text)
R2—27,000 ohms
R3—1,000 ohms
R4—120,000 ohms
R5—7,500 ohms, 2 watts (see text)
S1A, S1B—Miniature DPDT toggle switch (Lafayette 99 R 6162)
S2—SPST toggle switch
SO1—5-prong socket (Amphenol 78-S5S)
SR1—Silicon rectifier; minimum ratings: 50 ma, 400 PIV.
T1—Power transformer; secondaries: 125 V @ 15 ma, 6.3 V @ 0.6 A (Lafayette 33 R 3405)
TS1,TS2—2 terminal, screw-type terminal strip (H.H. Smith 872)
VI—7587 tube (RCA Nuvistor. Allied Radio, $5.20 plus postage)
Misc.—2⅛ x 3 x 5¼-in. Miniboxes, socket for V1 (Allied 40 U 260), plate cap for V1 (same as 6J7 grid cap), terminal strips

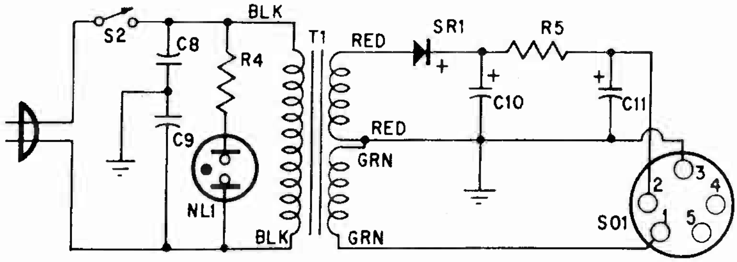
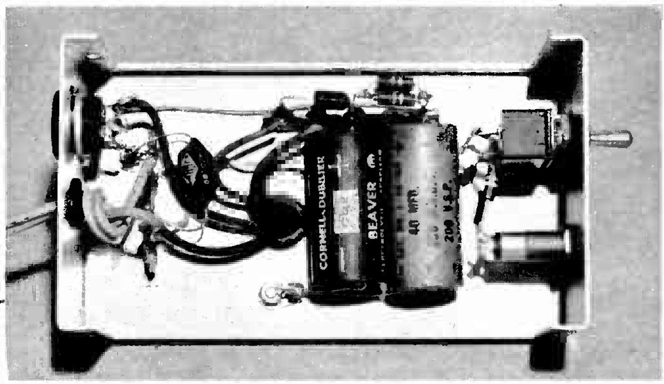


Fig. 6—Power supply schematic and layout. Line cord and socket SO1 are mounted at left. Rectifier SR1 and R5 (we paralleled three 22,000-ohm, ½-watt resistors) are mounted on terminal strip above electrolytics. Powe switch and neon lamp are at the right side of the cabinet.



NUVISTOR SWL BOOSTER

nect an antenna to TS1 and tune in a station close to 15 mc or below (WWV is a possibility at this frequency and those listed below)—but not above 15 mc. Adjust the receiver's RF gain control (or use a shorter antenna) so you barely can hear the signal with the audio gain wide open. Then set S1 to *on*. Slowly turn L2's slug-adjustment screw counterclockwise for maximum volume. Then adjust L1's slug for maximum volume. Next, tune in a 10-mc signal and adjust C5, then C1 for maximum volume and mark the panel. Do the same for 5 mc. Finally, put on the 15-mc marks.

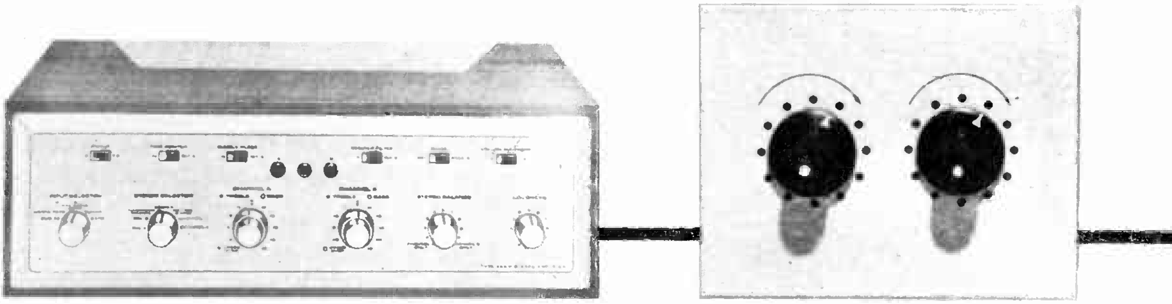
Operation

If your layout is sloppy, the booster may oscillate. Normally it will start below the frequency to which you try to tune the booster. For example, if you try to tune a 13-mc signal by adjusting (turning counterclockwise) C1 and C5 from the high side—the 15-mc position—you'll have no problem. If you attempt to tune (turning clockwise) from the low side—the 5-mc position—it's possible the booster will break into oscillation and jam the receiver.

If oscillation is so severe it always jams the receiver, lower the booster's gain by connecting a 3,300-ohm, ½-watt resistor from the junction of R2 and C4 to the nearest ground lug. If oscillation persists try increasing R1 a few hundred ohms at a time up to 1,000 ohms. If the oscillation continues, move the wiring around slightly and look for poor ground connections. Also check to see whether the antenna wire isn't near or crossing the booster's output cable. Reduced-gain adjustments still will provide between 20 and 30db of gain—3 to 5 S-units.

In normal operation C1's tuning is quite broad while C5's is razor sharp. Always set C1 to the approximate position, for example, between 5 and 10 mc or between 10 and 15 mc and then peak C5. Then go back and peak C1.

The booster should be used only when you're trying to dig for weak stations. Using the booster to receive a normally strong station such as the BBC, VOA or Radio Moscow can result in distortion caused by booster or receiver overload. If there is overload, simply flip S1 to its other position. This will bypass the signal around the booster and feed it directly to the receiver.



Big BOOM Box

GETTING real solid bass out of your stereo often is like trying to find the pot of gold at the end of the rainbow. First reason good bass is so hard to come by is that at low volume levels your ear's sensitivity begins to drop off around 300 cycles. Strike No. 2 is small speaker enclosures. In many cases the modern trend to bookshelf speakers has resulted in designs that sometimes produce faked bass.

The result is that there are a lot of midget speakers that really need a swift and hard kick in the low end.

Of course, bass can be increased by cranking up the amplifier's bass control. But since the control takes effect at about 1 kc, it not only raises the bass but increases the mid-range as well. Therefore, though the bass level is increased, the sound still is unsatisfactory.

For knee-bending bass at low volume levels only frequencies below about 200 cycles should be boosted. The low-cost way to achieve this is with our Big Boom Box bass booster.

The booster is a passive (no tubes or transistors) low-pass filter that you connect between your amplifier and speaker to give added oomph to the frequencies below 200 cycles.

For juke-box boom all that's required is a turn of the booster's controls. By advancing R2 the boost at 30 cycles will be about 9db—a real solid window-rattler.

Construction

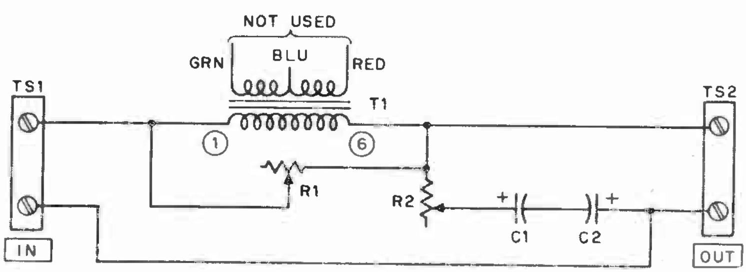
While layout is not critical—build the booster any way you want—component values are. Under no circumstances substitute a different part for L1 or change the values of C1 and C2. In fact, unless you are trying to keep cost at rock-bottom use quality capacitors for C1 and C2.

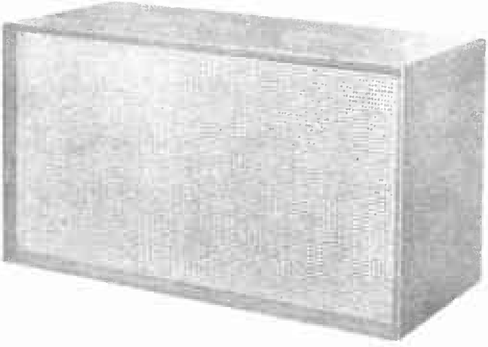
L1 is a universal output transformer used as a choke. Cut off the three primary leads and connect to secondary terminals 1 and 6.

Capacitors C1 and C2 are connected back-to-back; that is, connect the positive terminal of C1 to the positive terminal of C2 (or negative to negative). *Do not* connect the capacitors in series—plus to minus—unless you like distorted sound.

In order to provide an *off* position for the booster, R2 must be modified. Remove the

When R1 is set full clockwise (wiper to the left) all the signal goes through T1. Since the impedance of T1 gets lower at low frequencies, more bass than treble goes from input to output. C1, C2 and R2 provide additional attenuation of the highs.





cover by bending the tabs. You'll see that R2 is a wirewound pot whose resistance wire is wound from one side terminal to the other. The wiper rides on top of the wire. Hold R2 so the exposed rear is facing you and the lugs are pointing up. Using a pair of small diagonal cutters, cut through the wire where it connects to the left lug. To make certain you cut through the wire, cut about 1/16-in. into the form holding the wire. Reach in with a small screwdriver or ice pick and pull the wire away from the terminal, then unwind or pull back a few turns. Check with an ohmmeter to make certain the wiper does not touch the turns when it is fully counterclockwise.

We used phono jacks (see photo), but they cannot be used unless at least one of your amplifier's output terminals is grounded. On some transistor amplifiers one output terminal is *not* always grounded.

Using the booster under such conditions will cause the output transistors to be damaged if the metal cabinets of two boosters should touch. To get around this problem, use a two-lug terminal strip (TS1 and TS2) and run a common wire between the input and output lugs (bottom, in schematic) making certain there's no cabinet connection.

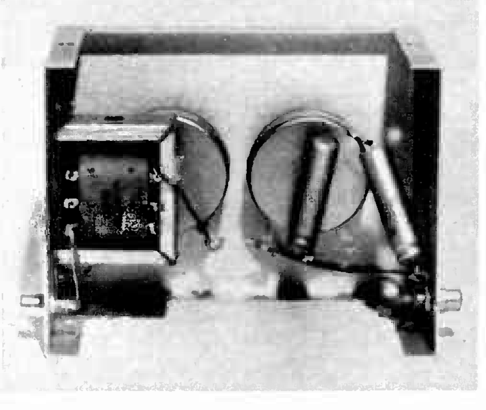
Using the Booster

Connect the amplifier to TS1 and the speaker to TS2. Set R1 and R2 counterclockwise—the *off* position (R1 shorts out T1 and R2 is open). Advance R1 to about 4/5ths of its rotation—a good starting point that will produce a 3db boost at 20 cps. For additional boost just turn R2 slightly clockwise for an additional boost of 3db or so. For more bass continue to advance R2.

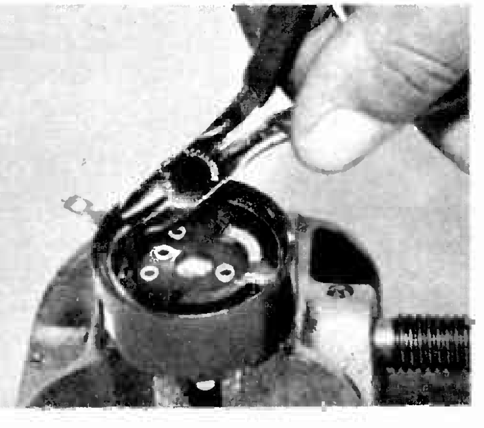
The booster is designed for low to moderate listening levels. If you try to produce thundering bass you're likely to burn out R1 and R2. The booster normally produces a moderate loss of gain, making it necessary to advance the amplifier's volume control in order to obtain the same effective volume level as when R1 and R2 are in the *off* position.

PARTS LIST

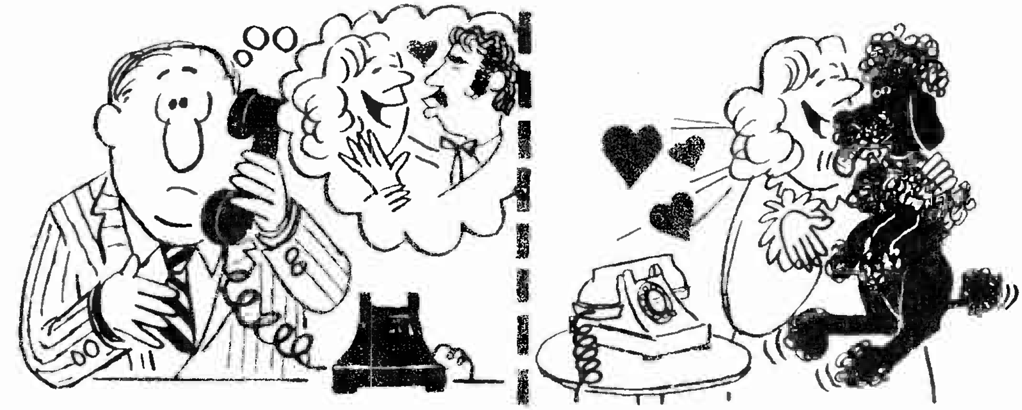
C1, C2—100 μf, 15 V electrolytic capacitor
L1—8 watt universal output transformer (Lafayette 33 R 7504)
R1—20 ohm, 4 watt wirewound potentiometer (Clarostat Series 58. Lafayette 32 R 7295)
R2—30 ohm, 4 watt wirewound potentiometer (Clarostat Series 58. Lafayette 32 R 7297)
TS1, TS2—Terminal strip (see text)
Misc.—3 x 4 x 5-in. Minibox, knobs



Parts are mounted in main section of 3 x 4 x 5-in. Minibox. R1 is mounted at left, R2 is mounted at right. Output jack is at left, input jack is at right.



To add off position to R2, cut wire where it connects to left lug. Then remove a few turns so wiper doesn't touch wire when turned all way to left.



008 Tele-Spy

Would You Believe 004?

By AL TOLER

WHEN the cat's away the mice just may play. Like, does the baby-sitter throw a blast for every teen-ager on the block? Is there hanky-panky between your wife and the poodle? Maybe the kids get up after you go over to the neighbors for a night of bridge. Or when you start on vacation, does it suddenly occur to you that you may have left the water running? Banish all doubts forever with our 008 Tele-Spy!

What it is? A device that turns your telephone into a private eye . . . err, ear, we mean. Here's how it works: buy a phone in any store, plug that phone into your regular phone's outlet. Whenever you call your number the phone will be answered electrically by the Tele-Spy *before* the bell rings! You'll then hear every sound in the room for 30 seconds or whatever time you want.

At the end of the snooping period the Tele-Spy disconnects itself from the phone line (hangs the phone up electrically) and is ready for another call. Should you want to make an outgoing call, the Tele-Spy won't interfere. However, it must be turned off to let an incoming call get through.

Construction. Our Tele-Spy is built in a 7 x 5 x 3-in. Minibox. We suggest you build it exactly as shown and make no parts substitutions or layout changes.

The circuit is made in two parts then wired together. First, mount all mechanical components, relays, switch etc., in the main-section of the Minibox. Capacitor C11 must be a non-polarized type, not an electrolytic.

While S1 need only be DPST switch, we used a DPDT type to provide an extra terminal for the line cord and circuit breaker. (A 1-A fuse can be substituted for CB1.)

Delay relay RY3 is mounted on a small bracket made from scrap aluminum. Mount the bracket as shown, so that RY3 is upright when the cabinet is in the operating position. mount J1 far from RY3's socket.

The amplifier is assembled on a 4⅜-in. square piece of perforated Vectorboard. Vector No. T28 push-in terminals are used for

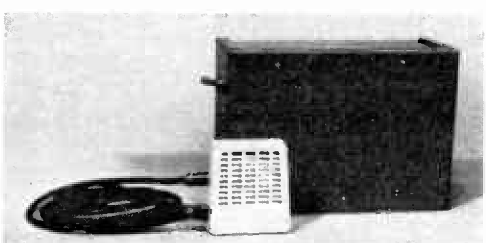


Fig. 1—Tele-Spy control box doesn't have to be near phone; it can be connected to line anywhere. Mike can be hidden as amplifier's gain is high.

tie points. To avoid a parts jam in tight corners, some resistors and capacitors should be mounted on end.

Double check the installation of the bridge rectifier consisting of diodes SR1-SR4. If a single diode is reversed either CB1 will open or T2 will be damaged. Also, double check capacitor polarities. With the exception of C1 and C11, all capacitors are polarized; note their connections carefully.

Mount the amplifier board in the bottom of the main section of the Minibox. If RY3's bracket interferes with T2, making it difficult to mount the amplifier, trim the excess metal from the bracket with tin snips. To prevent the push-in terminals (which protrude, through the board) from shorting to the chassis, slip a standoff insulator—two ¼-in. grommets—on each mounting screw between the board and the cabinet.

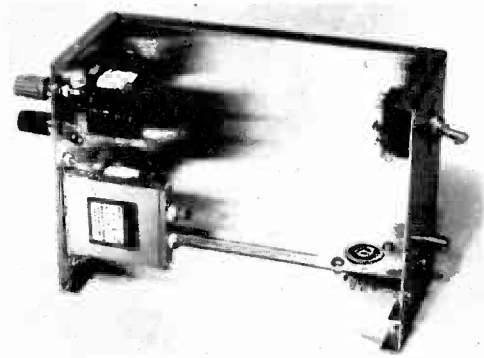
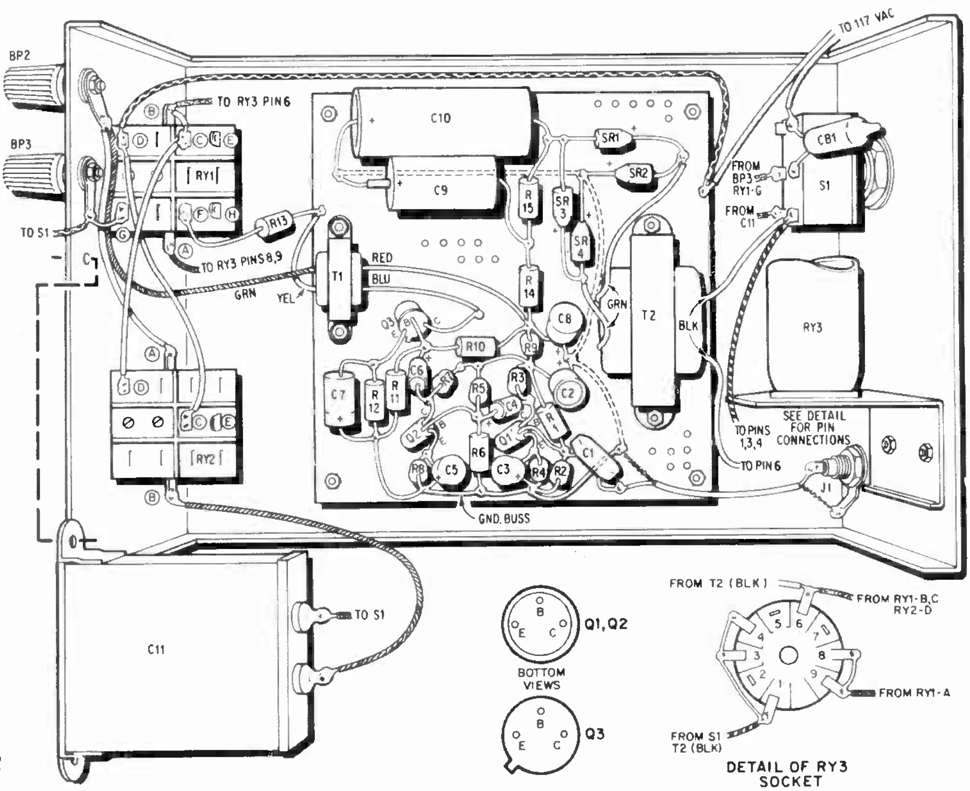


Fig. 2—Start construction by mounting all the cabinet components. L-bracket at the lower right supports 9-pin tube socket for delay relay RY3.

Complete the wiring in this order: S1 to C11 and BP3; C11 to RY2; RY3's socket (all connections); T2 and line cord to S1; all connections to RY1 with R13 last; T1's green lead to BP2 (cut off T1's black lead and use the full length of the green lead routing it

Fig. 3—Amplifier is assembled on a 4⅜-in.-square piece of perforated board. Push-in terminals are used for all tie points. All wiring except the ground buss (broken lines) is on top of the board. Notice the way several resistors and capacitors are mounted standing up to prevent a parts jam.



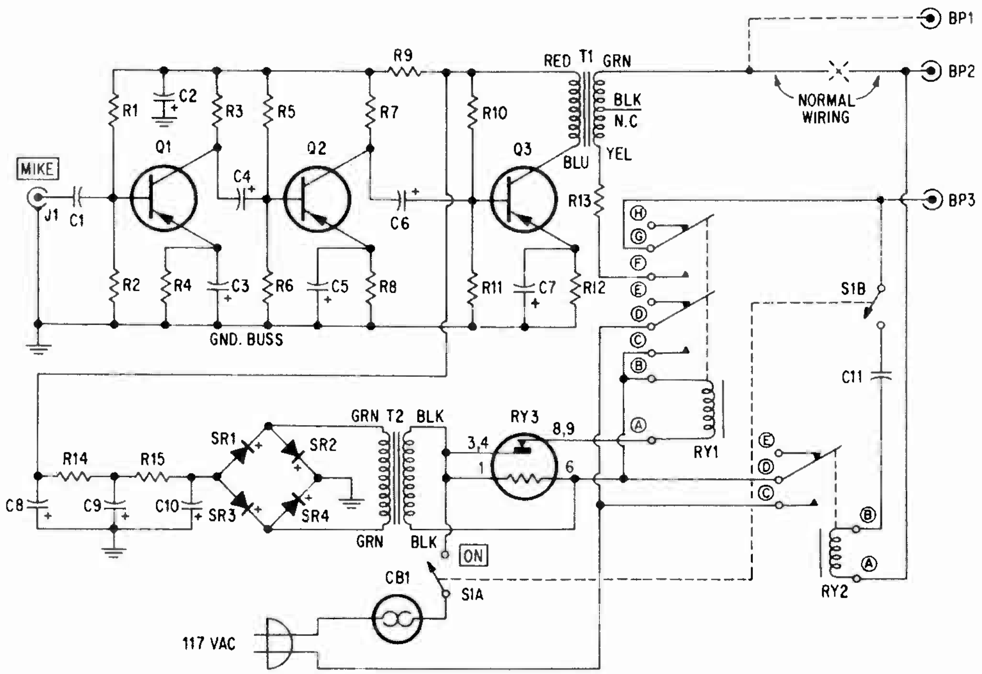


Fig. 4—Ring current energizes RY2: contacts C,D close and energize RY1. RY1's C,D contacts hold it closed, apply line voltage to T2. RY1's F,G contacts feed amp output to line at BP2,BP3. Voltage to RY1 goes to RY3's heater. After delay, RY3's contacts open and disconnect Tele-Spy.

PARTS LIST

BP1-BP3—5-way binding post
Capacitors: 12 V or higher unless otherwise indicated
C1—.25 μf ceramic disc
C2,C8—30 μf, electrolytic
C3,C5—50 μf, 6 V electrolytic
C4,C6—3 μf electrolytic
C7—30 μf, 6 V electrolytic
C9—100 μf electrolytic
C10—500 μf, electrolytic
C11—4 μf, 200 V metallized paper (Lafayette 34 R 7316 or equiv.) see text
CB1—1-A circuit breaker (Sylvania MB-315 Mite-T-Breaker. Allied 34 U 075) see text
J1—Phono jack
Q1,Q2—2N2613 transistor (RCA)
Q3—GE-transistor (GE-3)
Resistors: ½ watt, 10%
R1—82,000 ohms
R2,R6—10,000 ohms
R3,R7—4,700 ohms
R4—690 ohms
R5—47,000 ohms
R8—1,500 ohms
R9,R13,R15—470 ohms
R10—33,000 ohms
R11—22,000 ohms
R12—820 ohms
R14—100 ohms
RY1—DPDT relay, 115 VAC coil (Allied 74 U 657)
RY2—SPDT relay, 115 VAC coil (Allied 74 U 652)
RY3—Amperite delay relay (see table)
S1—DPDT toggle switch (see text)
SR1-SR4—Silicon rectifier; minimum ratings: 50 ma, 25 PIV (Allied 39 U 692 M or equiv.)
T1—Transistor driver transformer; primary: 1,500 ohms; secondary: 500 ohms, center tapped (Lafayette 33 R 8548)
T2—Filament transformer; secondary: 6.3 V @ 0.5 A
Misc.—7 x 5 x 3-in. Minibox, 9-pin tube socket, Vector Pattern B prepunched terminal board Type 45B30 (Allied 46 U 005), Vector push-in terminals Type T28 (Allied 40 U 879), crystal or ceramic microphone

clear of RY1's coil. J1 to board (even though it's a very short lead, use shielded wire).

The Tele-Spy's time delay is established by RY3. The chart at the end of this article lists several other relays and their delay time. Additional types may be selected from Amperite's listing of 115-V normally-closed relays in most parts catalogs.

Checkout. Connect a pair of magnetic headphones—500 ohms or higher—to binding posts BP2 and BP3. Turn on power with S1. Using an insulated screwdriver, press RY2's armature (the wiper contacts) and quickly remove the screwdriver. As soon as

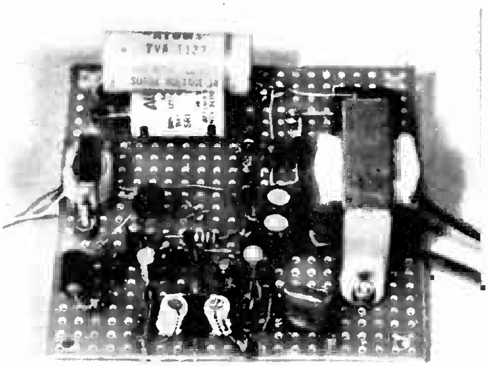


Fig. 5—Completed amplifier board ready to be installed in cabinet. Wiring is tight in spots making it necessary to mount several parts on end.

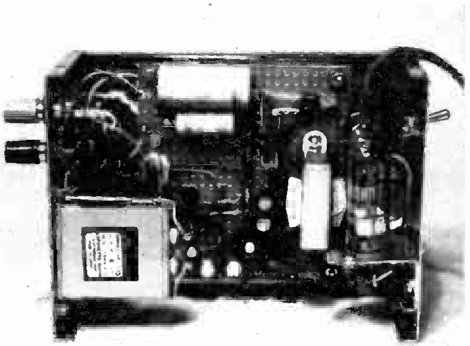


Fig. 6—Completed Tele-Spy. Final assembly results in tight quarters. To avoid burning wires when soldering, follow assembly steps in the text.

008 Tele-SPY

you've closed RY2, RY1 should close and RY2 should open. RY1 should remain closed. If RY1 doesn't close check the wiring to RY2's contacts and RY1's coil. Also check that RY3 has normally-*closed* contacts (just look, you'll see them).

As soon as RY1 closes you should hear a hiss or very slight hum in the phones indicating the amplifier is on. If you fail to hear this, check that power is applied to T2 by measuring the voltage across the black primary leads. If you measure the correct voltage (117 V) check for about 12 VDC at the diode-bridge output terminals (from junction of SR1 and SR3 to ground). If you get voltage there, check to make sure that R13 is not connected to the wrong contacts on RY1. If the amplifier breaks into oscillation look for a wiring error at the input end of C1.

The frequency-response of the amplifier will produce a *crisp* sound from a ceramic or crystal mike. The bass has been attenuated deliberately by the low input impedance of the transistor amplifier. Do not substitute a low- or medium-impedance dynamic mike as the sound at the receiving telephone will be muddy and difficult to understand.

Connecting to the Phone Lines. Our model is designed for operation with a two-wire telephone circuit where the talk and ring current is on the same pair of wires. Simply connect BP2 and BP3 to the two phone wires at a telephone jack. Direct connection to the phone wires is not recommended as it makes it difficult to move the Tele-Spy.

If you have a party line (two parties on the same talking line but with separate ringers) the Tele-Spy must be modified as shown on the schematic by the dashed line. Remove T1's green lead from BP2, add a third binding post (BP1) and put the green lead on it.

Next, determine which two of the three incoming telephone wires are the talking pair—they are usually the pair connected inside the telephone to terminals marked L1 and L2. The third wire is the common ringer wire. Connect the common ringer wire to BP3 and either of the talking pair to BP2. Have a friend call you, and let the phone ring. Notice if RY2 closes. If it fails to close connect the other talking wire to BP3—this should give you the ringing pair. Then connect the remaining wire to BP1.

Operation. Relay RY1 should operate as soon as the ring signal comes in on the telephone line. When RY2 closes the ring signal should stop before the bell rings. It *is* possible for the bell to give a slight, sharp ring before RY2's closing silences the bell (The bell signal stops as soon as T1 and R13 are connected across the line.) If the bell rings slightly, simply adjust its volume on the phone.

AMPERITE DELAY RELAYS	
Delay (seconds)	Type
15	115C15
30	115C30
60	115C60
90	115C90
120	115C120
180	115C180

A Super Battery Charger

FRUSTRATION is starting out (or rather, not starting) on a cold day with an auto battery that's pooped. You may huff, puff and swear but ultimately you're going to have to come to grips with the real problem—a juiceless battery.

The answer, of course is a battery charger. And if you have frequent battery trouble because of grim weather, cheapie purchases or little time for maintenance, you may need a *super* charger. We've done well with the $29.95 Heathkit GP-21, a trickle charger.

Unlike conventional trickle chargers, which feed a minute bit of current to the battery (even after full charge is reached), the GP-21 shuts itself off at full charge. But it will come on again to restore any charge lost through internal leakage. To the consumer this shut-off feature means that the battery does not remain warm and lose its water.

Another great feature is the solid-state sensing circuit. It is a fail-safe mechanism that makes it almost impossible to damage the charger (or the car's electrical system) because of a reversed or shorted battery-clip connection.

This deluxe charger doesn't have an AC power switch; it is *on* all the time. Normally there is no voltage at the clips. When it is connected to the battery, the sensing circuit measures the battery's voltage. If the measurement shows less than 13.4 volts, (which is the full-charge potential) our super charger will apply a charging current. The current is as high as 10 amps at a potential of 13.6 volts or lower. Exact current and voltage applied depend on the condition of your battery.

When a battery comes to full charge the charger stops pumping. Under no condition, including an uplugged AC line, will the battery discharge through the charger.

The GP-21 is an easy kit to build. We assembled ours in a little over two hours. You first install 19 parts on a 2⅜x1¼-in. printed-circuit board.

This is followed by mounting a half dozen parts and the power transformer in the cabinet. The board is then mounted in the cabinet and several connections are made between cabinet-mounted parts and the board. You then make up the clip leads, connect them and assemble the cabinet. That's it.

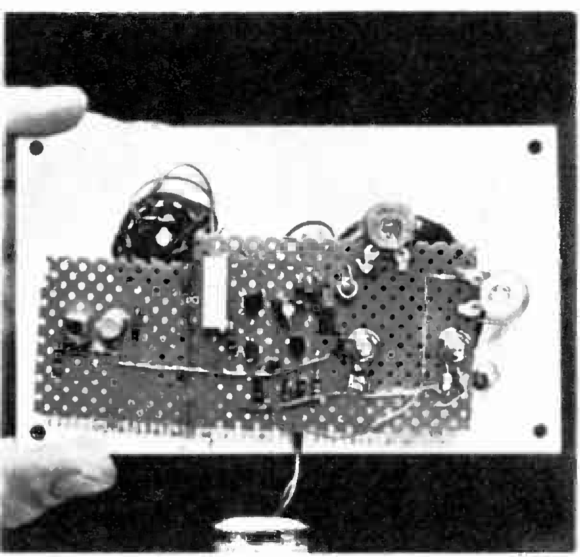
Our charger worked right off. When connected to the battery, which had been sitting for a cold week in the winter, the initial charge rate was 6 amps.

The GP-21 is protected by a circuit breaker. The front-panel pilot light remains on as long as the charger is plugged in the AC outlet.

Templates are included in the manual showing how to mount the charger on a wall. The GP-21 measures 9x5½x6⅜ in. and weighs 11¼ lbs.—*Bob Freed* ●

COMPONENTS are few and easily identified and the recipe-type manual is a big help.

Build a Wireless Tach for Small Engines



COMPARE photo of tach to diagram on next page. Jack J1 is hidden under circuit board.

By Herb Cohen

EVERY season has its small-bore gasoline engine. Whether your fancy turns to snowmobile or trailbike, outboard or lawnmower, each rig has a common need . . . an annual tuneup.

All these machines come with tuneup instructions in the owner's manual, which aren't hard to follow. As with a car engine, however, the tuner can do a better job if he knows how fast an engine is going. Auto tachometers are all over the place but there are few—almost none—that are sold for use with little engines. That's where our tach comes in.

Our tach is wireless—which means it doesn't have to be connected to the engine to read rpm. It has two ranges, 0-5,000 and 0-10,000 rpm, and works by picking up the faint signal generated each time high voltage jumps the gap on the spark plug. The low-power signal radiates via wires on the engine to the tach's antenna.

Engine rpm almost universally (in the small-model division) is equal to the spark count at the plug, whether it's a two- or four-stroker. The plug fires on every revolution, whether it be power or exhaust stroke. So if you count spark firing you're also counting rpm.

This holds true, as we said, for two-cycle or four-cycle one-cylinder engines. But it does *not* for two-cylinder, two-cycle power plants. If you're taking the rpm reading of a snowmobile, for example, divide the meter reading by two (each plug fires twice per crankshaft revolution) to get true rpm. And since all the spark plugs of a six-cylinder auto engine fire three times for every spin of the crankshaft, divide the meter reading by three to obtain the correct reading.

Before wiring the circuit, cut out holes for (and mount) meter (M1), rpm selector switch S1 and jack J1. Lay the meter face down and place a piece of 2x4-in. perforated circuit board over M1. Mount the perfboard to the meter, using the meter's terminal screws.

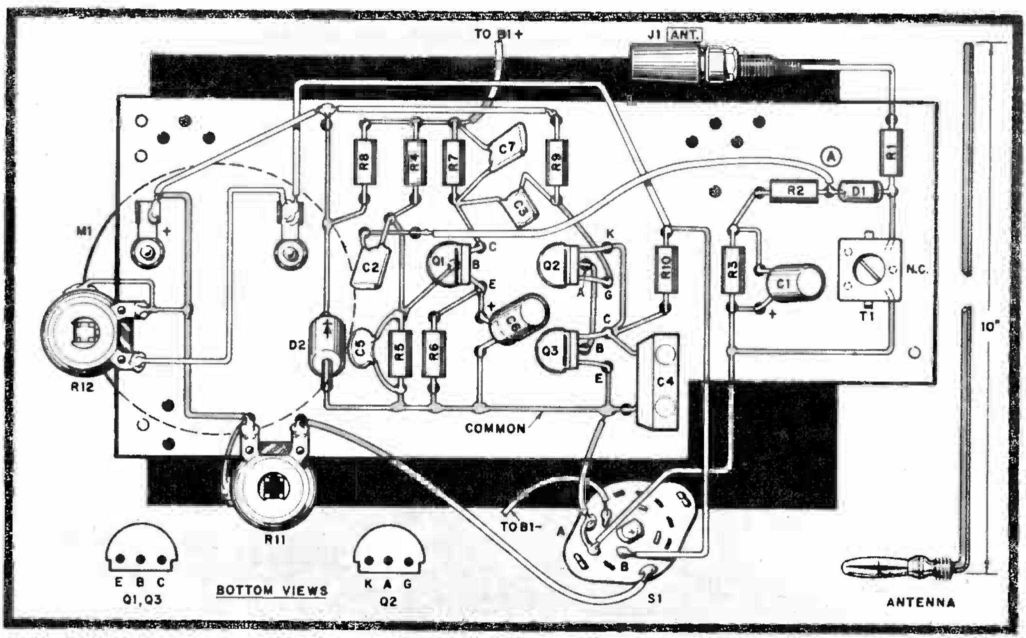
All board-mounted electronic components are arranged on one side of the board. The other side is used only to solder component leads together. Both calibrate pots R11 and R12 are mounted via their lugs. Solder components showing plug signs (C1, C6 and M1) or those with polarity bands or arrows (D1 and D2) exactly as shown.

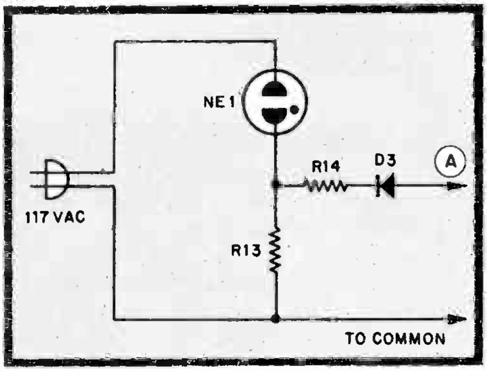
Transformer T1 has five solder pins and two mounting lugs on the bottom. Locate the edge having three pins and connect the two outermost pins in the circuit.

The antenna is a 1-ft. length of 1/8-in. brass rod. Bend in a J-shape so the long side measures 10-in. Solder a plug to the short end of the rod.

The tach can be calibrated two ways. After wiring, insert the antenna in J1 and advance S1 to its x100 position. Slowly bring the antenna towards any spark plug in a car equipped with a tach. When the meter needle shows a steady reading adjust R11 for an identical reading on M1. If the car has a V-8, remember to divide the meter reading by four for the correct rpm.

If you don't own a tach-equipped car, build the calibration circuit. After wiring, connect the wire labelled *com-*





PARTS LIST

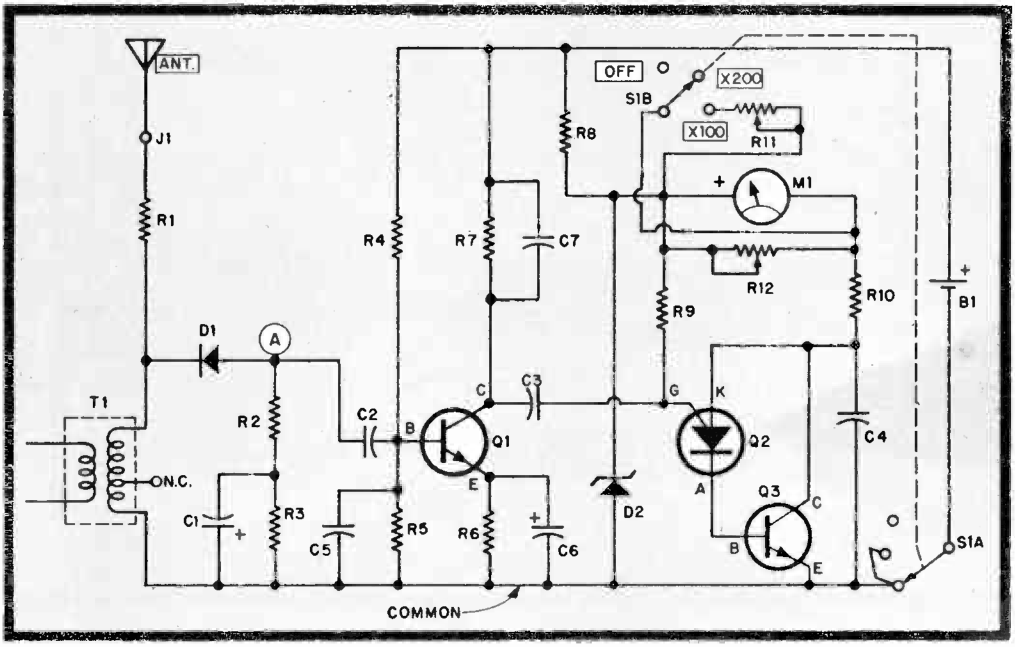
B1—9-volt transistor radio battery
Capacitors: 100 volts unless otherwise noted
C1—30 µf, 10 volts electrolytic
C2,C3,C7—0.001 µf C4—0.47 µf
C5—200 µµf C6—1 µf, 50 volts electrolytic
D1,D3—1N 914 silicon diode
D2—Zener diode: 4.7 volts @ 1 watt (1N 1519 or equiv.)
J1—5-way universal binding post
M1—0-50 µa DC microammeter (Calectro D1-910 or equiv.)
NE1—Neon lamp (NE-3 or equiv.)
Q1,Q3—Npn silicon transistor (2N 4401)
Q2—Programmable unijunction transistor (Motorola HEP S-9001)
Resistors: ¼-watt, 10% tolerance carbon unless otherwise noted
R1—390 ohms R5—33,000 ohms
R2—680 ohms R6,R8—1,000 ohms
R3—10,000 ohms R7,R9—5,600 ohms
R4—150,000 ohms R10—3,900 ohms
R11,R12—1,000-ohm, linear-taper miniature pot (Mallory MTC-53L4 or equiv.)
R13—10,000 ohms R14—4,700 ohms
S1—4-pole, 3-position rotary switch (Lafayette 99P 61566 or equiv.)
T1—Miniature 455 Kc IF transformer (Lafayette 99P 63026)
Misc.—6⅝"x3⅛x1⅞-in. bakelite utility case with aluminum panel, ⅛-in. OD brass rod, perforated circuit board, battery clip, knob, paint, decals, etc.

mon to the identically-labelled lead on the tach. Then touch *A* from the calibrator to the same point on the tach.

Plug the calibrator in 117 VAC and adjust R11 until M1 reads 1.8. Switch S1 to its x200 position and adjust R12 until the meter reads 3.6. Remove the calibrator and seal the pot adjustment holes with cement.

To use the tach, insert the brass antenna into J1, turn on the tach and advance S1 to the x200 position (then the x100 position for lower rpms). Slowly bring the antenna close to any of the ignition wires. The meter needle responds best when the antenna is about 1-ft. from the spark plug wiring.

You'll see the needle jump up- and down-scale at first. This means you should bring the antenna closer to the plug to steady the needle. ●



Travel Help from the Radio

By C. M. Stanbury

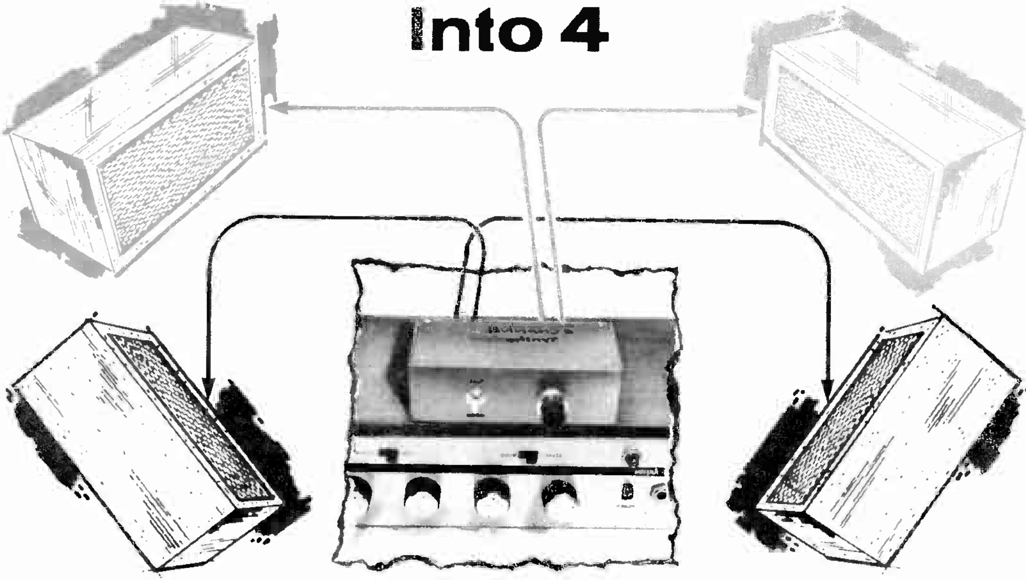
TRAVELING through strange parts in these days of gas uncertainty can be tricky business. One way to avoid problems is to stay abreast of local developments as you travel. How do you do this? We suggest your car's radio.

The stations in our list can be heard over much of their home states. Not only do they broadcast information about gas lines and laws but they are also sources of other valuable knowledge. Weather forecasts, traffic conditions, attractions to see, places to eat and stay as well as sporting and recreational events are all announced on radio.

In short, the radio can be one of the most important travel aids for the family on vacation. Tune in and get more out of your next trip. ●

STATE	KHZ	CALL	CITY
Alabama	1070	WAPI	Birmingham
Arizona	1360	KRUX	Glendale
Arkansas	1090	KAAY	Little Rock
California	740	KCBS	San Francisco
Colorado	850	KOA	Denver
Connecticut	1080	WTIC	Hartford
Delaware	1600	WKEN	Dover
Florida	690	WAPE	Jacksonville
Georgia	750	WSB	Atlanta
Idaho	670	KBOI	Boise
Illinois	780	WBBM	Chicago
Indiana	1070	WIBC	Indianapolis
Iowa	1040	WHO	Des Moines
Kansas	1410	KWBB	Wichita
Kentucky	840	WHAS	Louisville
Louisiana	870	WWL	New Orleans
Maine	910	WABI	Bangor
Maryland	1080	WBAL	Baltimore
Massachusetts	1030	WBZ	Boston
Michigan	760	WJR	Detroit
Minnesota	830	WCCO	Minneapolis
Mississippi	620	WJDX	Jackson
Missouri	1120	KMOX	St. Louis
Montana	790	KGHL	Billings
Nebraska	1110	KFAB	Omaha
Nevada	780	KCRL	Reno
N. Hampshire	1370	WFEA	Manchester
New Jersey	970	WWDJ	Newark
New Mexico	770	KOB	Albuquerque
New York	1180	WHAM	Rochester
N. Carolina	1110	WBT	Charlotte
N. Dakota	550	KFYR	Bismark
Ohio	700	WLW	Cincinnati
Oklahoma	1520	KOMA	Oklahoma City
Oregon	1120	KPNW	Eugene
Pennsylvania	1020	KDKA	Pittsburgh
Rhode Island	550	WCNG	Pawtucket
S. Carolina	1290	WFIG	Sumter
S. Dakota	1140	KSOO	Sioux Falls
Tennessee	1070	WFLI	Chattanooga
Texas	820	WBAP	Ft. Worth
Utah	1160	KSL	Salt Lake
Vermont	620	WVMT	Burlington
Virginia	1140	WRVA	Richmond
Washington	1090	KING	Seattle
W. Virginia	1170	WWVA	Wheeling
Wisconsin	1070	WTSO	Madison
Wyoming	1030	KTWO	Casper

Easy Way to Turn 2 Hi-Fi Channels Into 4



MAGIC BOX—Our easily-built 4-channel synthesizer sits on amplifier, as here, drives front speakers (black) plus two new speakers in rear (color).

HOTTEST thing on the hi-fi scene today is four-channel equipment—quadrasound. It's an attempt to get music played from a record in your living room to sound as much as possible like music from an orchestra in a music hall.

Two stereo speakers did it better than mono and now four do it better than two. In a hall, of course, you get the effect of speakers all around—the orchestra up front, echoes from the walls and the coughs, grunts, ughs and whispers of the audience. The echoes and grunts are referred to as *ambient sounds*.

Different four-channel systems do it in different ways. One type (discrete) actually records and plays back four channels, two for orchestra in front, two for ambience in rear, sometimes including grunts. Type No. 2 (matrix) records four channels of sound on two tracks and, on replay, restores the four. Lastly, system No. 3 (derived) uses the regular two channels of stereo from which to derive two additional channels (rear speakers). It's not the music hall, of course, but few living rooms are.

Our four-channel synthesizer simplifies the procedure even more, though it is in general type No. 3. Stereo sound, from records or tape, piped into our magic box come out as two normal left-right outputs for the front speakers. But now there are two additional outputs for moderate-quality rear speakers. The rear-channel sound is derived from the front channels and gives the illusion of music-hall ambience. A potentiometer (R2) controls rear-speaker volume. Total sound volume still is determined by the amplifier's volume controls.

Our synthesizer won't fool you into thinking you're in Philharmonic Hall but it can do quite a bit to enhance the

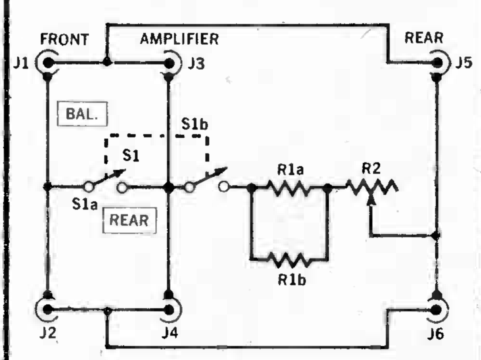


FIG. 1

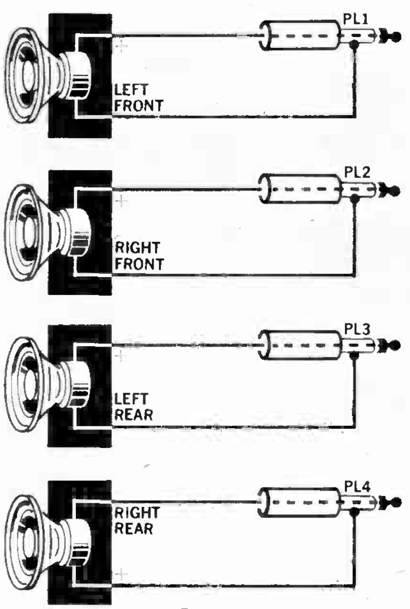
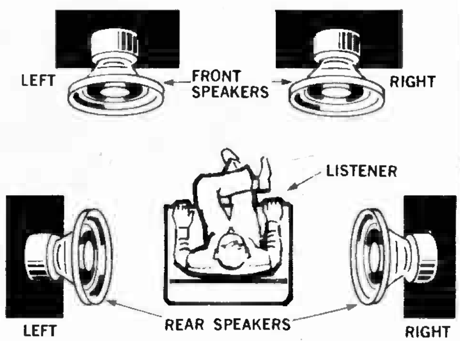


FIG. 2

SUGGESTED SPEAKER ARRANGEMENT FOR QUADRASOUND



listening pleasure in your living room.

Our synthesizer is extremely easy to build and is simplified to the point of having neither transistors nor power supply. Nothing about the parts layout is critical and you can use any plastic (but not metal) cabinet. Our model is built in a Radio Shack cabinet measuring 5x1½x2½ in. There is some heating of R1 and R2 so a ¼-in. ventilation hole should be drilled between each pair of jacks.

To keep the package small, R1 consists of two parallel-wired 22-ohm, 5-watt resistors. If your amplifier is rated for 20 watts per channel volume control R2 should be rated at 5 watts. If your amplifier is rated higher than 20 watts use a larger cabinet and change R2 to at least 10 watts. To take advantage of low-cost surplus components the 10-watt wirewound control used for R2 can be anywhere between 50 and 100 ohms.

Take extra care when wiring switch S1. Note that the grounded or common speaker wire circuits are lifted from the amplifier ground connection when S1 is in the BAL (balance) position with switch contacts open.

For proper sound the speakers must be correctly phased. As with all stereo equipment, the front speakers must be phase-matched. If the terminal on one speaker indicated with a painted dot or + symbol is connected to the amplifier output terminal indicated with a + symbol, the other speaker must be similarly connected.

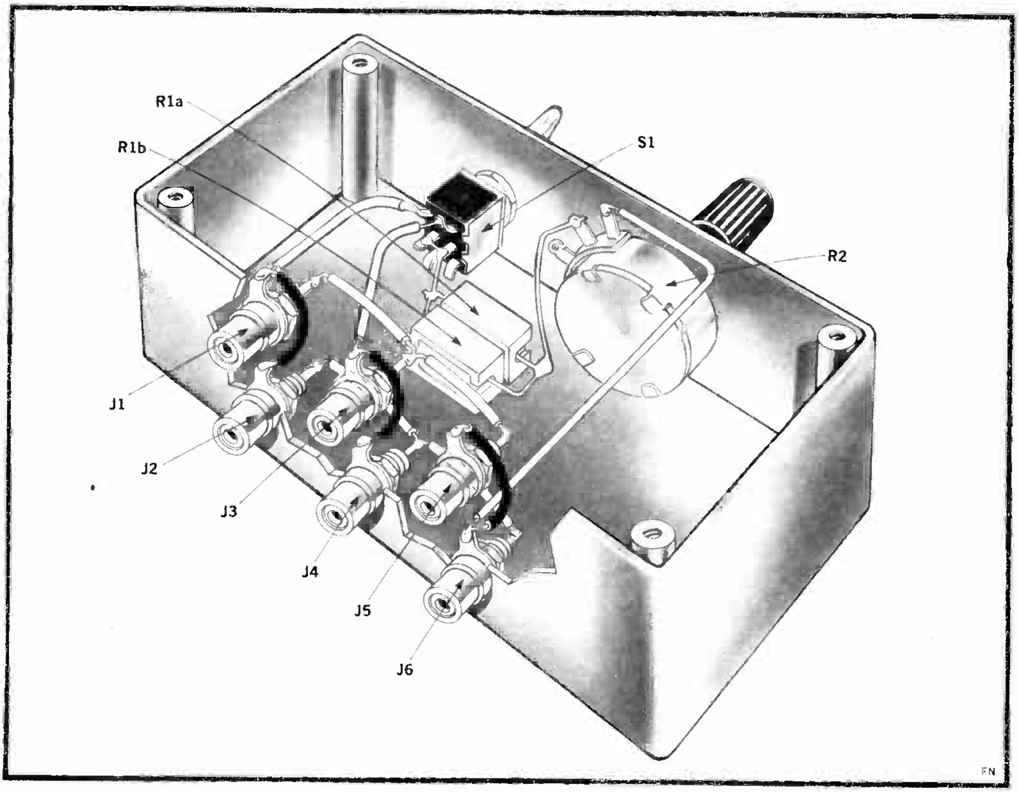
The rear speakers, however, must be reverse-phased. If one speaker (either one) has its + terminal connected to the amplifier's + output terminal the other rear speaker must have the oppo-

PARTS LIST

R1a,R1b—Parallel-wired 22 ohms/5 watts or 10 ohms/10 watts (see text)
R2—50 ohms/5 watts wirewound potentiometer or 50-100 ohms/10 watts (see text)
S1—DPST switch (any type)
J1 thru J6—Phono jack
PL1 thru PL4—Phono plug
Cabinet—Any plastic type

DIAGRAMS at left show simple circuit, the hookup for speakers plus location chart.

Easy Way to Turn 2 Hi-Fi Channels Into 4



LAYOUT of synthesizer can be anything you want. Our arrangement makes for neat project, however. Ventilation holes are needed between jacks.

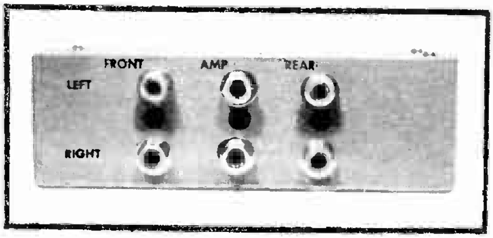
site or nonmarked terminal connected to matching amplifier + terminal.

For proper operation, the stereo amplifier must be set to precise balance. If the left-to-right speaker volume is unbalanced there will be considerable front signal appearing in the rear speakers, decreasing ambient sound.

To balance the system, set switch S1 to the BAL position. Set the amplifier to mono and play a stereo record. If your amplifier does not have a mono-stereo switch play a mono record or tape. Keep the total volume moderately low and adjust the amplifier's balance control for minimum sound at the speakers. Then set S1 to *rear* (contacts closed) and restore the amplifier to stereo.

If your amplifier has two friction-clutch volume controls—one for each channel—and no balance control, simply juggle the setting of both controls until you obtain minimum sound from the speakers with S1 in the BAL position.

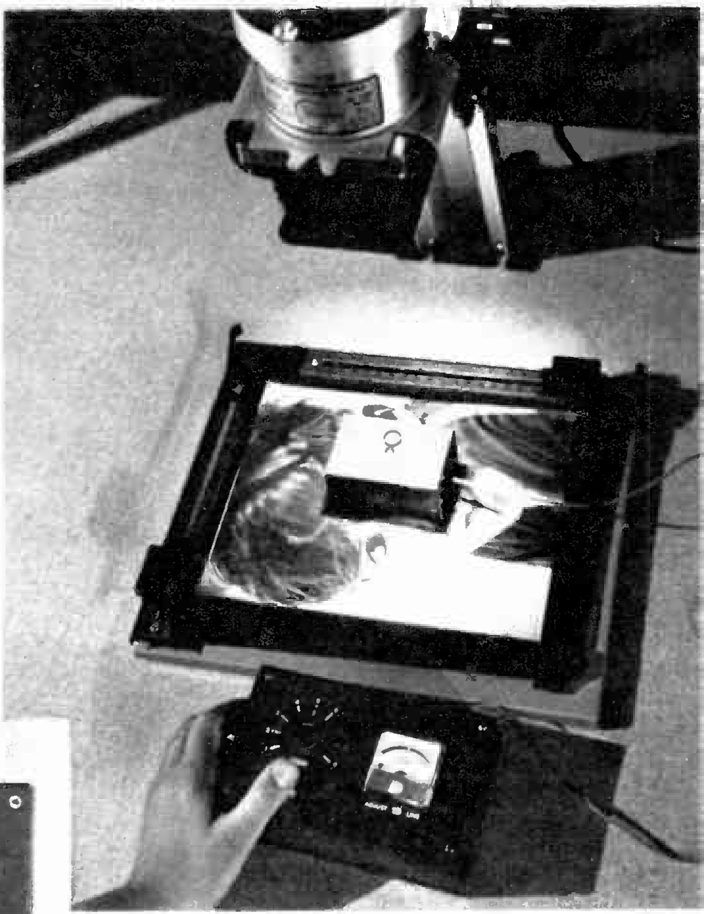
Adjust the overall sound volume with the normal amplifier controls. Use control R2 only to adjust the degree of rear ambient sound. ●

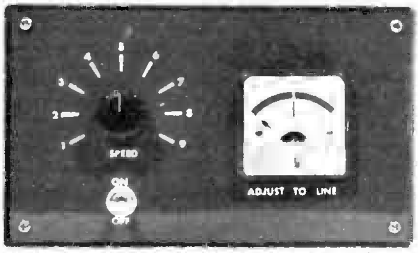


HOOKUP on back of synthesizer. Amplifier plugs in at center, speakers on the outside.

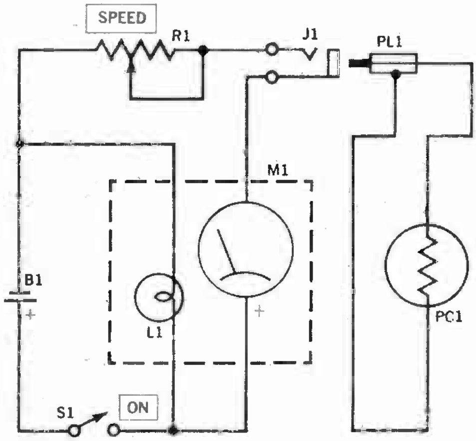
Beginner's Photo Enlarging Meter

By Herb Friedman





PAPER-SPEED control is first calibrated and then proper exposure is obtained by adjusting enlarger f-stop until needle is on line.



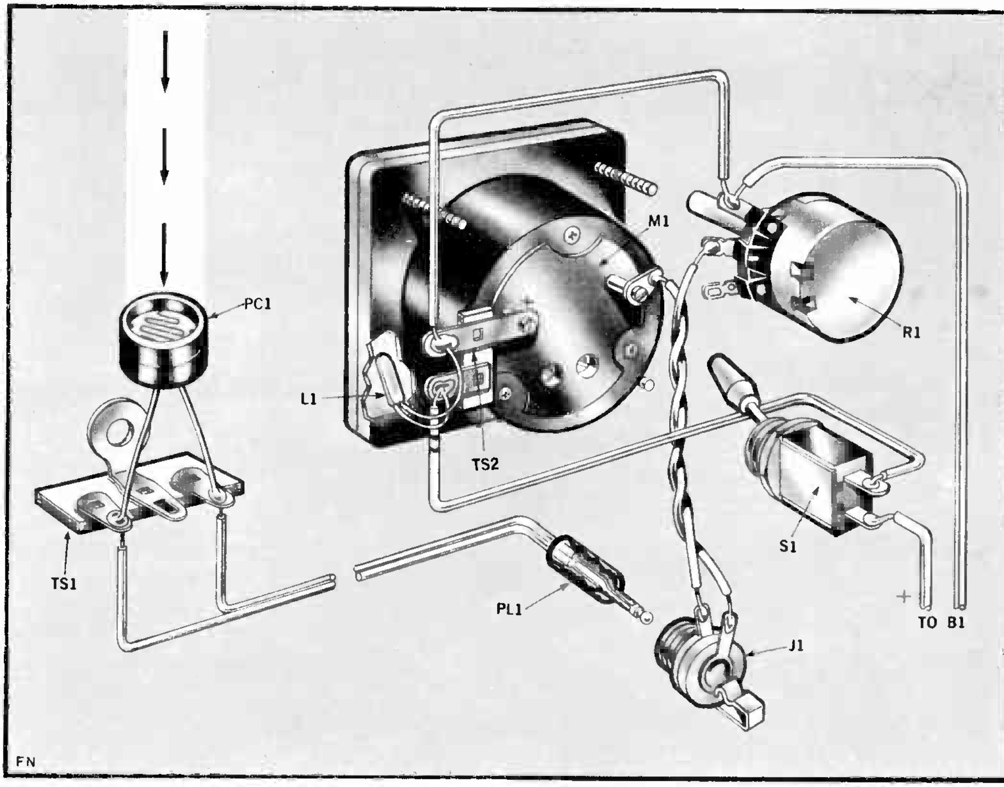
ENLARGING and printing your own photos can be a lot of fun. But when you have to make quite a few test strips it also can become an expensive drag.

Solution: an enlarging meter—preferably ours, which you can build yourself. In no time it will have you turning out near-professional-quality enlargements every time.

To keep the cost down and construction simple, we've eliminated gadgetry from our meter. It operates at a constant exposure time of 10 sec. This means that after the initial calibration for paper speed, you only have to adjust the f-stop on your enlarger lens to get a studio-like print every try. There is no time adjustment to fiddle with.

The meter uses a potentiometer or (R1) as a paper speed control. It can be used to calibrate the enlarging meter for any enlarging paper, such as Polycontrast, Kodabromide, Afga Jet or Dupont's Varigram.

Our meter consists first of a photocell (PCI) mounted in a small plastic



or metal enclosure. You can use a ½-in.-dia. hole and silicone adhesive. Glue or fasten two-lug terminal strip TS1 adjacent to PC1's mounting hole.

The control box contains all the other components and measures approximately 3 5/16x2x6 in. It comes with a pre-drilled hole for jack J1. Use the hole to avoid having to drill through the Bakelite cabinet. The K front panel is used to mount speed control R1, on/off switch and the meter assembly.

The meter mounts in a 1½-in.-dia. opening. Drill two holes and make certain that R1 and S1 clear the battery holder. Note that there is not enough room between the battery holder and the panel for a standard-size control and switch. So make sure they are miniature types.

While any mark on the meter-scale can be used for a reference line, the scale shown is much easier to see in a darkroom. Mount it over the existing meter scale. First snap the meter's front cover off. Remove both screens which hold down the scale and carefully slide it out. Take extra care not to damage the pointer. Place a thin coat of rubber cement over the original scale and drop the new one in place. Slide the scale back under the pointer. Secure with the original screws. The scale can be seen easily under a red or yellow safelight or by enlarger spill in a darkened room.

If you want to work in a fully-darkened room you can install a sub-miniature 6-V lamp (L1) from an inexpensive illuminated meter. Carefully cover the surface of the meter scale and pointer to protect them while you drill a small hole in the lower right corner. Use a 1/16-in. bit. Pass L1's leads through the meter and panel to the inside of the control box via this hole.

Blow away all metal and plastic chips and remove the protective cover from the scale. Position the bulb and then snap the meter cover in place. As a precaution against the fogging of paper from excess light, paint L1 with red lamp dye.

Beginner's Photo Enlarging Meter

The wires from R1's middle lug and M1's negative (unmarked) terminal, which are soldered to J1, should be about 12 in. long. Solder J1 to the free end of the wires but do not mount the jack until the battery is installed and wired. The leads going to the battery holder also are about 12 in. long.

Plug PL1 into J1 and set paper speed control R1 fully counterclockwise. Place a good-quality negative in the enlarger and make a 4x5 or 5x7-in. print, using a 10-sec. exposure and varying only the enlarger f-stop to control the amount of light striking the paper.

Repeat test printing until you come up with one you like. Then, without disturbing the enlarger settings, place a piece of ground glass or a focus plate under the enlarging lens (or in the filter carrier if the enlarger has one). Place photocell PC1 so that it's centered in the projected image on the easel. Rotate the speed control until the meter pointer lines up with the reference mark on the scale.

Note the setting of R1. It is the calibration for the brand (or speed) of paper used. Repeat the procedure for each kind of paper that you use and keep a record of the settings.

Once you know R1's setting you can make enlargements up to 8x10 in. with confidence. (Larger prints require a slightly different procedure.) The first step is to rack the enlarger to the desired size and focus. With the ground glass under the lens, center the photocell on the easel.

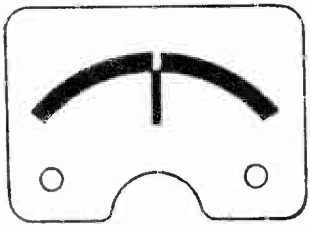
Turn the lens diaphragm ring until the meter rests over the reference line. Remove the ground glass and photocell, place paper in the easel and expose for ten seconds.

If you want to expose at a different time figure the changes this way: if our meter gives a reading of f-11 to go with its time constant of 10 sec., a 20 sec. exposure will call for f-16 (one stop smaller, half as much light). It works exactly as do camera scales—where going from 1/50 sec. to 1/100 sec. shutter speed means you double the light, such as from f-11 to f-8.

For prints larger than 8x10-in. less light hits the paper. So, to avoid excessively long exposure, it's a good idea to use faster paper to compensate for the decrease in light. Here we could use a small chart:

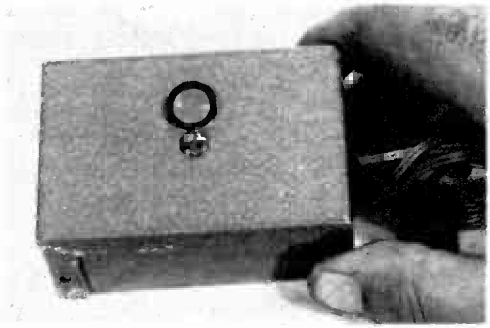
F 8 @ 10 sec. = F 11 @ 20 sec.
= F 16 @ 30 sec.
= F 5.6 @ 5 sec.
= F 4.5 @ 2.5 sec.
= F 3.5 @ 2 sec.

For more sensitivity you can eliminate the ground glass and position the photocell in one of the medium grey areas of the picture.



PARTS LIST

B1—6-Volt battery (Burgess Z4 or equiv.)
J1—Miniature open-circuit phone jack
L1—Meter illuminating pilot lamp (Lafayette Radio 99P 62622 or equiv.)
M1—0-50 μA DC meter (Lafayette 99P 50494)
PC1—Photocell (Radio Shack 276-116. Do not substitute.)
PL1—Miniature phone plug
R1—500,000-ohm, linear-taper pot
S1—SPST miniature switch
TS1—2-lug terminal strip
TS2—1-lug terminal strip
Misc.—Battery holder, cabinets, decals, knob, paint, wire, etc.



ALUMINUM box houses photocell and terminal strip. Turn photocell away from enlarger light to protect it when the meter is not used.

In-Out Thermometer

(Continued from page 4)

Replace the faceplate. Be sure that the adjusting cam finger on the plate slips into the O-shape fork on the movement. After replacing the faceplate on M1, turn the zero-adjust screw and see if the meter needle moves. If it moves, align the needle to the —20° mark on the scale.

Install thermistors R1 and R2 in separate probes. Depending on how you plan to use the thermometer, one probe will be built for indoor use, the other for outdoor.

Make an indoor probe by soldering the thermistor wire leads to the end of a length of three-conductor cable. If possible, buy cable with red, green and brown (or black) wires. The labels B, R and G below terminal block TB1 in the schematic indicate wire-color.

Slip a short length of shrink-fit plastic tubing over the solder joints and shrink the tubing in place with a match or candle flame. (Or use electrical tape for the job.) The tip of the thermistor bead must protrude past the tubing. Seal the tip of the tubing with a few dabs of epoxy.

To build an outdoor probe, first cut a 1 x 3¼-in. strip of perforated circuit board. Push three closely-spaced press-in clips into the board and position near one end of the strip. Solder each lead of the thermistor to these terminals and a corresponding wire from the cable.

Cut a ½-in. hole in the bottom of a 1-in.-dia. plastic pill vial and cement over the thermistor. The vial shields the thermistor from wind and weather, but not from heat and cold.

Calibrate the meter with an indoor probe. Start by filling an ice-filled glass with tap water. Stick a conventional thermometer into the bath and wait until the temperature drops to 40°F. When the thermometer indicates this temperature, press switch S2 and adjust pot R7 for a 40° reading.

Wipe the probe dry and heat the water to 100°F. When the temperature has stabilized, press S2 again. Adjust R6 for a 100°F meter reading. Repeat the calibration a couple of times until no further adjustments of pots R6 and R7 are necessary. ●

RC Slave Flash

(Continued from page 33)

guns should now go off. Turn the master station off until you are ready to take pictures. Also remember that it takes 20-30 sec. for some electronic flash guns to recharge.

A word of caution: If you use inexpensive regenerative walkie-talkies, a sudden burst of noise or another signal close to 5 khz may occasionally trigger the slave flash guns.

Operation of the slave will be affected by your surroundings. For example, superior performance will be easy in open spaces but in auto traffic, ignition noise might cause trouble.

To desensitize the slaves, turn down the volume control in the receiving walkie-talkies.

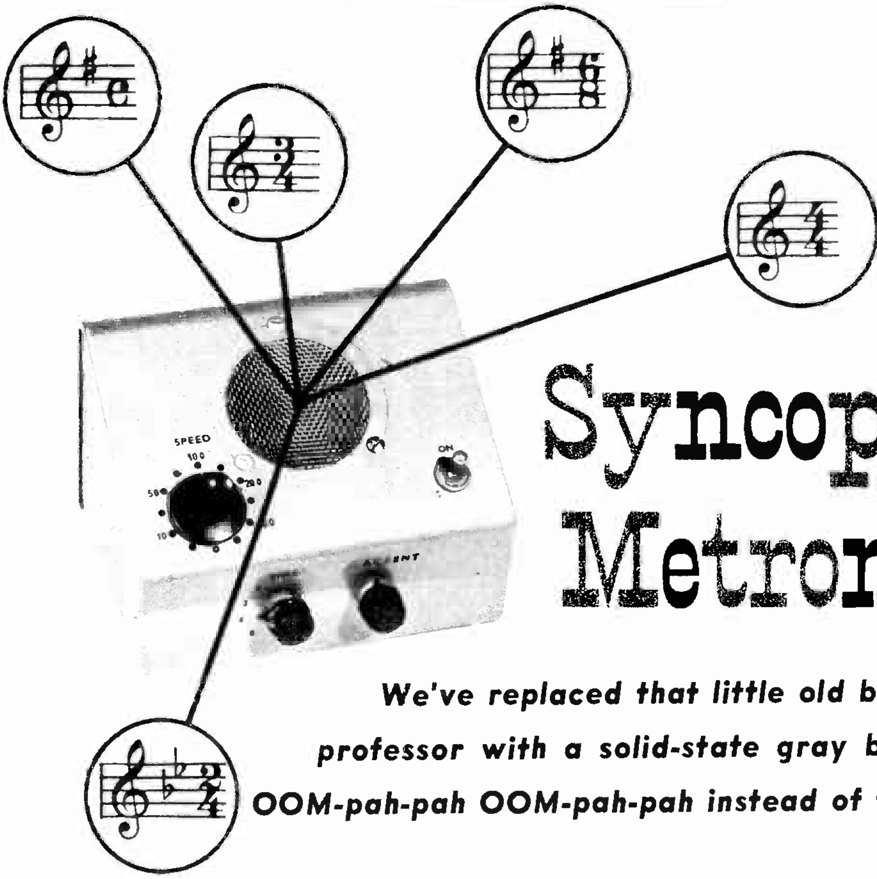
It should be noted that with this system you can use electronic flash guns which are AC or DC operated. Use shutter speeds around 1/30 sec. because even though the flash itself lasts less than 1 millisecond, the process of modulating, demodulating and detecting the 5khz signal takes approximately 20 ms. to be completed. ●

HOW IT WORKS

Integrated circuit IC1 in the master produces a 5 khz tone. In order for this AC signal or tone to get to the walkie-talkie for transmission to the receiver, (where the strobe is located) it has to get through an electronic gate. The gate consists of diode D1 and resistors R4, R5, R6 and R7. Normally this gate is closed because D1 is reversed biased by B1. However when either test switch S2 or the strobe contacts in the camera are closed the positive battery voltage is applied to the diode allowing it to conduct. The 5 khz is then passed on to the transmitter while capacitor C5 isolates the battery bias from the walkie-talkie speaker.

At the slave station the signal is fed into integrated circuit, IC2. This IC, a narrow band detector, will only respond to frequencies that are very close to 5 khz thus reducing the chances of false firing. IC2 drives an indicator light, LED1 and the opto-electronic coupler, OPT which is another light emitting diode (LED) and a photo transistor.

The 5 khz signal causes the indicating light and the LED in the coupler to light up and the photo transistor to conduct. This transistor triggers the gate (G) of the silicon controled rectifier SCR1, to operate the slave flash with a pulse from A.



The Syncopated Metronome

We've replaced that little old bearded music professor with a solid-state gray box that goes OOM-pah-pah OOM-pah-pah instead of tick tick tick!

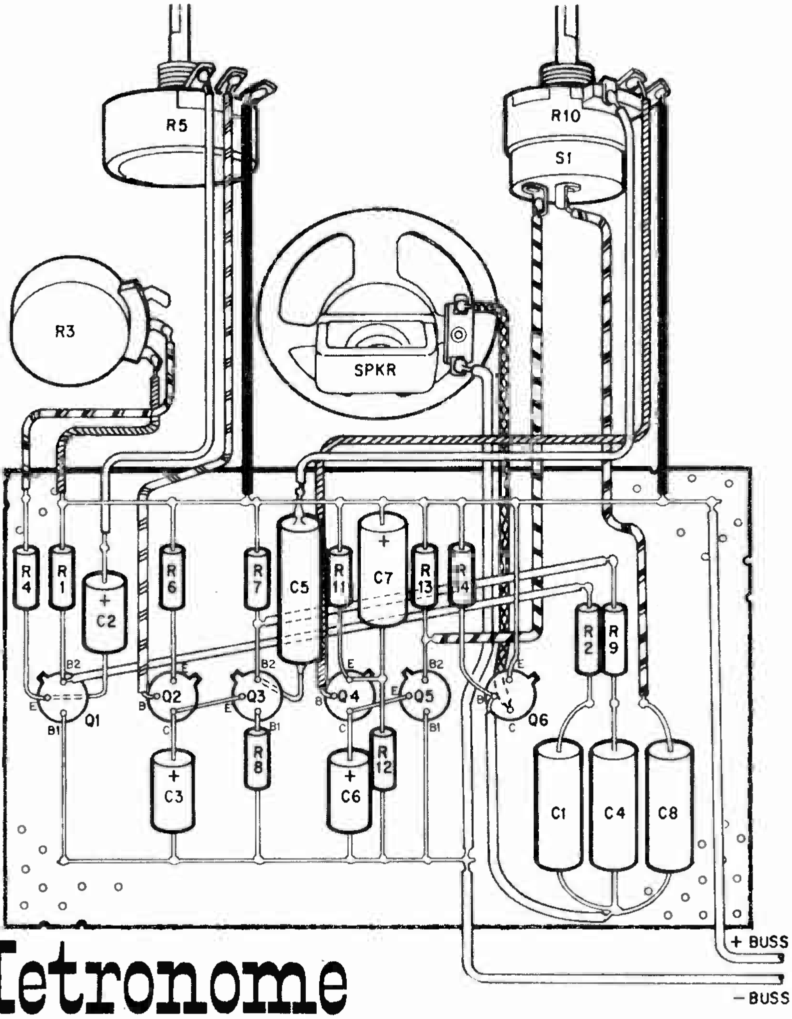
FINGERS on the correct keys? What are the sharps or flats? Am I holding my hands properly? What notes come next? When do I hit the pedal? Ready? Now start playing and watch the timing. With all these things on your mind in the early months of music lessons you begin to feel you won't be past chopsticks after a year of practice.

There are no shortcuts to learning to play a musical instrument. It takes plenty of disciplined practice. But one thing—timing—can be developed quickly with a metronome. However, the ordinary kind that just ticks isn't enough. Reason is, this kind merely helps build up speed and gives an evenness to your playing.

In all music, a specific beat in a measure is accentuated. For example, when you think of or play a waltz, you usually count to yourself, **ONE** *two three*, **ONE** *two three*, and so on. Or, the rhythm could be **ONE** *two three four*, **ONE** *two three four*. In both examples you must add a little emphasis to that first beat—**ONE**.

And this is what the Syncopated Metronome does. It relieves you of the chore of counting and accenting. Just set it for the speed you want (its range is about 10 to 300 beats per minute), set its *time* control for the time of the music (2/4, 3/4, 4/4, 6/8, 9/8) and you're free to concentrate on other things. While you take care of the keys, sharps and fingering, the metronome sits there setting the pace—**ONE** *two three*, **ONE** *two three*, **ONE** *two three*. It can almost play a tune itself. Fig. 2. shows the relative amplitude of its output pulses or tick sounds. The vertical bars in color are additional emphasis for 6/8 and 9/8 time.

In fact, it could be used to help dance students keep time. The rhythmic beats and accents also could be helpful in learning typing, doing exercises, lulling you to sleep, keeping you awake, providing inspiration for composing music and acting as an audible timer. Besides all that, it's a mighty interesting electronics project for the experimenter. To the best of our knowledge there is no similar product on the market. All metronomes we have unearthed just go tick tick tick. So if you're fast with the tools you may be the second person in the world to own a Syncopated Metronome (the author modestly claims to be owner No. 1).



Metronome

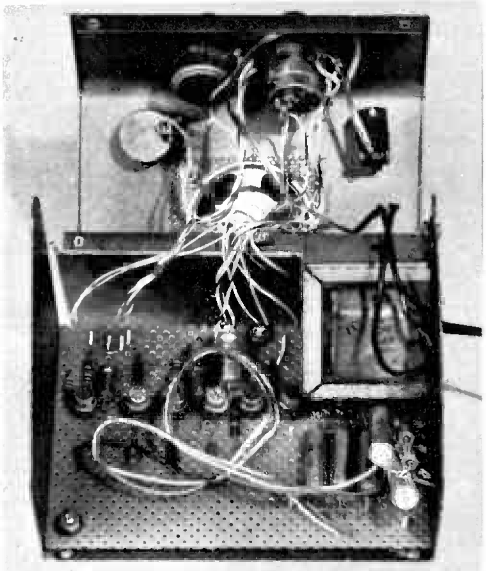


Fig. 1—Mount components on perforated board as shown above and run long leads to R3, R5, Spkr, R10 and S1. Leads to R2, R9 go under board. Mount board in U-section of cabinet as shown below. Toggle switch, upper right of photo, turns unit on.

Construction

The complete unit fits neatly in a 4¼ x 6 x 4-in. meter case. The circuit is built on a 3¾ x 5½-in. piece of perforated board. Most components are installed on the board and can be mounted either with flea clips or by bending their leads on the underside of the board. Interconnecting wires and parts' leads can then be soldered to each other. In most cases the component lead alone is sufficient to connect to its mating part. Very little extra hook-up wire is required. It is important that R3 have a reverse logarithmic taper, as specified in our Parts List, in order to spread out the markings on the *speed* dial.

The power supply can be built on the side of the case as shown in Figs. 1 and 3. The opening in the case intended for a meter accommodates the speaker perfectly. Use a piece of copper screen to protect the speaker cone and use three solder lugs to hold it in place. We used a 100-ohm speaker to eliminate an output transformer.

Mount all controls and switches on the front of the cabinet and make sure the leads to them are long. Should repairs be necessary, this will allow the component board to be completely removed from the cabinet without the need to unsolder wires.

Although the dress of the leads and component arrangement is not critical, the layout shown should be followed closely to avoid mechanical problems when the cabinet is finally assembled.

Calibration

The metronome can be calibrated by ear if you have a good sense of time; however, careful calibration of the *speed, time* and *accentuate* dials is desirable. The most important ingredients required for calibration are a watch with a sweep-second hand and

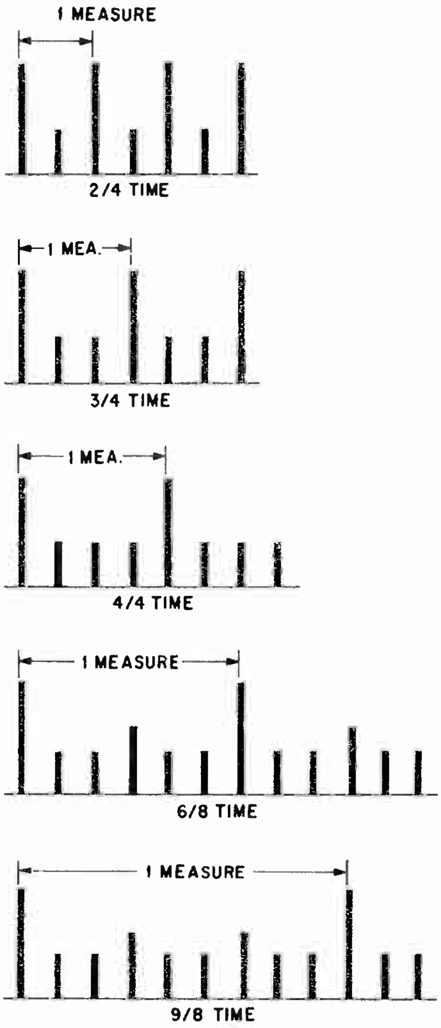


Fig. 2—Diagram shows number of beats in a measure for several times. The accentuated beats are determined by setting of R5. Close switch S1 and adjust R10 and you will get additional emphasis (pulses shown in color) for 6/8 and 9/8 time.

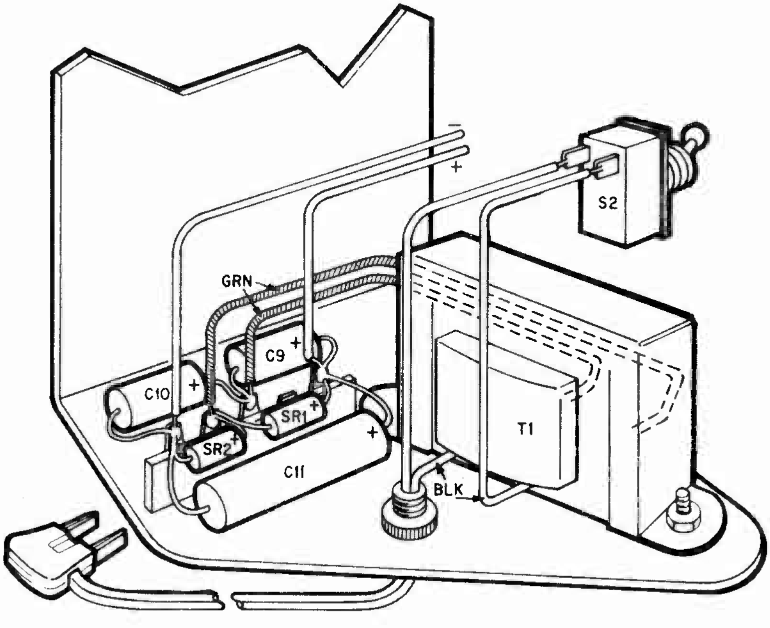
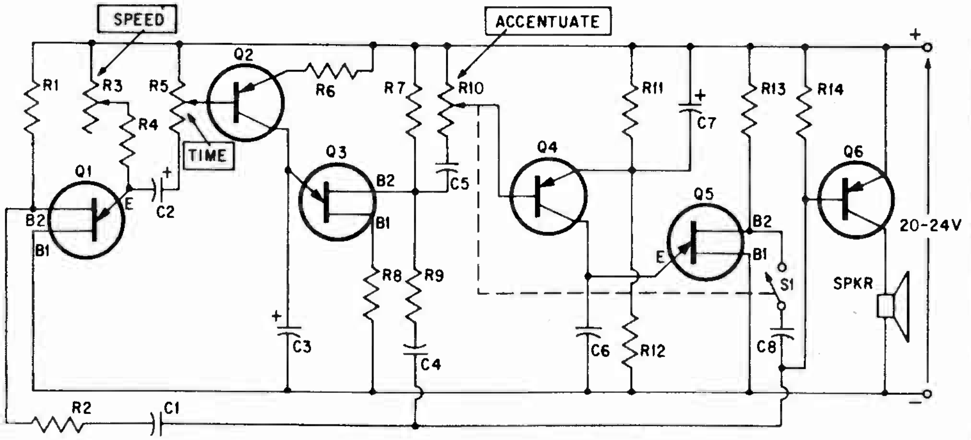


Fig. 3—Power supply is a simple affair that can be built on side of U-section of cabinet. Mount diodes and capacitors on 6-lug terminal strip and make sure ground lug is not used for a tie point. AC power switch S2 gets mounted in the main section of meter cabinet.



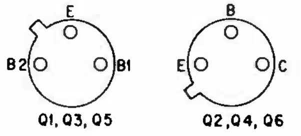


Fig. 4—Schematic. Basic pulse, generated by Q1 and fed to output transistor Q6, is fed also via Q2 to emitter of Q3. When voltage builds up on C3 to level required for Q3 to fire (time delay is established by R5) Q3 fires and sends a pulse to Q6 to increase output volume. Transistor views (left) are of base.

Metronome

a lot of patience.

Set the *speed* pointer anywhere, count the number of beats per minute and mark the dial accordingly. Repeat this for about a dozen places on the dial. Mark these points with a soft marker crayon. Then make the markings permanent with transfer-type numbers and a dab of lacquer.

The *time* dial (R5) is calibrated merely by listening for the emphasized beat. At some point near R5's most clockwise position, every *other* beat will be accentuated (2/4 time). Turning R5 counterclockwise will produce emphasis on every third, fourth, fifth, sixth, and so on, beats. The setting for each of the points is quite broad. The correct spot in each range is where the sound of the accentuated beat is loudest and cleanest. That is, the accentuated beat should not have a crackling sound. A convenient speed of, say, 60 beats-per-minute should be used when calibrating R5's scale.

The dial for *accentuate* control R10 is also calibrated by careful listening. This control and S1 are used to provide a second subordinated accent on, say, the fourth beat of 6/8 or 9/8 time, to visualize this, refer to the two bottom diagrams in Fig. 2. The settings here are somewhat more critical.

PARTS LIST

C1, C4, C8—.1 µf, 100 V tubular capacitor
C2—5 µf, 25 V electrolytic capacitor
C3—3 µf, 50 V electrolytic capacitor (Sprague TE-1302, Lafayette 34 R 8465, or equiv.)
C5—.47 µf, 100 V tubular capacitor
C6—1 µf, 25 V electrolytic capacitor (Sprague TE-1200, Lafayette 34 R 8506, or equiv.)
C7—20 µf, 10 V electrolytic capacitor
C9, C10—25 µf, 15 V electrolytic capacitor
C11—100 µf, 25 V electrolytic capacitor
Q1, Q3, Q5—2N2160 unijunction transistor (GE)
Q2, Q4, Q6—2N404 transistor
Resistors: ½ watt 10% unless otherwise indicated
R1, R7, R13—330 ohms
R2—22,000 ohms
R3—1 megohm, reverse log taper potentiometer (IRC/CTS type Q17-137, Lafayette 33 R 4354)
R4—33,000 ohms
R5—50 ohm, wirewound potentiometer (IRC WPK-50 or equiv.)
R6, R11—100 ohms
R8—22 ohms
R9—4,700 ohms
R10—500 ohm, linear taper potentiometer with SPST switch
R12—1,000 ohms
R14—10,000 ohms
S1—SPST switch on R10
S2—SPST toggle switch
SPKR—100 ohm, 2½-in. dia. speaker (Quam 22A06Z100, Allied 59 U 425)
SR1, SR2—Silicon rectifier; minimum ratings: 100 ma, 50 PIV (RCA 1N3253 or equiv.)
T1—Filament transformer; secondary: 12.6 V @ 1.5 A (Allied 64 U 136 or equiv.)
Misc.—4¼ x 6 x 4-in. meter cabinet (Bud CMA-1930. Allied 87 Z 583, $2.40 plus postage. Not listed in catalog), perforated board, knobs, AC line cord.

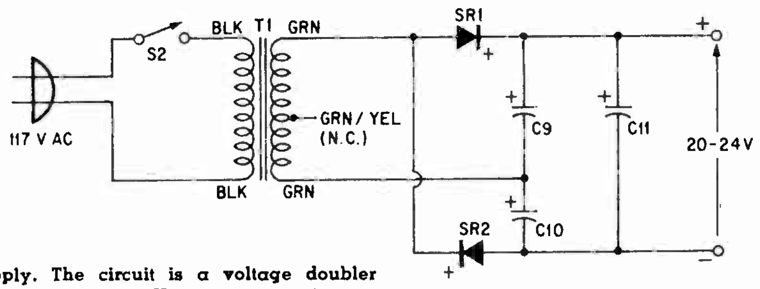


Fig. 5—Power supply. The circuit is a voltage doubler that supplies 20-24 V from a 12.6-V filament transformer.

The exact settings for both the *time* and *accentuate* dials are somewhat dependent upon the setting of the *speed* control and therefore the calibration points are to be considered more as broad guides.

The final setting should always be determined by listening. If R10 is not set properly, the second accentuate pulse may not coincide with the main accent pulse and the sound will be very rough. To correct this merely advance or retard R10 somewhat to pull it into step.

Resistors R2 and R9 affect the relative amplitude of the accentuated and non-accentuated beats. By changing their values you can change the relative amplitudes of the beats.

How it Works

The metronome uses unijunction transistors to provide stable operation. Take a look at the schematic in Fig. 4. Unijunction transistor Q1 is connected as a relaxation oscillator which provides the basic beats. The 1-megohm potentiometer (R3) labeled *speed* provides a speed range of about 10 to 300 beats-per-minute.

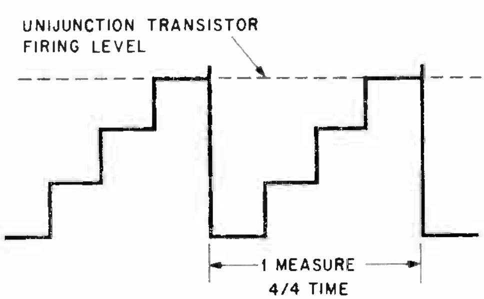


Fig. 6—Q2's collector waveform. When R5 is set for 4/4 time, three pulses charge C3 almost to Q3's firing level. Fourth pulse causes Q3 to fire and produce a pulse that also is fed to Q6.

When the voltage on a unijunction transistor's emitter rises to a particular percentage of the voltage difference between its bases, the transistor conducts, or fires. Until this happens, the impedance between the emitter and base 1 is high.

When power is turned on, Q1 conducts, the impedance between the emitter and base 1 drops to a low value and C2 charges rapidly. As soon as C2 is fully charged, Q1 stops conducting and C2 discharges slowly through resistors R3, R4 and R5. When C2 discharges to the point where Q1's emitter voltage is again at the firing point, Q1 again fires and C2 recharges. This cycle repeats itself continuously at a rate determined by the time constant of C2, and the series combination of R3, R4, and R5.

● **The Time Control.** Pulses of current caused by the charging and discharging of C2 also are fed to *time* potentiometer R5. This control establishes which beat will be accentuated by varying the amount of voltage of a pulse that is fed to the base of Q2 and subsequently the emitter of Q3—a staircase counter.

● **The Accentuate Control.** To achieve compound times such as 6/8 and 9/8, extra emphasis is added to every sixth or ninth pulse, respectively. This is accomplished by closing S1 which adds the output of Q5 to the output of Q1 and Q3. Q5, like Q3, is also a staircase counter, and pulses are accumulated on C6 in the same fashion as they were on C3. Control R10, labeled *accentuate*, is adjusted to provide compound accentuation upon every sixth or ninth, etc. output pulse generated by Q1. Fig. 2 shows the relative pulse amplitudes for 6/8 and 9/8 time. An enterprising musician can achieve many other combinations of emphasis than those shown, for new and off-beat music. Good playing!

FOR SUPER TV TRY A RHOMBIC ANTENNA

By
DAVID WALKER

YOU way out there in TV's fringes! Is your picture filled with snow? Or, maybe that's all you can get on several channels on which your neighbor gets good pictures.

If you're about to go back to listening to the radio, we have a way of snagging those weak TV signals without making you spend a lot of money for one of those giant, ugly super-skyhooks. Our antenna is a rhombic. All it takes to make one is about 150 ft. of copper wire, four insulators, and a resistor.

Shaped like a diamond, the rhombic is one of the best-known yet least-used antennas. The reason is real estate. Although it can provide a sizzling signal, it needs space in which to do it. A rhombic antenna can sock the receiver with a signal some 15db stronger than that from an ordinary dipole. And it does it over most of the band without retuning.

The rhombic's high gain may be just the thing to clear up snowy images, or snare a channel beamed to another city. The antenna is nothing more than wire in the shape of a diamond, or double-V, pattern supported at its four corners.

Here's what to consider before stringing one up. Since available space may be a limitation, we have plans for two basic types. One, an all-band design, covers channels 2 through 13. The other is a high-band job for channels 7 through 13. The one to choose depends on available space and the reception you're now getting.

If your present TV antenna pulls in channels 2 through 6 without snow, but the high channels are weak, the high-channel rhombic is your best bet. It needs only an area of about 32 × 12 ft. Its low-channel performance will produce somewhat less signal than a conventional TV antenna.

Channels 7 through 13, however, will be given a big boost. In our location (50 miles northeast of New York City) the high-channel rhombic completely cleaned up poor pictures on channels 7, 9, 11 and 13. If low-channel reception is your problem and you've got a 64 × 24 ft. antenna site, the all-channel rhombic is the one to build.

There's some juggling you can do with these dimensions. Since the rhombic is directional, non-resonant and relatively wideband, you can select intermediate dimensions. Gain will vary according to length. The two sizes described, however, represent practical examples for TV reception. If made longer, the antenna's performance becomes critical and

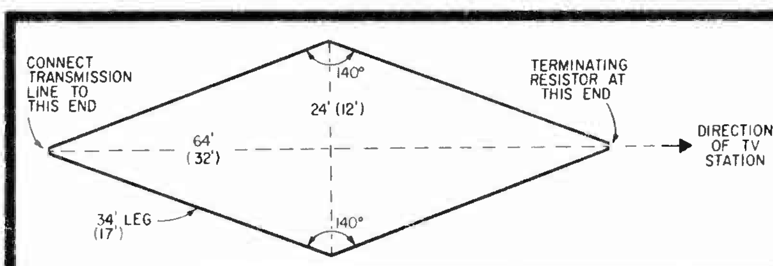
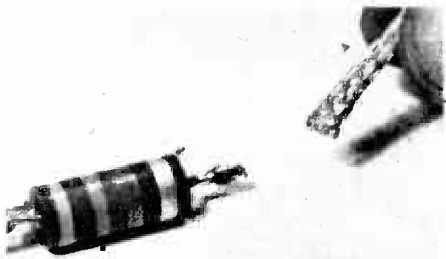


Fig. 1—Rhombic Dimensions. 64 × 24-ft. measurements are for all-channel model. 32 × 12-ft. dimensions in parentheses are for high-channel (7 thru 13) model. Critical things are 140° angles.



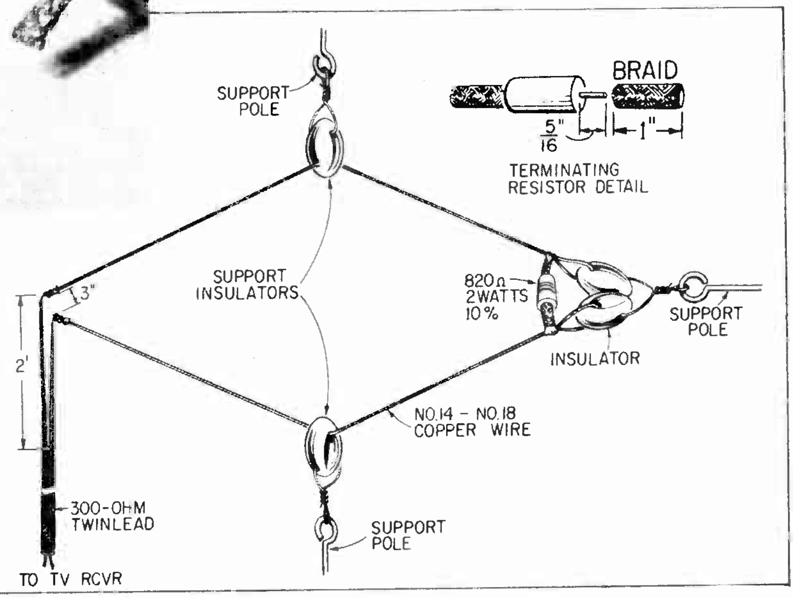


Fig. 2—Photo above shows how braid from coax is connected to 800-ohm, 2-watt carbon resistor. Diagram at right shows all construction details. Hooks at insulators go into poles, trees or the attic's beams.

the pickup pattern gets extremely narrow.

Shorter dimensions make a conventional TV antenna the more practical choice. It's also possible to use a high-channel rhombic to favor a certain direction and a regular TV antenna for other channels. A knife switch installed at the TV receiver will let you select either antenna.

Despite its simplicity, a rhombic requires careful construction and installation to get the correct angles and layout. The antenna (shown in Fig. 1) consists of four equal-length legs. Dimensions are given for both all-channel and high-channel models (the latter's dimensions are enclosed in parentheses).

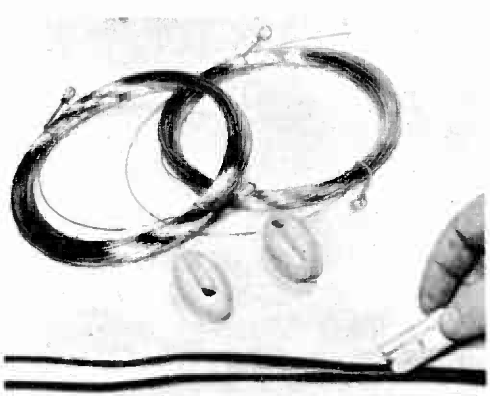


Fig. 3—This is all the material required for antenna: 150 ft. No. 14-18 copper wire and porcelain strain insulators. Slit 2 ft. of twinlead.

Note that a terminating resistor is installed at one end; this is the end to be aimed to the TV station. At the opposite end you connect the TV transmission line. An important dimension, and one that remains the same for both models, is the 140° angle. But you won't have to hire a surveyor to lay out the rhombic on your site. There's a simple way to help find where to install supports, get the correct angles and aim the antenna in the desired direction.

Construction. Obtain a sheet of graph paper with ⅛-in. squares. Draw your rhombic on it, letting each square equal one foot. (If you don't have a protractor, use the 140° angle in Fig. 1 as a guide.)

Once you've drawn the rhombic to scale, obtain another piece of graph paper and sketch your house and property lines on it to the same scale.

Now decide where the rhombic is to be located on the site. If you have a frame house it may be possible, as shown in Fig. 6, to install all or part of the rhombic in the attic. (Nearby cables or metal gutters, however, could upset electrical performance.) Height above the ground should be at least 17 ft.

Once this is complete you'll be able to move the rhombic to various trial positions (on paper, that is) on the site for best installation. At this time, too, you must aim it in the desired direction. When you're satisfied that

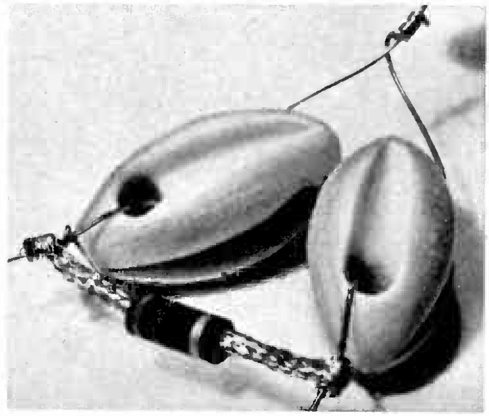


Fig. 4—Photo at right shows the resistor end of the antenna. Braid from coax must be added to resistor's leads to allow for flexing caused by wind.

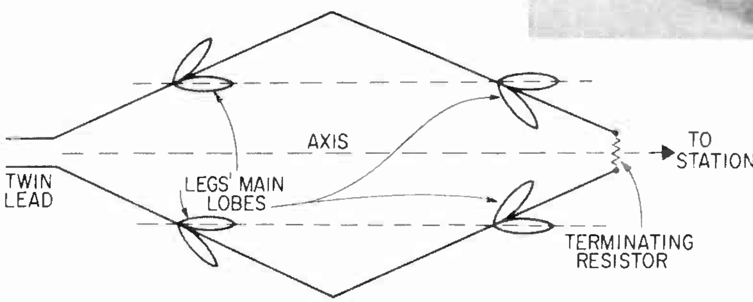


Fig. 5—When legs are longer than signal's wavelength, lobes (pickup pattern) overlap, add signals along axis. Resistor absorbs energy after it has traveled through antenna to prevent it from reflecting back and changing pattern of the lobes.

the rhombic is situated correctly, clip the two pieces of graph paper together. You'll now have a guide for laying out various support locations and the 140° angle between legs.

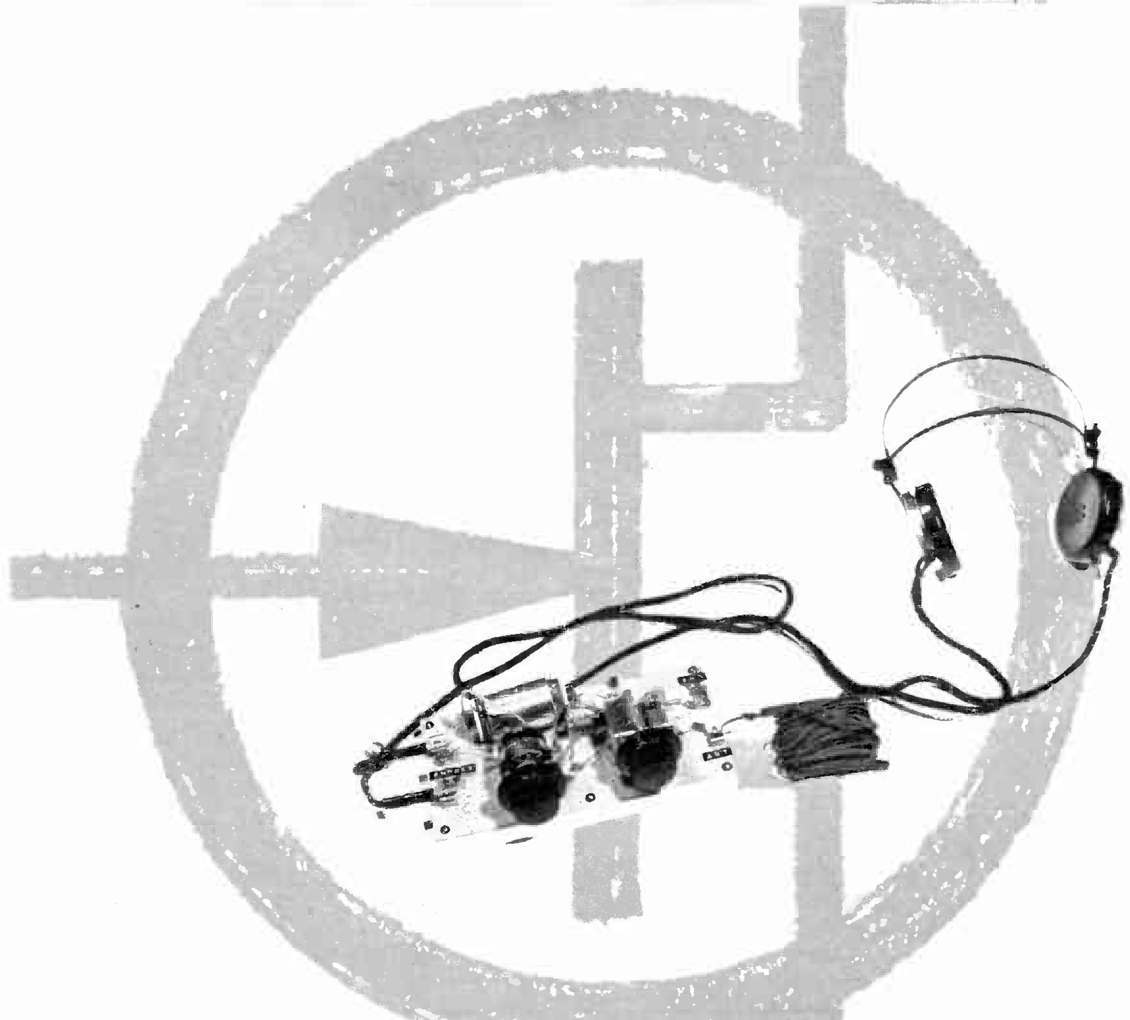
Follow Fig. 2 and the photos when constructing the antenna. The transmission line is ordinary TV twinlead which is modified for proper matching where it is connected to the antenna. The impedance of a rhombic is approximately 800 ohms. To match 300-ohm twinlead to the antenna, you must slit the twinlead about 2 ft. and spread its ends 3 in. as in Fig. 2. This spacing increases line impedance to that of the antenna. Try to bring the twinlead straight down from its connection point at the antenna for at least several feet before bending it. The remaining line to the TV receiver may be any length.

The 800-ohm, 2-watt terminating resistor also gets special treatment. To prevent the resistor's leads from breaking because of antenna sway, solder two short lengths of wire braid to each lead as we show in Fig. 2. Wire braid (cut from shielded wire or coax) will flex readily. Do not use a wirewound resistor for the terminating resistor as it will introduce undesirable inductance.

The antenna must be supported by insulators at each corner and the twinlead may be held by TV stand-offs. If an attic is used for support points (the wood must be absolutely dry) staple the wire directly to rafters at a few points as shown in Fig. 6.

How it Works. Take a look at Fig. 5. On each leg you see lobes, which represent pickup patterns and which add along the antenna's center line. Gain is proportionate to the number of wavelengths at the operating frequency. In the all-channel rhombic, the 34-ft. leg is approximately two wavelengths long on channel 2. This provides a theoretical gain over a half-wave dipole of about 8db. That same 34-ft. leg on channel 13 is 7 wavelengths long. Gain is now about 12db.

Fig. 6—Spread slit (so it matches rhombic's impedance) of twinlead 3 in. and attach to rhombic's legs. Shown here is our installation in attic.



build a 1-FET Radio!

By CHARLES GREEN W3IKH

THE term *solid-state* really is In nowadays. If electronic equipment isn't all-transistor it just ain't Boss. But, great as transistors are, they have shortcomings—one of which is low input impedance In many applications this is of no consequence. But when it comes to tuned circuits (L-C) it creates problems.

A tuned circuit, of course, can be tapped down to match the input impedance of a transistor—but there's another rub. Since a transistor may draw current from a tuned circuit, the Q (selectivity) and the gain of the circuit will be lowered.

Enter a different and relatively new device called a field-effect transistor (FET). It has an extremely-high input impedance, on the order of megohms. Matter of fact, in many respects the FET and its circuit resemble a tube circuit. FETs operate at low voltages like conventional

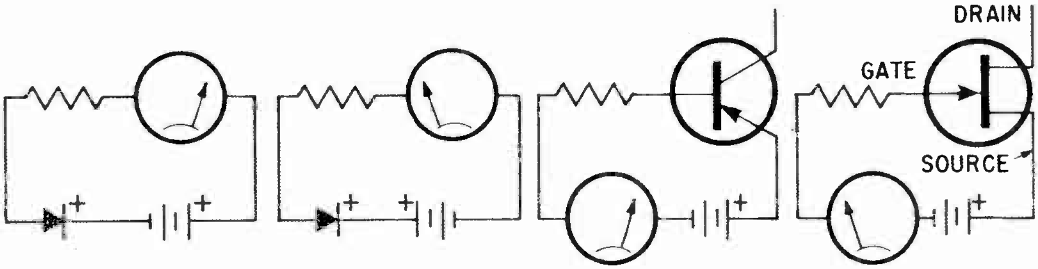
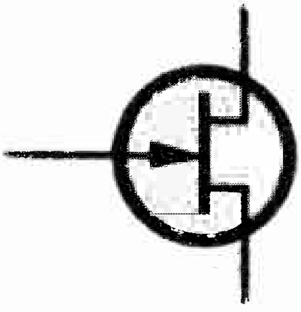


Fig. 1—Heavy current flows in forward-biased diode, meaning circuit resistance is low. Reverse-biased diode current is low so circuit resistance is high. Large current in transistor's forward-biased emitter-base junction means low impedance. Reverse-biased gate-source junction of FET means high input impedance.



transistors, don't load down circuits, and their internal noise is much lower than that of a conventional transistor.

A good way to become familiar with the high-input-impedance characteristics of the FET is with our FET regen radio. Its performance and operation are practically identical to those of a tube regen radio. The circuit uses only one FET, covers the broadcast band and produces good headphone volume. We breadboarded our radio but you could build it in any way you want.

But before we get to the radio itself, let's talk about the FET to see how it works and why its input impedance is so much higher than that of a conventional (bipolar) transistor.

How The FET Works. Take a look at Fig. 2, a pictorial representation of an FET and a basic circuit. The FET consists of a bar of N-type silicon (an impurity has been added to give it free electrons). At the ends of the bar are contacts. Because it supplies electrons, the contact at one end is called the *source*. It is analogous to a conventional transistor's emitter and a tube's cathode.

Because it collects electrons from the source, the contact at the other end of the bar is called the *drain*. It is analogous to a conventional transistor's collector and a tube's plate.

On the top and bottom of the bar at the center are pieces of P-type silicon which form PN junctions with the bar. The junctions are like the base-emitter and base-collector junctions in a conventional transistor. The P-type pieces of silicon form what is called a *gate*. The gate controls the flow of electrons from the source to the drain and is analogous to the base in a conventional transistor and the grid in a tube.

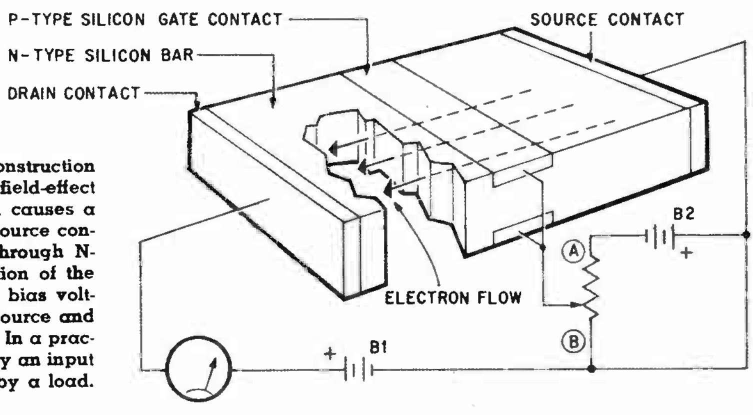


Fig. 2—Diagram shows construction of an N-channel junction field-effect transistor (JFET). Battery B1 causes a flow of electrons from the source contact to the drain contact through N-type silicon bar. The function of the potentiometer is to apply a bias voltage from B2 between the source and gate to control current flow. In a practical circuit B2 is replaced by an input signal and B1 is replaced by a load.

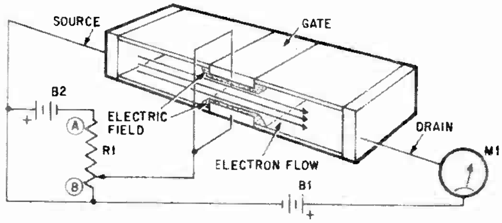


Fig. 3—A small negative voltage from B2 applied to gate causes electric field (gray dots) to narrow the channel through which the electrons flow.

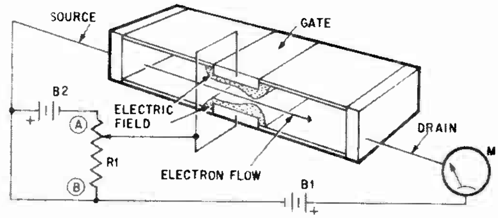


Fig. 4—A large negative voltage from B2 applied to gate increases size of electric field. Field narrows channel, further reducing electron flow.

Assume that the potentiometer's wiper is at *B* as shown in Fig. 2. The gate now is connected to the positive end of B2 and is at the same potential as the source. The gate in this situation does nothing and the bar appears simply as a resistance between source and drain. Because of the way B1 is connected and since the whole bar acts as a resistor, any point along the bar is more positive than another point closer to the source.

Electrons supplied to the source by the negative terminal of B1 flow through the bar to the drain, which is connected to B1's positive terminal. The current magnitude depends on the dimensions of the bar and the amount of impurity in it.

If the potentiometer's wiper is moved toward *A* the gate becomes negative with respect to the source. Therefore, the PN junction between the gate and the bar is reverse-biased (gate, P-type material, negative; bar, N-type material, positive).

To see illustrations of forward and reverse bias, look at Fig. 1. The diode at the left is forward-biased because its P-type silicon anode is positive with respect to its N-type-silicon cathode. The second diode from the left in Fig. 1 is reverse-biased because its anode is negative and its cathode is positive. In other words, for a solid-state diode to be forward-biased, the P-type semiconductor material always must be positive with respect to N-type semiconductor material.

(We're leading up to the reason why the FET has a high input impedance.) When a diode is reverse-biased, only a small leakage current flows in the circuit. All things being equal, when there's little current in a circuit it means the circuit resistance is high. When the diode is forward-biased, current flow is high. All things again being equal, this means circuit resistance is low.

Because the base-emitter circuit always is forward-biased in a conventional transistor, a large current flows. This is why the input

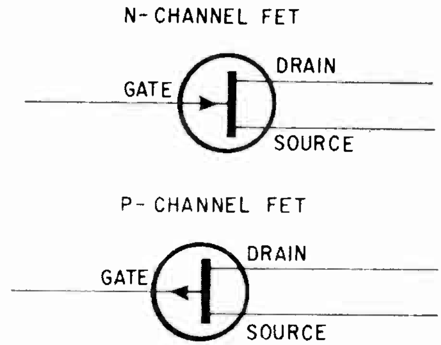


Fig. 5—Standard symbols for FETs. Arrow points toward vertical bar in N-channel FET. Arrow points away from vertical bar in a P-channel FET.

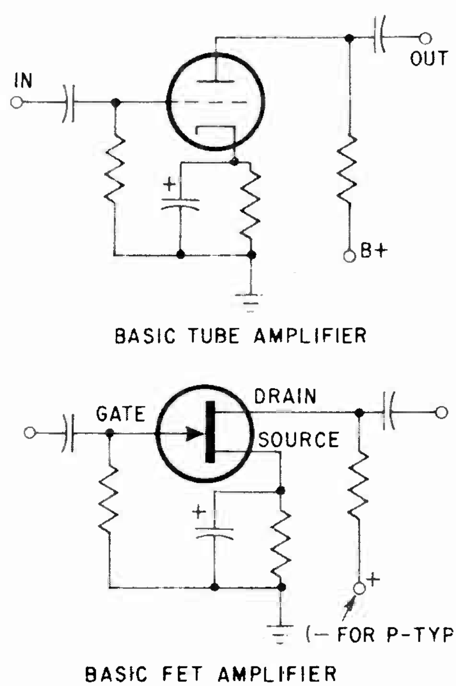
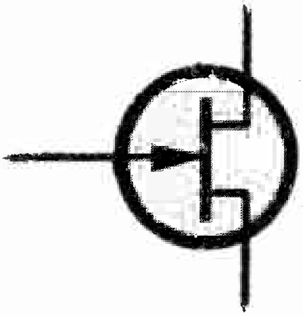


Fig. 6—Notice the similarity of a triode's and an N-channel FET's basic circuit. The drain and source can be interchanged in an FET's circuit.



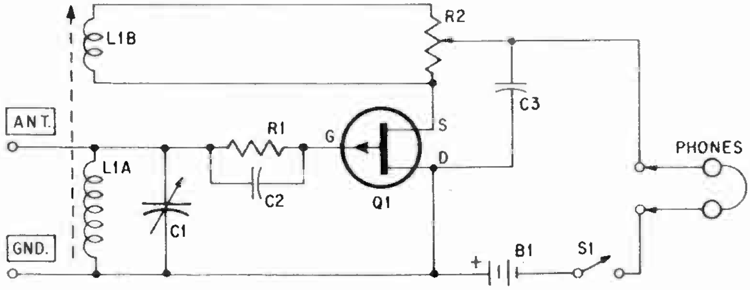


Fig. 7—Schematic of FET regen broadcast radio. Detector is a gate-leak (analogous to grid-leak) detector. To increase the receiver's sensitivity, the circuit is made regenerative by feeding some of signal back to gate via L1B.

impedance of a conventional transistor is low.

Since the source-gate junction of an N-channel FET is *always* reverse-biased (source positive, gate negative) as in Figs. 1 and 2, the current in this junction (or the input circuit) is low. Therefore, the resistance of the input circuit must be high.

How The FET Amplifies. We must be able to control a flow of electrons in order to amplify. Take a look at Fig. 3 and recall what we said about the silicon bar acting as a resistance. When the potentiometer's wiper arm is just above *B* electrons from B2's negative terminal appear at the gate. These electrons diffuse into the bar and their concentration is greater at the right side of the gate. Reason for this is that the bar gets progressively more positive as you go from source to drain. Therefore, more electrons are pulled into the bar at the more-positive right side of the gate.

These free electrons form an electric field (hence the term *field effect*) or a space-charge region. This region narrows the bar's channel through which the electrons pass when going from source to drain. The greater the negative voltage on the gate, the narrower the channel and the fewer the electrons that can pass.

When the potentiometer's wiper is moved nearer to *A*, as in Fig. 4, more electrons build up around the gate. This causes the space-charge region to increase in size and further limit the number of electrons going from source to drain. When the potentiometer's wiper is moved all the way to *A* we reach what is termed the pinch-off voltage and the channel in the bar is sealed. Electrons no longer can get to the drain.

Now we have amplification since we can use a small voltage in the source-gate circuit to control a large current in the source-drain

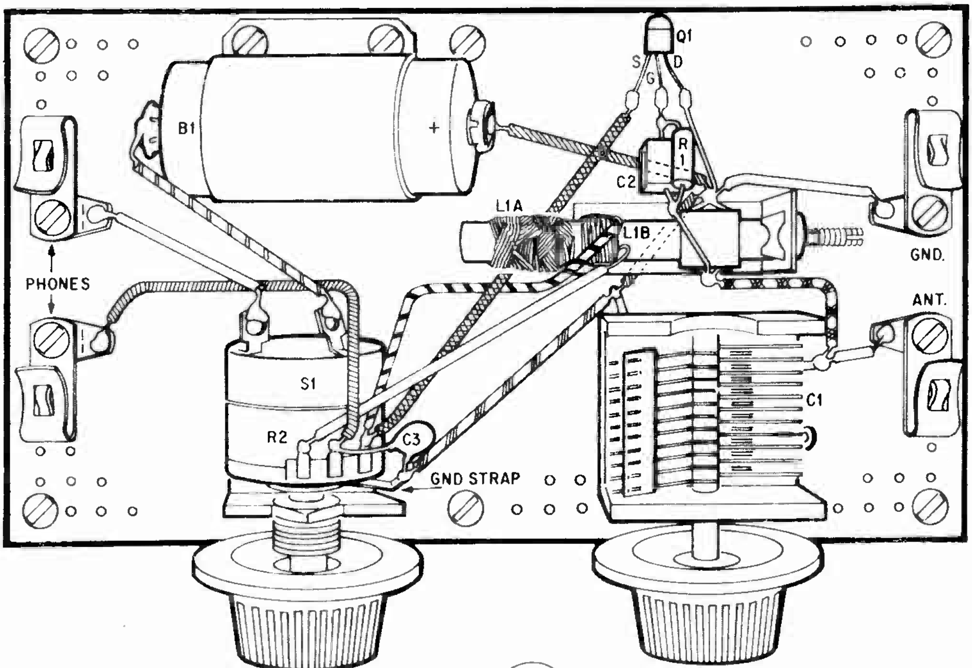
PARTS LIST

B1—12 V battery (Burgess PM8 or equiv.)
C1—10-365 μμf variable capacitor (Lafayette 32 R 1103 or equiv.)
C2—220 μμf, 500 V silvered mica or ceramic disc capacitor
C3—500μμf, 1,000 V ceramic disc capacitor
L1A—Ferrite antenna coil (Q approx. 250. J.W. Miller No. 6300. Lafayette 34 R 8705)
L1B—25 turns No. 28 enameled wire wound over L1A (see text)
Q1—2N3820 FET (Texas Instruments. Allied, $3.75 plus postage. Not listed in catalog)
R1—2.2 megohm, ½ watt, 10% resistor
R2—10,000 ohm, linear taper potentiometer with SPST switch
S1—SPST switch
Misc.—Perforated board, fahnestock clips, battery clips, knobs, flea clips, antenna wire, No. 28 enameled wire

circuit. Install a load instead of a meter, replace B2 with an input signal, and we have a practical amplifying device.

FETs are available as either N or P types—just like NPN and PNP transistors. In the N-type FET, a positive voltage is connected to the drain and the gate is negatively biased—exactly like a tube. The gate is positively biased in P-type FETs and a negative voltage is connected to the drain. Both types have a high input impedance and differ only in the type of semiconductor material used.

How The Radio Works. Refer to Fig. 7. Signals from the antenna are tuned by L1A/C1 and fed through gate-leak resistor R1 to the FET's gate. By the way, notice the values of R1 and C2. (2.2 megohms and 220 μμf, respectively). They're about the same as they'd be in a tube receiver. This is because of the FET's high input impedance. The signals are detected in the source-gate circuit (which acts as a diode). The signal is fed to tickler coil L1B in the drain circuit and inductively coupled to L1A, then back to the gate circuit where it is amplified further. Regeneration is controlled by R2.



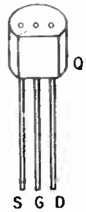


Fig. 9—Diagram above shows layout of radio on 3¾ x 6¾-in. perforated board. Because flea clips protrude from board's rear, put blocks of wood under board's edges. Use the diagram at left to identify FET's leads.

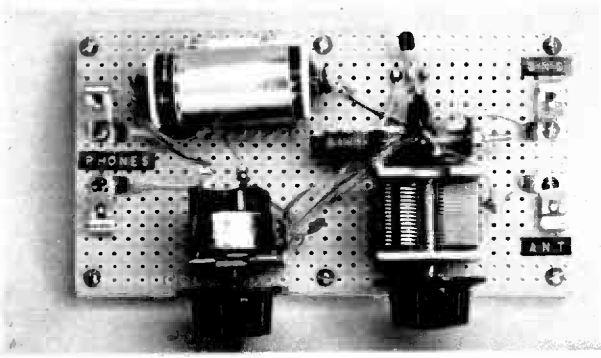


Fig. 8—Our radio was breadboarded on piece of perforated board to make it easy to experiment with circuit. Receiver can be put in small box.

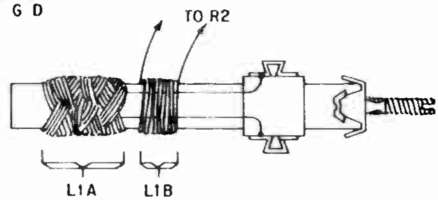


Fig. 10—Feedback winding L1B is wound on form slightly to the right of existing winding. It is 25 scramble-wound turns of No. 28 enameled wire.

Construction. Details about building the receiver are covered in the captions for Figs. 8 and 9. Coil L1 is mounted with the bracket supplied with it. Before installing L1, scatter-wind 25 turns of No. 28 enameled wire around the form as shown in Fig. 10. Wind the wire in the same direction as the original winding.

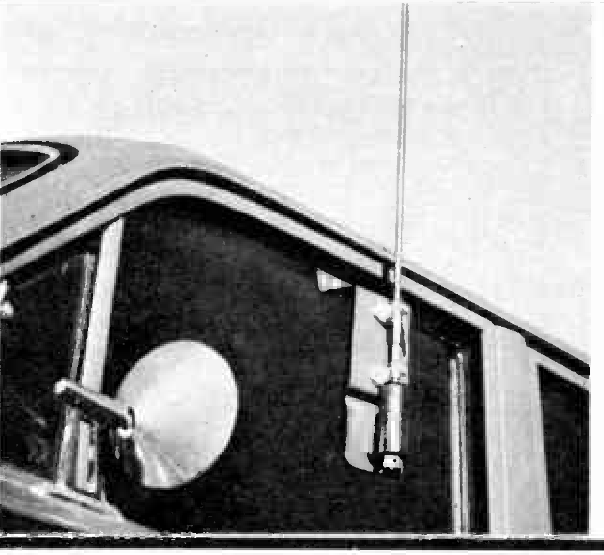
Operation. In good locations, a 25-ft. indoor antenna is all you'll need. In weak-signal areas, a ground and outside antenna are required. For long antennas, you may have to insert a small capacitor in series with the antenna and the receiver. The value should be determined experimentally. Use phones of at least 2,000 ohms impedance. Crystal headphones can be used but you must connect a 2,000-ohm, ½-watt resistor across the headphone connectors.

Tune C1 for a station while simultaneously adjusting R2 until you hear a whistle (oscillation). Back off R2 until the whistle disappears and you hear the station. C1 then may have to be readjusted.

If you don't hear a whistle reverse L1B's connections and try again. Since the characteristics of FETs vary (as in conventional transistors), the number of turns for L1B may have to be increased or decreased for proper regeneration.

The Win-Tenna for Walkie-Talkies

By FRED BLECHMAN, K6UGT



VACATION time often means going away with friends—and if it's a big crowd, *two* cars frequently must be used to carry the people, luggage, pets, pots, blankets, tents and other paraphernalia.

When traveling in caravan on vacations, moving day, to sports events or when double dating, it's oftentimes desirable and necessary to maintain communications between the cars. A pair of 5-watt CB transceivers would be the logical answer. However, installing such equipment for these rare occasions would be prohibitively expensive in light of their limited future use.

Next best thing is a pair of walkie-talkies. They're inexpensive, require no installation and have their own built-in power supply. But have you ever tried using one in a car? There's a whip antenna to contend with. If you haven't used a walkie-talkie on the road, take it from us, it's mighty inconvenient, if not impossible, to stick the whip antenna out the car's window. And it's dangerous too.

Obvious thing, you might think, is to remove the antenna from the walkie-talkie and temporarily fasten it to a car window. You might even try to connect the walkie-talkie to the car-radio antenna.

Not many people would want to butcher the walkie-talkie and even fewer would want to disable the car radio for the sake of occasional communications between cars.

The answer: the Win-Tenna. It's a base-loaded whip which you attach to your car's window with an adjustable home-made bracket. The cable from the antenna clips to your walkie-talkie's *collapsed* antenna. With this set-up in the car anyone in any seat can conveniently communicate with people in the other similarly-equipped car. Our diagram is intended mainly as a guide, hence the lack of detailed and complete dimensions.

The window clip fits over the top of the window on the driver's or passenger's side of the car. You can use either the front or back windows. The window is then rolled up and the suction cup is moistened and pressed firmly against the glass. The adjustment slots in the window clip allow you to set the antenna so it's perpendicular to the ground. This feature is important since the windows of most cars slant inwards at the top.

Construction

The first thing to do is bend the mounting bracket and window clip to suit the car on which it will be used, using our diagrams as guides. The material should be soft aluminum about 1/16 in. thick. The insulated stand-off posts are made of glazed ceramic and come in various sizes. They're supplied with all mounting hardware. We specify 1-in. posts, but you might have to use a different size. It depends on the window slant angle.

You'll also need one alligator clip, a solder lug, and about 4 ft. of insulated wire for each Win-Tenna. The suction cup can be salvaged from your junk box, an old toy, or it can be purchased at an auto-parts store. Even the Sears, Roebuck catalog includes a suction cup for 15¢ (its number is 28 A 6010).

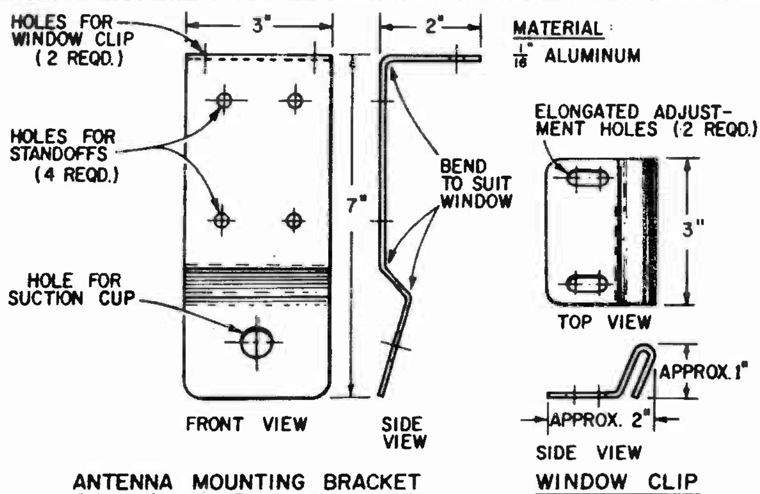
Attach the stand-off posts and window clip to the mounting bracket with screws, lock-washers and nuts. Use plastic cable clamps to hold the antenna to the posts. Solder an alligator clip on the end of the lead-in wire. On the other end of the wire solder a large ground lug. The lug can be either soldered to the bottom of the antenna or attached with a machine screw. Fasten the suction cup on the mounting bracket and the job is complete.

Installation

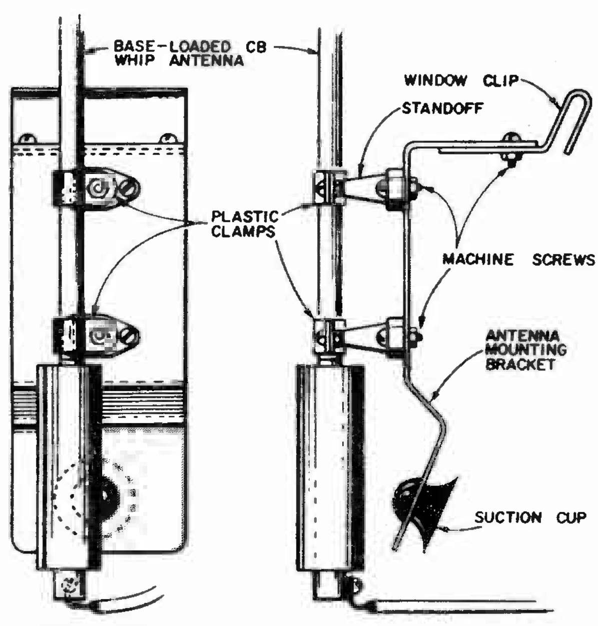
Feed the lead-in wire through the wing window or through the window on which the Win-Tenna is mounted. Attach the alligator clip to the top of the *collapsed* walkie-talkie antenna. A small metal bracket shaped as a holster can be made and used to hold the walkie-talkie to the window sash to keep it out of the way. Such a holder makes for operating convenience.

Don't expect fantastic range from the Win-Tenna since some power is lost between the walkie-talkie and the antenna. Two cars with Win-Tennas and typical 100-mw walkie-talkies can communicate a few blocks depending on the terrain. Superregenerative-receiver walkie-talkies are relatively immune to ignition noise, and may be a better choice for auto use than more expensive superhets.

You can try any number of variations on the Win-Tenna—the idea here is to give you the basic plans. May you and your drivey-talkies enjoy many chatty miles together.



For most windows, the dimensions shown above will hold, but you may have to change a few for your car. Thing to keep in mind if you change dimensions is that bracket must provide plenty of support for antenna so wind won't bend it. Bracket should be adjusted with elongated holes in window clip to keep antenna vertical. Base-loaded whip antenna is available for $3.95 plus postage from Radio Shack (catalog No. 21-907) or Lafayette (catalog No. 99 R 3015). Discard the PL-259 connector that comes with antenna. Stand-off insulators are E.F. Johnson No. 135-22. They're available from Allied (catalog No. 46 U 237) for 22¢ each plus postage.



Add Automatic Shutoff to your RECORDER

By IRVING KARMIN

ONE essential feature that often is missing from tape recorders is automatic shutoff. Manufacturers sometimes feel it's a frill and leave it off to keep the price down.

Add automatic shutoff to your recorder and you won't have to worry about what happens if you're not standing right over the machine when the tape ends or breaks. It's a simple, inexpensive accessory to add and will only take an hour or so.

The recorder to which we added automatic shutoff is a Lafayette Model RK-137A, an AC-powered tube job. Since there's little space underneath the deck plate, we mounted the switch between the reels. A small perforated circuit board installed inside the machine holds the four other parts.

There are three basic recorder designs, each of which requires a different circuit. The designs are: 1) AC powered, tube electronics; 2) AC powered, solid-state electronics, and 3) battery powered, solid-state electronics.

If your machine is the first type—AC powered, tube electronics, like the Lafayette RK-137A—use the circuit shown in Fig. 3.

If your machine is AC-powered with solid-state electronics, eliminate SR1 and C2 since low-voltage DC is available to operate the relay directly. However you may have to connect a resistor in series with the relay—it depends on the B+ voltage.

Relay RY1 is designed to operate on 6 VDC. Its coil's resistance is 335 ohms, which means at 6 V it will pull 0.018 A (18 ma). If the DC voltage used for the recorder's elec-

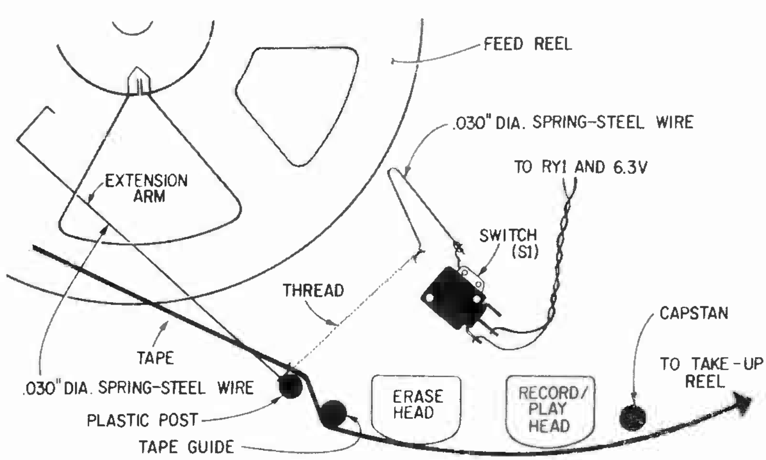


Fig. 1—Diagram shows where to install spring-steel extension arm and switch on top of deck. Switch and arm should be cemented to deck plate with epoxy. Note how tape is threaded over plastic post and around the existing tape guide post on machine.

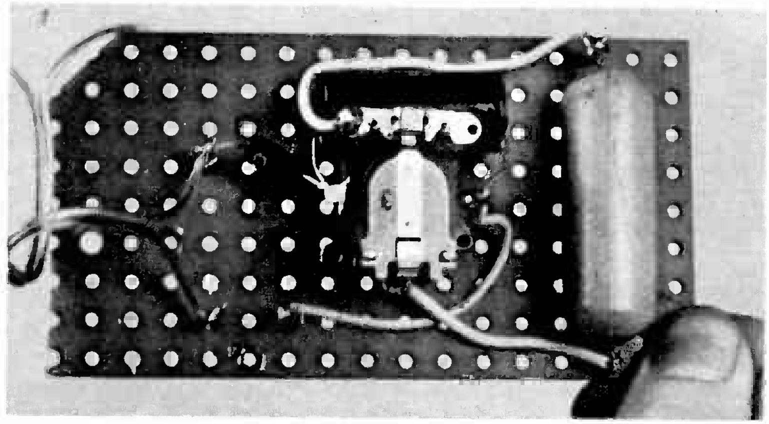


Fig. 2—We mounted relay and other parts on 4½ x 2½-in. piece of perforated circuit board. Leads at left go to 6.3-V filament winding on recorder's power transformer. Leads from switch get connected to lugs at bottom. Leads from motor(s) and 117 VAC can be connected directly to capacitor at right side of board.

tronics is, say, 12 V the resistor will have to drop the extra 6 V. To compute the resistor's value, use Ohm's Law: R = E/I. E is the voltage to be dropped (6 V). I is the current in amperes drawn by the relay (0.018A). Therefore R = 6/0.018, which equals 330 ohms. A 1-watt resistor will handle the power.

If your recorder is battery-powered simply connect the switch in series with one of the motor's leads.

Construction. First things to do are determine the best place to mount the switch and spring-steel extension arm. Remove the switch's actuator arm and cement (with epoxy) a piece of spring-steel wire (shaped as shown in Fig. 1) in its place.

Bend a length of spring-steel wire to the shape shown for the extension arm and put a ¾-in.-long by 3/16-in.-dia. plastic post on one end. Temporarily secure the extension arm and the switch on the deck plate with tape. Then connect the extension arm to the

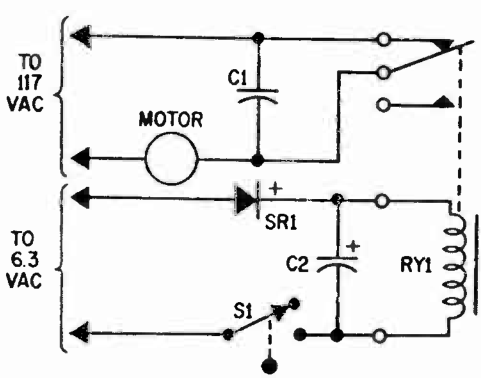


Fig. 3—Circuit for AC-powered tube recorder. When tape breaks, S1 closes and energizes RY1, whose contacts open, remove power from motor(s).

spring-steel wire on the switch with a piece of heavy thread.

Put a tape on the machine as you would to make a recording and start the recorder. Simultaneously adjust the position of the extension arm and switch so the tension of the tape against the post actuates the switch.

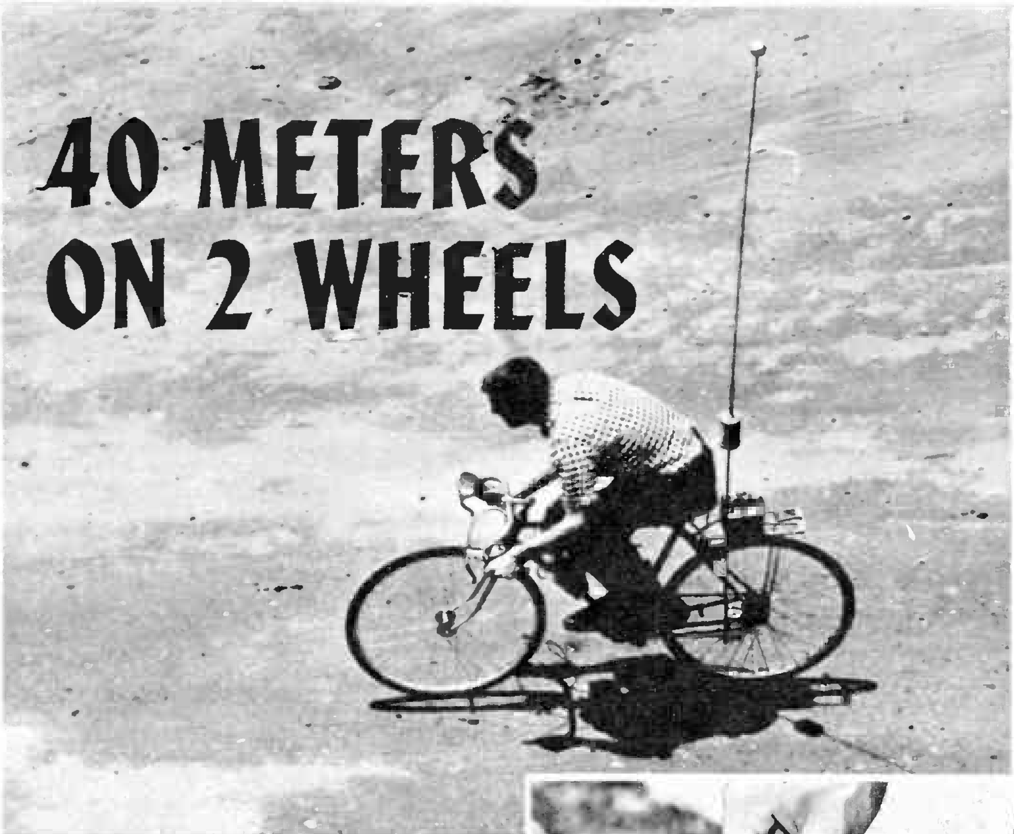
After you're satisfied with the mechanical operation, cement the extension arm and switch to the deck plate with epoxy. Install the circuit board in a convenient place inside the recorder. Break one of the leads going to the motor(s) and connect the leads to the *normally closed* relay contacts. Also be sure to connect the wires to the switch's *normally closed* contacts. Connect one wire from the switch to one side of the 6.3-V filament winding on the recorder's power transformer. Connect the other wire to one of the relay's coil lugs. Connect the relay's other coil lug to diode SR1 and capacitor C2.

Check for proper operation by pulling the post toward the front of tape recorder. The motor(s) should start. Thread a tape around the plastic post as shown in color in Fig. 1, turn the reels to put tension on tape to start the motor(s) and you're ready to go.

PARTS LIST

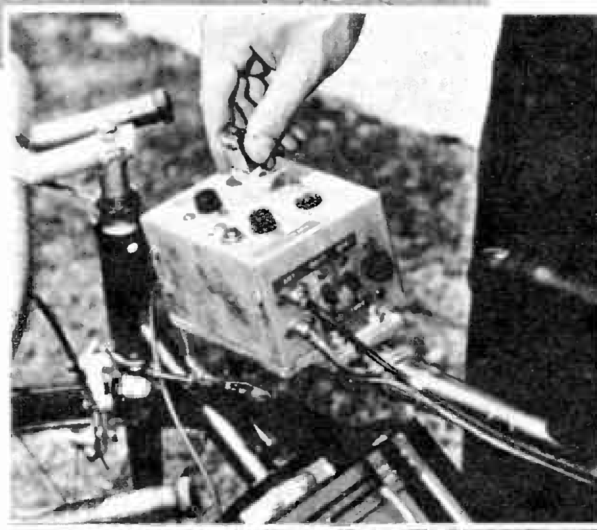
C1—.25 μf, 400 V tubular capacitor
C2—200 μf, 12 V electrolytic capacitor
RY1—SPDT relay; 6-VDC, 335-ohm coil (Potter and Brumfield RS5D. Lafayette 30 R 8598)
S1—SPDT subminiature snap switch. Cemco No. MAC-100-1. (Columbus Electric Mfg. Co., 621 N. Hamilton Rd., Columbus, Ohio 43219. $1.85 plus 20¢ postage)
SR1—Silicon rectifier; minimum ratings: 50 ma, 100 PIV.
Misc.—Perforated board, flea clips, .030-in.-dia. spring-steel wire, phono pickup wire (Belden No. 8429), 3/16-in.-dia. x 1-in.-long plastic rod.

40 METERS ON 2 WHEELS



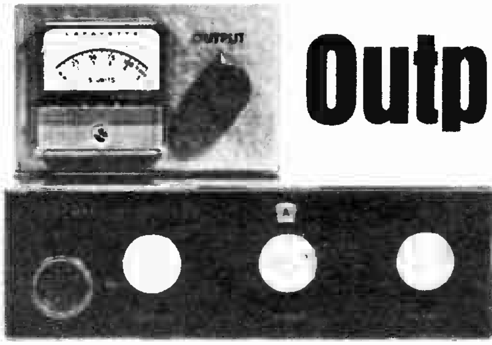
YOU don't need a driver's license to take amateur radio on the road. All you really need is your ham license. When Brad Good, WB6LUC, pedals his ten-speed bicycle around his home in Lakewood, Calif., the antenna on his 40-meter rig may draw double takes from passing motorists, but who cares? He can boast a 5-watt output that will reach out several miles from any convenient hilltop.

To climb the hill, Brad has to contend with the ten pounds his radio gear adds to the weight of the bicycle. He built the transmitter in an electronics class at Lakewood High School, using parts that cost him—all told—about $50.



In the picture at right he inserts a 7293-kc crystal in the transmitter. The receiver can just be seen at the bottom of the picture, mounted on the diagonal bar below the transmitter. Dry-cell power supply is mounted on a rack over the bicycle's rear wheel.

One awkward element in his mobile rig, says Brad, is the antenna. It reaches 9½ ft. above ground level, snagging overhead trees if he is unwary. Any inconvenience, however, is offset by the fact that Brad's rig is—as far as he knows—the first bicycle mobile in use in the U.S. He also maintains a more conventional shack at home.



Output Meter for Solid-State CB Rigs

Check relative output power, modulation and your antenna at a glance.

By BERT MANN

IN the early days, CB transceivers started off small and simple. Then as time passed, they grew in complexity and got bigger—and bigger—and bigger. It took a lot of space to cram in super sensitivity, selectivity and talk power. And the rigs got heavier and heavier, too.

All of a sudden—zap—CB transceivers went solid-state. On the new scene there appeared two-pound handfuls that contained more features and boasted equal or better performance than the best of the old tube rigs.

But after you struggle out from under the long lists of features of solid-state CB rigs, you realize something is missing—an RF output meter. Very few of the tiny transistor rigs have one. And if you remember the days when tube transceivers didn't have an output meter, you know what it was like when someone didn't answer your shout.

You wondered whether or not the transmitter had pooped out, if the modulation was just hash, or if the signal even got to the antenna. In short, without an output meter you never knew for certain if your signal was getting out. Although the new breed of solid-state rigs have just about every feature, they lack the old output meter. Again, you can't know for sure whether pressing the PTT button is putting anything into sky-hook or just exercising your finger.

But for less than a ten spot, perhaps even less than five, you can add an output meter to any solid-state rig. It will indicate relative output power, modulation, and changes in the antenna-system's SWR.

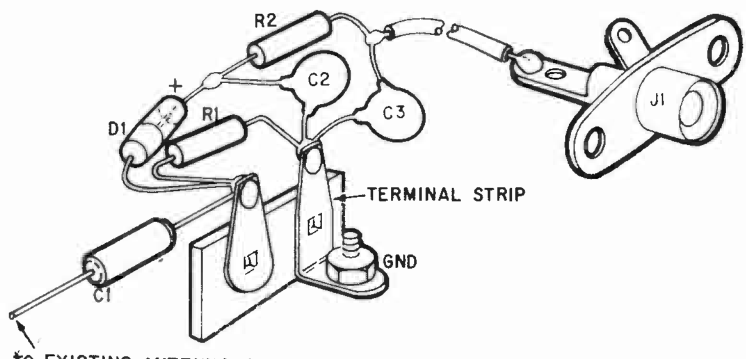
Squeezing It In

Because solid-state rigs are so compact there is virtually no extra space in them for even a miniature meter. In fact, the height of some rigs is less than the height of a conventional panel meter. As a result, the meter must be added outboard. However, the power-detector circuit (Fig. 1) *can* be built into the transceiver. There's always room for a few extra components providing they're small.

The power detector's output—DC proportional to the transceiver's RF output—is fed to a small phono jack (J1) mounted on the rig's rear apron. The meter (M1) and the calibrating potentiometer (R3) are mounted in a very tiny Minibox which is plugged into J1. The meter can be connected only during tests or it can be left permanently connected as it causes no measurable loss of output power.

Construction

The power-detector circuit, which consists of C1, C2, C3, R1, R2 and D1, must be mounted close to the transceiver's output connector. To con-



Output Meter for Solid-State CB Rigs

serve space, all components must be the miniature size we specify in the Parts List. The resistors are rated at 1/10 watt, the capacitors are low-voltage ceramic discs and the diode is a 1N34A.

Leads should be kept very short—about ¼-in. Since the components are sensitive to heat, a heat sink such as an alligator clip must be used on each lead when soldering. We suggest you use a low wattage iron—less than 50 watts. The connecting cable to the meter box, can be shielded microphone cable or small-diameter coax.

Checkout and Calibration

Connect the indicator to J1 and connect your antenna to the transceiver. Turn on power and press your PTT button. M1 will indicate something—the exact value is not important. Turn R3 to see if M1's pointer can be adjusted above and below the center of the meter's scale.

Now talk into the mike. M1's pointer should wiggle, indicating modulation. Depending on the type of rig and the power detector's installation, the meter may wiggle up or down with modulation. If it wiggles down do not assume something is wrong. The direction of our meter's needle movement bears no relationship to the usual upward movement of a power-output meter. In fact, if you connect a power meter to the transceiver it will most likely show an increase in power during modulation even if the needle wiggles downward. The only

Fig. 1—Although solid-state CB rigs have next to nothing in the way of extra space, there's always a little near the output jack. Circuit at top is shown installed in the photo above.

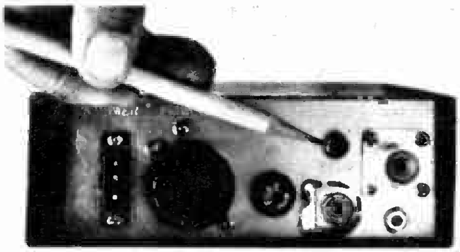


Fig. 2—Pencil points to the added phono jack which feeds the output of the power detector to the remote indicator. Rig is a Lafayette HB-555.

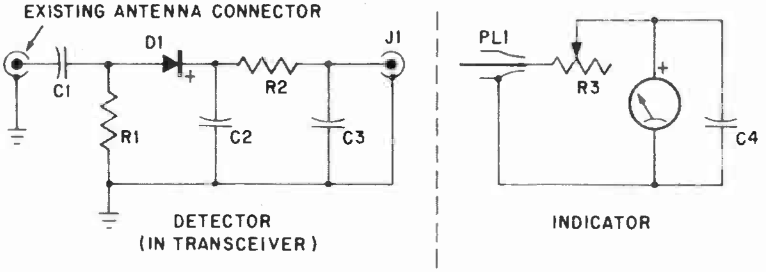


Fig. 3—Complete circuit. Detector, left of dashed line, is installed in transceiver near output connector. Remote indicator at right of line is connected with shielded wire.

PARTS LIST

C1—5 $\mu\mu$f, 600 V tubular ceramic capacitor (Centralab D6-050. Lafayette 33 R 2061 or equiv.)
C2,C3—.01 μf, 75 V subminiature ceramic capacitor (Lafayette 33 R 6902)
C4—.01 μf, 1,000 V ceramic disc capacitor
D1—1N34A diode
J1—Phone jack
M1—0-1 ma DC milliammeter (Lafayette 99 R 2513 miniature S-meter or equiv.)
PL1—Phono plug
R1—1,000 ohm, 1/10 watt, 10% resistor
R2—3,300 ohm, 1/10 watt, 10% resistor
R3—10,000 ohm, linear taper potentiometer
Misc.—3¼ x 2⅛ x 1⅝-in. Minibox, miniature terminal strip, shielded cable

thing to be concerned with is that the needle moves. If it doesn't, you have no modulation.

Adjustment

We suggest you use the output meter in the following manner: First, check your rig with a power output meter to be certain the antenna system is up to its rated performance. Then connect the antenna to the transceiver, connect our indicator and press the PTT button. Adjust R3 so M1's pointer is at exactly the mid-scale.

If the transmitter performs properly, the meter will always rise to mid-scale when the transmitter is keyed and will wiggle during modulation. Should the transmitter's output start to fall the meter will no longer rise to mid-scale and you'll know something's wrong. Similarly, if the meter fails to wiggle under modulation you know you're talking only to yourself.

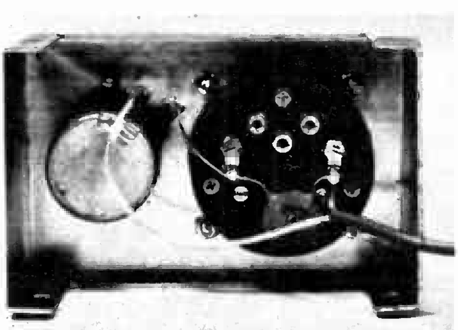
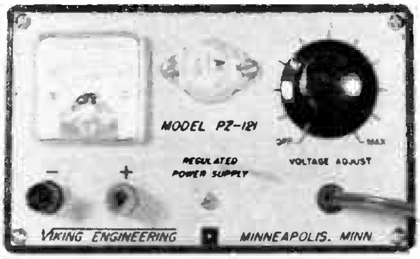


Fig. 4—Cabinet for the remote indicator is a 3¼ x 2⅛ x 1⅝-in. Minibox. The hole for the meter can be cut with a standard 1½-in.-dia. socket punch.

Should something happen to the antenna system, SWR will increase. This generally results in a sharp increase or decrease in voltage at points along the transmission line. Since the transceiver's output jack is part of the transmission line the voltage sensed by the power detector will show a sharp increase or decrease. Therefore, if M1's indication changes sharply from mid-scale, you can be certain you've got antenna trouble.

Note that the meter we specify—an S-meter—has an 0-5 scale. This is not a power-output scale and no adjustment of R3 will turn M1 into a direct-power meter. We selected the meter specified for M1 only because it is inexpensive. Any 0-1 ma meter can be used. The scales have no relationship to RF output power.

If desired, the output meter can be calibrated to indicate the transceiver's relative output power at several levels. Borrow a calibrated output-power meter and connect it to the transceiver's output jack. Operate the transmitter and note the output power on the calibrated meter. Adjust our meter's calibration control (R3) for a convenient reference and then mark the meter's scale to correspond with the indication on the calibrated output-power meter. Then reduce the transceiver's output power by detuning the final RF amplifier, and mark the meter's scale at each of several different power levels.



Experimenter's Power Supply

MOST everyone who works with transistors and other solid-state devices is constantly shelling out money for batteries, batteries and more batteries. You need not, though, if you own a Model PZ-121 regulated power supply made by Viking Engineering of Mpls. (P.O. Box 9507, Minneapolis, Minn. 55440). The supply can be ordered directly from Viking for $13.95 or $19.95 (plus postage) for the kit or assembled versions, respectively.

The PZ-121 provides 0-15 VDC at 200 ma continuously. It can supply up to 250 ma intermittently for 30-second intervals. Consisting of a power transformer, bridge rectifier and a zener-diode regulator, the 6¼ x 2 x 3¾-in. supply can withstand a shorted output for up to 15 seconds. Actually it is the transformer, not the transistor, that gets damaged by the short. Long-term overload will simply blow a fusing resistor. The output is available at two insulated 5-way binding posts and is metered.

Total assembly time should be about an hour—two, if you take it extra slow. We had no problem putting the kit together. The illustrations were excellent and there were only 19 construction steps.

Performance. The PZ-121's specs state that regulation is 0.2 V for current from 0 to 100 ma. This means that if you measure the output voltage under no load (zero current) and then draw up to 100 ma, the output voltage will fall no more than 0.2 V. We found the supply met this regulation spec but only at maximum output voltage. At 9 V and 6 V the regulation was 0.4 V—not exactly up to spec, but pretty good.

At 200-ma output, for which there was no claimed spec, regulation was 0.75 V at 15 V, 1.6 V at 9 V and 1.2 V at 6 V.

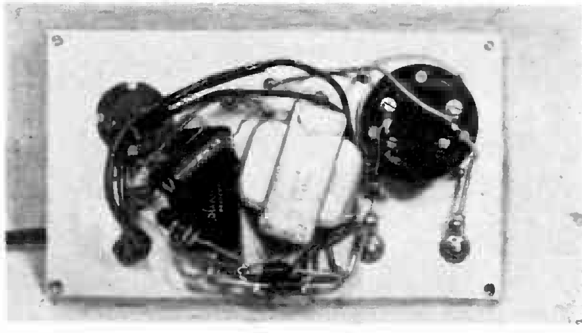
The AC ripple component was much better than the claimed 5 mv being 2.4 mv at 1.5, 3, 6, 9 and 15 V. (The ripple component is the amount of residual AC at the output.

While the maximum output was listed at 15 V we were able to get only 14.5 V out of the supply. This slight difference was due to the tolerance of the zener diode. Allowing for a 10-per-cent tolerance, the output voltage could range from 13.5 V to 16.5 V.

Our model's meter was very inaccurate because the value of the multiplier resistor was wrong and the meter was defective.

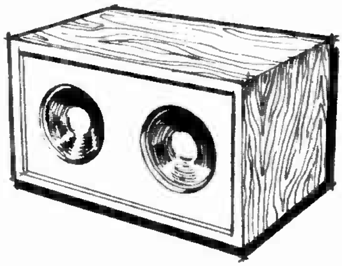
We suggest you check your supply's output voltage with an accurate VOM. Set the supply for a 9-V output (on the VOM). Remove the meter's 15,000-ohm multiplier resistor (R4) and replace it with a lower-value resistor (around 12,000 ohms) to get the supply's meter to indicate 9 V. Then adjust the supply for different output voltages and use the VOM to check the accuracy of the supply's meter. If accuracy is still off, most likely the meter is defective. Viking will replace any defective component without question.

Except for the bad meter, which could have been a one-in-a thousand defect, the PZ-121 represents a mighty good buy and will pay for itself in no time as a bench battery substitute.



All parts mount on rear of panel. Rectifier diodes are at bottom. Filter capacitors are at left between voltage-adjust pot and the transformer.

For Super Sound, Try The



TWIN FIN!

By HARRY KOLBE

BACK in hi-fi's salad days the word *woofer* always meant a big speaker—husky, heavy and at least 12 in. in diameter.

Fifteen-in. woofers were common, too. And for the really well-heeled audiophile who wasn't afraid of a little conspicuous (though hidden by a grille cloth) consumption, there was even a 30-in. woofer.

Would you believe that 3- to 6-in. speakers are being called woofers today? By George, it's true! Big thing about this new breed of small woofers is that the resonant frequency is not in the 100- to 200-cps range where you'd expect to find it in a conventional speaker of the same size.

The resonance of the new small speakers is between 35 and 60 cps! What does this mean in terms of performance? More bass than from a conventional small speaker. Here's why: the output of a speaker falls off rapidly below resonant frequency. Other things being equal, if you lower the resonant frequency the low-end response improves.

How is the resonant frequency of a speaker lowered? One way is to make the cone and voice-coil suspension extremely compliant. Touch a high-compliance speaker's cone and you'll notice it moves in and out freely and also moves a greater distance than it would in a conventional speaker.

And this greater movement means more bass (for a speaker this size, compared to a conventional speaker of the same size) because more air is being moved. Compared to a 10- or 12-in. speaker, whose cone has a large area, a small-diameter speaker's cone must move a greater distance to move the same amount of air.

These small high-compliance speakers also have large magnets and long magnetic gaps to keep the voice coil always surrounded by lines of magnetic flux. This is necessary to prevent distortion on long voice-coil excursions.

The development and availability of these high-compliance small speakers make possible the Twin Fin—a distributed-port bass-reflex system that has excellent response characteristics, considering its small size.

The Twin Fin measures 14 x 8 x 8¼-in. It has a 5-in. woofer and a 5-in. tweeter—the two fives giving the system its name, a fin being five in slang. The woofer has a resonant frequency of around 40 cps—mighty low considering its diameter.

Outstanding as the sound is from the Twin

Fig. 1—Smart-looking . . . and clean-sounding, too! The dimensions of the Twin Fin are 14 x 8 x 8½ in. System consists of a 5-in. woofer and 5-in. tweeter.

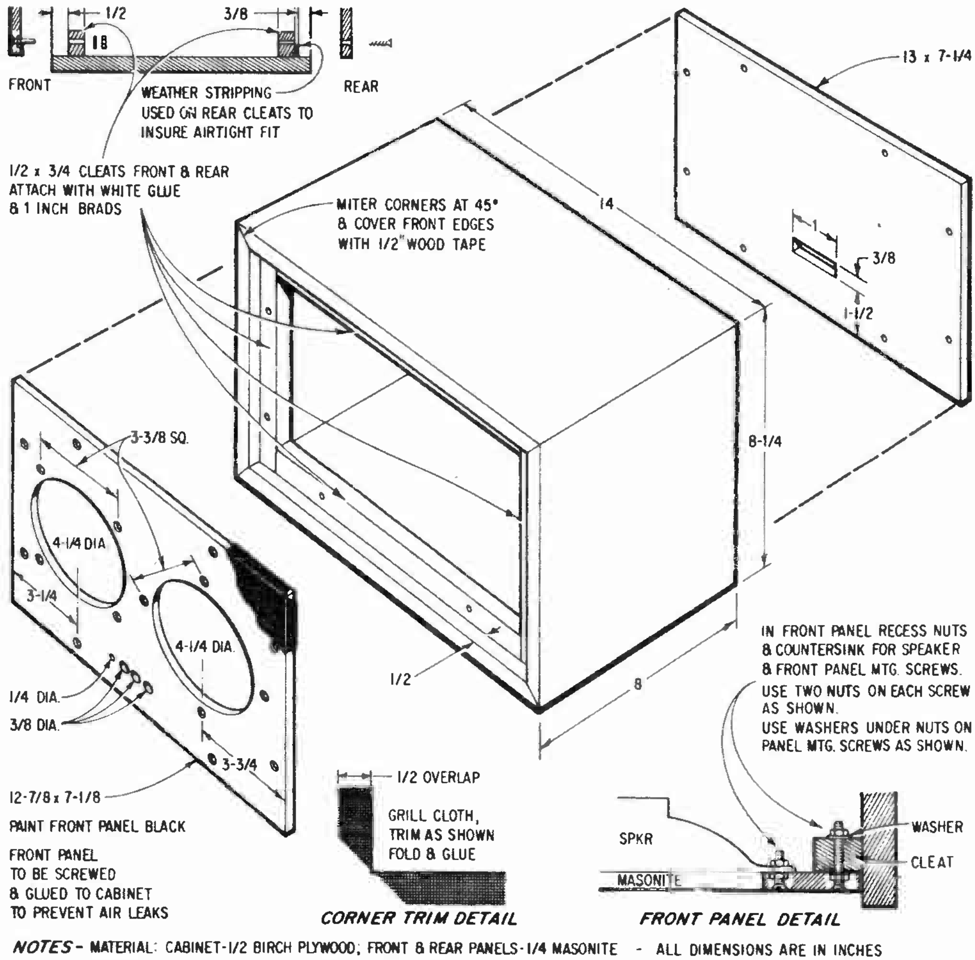


Fig. 2—Our cabinet's corners are mitered 45° but they could be butted as edges are covered with wood tape. Note in lower right corner how speaker and front panel are mounted.

TWIN FIN!

PARTS LIST

C1, C2—8 μf, 150 V electrolytic capacitor
L1—Choke: 270 turns # 18 enameled wire wound on 1-in.-dia. x 1½-in.-long form. (see text)
SPKR 1—5-in. woofer speaker. Fane E/W750
SPKR 2—5-in. tweeter speaker. Fane L/C-STW
Both speakers are available for $15.50 plus 75¢ postage from Electronic Workshop, Inc., 26 W. 8th St., New York, N.Y. 10011.
½-in. thick birch plywood
¼-in. thick masonite
1-in. thick fiberglass wool
Terminal strip
White glue
18 enameled wire
Grille cloth
½-in. wood tape

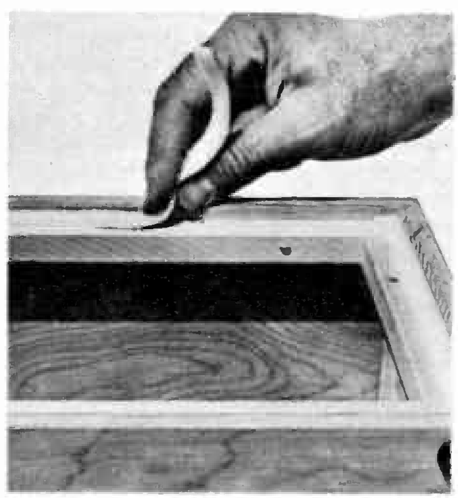


Fig. 3—Rear of cabinet. To be sure of getting an airtight seal, glue weather stripping on cleats. Attach panel with eight flat-head wood screws.

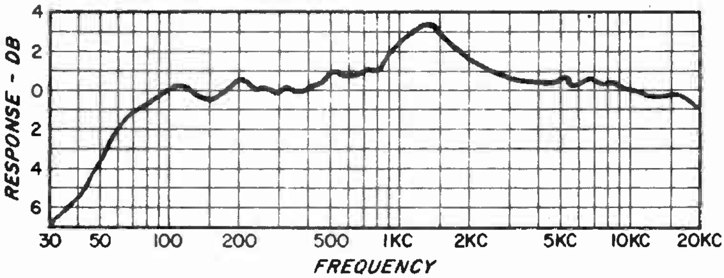


Fig. 5—Twin Fin speaker-system frequency response. Except for slight rise at about 1,500 cps, response is flat within 2db from 60 cps to 15 kc. The mike used to measure response was a PML type EC-61A calibrated condenser microphone.

Fin, you must remember that it's a medium-fi speaker. Don't expect it to produce knee-bending bass as you would from a larger speaker system that includes a 10- or 12-in. woofer.

The Twin Fin's response is flat within 2db from 60 cps to 15 kc. There is a slight rise in response around 1,500 cps, as shown in our curve in Fig. 5.

The Fane speakers used in the Twin Fin are made in England and are not generally available in this country. However, we have made arrangements with Electronic Workshop, Inc., to supply the speakers to EI readers. The price for both is $15.50 plus 75¢ postage. Ordering information appears in our Parts List. Do not substitute other speakers because the enclosure was designed and tuned around the Fane speakers.

The Cabinet

For the top, bottom and sides of the cabinet you'll need an 8-in.-wide by 45-in.-long piece of ½-in. birch plywood. Of course, you could use pine. The choice is yours.

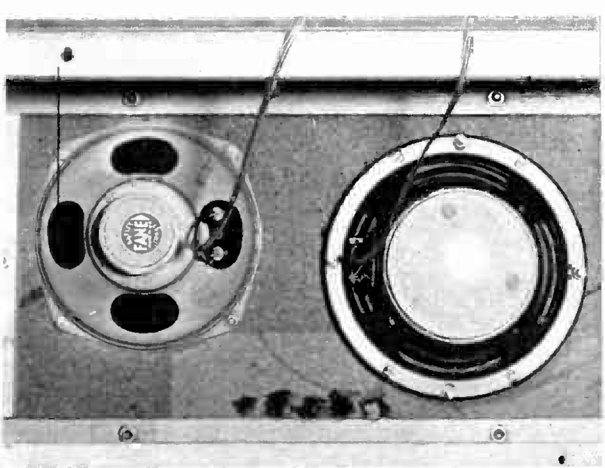


Fig. 4—Rear of front panel after being attached to cabinet. Tweeter is at the left, woofer is at right. Port holes were plugged during tuning.

Cut two 8 x 14-in. pieces for the top and bottom and two 8 x 8¼-in. pieces for the sides. Next thing to do is miter the edges (8-in. dimensions) 45° as shown in Fig. 2.

Of course, if you don't want to miter the edges, you can butt them together. The front edges of the cabinet are covered with ½-in. wood tape, which will hide the butted corners. But you must miter the wood tape at the corners. If you choose this type of construction, the dimensions of the sides will be somewhat different. The important thing is that the overall dimensions of the cabinet remain the same.

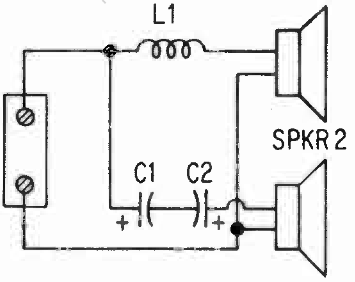
To make sure the cabinet is absolutely square, cut two 13 x 7¼-in. panels out of ¼-in. Masonite. (One will be used as is for the back panel. The other one will be trimmed to 12⅞ x 7⅛-in. later for the front panel.) Install the panels temporarily in the front and back and tie cord around the cabinet to hold it together firmly until the white glue, applied to all corners, dries.

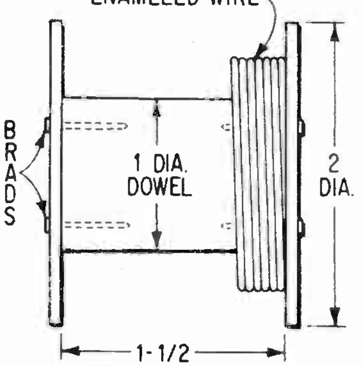
After the glue has dried, remove the panels and install the ½ x ¾-in. cleats, using white glue and 1-in. finishing nails. Details showing the installation of the cleats appear in the upper left corner of the pictorial in Fig. 2.

Next thing to tackle is the front panel. Trim one 13 x 7¼-in. piece of Masonite to 12⅞ x 7⅛-in. Using a hole cutter, cut two 4¼-in.-dia. holes in the front panel for the speakers. If you don't have a hole cutter, draw two 4¼-in.-dia. circles with a compass on the front panel. Back up the panel with a piece of scrap wood and drill a ½-in.-dia. hole inside and tangent to the circle. Then use a keyhole saw to cut out the 4½-in.-dia. hole.

The hole center for the woofer should be

Fig. 6—In crossover schematic, SPKR 1 is woofer. SPKR 2 is tweeter. Note that electrolytics are connected in series and that like-polarity terminals are tied together. Choke is 270 turns of #18 enameled wire wound on 1-in.-dia. x 1¼-in.-long form. Wind wire evenly, tightly and in layers, then apply tape. The brads should be brass.





TWIN FIN!

3¼-in. in from the left side. The center of the hole for the tweeter should be 3¾-in. in from the right side. The speaker mounting holes should be drilled on a 3⅜-in. square, centered about the speaker holes.

Centered between the speaker holes and 1-in. above the bottom of the panel drill one ¼-in.-dia. port hole and three ⅜-in.-dia. port holes. The space between the holes is ⅝-in.

After all holes have been drilled in the front panel, install the mounting screws for the speaker and panel as shown in the lower right corner of Fig. 2. Don't install the speakers yet.

Next, paint the front panel black. After the paint has dried, apply a light coat of glue, stretch the grille cloth tight on the panel and put the panel under a pile of heavy books until the glue dries. Make sure there are no bulges in the cloth and that the weave is straight.

Now install the speakers on the panel. Apply a coat of glue to the front-panel cleats, install the panel and tighten the nuts on the front-panel machine screws. It is important that the nuts be tight so there are no air leaks.

The Crossover Network

The crossover network for the Twin Fin was designed for a crossover frequency of 1,600 cps. The choke is made by winding 270 turns of enameled wire on a 1-in.-dia.

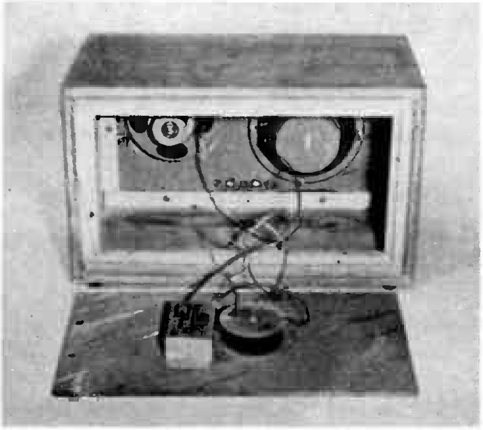


Fig. 7—Completed cabinet ready for stuffing with fiberglass blocks. Mount choke with 2½-in.-long machine screw. Cement electrolytics with epoxy.

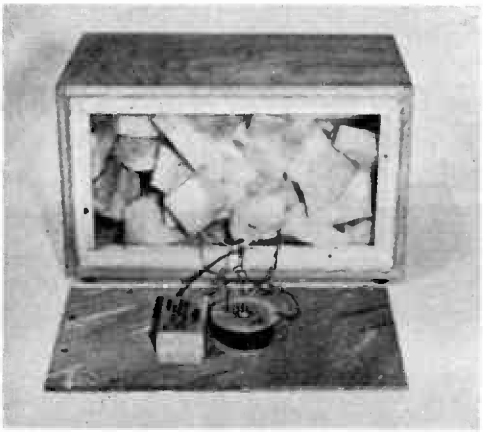
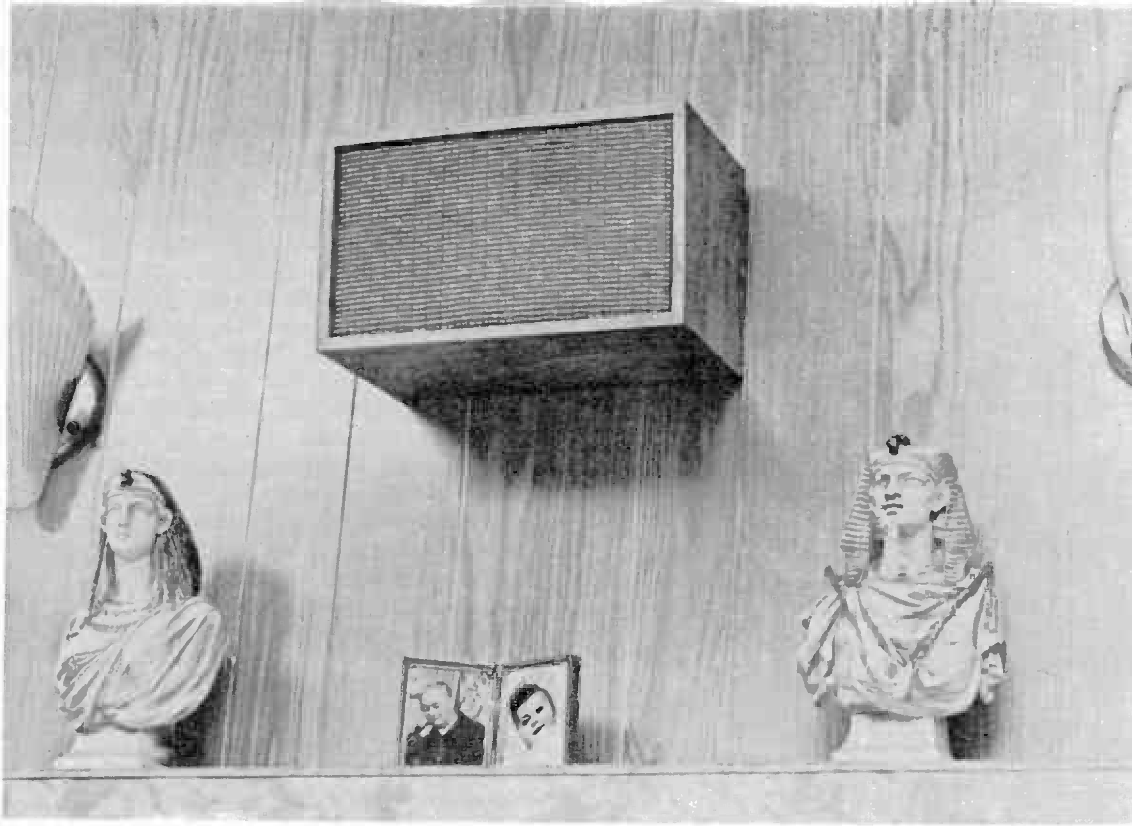
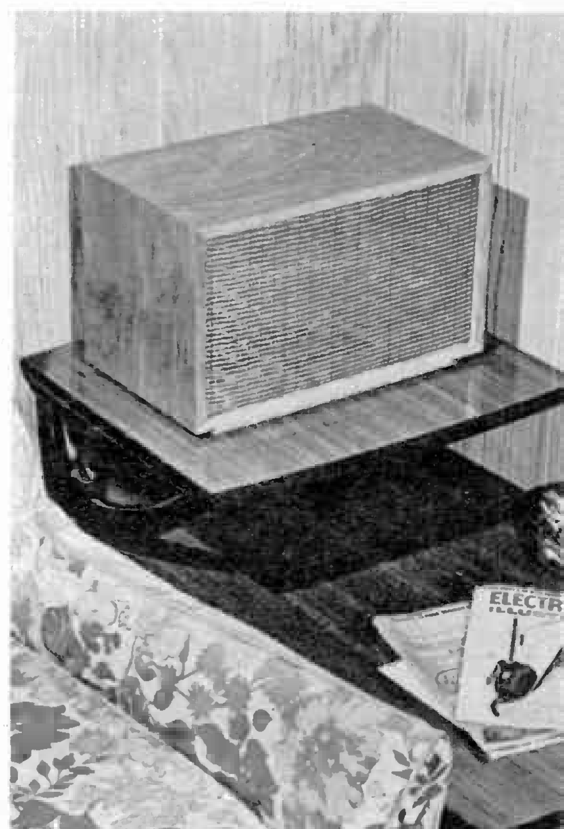


Fig. 8—After you've connected the speakers and the crossover network, stuff the cabinet with 52 2-in.-sq. x 1-in.-thick blocks of fiberglass wool.



As evidenced from these photos, twin fin speaker does not necessarily have to be positioned in bookcase. It looks just as attractive on den wall, or even on end table; and super sound does not suffer.



x 1½-in.-long form as shown in Fig. 6. Wind the wire as evenly as possible, distributing it over the entire length of the form.

Connect the capacitors in series but make sure you connect either the negative or positive leads together. *Do not* connect a negative lead to a positive end.

Install the crossover network on the back panel, making sure the coil and the capacitors aren't loose. (Loose parts will mean disturbing rattles later on.)

On the back panel, install a two-screw terminal strip. Don't simply drill a hole through for a wire. Such a hole will admit air which will affect the speaker's performance.

Before closing the cabinet, fill it with 52 blocks of 2-in.-square x 1-in.-thick pieces of acoustic fiberglass. Attach the back panel with flat-head wood screws.

Don't be surprised if you have to turn your amplifier's volume up a little higher than usual. The Twin Fin is a bit inefficient and needs an extra push. But this in no way means its performance will suffer.

Good listening!

CONAR'S BUILD-IT-YOURSELF TREASURE FINDER

YOU can get rich with gold and silver and precious relics, say the ads. All you have to do is invest in a metal locator, known to the romantics as a treasure finder, and the wealth of the Indies can be yours!

Pirate treasure buried for centuries under wave-washed beaches, treasure chests filled to overflowing with pieces-of-eight, jewels to dazzle the eyes of Arab potentates, enough wealth for a lifetime of Cadillacs and girls to fill them. All this wealth can be yours, or so one might think, simply by walking along a beach with metal locator in hand and waiting till the beep in the headphones turns into a boop.

The modern metal locator is the kid brother of the Army's mine detector. A small box mounted near the handle of a pole contains two oscillators, a mixer and a headphone jack. At the other end of the pole is a large coil of wire (part of the tuned circuit of one oscillator) in the search head.

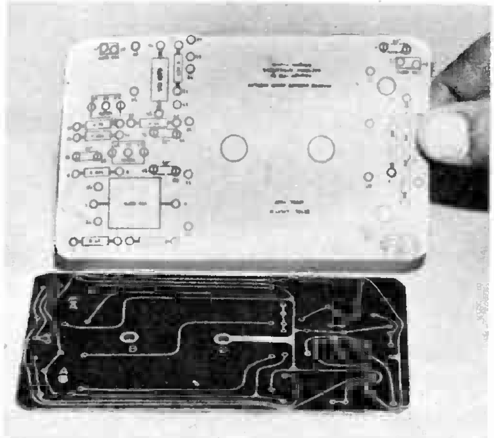
Operation is simple. One oscillator's frequency is adjusted to about 400 cps below the frequency of the oscillator in which the search head serves as tuning coil. The outputs of the two oscillators are fed to a mixer which produces a 400-cps difference frequency that is fed to the headphones. When the search head is brought near metal its inductance changes. This changes one oscillator's frequency, which causes the tone in the headphones to increase or decrease in pitch, depending on the type of metal.

While really sensitive metal locators cost several hundred dollars, many inexpensive models are available to the hobbyist. A typical low-cost model is one distributed by the Conar Division of the National Radio Institute (3939 Wisconsin Ave. N.W., Washington, D.C. 20016). The stock number is 100TUK and it sells for $49.95 with headphones, batteries and a general-purpose search head. Assembled, the price is $54.50. A small-object (No. 1AC) search head is available for $9.50 extra. A large-object search head (No. 2AC) is available for $21.50. The kit consists of a hollow aluminum pole, an assembled search head and the control box.

The control box has a printed-circuit (PC) board which is somewhat unusual. A PC board normally has the wiring etched on one side and the component layout printed on the other. Not so with Conar's treasure finder. There is no printed layout on the board. Instead, you stick an overlay—a template—on the board. The template contains numbered holes which line up with the predrilled holes in the board. You then push the component leads through the holes as described in the assembly manual. For example, a step might read *33k resistor through circle holes 21 and 22.*

We found the procedure of locating numbered holes to be cumbersome. Also, the holes were in poor register, thereby increasing the possibility of error. Luckily, there are few components so the two errors we made were noticed quickly. Particularly troublesome was the hole registration for the transistors—these had to be triple-checked.

Once the control box is assembled everything else goes together with a screwdriver in about 20 minutes. Allowing double time for extra-careful checks during control-box as-



To mount circuit-board parts, you first stick Conar's overlay on reverse side of board. Parts leads are pushed through holes in the template.

sembly, the kit took slightly over four hours to build. It probably would have taken three with a better template. (Our cover shows the control box with printed-circuit board inside, the headphones and reproductions of Spanish pieces of eight.)

Alignment and operation are easy. You plug in the headphones, turn on the power, keep the search head away from metal and adjust the tuning control (protruding from the control box) for a tone in the headphones.

The locator needs time to warm up. When we took it directly from car to beach the oscillators drifted so much we were unable to keep the tone steady. Only after leaving the unit in the sun for 15 minutes did the stability improve.

The locator's sensitivity depends on the size of the metal object and its depth below ground. With the general-purpose search head supplied, the smallest object we could locate was a half dollar buried about an inch under the sand. Water pipes could be spotted slightly over 2 ft. below the head.

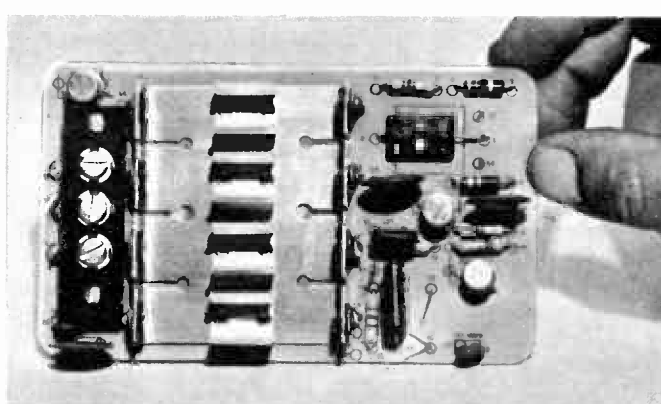
Did the electronic metalhound find pirate gold? No. On the other hand, Conar isn't one of those claiming quick riches from its product. Besides that, we doubt that Captain Kidd buried his bundle at Coney Island, anyway. Spent it, yes. And quickly. Buried it, no. However, the locator did turn out to be useful for locating sewer, water and electrical pipes. And we've got the best collection of bottle caps in town, not to mention half a sandwich wrapped in aluminum foil left over from a picnic. But then we never really did believe we'd find riches—only a lot of fun for the junior members of the family. That we did find.

When those lazy afternoons with nothing to do roll around you can use the metal locator to play a game that will keep the kids occupied for hours.

It's played this way: cut a square or circle of aluminum, about 3 in. in diameter or make up some real pirate's treasure by closely spacing three or four half dollars in an envelope. Bury it from 1 to 2 ft. in the sand. Then send the kids out to find the treasure. At this depth the metal locator's tone change when it's over the treasure will be slight so the one who locates the treasure will be showing real skill. If everyone fails, move the treasure a little closer to the surface.

The object is to keep the treasure deep enough to produce only a slight shift in the tone. If you don't bury it deep enough anyone will find it since its closeness to the surface will produce a drastic change in tone.

Assembled printed-circuit board goes into control box; note small number of components. The battery clips hold four penlite cells. The leads from the search head get connected to the three terminal-strip screws at the left. We experienced some difficulty in fitting component leads through holes in board (predrilled) because holes in the template and the board did not line up perfectly.



SUPER SENSITIVE FIELD STRENGTH METER

By F. DAVID HERMAN

GIVEN the choice of but one test instrument for your ham shack, what would you take? You know your onions if the answer is a field-strength meter (FSM). It is regarded by most hams as the best all-round instrument. True, it can't measure standing-wave ratio (SWR) but, being a relative-power indicator, it *can* tell you when your rig and your antenna are tuned to a razor's edge.

It also can sniff out harmonics and parasitics that have been bugging both you and the FCC. And an FSM probably is the only instrument commonly used by hams that will tell whether a flea-power rig is putting any soup into the line.

But to do all the jobs right you need something more than a ham-band-only FSM. Reason is, parasitics sometimes fall outside the bands. And to find the stage in which harmonics are being developed or to even tune a flea-power rig, you need top sensitivity. In short, you need an FSM which is super sensitive, one that tunes all the commonly-used ham bands from 160 to 2 meters—and then all the frequencies in between. Now add up all these features, figure ten bucks for parts and an evening's work and you've got our Super-Sensitive (amplified) FSM.

Construction

Our FSM is built on the main section of a 5¼ x 3 x 2⅛-in. Minibox. To avoid creating a parts jam or spreading the components too far apart, we suggest you use the front-panel template shown in Fig. 5 as a drilling guide. The specified meter mounts in a hole cut with a 1½-in. socket punch. Do not substitute any other variable capacitor for C1.

Mount all cabinet components, including the battery holder and antenna jack J1, before you start wiring. J1 is a standard insulated banana jack. It should be used instead of the jack supplied with the telescoping antenna because the latter is not strong enough to support the antenna. Mount the antenna in a hollow-type banana plug. Fill the hollow with molten solder and fit the antenna's threaded base into it. While the antenna does not accept solder, the solder will harden around the threads forming a rigid connection. Complete all wiring before you install the coils.

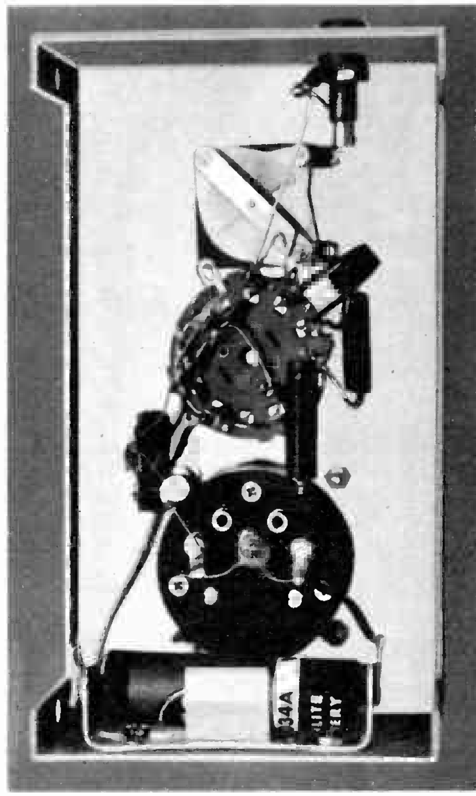
To keep cost down, Q1 can be any general-purpose transistor such as a 2N217. Naturally, the sensitivity of the FSM will depend on the gain of Q1. Also, Q1's leakage current will result in a slight residual meter reading. For maximum gain (sensitivity) and lowest residual reading (almost non-existent) use an RCA 2N2613 transistor for Q1.

Similarly, to keep costs down, D1 can be any diode such as a 1N34A. However, a 1N34A will reduce sensitivity from about 50 to 150 mc. For maximum sensitivity on the high band, use a 1N48 diode.

Coils L1 and L2 are homebrew; L3 and L4 are standard stock. L1 must be made with extra care if you want coverage to the top of the 2-meter band. If L1 is not wound carefully the FSM's top frequency will be around 120 mc. First, remove the insulation from a 6-in. piece of No. 20 solid hookup wire. Then tensilize the wire by clamping one end in a vise and pulling the other end until the wire goes dead slack.

Using the shank of a ¼-in. drill as a form, wind a single-turn coil. Note from the photograph and pictorial (Figs. 2 and 3) that L1 is not a hairpin coil. That is, the winding is a full 360°. Finally, pull the coil leads apart (along the axis perpendicular to the plane of the coil) so the leads are spaced exactly 5/16-in. When L1 is installed on S1 make certain the leads are exactly ¼-in. long—no more, no less. Also, position L1 so it sticks straight up from S1 toward the cabinet back.

Coil L2 consists of 5 closewound turns of



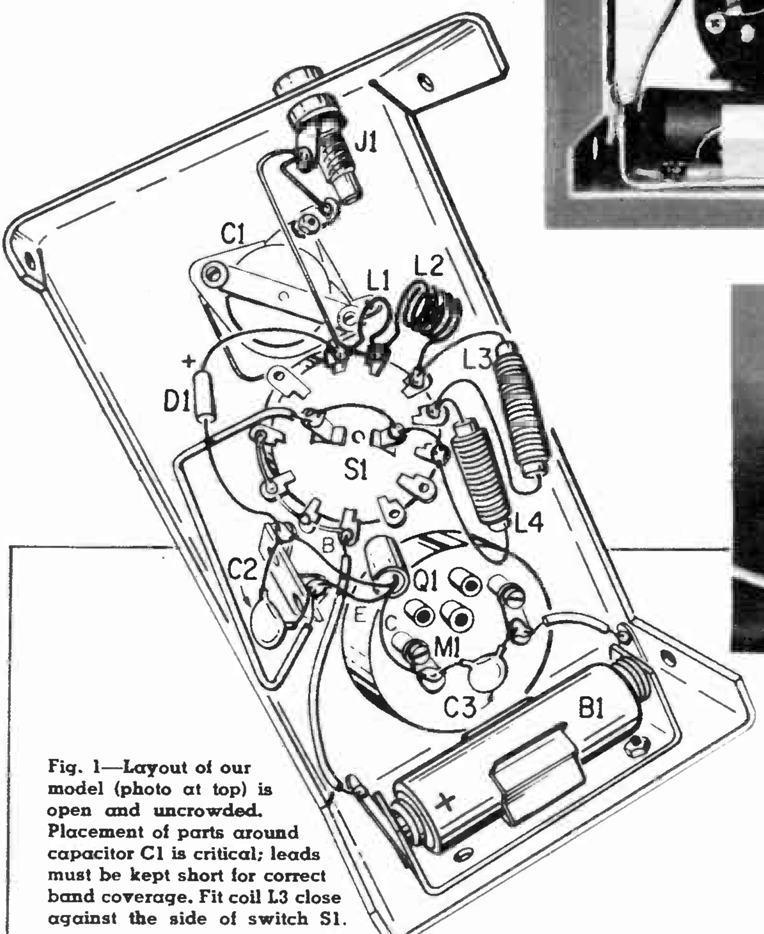


Fig. 1—Layout of our model (photo at top) is open and uncrowded. Placement of parts around capacitor C1 is critical; leads must be kept short for correct band coverage. Fit coil L3 close against the side of switch S1.

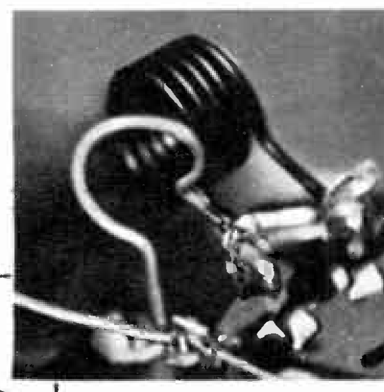


Fig. 2—Closeup of homebrew coils. L1 is at left. After making single turn, spread loop 5/16 in. Length of leads to switch lugs must be exactly ¼ in. Coil L2, 5 closewound turns, also must be mounted no more or less than ¼ in. from lugs on switch.

SUPER-SENSITIVE FIELD-STRENGTH METER

PARTS LIST

B1—1.5 V penlite cell
C1—10-365 $\mu\mu f$ miniature variable capacitor (Lafayette 99 R 6217)
C2—.005 μf, 1,000 V ceramic disc capacitor
C3—.001 μf, 1,000 V ceramic disc capacitor
D1—1N34A or 1N48 diode (see text)
J1—Banana jack
L1—Coil wound with No. 20 solid hookup wire (see text)
L2—Coil wound with No. 18 enameled wire (see text)
L3—2.4 μh RF choke. J. W. Miller 4606 (Allied 63 U 830)
L4—24 μh RF choke. J. W. Miller 4626 (Allied 63 U 839)
M1—0-1 ma DC milliammeter (Lafayette S-meter; 99 R 2507)
Q1—2N217 or 2N2613 transistor (see text)
S1—2 pole, 6 position rotary switch (Mallory 3226J)
Misc.—Telescoping antenna (Lafayette 99 G 4001), banana plug, 5¼ x 3 x 2⅛-in. Minibox, battery holder

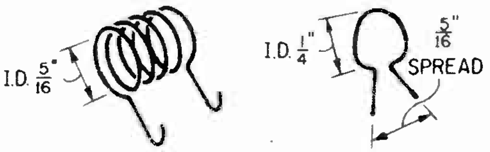


Fig. 3—Coil dimensions. At left is L2. Its turns must be closewound. Coil L1 is at right. Wind both coils on drill shanks and cut leads to 5/16-in. so coils will be ¼-in. from the switch lugs.

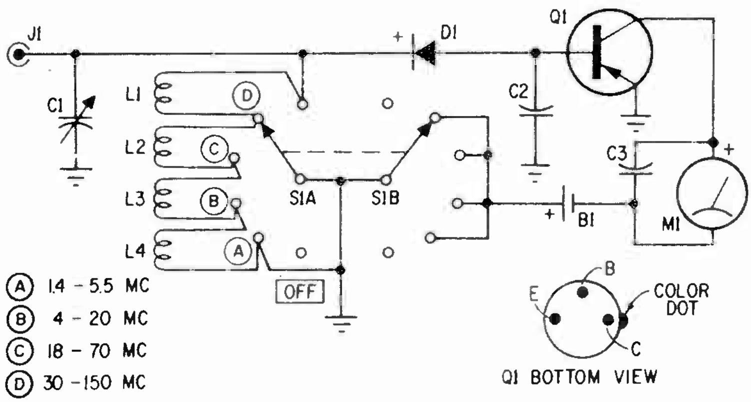


Fig. 4—Schematic of FSM. Signals picked up by antenna plugged into J1 are tuned by C1 and coil selected by S1. (Inductances of coils are added as S1 is moved from position D to A.) Tuned signal is detected by D1 and applied to base of Q1. Q1 amplifies signal to drive meter M1. Band covered by each coil is at lower left of schematic.

No. 18 enameled wire. Use the shank of a 5/16-in. drill for the form. Again, tensilize the wire before winding the coil. L2 is installed with ¼-in. leads. Use the exact coils we specify for L3 and L4.

When the unit is completed you'll find that a standard knob will not fit on C1's shaft and the supplied knob is useless. Cut off a ¼-in. length of a *round* volume-control shaft and, using epoxy, cement the piece of shaft to C1's shaft stub. Let the joint dry 24 hours.

Calibration

The FSM's approximate frequency ranges are shown in Fig. 4. The exact coverage is determined by L1's and L2's construction and the layout. However, if carefully built, coverage will be close to that shown in the chart.

Paste a semicircle of paper (with four bands inscribed) on the cabinet over C1's shaft with rubber cement. Mark the four bands—A, B, C, D—starting at the outer edge. Set C1 to maximum capacity (plates fully meshed) and set S1 to band *A*.

Either a grid-dip oscillator (GDO) or a signal generator can be used as the calibrating signal source, though it will be easier with a GDO.

Hold the GDO about 2 in. from the fully extended antenna and sweep the GDO down from 1.4 mc. When M1 peaks, mark the dial with the GDO's frequency. Then set the GDO to each of the desired calibration frequencies and adjust C1 for peak indication. Mark the panel as you go along. For the top of the band set C1 to *minimum* capacity and sweep the GDO frequency. Perform the B-, C- and D-band calibrations the same way.

If you can't borrow a GDO you can use a signal generator. But you must take extra

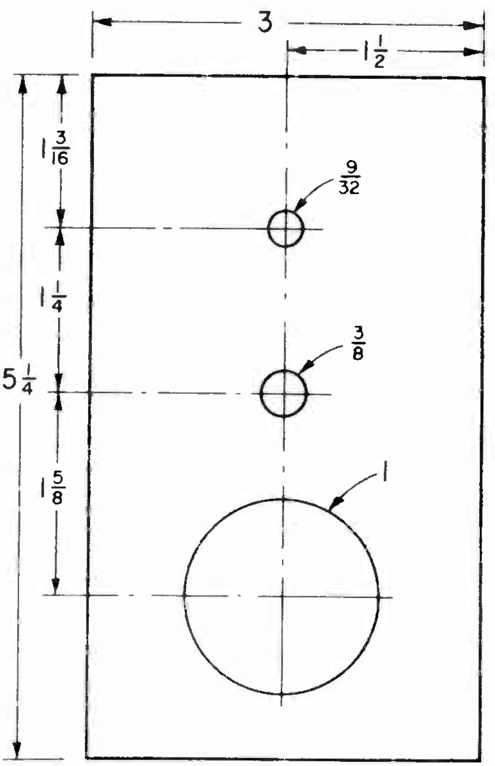


Fig. 5—Because parts placement is critical, use dimensions shown above for drilling main section of Minibox. The 1½-in.-dia. hole at bottom for meter can be made with a socket punch.

care not to pin M1. The generator's output level must be kept low. First, try connecting the generator's ground lead to the FSM cabinet and just *wrap* the hot lead around the antenna. If M1 pins with the generator's output control at off (remember, this is a *sensitive* FSM), try placing the generator's output lead about a foot from the antenna.

When using a generator whose high-frequency output is a harmonic of a lower frequency, make certain you are calibrating the FSM to the correct frequency. For example, if you are calibrating at 100 mc, make certain the FSM is not tuned to the generator's 50-mc output.

Using the FSM

Keep in mind at all times that our FSM is extremely sensitive and must be used carefully. Do not stick the FSM close to an antenna or oscillator when the equipment is on. Rather, keep the FSM as far as possible from the equipment for an easily readable meter indication. Only if the meter reading is so low it becomes inconvenient or difficult to observe should the FSM be moved closer to the signal source.

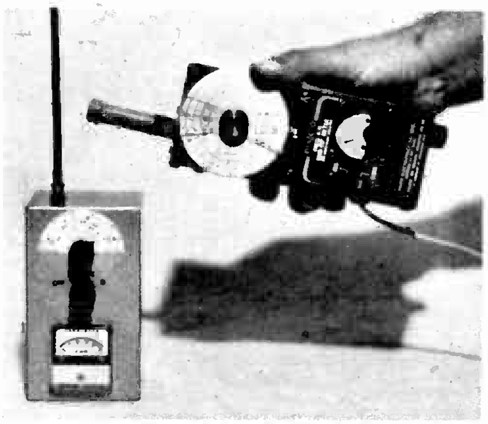


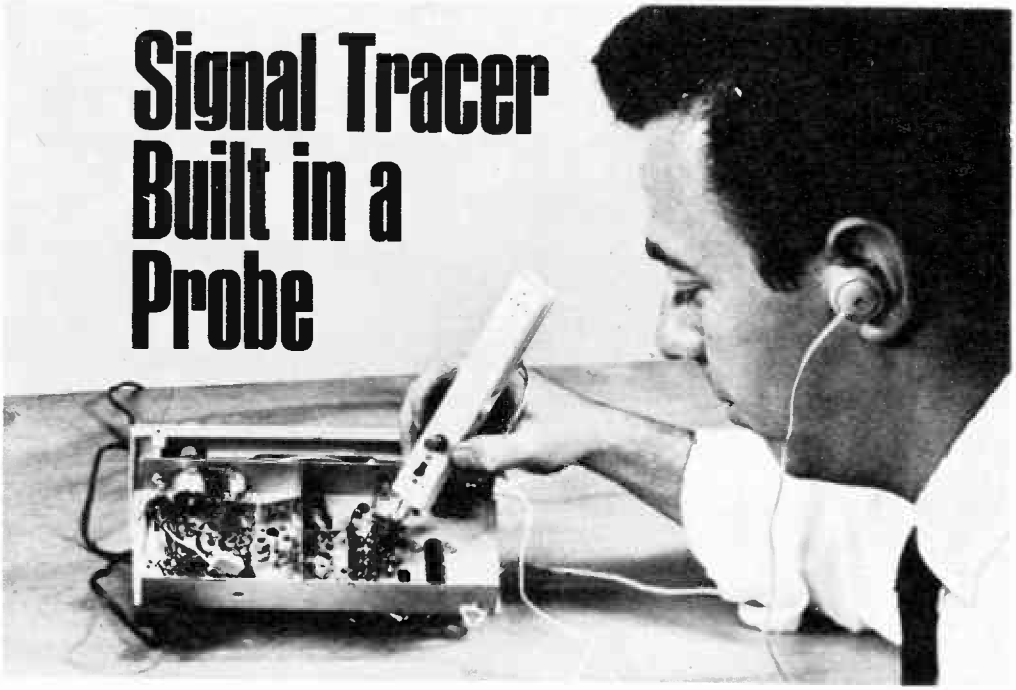
Fig. 6—Easiest way to calibrate the FSM is with a GDO. But be careful you don't overload the FSM. If the FSM's meter pins, move GDO farther away.

Generally speaking, low-power oscillators, such as are in 5- to 10-watt transmitters or solid-state transceivers, will require that the FSM's antenna be placed in close proximity to the oscillator tank circuit. However, the FSM's antenna should be far away from the tank circuit (or any resonant circuit, for that matter) when power is on and you're tuning up. If the antenna is placed close to a tuned circuit the inductive-capacity effects of the antenna may detune the FSM.

When using an FSM to tune an antenna, such as the multi-element type where the element spacing and length is adjusted for optimum forward gain or high front-to-back ratio, keep the FSM about five wavelengths from the antenna.

When using the FSM to track down harmonic TVI, make certain the instrument is tuned to the correct harmonic. First, tune to the lowest frequency that causes the meter to indicate. This is the transmitter's fundamental frequency. (But make certain you are not reading signal leak-through from one of the lower-frequency multiplier stages.) Then tune for the next higher frequency that causes a meter indication. If the frequency is twice the fundamental frequency it is the second harmonic. Then check for an indication at three and four times the fundamental.

Signal Tracer Built in a Probe



By
CLARE GREEN, W6FFS

"IT is difference of opinion that makes horse races," said Mark Twain. And we say when troubleshooting electronic equipment it's difference of opinion that makes for so many kinds of test instruments.

Truth of the matter is, you don't need a shop full of gear to track down troubles in amplifiers, tuners or receivers. All it takes is our handy little signal tracer. This pocket-size gadget will locate defective stages in any radio or amplifier, be it AM or FM, tube or transistor. And the tracer will also prove itself useful for tracking down sources of hum, noise and distortion. Because the tracer has a standard phono jack for its input, you can plug audio cables directly into it to check signals. Such cables would be those from your stereo system's record player, tuner or tape deck.

The tracer basically is a high-gain transistor audio amplifier. To trace audio signals, you set input-selector switch S1 to the *AF* position. The signal then goes via C1 and volume control R2 to input transistor Q1.

To trace RF signals, you set S1 to the *RF* position. The signal detected (converted to audio) by D1 and D2 is fed via R2 to input transistor Q1.

You listen for the signals with a miniature crystal earphone. An 8.4-V mercury battery supplies operating power. For economy, convenient handling and small size, we built our model in a plastic toothbrush case. You can slip the tracer into your pocket and never know it's there. The volume control, conveniently mounted on the cover of the case, varies the level of signals to the transistor amplifier. Such a control is necessary to prevent high-level signals from overloading the amplifier.

Construction

The transistor amplifier is built on a ¾ x 2⅛-in. piece of perforated circuit board. First, temporarily position volume control R2, the battery and switch S1 inside the plastic case. Then check to make sure the board fits before you install parts on it. We used standard components for our amplifier but space can be saved by using low-voltage capacitors and ¼-watt resistors. To save even more space, use 1/10-watt resistors.

Wire the amplifier as shown in the pictorial, using flea clips to mount the parts. Cut off the ends of the flea clips sticking through the back of the board so the board will fit low in the case.

The holes in the case for J1 and S1 can

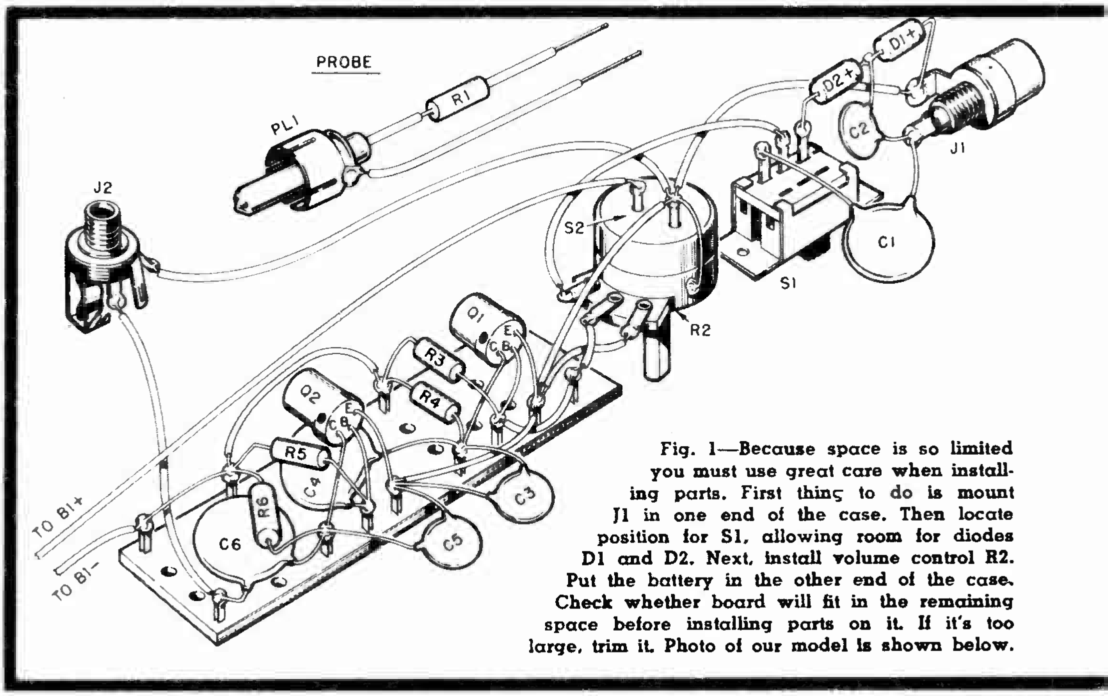
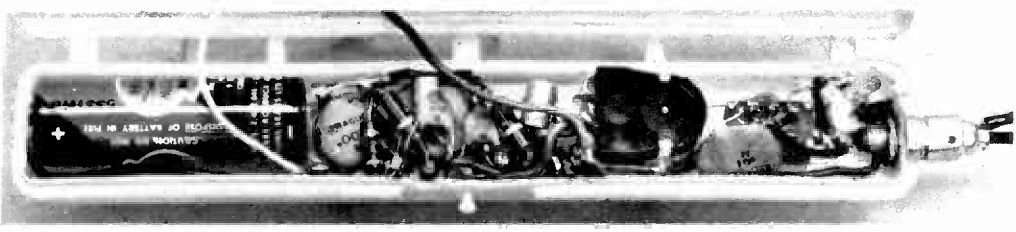


Fig. 1—Because space is so limited you must use great care when installing parts. First thing to do is mount J1 in one end of the case. Then locate position for S1, allowing room for diodes D1 and D2. Next, install volume control R2. Put the battery in the other end of the case. Check whether board will fit in the remaining space before installing parts on it. If it's too large, trim it. Photo of our model is shown below.



be made with a single-edge razor blade. Cut the front of the case's cover so it fits snugly around J1. Position J2 in the cover in such a way that it will not touch components on the board when the cover is closed.

Detector diodes D1 and D2 are held in place by their leads. Make the connections as short as possible and watch the heat when soldering since too much will destroy the diodes. Also, when bending the leads of D1 and D2, hold each lead with a pair of needle-nose pliers at the diode's body. It's then safe to bend the remaining lead.

Check Out

Plug a crystal phone into J2, set S1 to the *AF* position, turn the volume control full clockwise and touch the probe tip. You should hear a loud noise.

Try the tracer on a working radio. (Caution: if the radio is an AC/DC type use a neon lamp or VOM to make sure the chassis is at ground potential.) Connect the probe to the volume control (probe's center wire, which actually is R1, to center lug on the control and touch the outside probe wire to chassis). Turn the radio's volume control full up. With S1 in the *AF* position you should hear the signal. Move the probe to the plate of the first audio tube and you also should hear the signal. Set S1 to *RF* and touch the probe to the plate of an IF tube. You again should hear a signal. In both cases make sure the ground lead on the probe touches the chassis.

The tracer can be used to check any of a radio's circuits where a signal normally would be present. You also can connect an RF or AF signal generator to the receiver if strong signals are not available in your area.

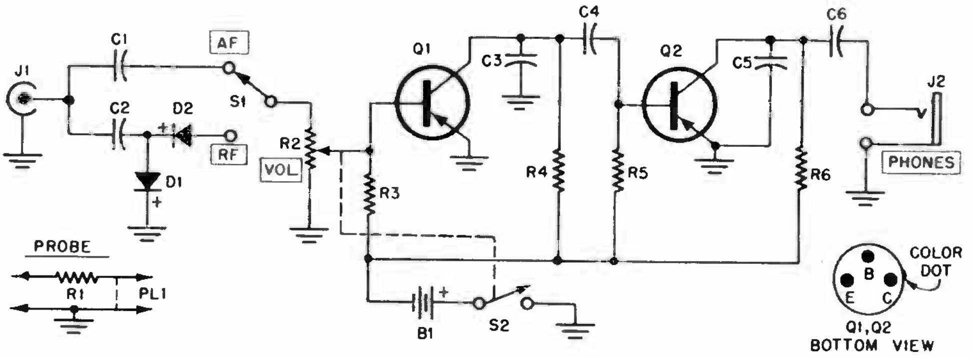


Fig. 2—When S1 is set to AF, audio signals go via C1, S1 and R2 to base of input transistor Q1. To trace RF signals, set S1 to RF. Audio output of D1,D2 detector circuit then is fed via R2 to Q1. R1 is used in probe to prevent the tracer from loading the circuit to which it is connected. First try probe without resistor. If it loads down circuit, use up to a 1-meg. resistor in the probe.

Signal Tracer Built in a Probe

How It Works

Signals from the probe, which is plugged into J1, are fed to C1 and C2. RF signals are fed through C2 to diode detectors D1 and D2. AF signals go via C1 to S1. S1 selects the input signal to be fed to the base of Q1. The amplified signal is fed through C4 to the next amplifier stage. Q2's output goes via C6 to earphone jack J2. The 8.4-V mercury battery supplies the power.

Generally speaking, you start troubleshooting at the output of a receiver or amplifier and work your way back to the input. Always feed the injector's signal to the grid of a tube or the base of a transistor. Touch the tracer's probe to the plate of the tube or the collector of a transistor. When you pick up the signal, you've found the defective stage.

PARTS LIST

- B1—8.4 V mercury battery (Eveready E126 or equiv.)
- C1—.01 μf, 1,000 V ceramic disc capacitor
- C2—100 μμf, 1,000 V ceramic disc capacitor
- C3,C5—470 μμf, subminiature ceramic disc capacitor (25 V minimum)
- C4—.01 μf subminiature ceramic disc capacitor (25 V minimum)
- C6—.005 μf subminiature ceramic disc capacitor (25 V minimum)
- D1,D2—IN34A diode
- J1—Phono jack (Switchcraft 371 or equiv.)
- J2—Miniature phone jack
- PL1—Phono plug
- Q1,Q2—2N2613 transistor (RCA)
- Resistors: ¼ watt, 10% unless otherwise indicated
- R1—1 meg (see caption, Fig. 2)
- R2—50,000 ohm potentiometer with SPST switch (Lafayette 32 C 7367 or equiv.)
- R3,R5—820,000 ohms
- R4,R6—4,700 ohms
- S1—SPDT miniature slide switch
- S2—SPST switch on R2
- Misc.—Plastic toothbrush case, perforated board, flea clips, crystal earphone (Lafayette 99 C 2515 or equiv.)

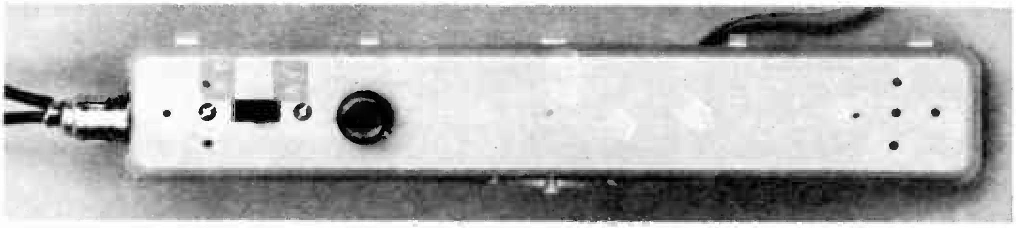


Fig. 3—Photo of underside of our model shows location of input-selector switch S1 and volume control R2.

The Flexible Flea

Get out of the big-power race with our flea-power transmitter. Its milliwatts can shout or whisper.

By CHARLES GREEN, W3IKH

FOR many amateurs, the goal of ham radio is only a log full of long-distance QSOs. All too often this results in a power race in which operators pile on more and more watts until a full gallon, the legal limit, is reached. Unfortunately this usually ends up being very expensive, may not accomplish much and is a poor way to develop genuine hamming skills.

Why not go the other way? That is, see how many QSOs you can make with hardly any power at all. That takes technique!

In other words, if you can produce a QSO with a half watt when your neighbor uses a half gallon to do the same thing, you're the better operator.

Reduce Power

The way to enter the contest of low-power hamming is with the Flexible Flea—a 20, 40 and 80-meter CW transmitter whose input power can be varied continuously from 100 milliwatts to 5 watts. One way to start the game is by establishing a contact with 5 watts. Then you progressively reduce the power to see how little it takes to maintain the contact. Or, you can simply start off at the bottom with say, 200 milliwatts, to see how far you can get with this power. The longer the range you can get with low power, the greater feeling of accomplishment.

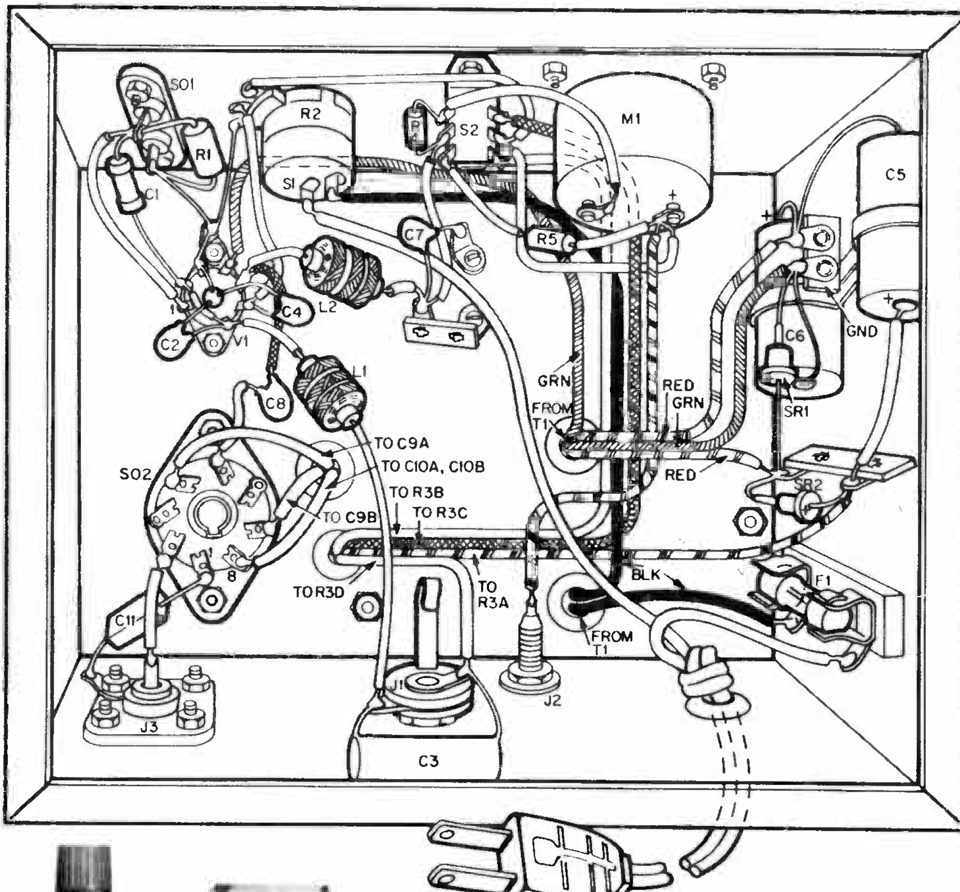
Operation on the three bands is achieved with plug-in coils. The input power of the final (and only stage) is indicated directly on a calibrated panel meter. (On the last page of this article there's a scale which you can cut out and paste on the face of your meter.) A 6AK6 tube is the crystal-controlled oscillator. It is followed by a pi-net output, designed to feed 50 to 72-ohm antennas.

Construction

Mount the components on a 5 x 7 x 3-in. aluminum chassis as shown in our pictorial in Fig. 1. Install variable capacitors C9 and C10 with nuts or washers between their frame and the chassis to keep their fiber side-insulators from touching the chassis.

As in all RF circuits, the wiring to and near V1 is critical. In particular, the grid and plate wiring should be as short and direct as possible.

Install rubber grommets in the top-chassis holes through which wires pass to C9, C10 and R3. Keep the power-supply wiring close



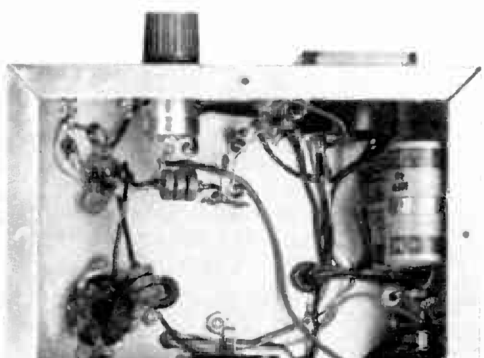


Fig. 1—Underside of transmitter. To layout your chassis, take dimensions from pictorial and multiply by about 2. Arrangement of parts in RF section of transmitter is important; therefore, duplicate our layout as closely as possible. The lugs at the left side of switch S2 are S2A.

The Flexible Flea

to the chassis and away from the RF wiring around V1.

Since R3 is supplied with only one sliding contact, you'll have to make another contact from a piece of soft aluminum. Cut a strip of soft aluminum, approximately 3/8-in. wide x 2¾-in. long, and bend it around R3 so the ends stick out. Remove the strip and put a contact dimple in it with a center punch, using a wood dowel for support. Drill holes in the ends of the strip and install the contact on R3 with a spade lug and a mounting screw. Don't tighten the screw yet.

To prevent ourselves from accidentally touching R3 (which gets quite hot and is also a shock hazard), we made a 1⅛ x 1½ x 2⅜-in. cover for R3 out of a piece of perforated aluminum. We then put flanges at the rear and side of the cover to fasten it to the chassis with self-tapping screws. The cover should be mounted carefully so it doesn't come in contact with R3's lugs.

The three plug-in coils (L3, L4 and L5) are made from a 3-in. length of Barker and Williamson No. 3016 Miniductor coil stock as shown in Fig. 4. The holders for the coils and jumper wires are the bases of discarded

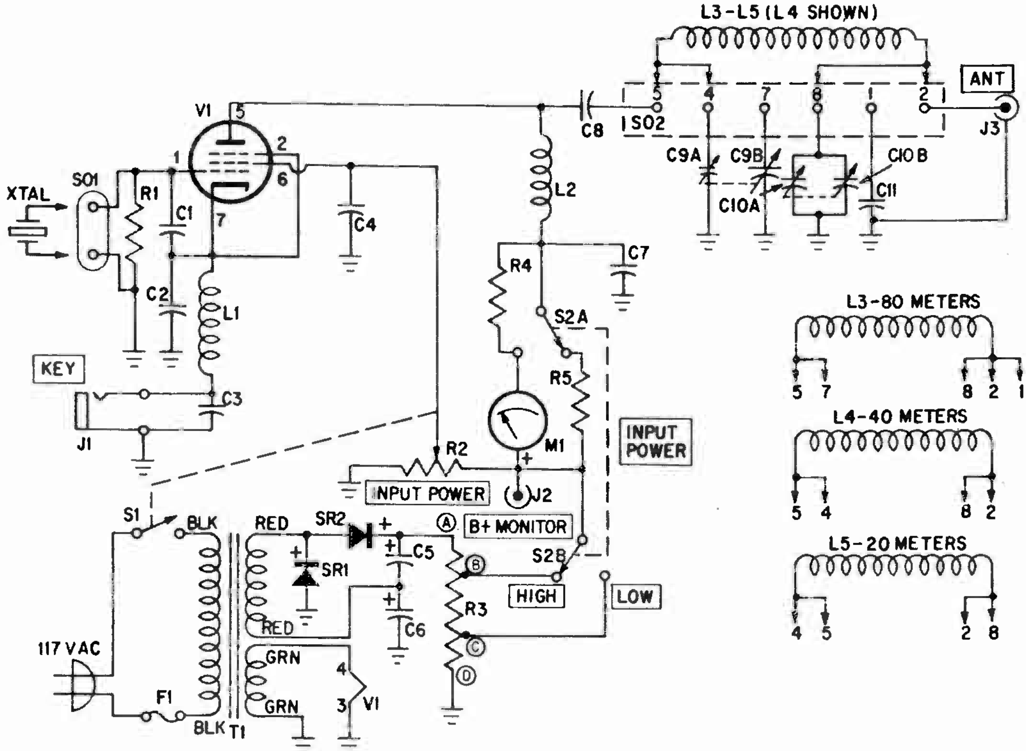


Fig. 2—Transmitter schematic. S2 determines input power. When it's set to "high" (shown), high B+ is supplied to V1 from tap "B" on R3. When S2 is set to "low," lower B+ is supplied to V1 from tap "C." R2, which establishes V1's screen voltage, is used to vary the input power continuously in both ranges. 80-meter coil, L3, is 33 turns. 40-meter coil, L4, is 17½ turns. 20-meter coil, L5, is 8½ turns. (See Fig. 4.)

PARTS LIST

Capacitors:
C1—15 μμf, 500 V silvered mica
C2—100 μμf, 500 V ceramic disc
C3—.1 μf, 600 V tubular
C4, C7, C8—.001 μf, 1,000 V ceramic disc
C5, C6—40 μf, 150 V electrolytic
C9A, C9B—2 gang superhet type variable capacitor; front section (C9B): 10.5-365 μμf; rear section (C9A): 7.6-132 μμf. (Lafayette 32 R 1101 or equiv.)
C10A, C10B—2 gang TRF type variable capacitor: 10.3-365.7 μμf per section (Lafayette 32 G 1102 or equiv.)
C11—470 μμf, 500 V silvered mica
F1—1 A fuse and holder
J1—Open circuit phone jack
J2—Insulated phone tip jack
J3—SO-239 chassis mount coax connector
L1, L2—1 mh RF choke (National R-50 or equiv.)
L3, L4, L5—Coils wound from Barker & Williamson 1-in. dia. 32 turns-per-inch Miniductor No. 3016 (Lafayette 40 R 1625 or equiv.) See Figs. 2 and 4.
M1—0-5 ma DC milliammeter
R1—27,000 ohms, 1 watt 10% resistor
R2—50,000 ohm linear taper potentiometer with SPST switch
R3—6,000 ohm, 25 watt, adjustable wire-wound resistor
R4—300 ohm, ½ watt, 5% resistor (see text)
R5—36 ohm, ½ watt, 5% resistor (see text)
S1—SPST switch on R2
S2A, S2B—DPDT slide switch
SO1—Crystal socket (National CS-6 or equiv.)
SO2—Octal tube socket
SR1, SR2—Silicon rectifier; minimum ratings: 600 ma, 400 PIV
T1—Power transformer; secondary: 125 V @ 50 ma, 6.3 V @ 2 A (Allied 61 U 411 or equiv.)
V1—6AK6 tube
XTAL—20, 40 or 80 meter crystal
Misc.—5 x 7 x 3-in. aluminum chassis; 5 x 7-in. chassis bottom plate; octal tube bases for L3, L4, and L5; 7-pin tube socket (for V1), knobs, perforated aluminum

octal tubes.

We determined the value of C11 experimentally to match our rig to our 80-meter antenna. You can try another value for C11 for best match to your antenna.

Adjustment and Operation

Remove V1, L3, L4 or L5 and the protective cover over R3. Connect a voltmeter, set to measure DC voltage, to J2 and turn on AC power. Set S1 to *high* and adjust sliding

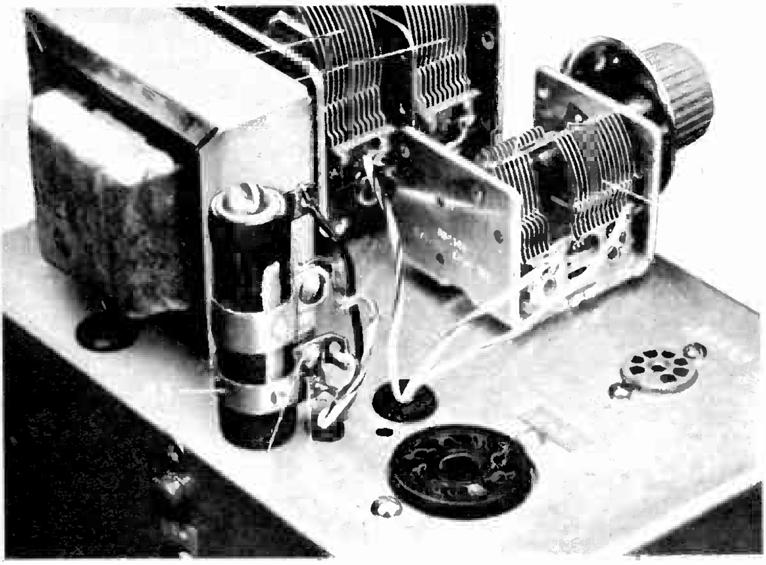


Fig. 3—Closeup of top of chassis shows mounting of B+ voltage-divider power resistor R3. Mount R3 with a ¼-20 x 2½-in. screw. Slider contact "C" is home brew since only one slider is supplied. Make a cover of perforated aluminum to fit over R3 so you don't touch it. If you did you'd get a nasty shock and burn. Both sections of C10 (top) are connected in parallel. C9A is the smaller section of C9.

contact *B* (Fig. 3) until the VOM indicates about 245 V. *Caution:* Always turn off AC power before adjusting the contact and do not touch the resistor since it will be hot. Set S2 to *low* and set contact C so the voltage is about 110 V.

Plug in the 80-meter coil, V1 an 80-meter crystal and connect a 50- to 72-ohm dummy load to J3. (You could use two parallel-connected 150-ohm 2-watt *carbon* resistors for the dummy load.) Set S2 to *high*, set R2 full clockwise and set *tuning* capacitor C9 and *loading* capacitor C10 full counterclockwise (plates fully meshed).

Hold the key closed and quickly tune C9 for resonance—indicated on M1 by a dip in power. Slowly open the plates of *loading* capacitor C10 until the power (plate current) rises to about the 1-watt mark on M1. Then retune C9 for a dip and adjust C10 for a 5-watt indication, alternately adjusting C9 and C10 until a dip produced by C9 brings the meter indication to 5 watts. Finally, readjust R2 for 5-watt input power. (See *The Radio Amateur's Handbook* for explanations on how pi-network operate and are tuned.)

Do not change the setting of C9 and C10. Now, with the key closed and M1 indicating 5 watts, check the B+ voltage at J2 and adjust sliding-contact B until the voltage is 200 V with the key closed.

Do not change the setting of C9 and C10 in the next step: Turn R2 fully counterclockwise, switch S2 to *low* and close the key. Turn R2 clockwise until M1 indicates 500 milliwatts (full scale). The VOM connected to J2 should indicate 100 V. If it does not, adjust contact C on R3 until the VOM indicates 100 V with the key down. Turn off AC power and install the protective cover over R3.

Connect a 50 to 72 ohm antenna to J3 and try the rig on the air. Always tune the transmitter (as you did with a dummy load) first with 5-watt input power. Then reduce the power as desired (without retuning C9 and C10). Operation below 300 milliwatts input power on 20 meters is not recommended because the transmitter will double and the output power will be much lower.

How it Works

The crystal is the frequency-determining component in a Colpitts oscillator circuit consisting of V1, C1, C2, R1 and L1. V1 functions as a straight-through oscillator amplifier on 80 and 40 meters. In 20-meter operation, V1 doubles in the plate circuit. A key in V1's cathode circuit starts the oscillator and C3 minimizes key clicks.

Potentiometer R4 controls the input power by varying V1's screen voltage over either of the B+ voltages selected by S2B. M1 indicates V1's input power and is switched by

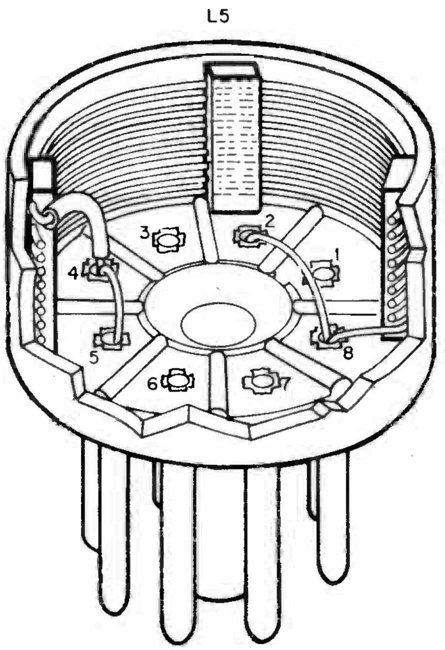


Fig. 4—Pictorial of 20-meter coil. The three diagrams at the right of the schematic in Fig. 2 show pin connections of coils and the jumpers.

S2A to the *low* (500 milliwatt) or *high* (5 watt) ranges.

Plug-in coils L3, L4 and L5 (in conjunction with C9A/B, C10A/B and C11) have jumper connections in their bases to establish the proper L/C ratio in the pi-net output circuit. The RF output is fed to J3, to which can be connected a 52- to 72-ohm antenna.

The two B+ voltages (for high and low ranges) are supplied by voltage divider R3 and the voltage-doubler power supply, which consists of T1, SR1, SR2, C5 and C6.

The resistance values of R4 and R5 were determined by the author to cause M1 to indicate full scale, or 5 watts, when the *measured* input power was 5 watts.

The resistance values we specify for R4 and R5 should be satisfactory. However, if you want your meter to be calibrated with greater accuracy, here's the way to do it: Input power is a product of V1's plate voltage and its plate current.

To determine the power, first connect a dummy load to J3. With the transmitter tuned and loaded (as explained earlier), set *input-power* switch S2 set to *high* and measure the voltage on V1's plate with respect to ground. Then, disconnect the lead going from the center lug on S2A (see pictorial in Fig. 1) to the terminal strip to which are connected L2 and C7. Set up a VOM to measure current and connect its positive lead to the center lug on S2A and the negative lead to the junction of L2 and C7.

Turn on the power and read the current on the VOM. Multiply the current you read by the plate voltage and multiply them. Compare your answer with the power indicated on M1. If the indication in M1 is low, decrease the value of R4 experimentally. On the other hand, if the indication is high, increase the value of R4.

VOLTAGE CHART

V1 (pins)	S1 set to HIGH		S1 set to LOW	
	key up	key down	key up	key down
1	0	—38	0	—6
2	35	0	11	0
3	0	0	0	0
4	6.3(AC)	6.3(AC)	6.3(AC)	6.3(AC)
5	245	200	110	100
6	245	200	68	56
7	35	0	11	0
J3	245	200	110	100

Notes:
1) 72-ohm dummy load connected to J3. S2 set to *high*. Transmitter tuned for 5-watt input power. Or, S1 set to *low* and R2 adjusted for 500 milliwatt input power.
2) 80-meter coil and 80-meter crystal used for test voltages.
3) Voltages measured with a VTVM.

Fig. 5—If the transmitter does not operate properly, measure all voltages at V1's pins. If they differ from ours above, start troubleshooting.

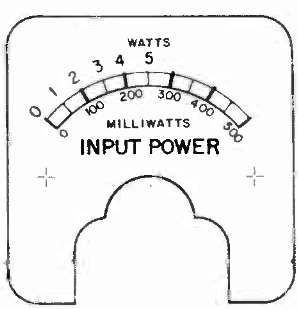


Fig. 6—Meter is calibrated in milliamperes, but if you paste this scale over its scale, you'll be able to read the rig's input power directly.

SLOPING-ROOF TOWER MOUNT

IT'S a big day when that tower finally is delivered and unpacked. But the excitement fades when your neighbor appears in the yard just as you start to mount the tower astride the ridge pole.

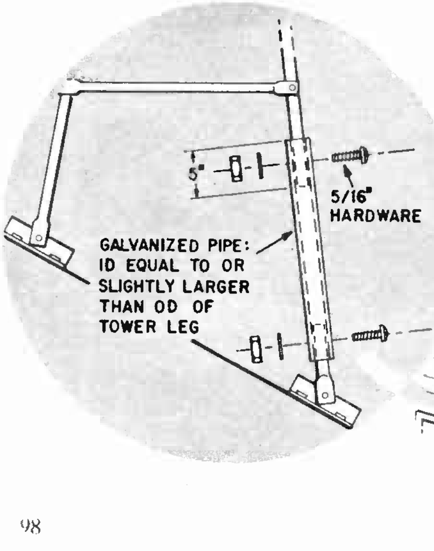
Unfortunately, he's there to complain, not help. He may say one of several things, all having to do with the fact that the elements of your antenna extend over his property line. Maybe it's a two-family house. Perhaps a narrow lot. Or maybe his line is just close to your hacienda.

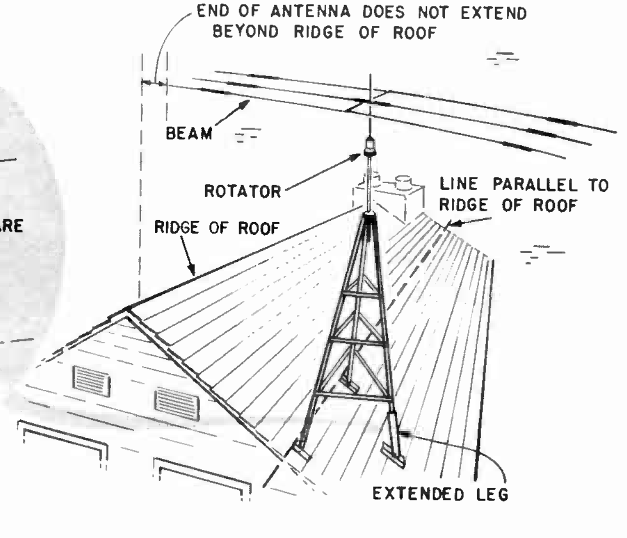
There really is no need to sell the house or worry about having a Tower of Pisa on your hands. First thing to do is determine how wide your beam really is. Take half this dimension and use it as a starting point to determine how far back you must mount the tower to keep the beam ends from passing over your neighbor's property line.

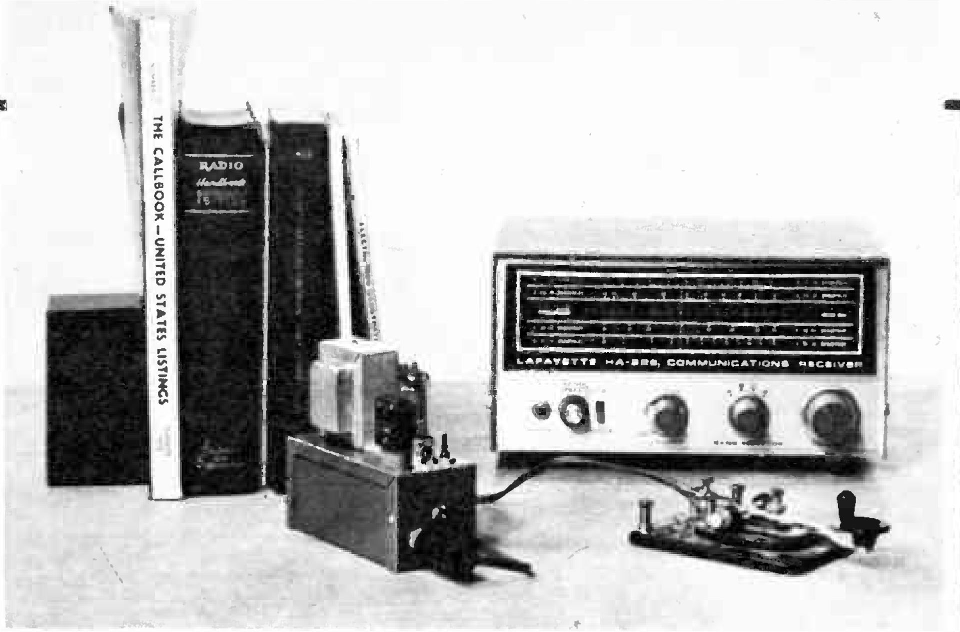
Next, mark off a line on your roof parallel to the ridge (as shown below in a two-family-house situation) far enough down so the beam will stay over your property. Then bolt two of the tower's feet to the roof on this line. The third leg should face the side of the house. About 6 in. from the foot, cut the leg. Lift up the tower so it is vertical to determine the length of galvanized pipe required to extend the leg and join it to the foot.

—*Paul Hertzberg, K2DUX*

The piece of pipe used to extend our tower's leg was about 2 ft. long. The pipe's inside diameter was slightly larger than the outside diameter of the tower's leg. When cutting the leg, leave about 6 in. attached to the foot for support.







1-Bottle Xmitter for 40

You'll be surprised at the reach of this 15-watter you can build for $15.

By JAMES B. WHITE, W5LET

SMALL? Why, man, you can hold it in the palm of your hand. In fact it might even disappear into the clutter of your operating table. But don't let it fool you. The signal our 1-bottle (tube) transmitter puts out is *big, big, big!* It will work stations far, far away.

The transmitter runs 15 watts (input power) on the 40-meter band. Power output of our model is six watts into a 50-70 ohm load. There are few parts—some two dozen counting the sockets, terminal strips, and other things like four capacitors and three resistors. The circuit features a transformer power supply, which reduces the possibility of shock considerably. Even if you have to buy everything from scratch it won't cost over $15.

Our first CQ with it (from Louisiana) brought an answer from the midwest. During our first hour on the air, we worked both the east and west coasts. With a better antenna and operating at a time of the day when DX is coming in, there is no reason why the little rig couldn't work the world.

The transmitter will make a fine first rig for the Novice, or because of its small size it's a perfect second rig for the oldtimer. Then again, it can be tucked away on a corner of the operating table and used as a standby transmitter when the big rig breaks down.

There is nothing difficult about putting it together. There is only one tube, a 6AQ5A operating as a straightforward crystal oscillator. To simplify things, there is no variable capacitor to tune the plate circuit to resonance.

Instead, tuning is accomplished by the plate-to-cathode capacity within the tube. This has the same effect as a fixed capacitor placed across plate coil L1. The resonant point of the tuned circuit is established with a slug-tuned coil (L1, L2). This coil is wound on a standard form made by the National Co. Neon lamp NL1 serves as an RF indicator. It also provides a means of letting you monitor visually your sending.

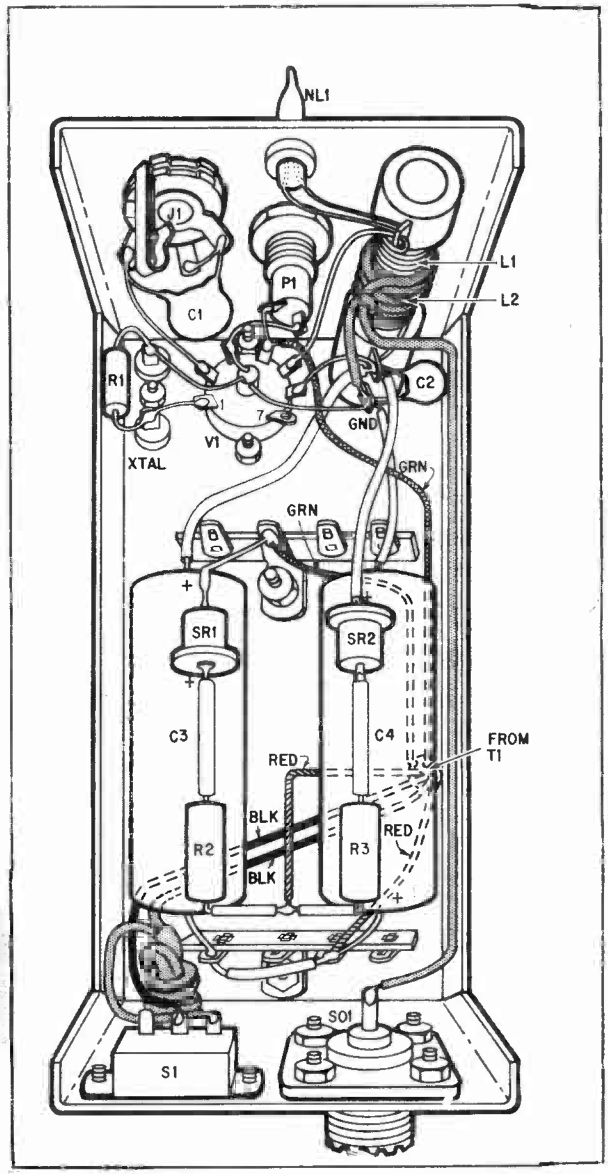
The transformer power supply is a voltage doubler which uses two silicon rectifiers (SR1, SR2). These not only cut down on the size of the rig, but also eliminate most of the heat that usually is produced at this point.

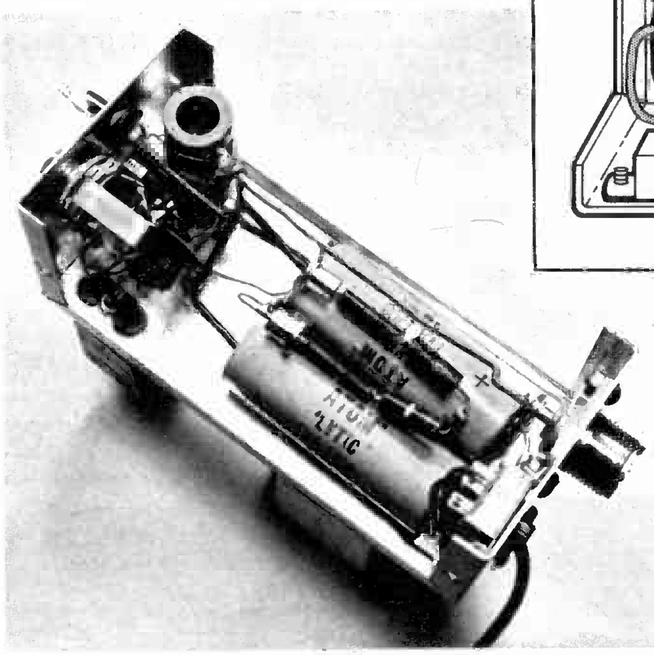
All of the parts are mounted in a 5 x 2¼ x 2¼-in. Minibox. On the top are the power transformer, coil, tube and crystal sockets. The coax antenna connector, SO1, AC power switch S1 and the line cord are on the transformer end of the cabinet. On the other end is the jack (J1) for the key as well as the neon RF indicator (NL1) and the AC pilot light (P1).

Begin construction by drilling all holes. Most of them are small. There is one exception—the hole for the tube socket which has a diameter of ⅝ in. RF indicator NL1 gets mounted in a small rubber grommet. This gives it a good firm mounting and provides capacitive coupling to ground.

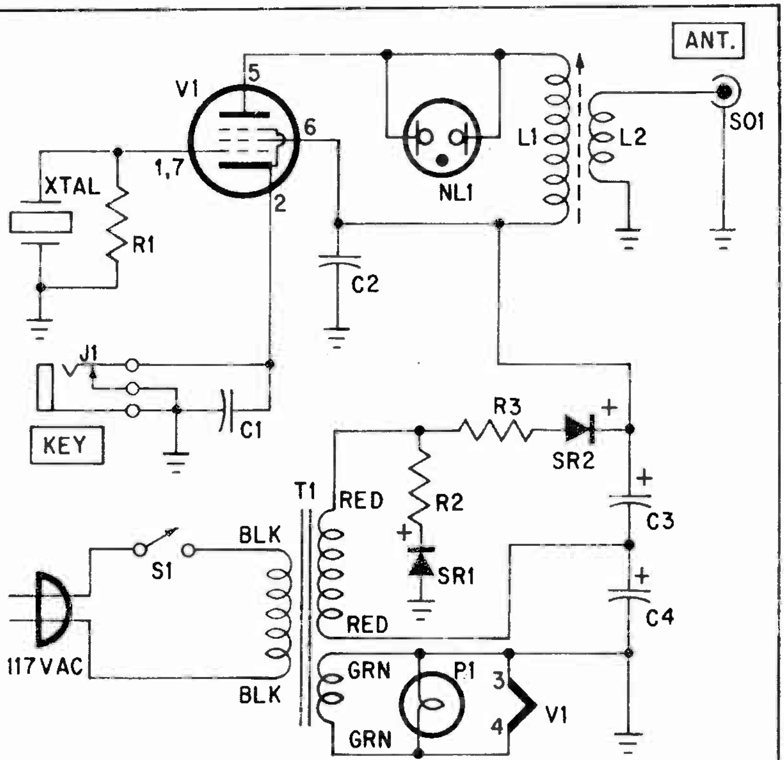
Next, deburr the holes and mount the crystal and tube sockets. When mounting the tube socket, orient it so that pin 1 is near the crystal socket. Mount the transformer next, placing a four-lug terminal strip under each mounting screw's nut.

The coil is next. First, wind plate coil L1. It consists of 45 turns of No. 28 enameled wire. There is a space on the form for just this number of turns if you wind them closely and evenly. Over this coil (at the end near the mounting screw) wind four turns of No. 20 insulated solid hookup wire. Twist the ends so the turns are tight. Be sure that L2





The underside of the cabinet is not particularly crowded. The two filter capacitors (C3,C4) take up most of the space. They are supported by two terminal strips which they fit between. Rectifiers SR1 and SR2 and current-limiting resistors R2 and R3 go on top of the capacitors. Be sure to use spaghetti on bare leads in the power supply. Note the location of the ground lug on the coil form.



The circuit couldn't be simpler. V1, a 6AQ5A, operates as a combined crystal oscillator and RF amplifier. It is capable of running 15 watts on the 40-meter band. Note that transmitter will be on if key is not plugged in. Power supply is transformer-type voltage doubler. P1 lights when AC power is on; NL1 lights when transmitter is keyed.

1-Bottle Xmitter for 40

is wound in the same direction as L1. And be sure to leave one of L2's leads long so it will reach the end of the cabinet where it connects to SO1.

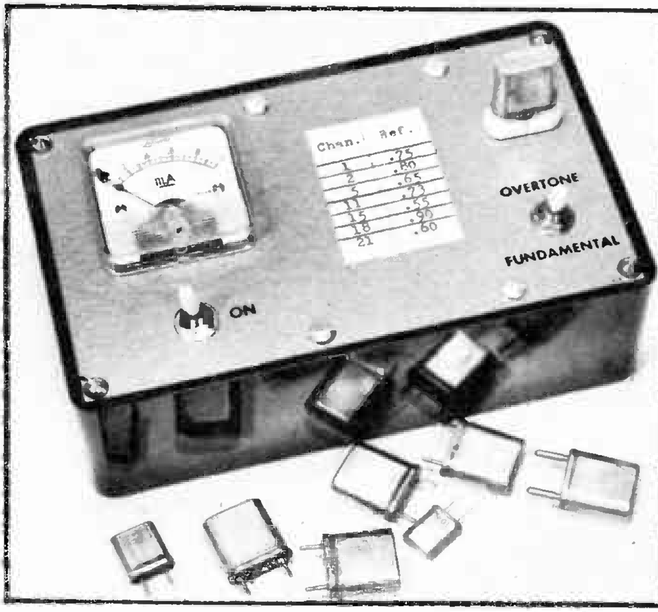
After completing the coil mount it and wire it into the circuit. The short lead of L2 goes to the ground lug on the coil form. The top lug of L1 connects to pin 5 of V1. The bottom end of L1 goes to pin 6 of V1. NL1's two leads to the top lug on L1.

On The Air. Plug in a 40-meter crystal and a 6AQ5A then turn on power. Pilot lamp P1 should light. Allow about 30 seconds for the tube to warm up. If everything is okay, NL1 will glow.

Using a field-strength meter, tune the plate circuit to resonance by turning the coil's adjusting screw for highest indication. Connect a 40-meter antenna to SO1, plug a key into J1, and with the key down peak the coil again. When the key is up, NL1 should go out. You're now ready to burn a hole in the ether.

PARTS LIST

C1,C2—.01 µf, 1,000 V ceramic disc capacitor
C3,C4—16 µf, 450 V electrolytic capacitor
J1—Closed-circuit phone jack
L1—Plate coil: 45 turns No. 28 enameled wire wound on National Co. XR-50 coil form. (Allied 54 D 1813. $1.50 plus postage. Not listed in catalog. See text.)
L2—Antenna coil: 4 turns No. 20 insulated solid hookup wire wound over L1. (See text)
NL1—NE-2 neon lamp
P1—Miniature 6 V pilot lamp and holder
R1—100,000 ohm, ½ watt, 10% resistor
R2,R3—10 ohm, 1 watt, 10% resistor
S1—Miniature SPST slide switch
SO1—SO-239 coax connector
SR1,SR2—Silicon rectifier; minimum ratings: 400 PIV, 400 ma
T1—Power transformer; secondaries: 125 V @ 50 ma, 6.3 V @ 2 A (Allied 54 A 1411 or equiv).
V1—6AQ5A tube
XTAL—40-meter crystal (FT-243 holder) and socket
Misc.—5 x 2¼ x 2¼-in. Minibox, 7-pin tube socket, 4-lug terminal strips (2)



All Transistor Rock Checker

By
HERB FRIEDMAN
KBI9457

A BAD crystal often is the last thing a CBer thinks of when his rig's performance isn't up to snuff. But rocks do poop out. And the reason they do is because transceivers often pull the last drop out of the rock, leaving no reserve activity. And when a crystal's output falls the rig's output goes right down to the basement.

Or, due to a failing crystal, the receiver's sensitivity could get so bad you hardly could hear a shout from a station a block away. And a reduction in RF drive to the final—caused by a weak crystal—can affect modulation adversely.

On the flip side of the coin there are those CBers who suspect the crystal at the first sign of poor performance. This means many good crystals are consigned to the junk box that shouldn't be. But with our 1-transistor rock checker handy you'll know for sure whether your crystals are good or bad.

The checker will determine the condition of 99 per cent of all (6 mc and up) overtone and fundamental crystals used in CB gear. The meter indicates directly whether a crystal is bad, fair or good. You also can use the checker to keep track of a crystal's continuing performance. You simply jot down the meter indication when you check a new crystal, then compare it periodically with the indication after the crystal has been put in service.

Construction. Parts layout and component values are extremely critical; therefore, follow the pictorial closely and use only the components specified. Make no substitutions.

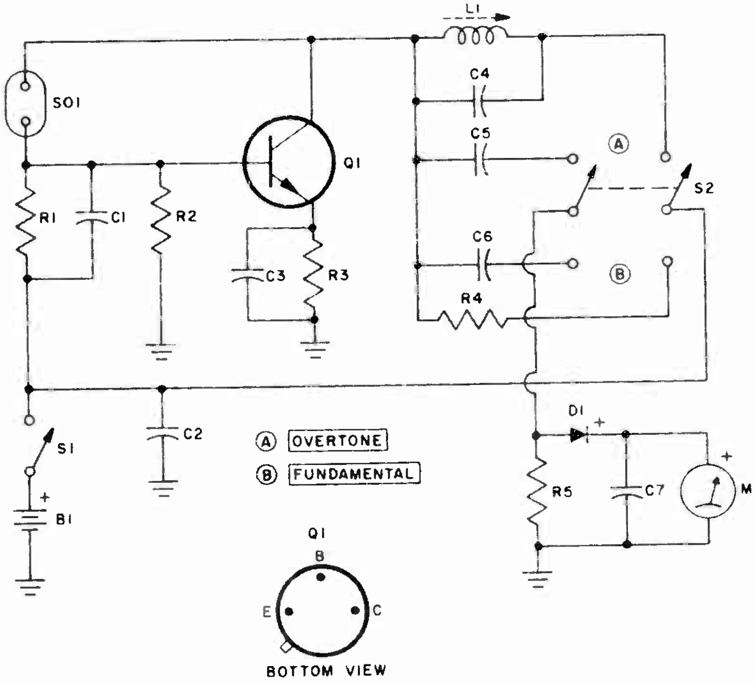
Start off with L1, which is wound on a J. W. Miller No. 4400 coil form. Unlike the case with other coil forms, you must install the ring-terminal lugs and slug spring on this one. Take the slug spring—the triangular wire object—and slip it in the notch at the top of the mounting bushing. Slip one ring terminal on the form and slide it on until it is 5/32 in. from the end with the metal collar.

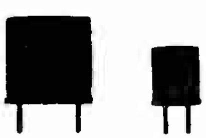
Next, tensilize a 4-ft. length of #22 enameled wire by clamping one end in a vise and pulling until the wire goes dead slack. (If the wire isn't tensilized the coil will unwind.) Attach one end of the wire to the mounted ring terminal and wind on 15 tight, close-wound turns. Then slide the other ring terminal up against the winding and solder and the wire to it. If the coil looks sloppy take it apart and wind it again. Set L1 aside.

Install all parts on a 2 7/16 x 3 3/8-in. piece of perforated board and mount the board on the back of the cabinet cover, using ¼-in. spacers between the board and the cover at each mounting screw. Flea clips should be used for tie points.

Note S2's wiring carefully. Capacitor C5 is switched into the circuit when L1/C4 are switched in. If C5 and C6 are reversed the meter will indicate, but incorrectly.

Schematic of checker. Circuit is simply an oscillator in which meter measures detected RF output voltage at collector of Q1. Since capacitors C5 and C6 form an RF voltage-divider network for the meter's calibration, they must be 5 per cent silvered micas because their values are critical.





Only an HC-6/U crystal socket is indicated because it is almost impossible to obtain sockets for wire-lead and close-pin crystals. If your rig uses miniature crystals solder two small alligator clips to short lengths of wire. Then, to test miniature crystals simply plug the clip leads into SO1 and connect the clips to the crystal.

Test and Alignment. Connect a milliammeter, set to measure at least 25 ma, in series with one of B1's leads and turn S1 *on*. Do not place a crystal in SO1. Current should be from 6 to 9 ma. If the meter indicates higher than 12 ma, turn off the power quickly and check for a wiring error.

Set S2 to the *overtone* position (L1/C4 in the circuit, R4 out of the circuit), plug a mid-band transmit overtone crystal in SO1 and adjust L1's slug for maximum dip on the test meter. While watching M1, adjust L1 for maximum indication. The adjustment may be broad. If it is, turn the slug to the midway point. If adjusting L1 causes M1 to go off-scale, you may have interchanged C5 and C6.

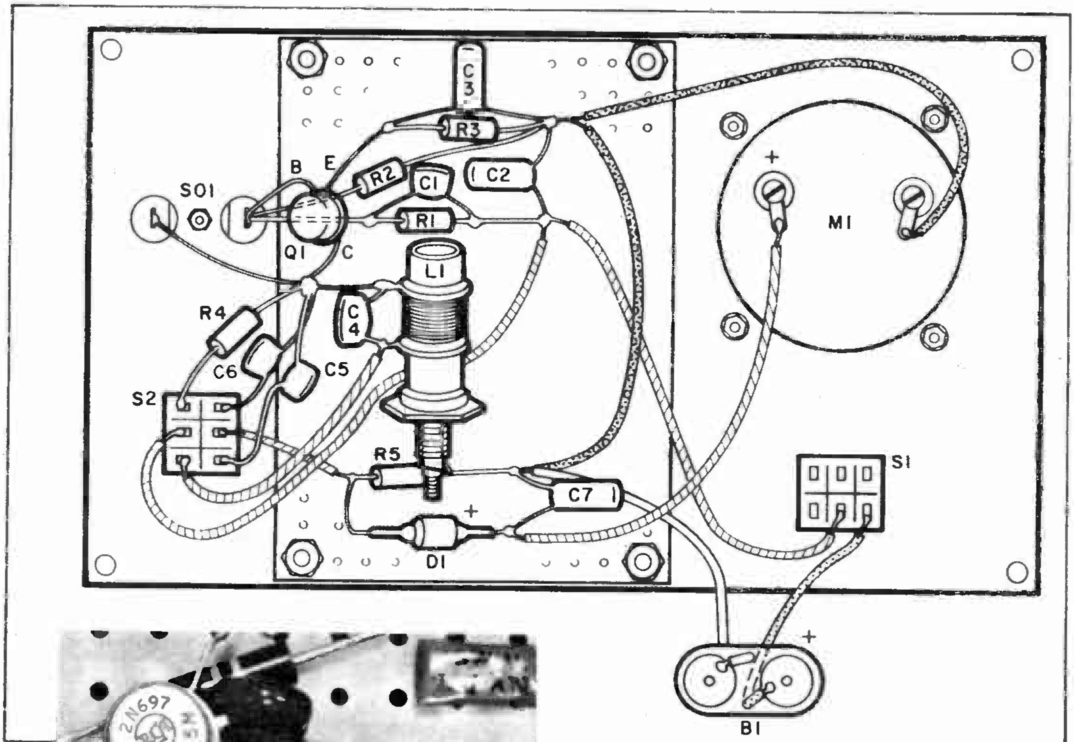
No adjustment to L1's slug is needed for fundamental crystals. Just plug the crystal into SO1, set S2 to *fundamental* and check to see that M1 indicates. If you don't get an indication check for a wiring error.

PARTS LIST

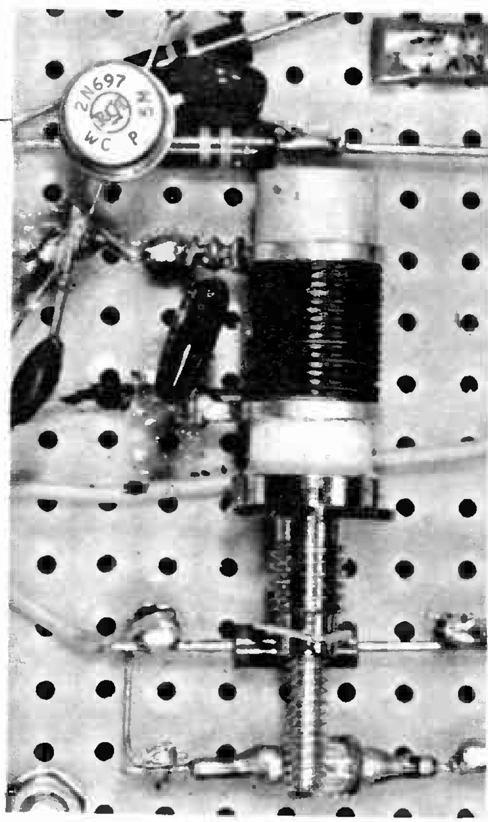
B1—9 V battery (Burgess 2U6 or equiv.)
Capacitors: All 75 V or higher
C1—33 μμf C2, C3, C7—.01 μf
C4—100 μμf, 5% silvered mica
C5—10 μμf C6—22 μμf, 5% silvered mica
D1—1N34A diode
L1—Coil, wound on J.W. Miller No. 4400 form (Lafayette 34 R 8951)
M1—0-1 ma DC milliammeter (Lafayette 99 R 5052 or equiv.)
Q1—2N697 transistor
Resistors: ½ watt, 10%
R1—27,000 ohms R2—10,000 ohms
R3—10 ohms R4—470 ohms
R5—1,000 ohms
S1—SPST toggle or slide switch
S2—DPDT miniature toggle switch
SO1—Socket for HC-6/U crystal (National Type CS-7. Lafayette 40 R 3715 or equiv.)
Misc.—6¼ x 3¾ x 2-in. Bakelite box (Lafayette 19 R 2001), cover for box (Lafayette 19 R 3701), perforated board, flea clips, alligator clips.

Using the Checker. For both overtone and fundamental crystals this is M1's calibration: *bad:* 0 to 0.25; *fair or questionable:* 0.25 to 0.5; *good:* 0.5 to 1.0. Naturally, the more active the crystal the higher the meter indication.

As a general rule, overtone crystals tend



Circuit board just fits on cabinet cover. Layout is critical; therefore, mount D1 and associated parts at bottom of board. Install Q1 and its circuit at top of board. L1 goes between the two circuits.



Be sure D1 is under L1's slug against the board, not up in the air. If L1 is wound correctly its terminals should line up with two flea clips spaced two holes apart. Solder L1 directly to clips.

to cause a meter indication of 0.7 or higher when they are new. Fundamental crystals will cause indications from about 0.4 to 0.7. To keep track of a crystal's performance, cement a chart on the front panel, showing the indication you get with a new crystal. Then you can check suspect crystals against reference values.

Overtone crystals also will produce an indication on M1 when S2 is set to *fundamental* while fundamental crystals might indicate when S2 is set to *overtone*. Readings taken with S2 in the wrong position naturally are meaningless. Always set S2 to the correct position before inserting a crystal.

Note: Some overtone crystals used in older CB rigs will not cause the checker's circuit to oscillate. It is easy to tell whether your crystal fits this group since it will perform in the transceiver but will not cause M1 to indicate higher than 0.1—if at all. If your crystal fails to start the oscillator, substitute a 130 $\mu\mu f$ capacitor for C4. This will permit you to test your hard-start crystals.

A First! For the NEW Radio-Control Band!

BUILD A 72-mc R/C RECEIVER

By E. L. GARRETT

RADIO-CONTROL fans are doing well these days if they can sail a boat in a straight line. One reason for the often erratic performance of R/C models is heavy interference from Citizens Band operators.

And since only six frequencies are available in the 27-mc band, anyway, control of models becomes quite a headache at local meets where many models are being operated at the same time.

Both problems get worse every day as more CB rigs go on the air and R/C activity increases. One approach to solving the problem is to equip models with super-selective superhet receivers—but these are expensive.

Because of the difficulties R/C fans have been having, the FCC recently made available five new frequencies in the 72-76 mc band (72.08, 72.24, 72.40, 72.96 and 75.64 mc) which can be used for R/C purposes. Transmitters for these new R/C frequencies must, of course, be type-approved by the FCC. Type-approval is granted after such things as frequency accuracy, stability and spurious radiation are checked. Here's a receiver developed for the new band just opened by the FCC.

The circuit is a superregen and is similar to that used in many 27-mc R/C receivers. We have utilized low-cost silicon transistors throughout for stability and to keep the total semiconductor bill under $3. Exotic parts are not required but components must be small. For this reason it is important to use the components specified in our Parts List. They have been selected to assure reliability and because of small size. Use larger-size parts and you won't be able to build the receiver with the small dimensions

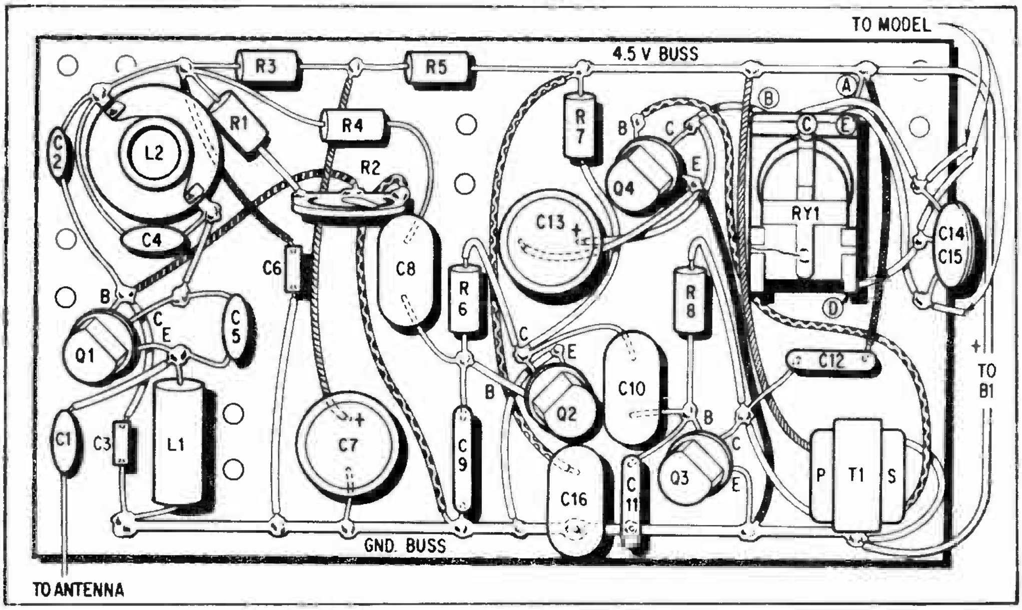


Fig. 1—Because receiver operates near 72 mc. follow layout exactly at left side of board near Q1. Most wiring in our model is on rear of board. We used a dual .01 μf disc capacitor for C14 and C15.

R/C RECEIVER

which our model had.

Several parts are available only from Ace Radio Control. They are marked with an asterisk in the Parts List and the individual prices are included after the description. Ace's address is at the end of the Parts List.

Construction

All parts can be mounted on a 3 x 1¾-in. piece of perforated phenolic board. We used brass eyelets for tie points, but you could use flea clips. Install a piece of heavy wire lengthwise on one of the board's edges. One end of the buss is retained by an eyelet. The other end is soldered to one of T1's mounting tabs. A shorter buss connection runs partially along the top edge of the board, for positive-supply-voltage connections.

Enlarge the holes for the eyelets (not necessary for flea clips) and fasten them in place. Also enlarge the holes for the coil form, the relay mounting screws and transformer T1. When mounting L2, C7, C13 and T1, add a drop of cement to hold them firmly in place.

Leave the transistors until last and be sure to heat sink their leads when you solder them. Note that the collector and base leads of the transistors are reversed from the positions you'd generally expect them to be in.

The leads of T1 should be bent outward a bit, to fit in the holes in the board. Do this job carefully with small pliers or tweezers before you mount T1.

Note that parts layout is very similar to that of the schematic. With reasonable care it's pretty difficult to make a wiring error.

When all parts are installed, carefully check the wiring—especially the transistor connections and the polarity of the electrolytics. If all appears okay, you are ready for a test. The receiver is designed to operate on from 4.5-4.8 VDC—however, it will operate down to about 3.5 V, and as high as 6 V.

The relay will close at around 15 ma and open at about 10 ma. This is satisfactory, but spring tension could be changed a bit to shift these values, as relay current at 4.5 V is around 40 ma. Greater spring tension might be necessary, if vibration in a model causes contact chatter.

Adjustment

Set R2's wiper at the ground end and then connect a 50-ma meter in series with one battery lead. You should read a current of about 2 ma, and the needle should be very steady. Now slowly advance R2, until you'll see the meter jump suddenly to about 20 ma, then drop back as you move the arm farther toward the positive end.

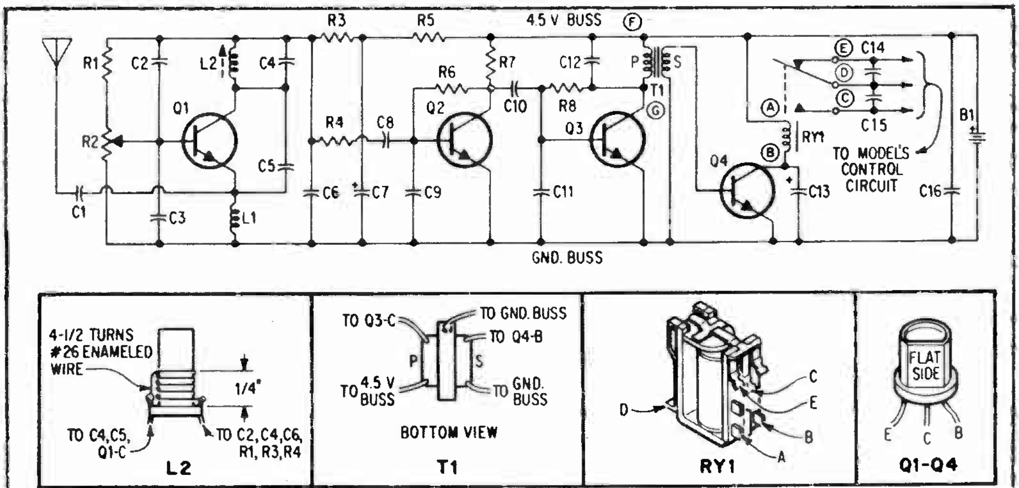


Fig. 2—Superregen detector Q1 is followed by three stages of audio to boost level of signal to actuate relay RY1. Sketches show coil, transformer, relay and transistor details. Wind L1 with care or receiver won't tune near 72 mc. If necessary, expand or compress L2's turns to tune around 72 mc.

The proper setting is when the indication is 3 to 4 ma (no input signal of course). The needle should be slightly unsteady, too. If you connect a pair of high-impedance (crystal) phones in series with a 500 $\mu\mu$f capacitor to points F and G, you will hear nothing with R2 set at the ground end. As you reach mid-range, you'll hear a loud rushing noise, with a vague squeal at first, which will change to a smooth hiss as R2's arm is advanced. The sudden change in noise and meter indication occurs when Q1 breaks into oscillation.

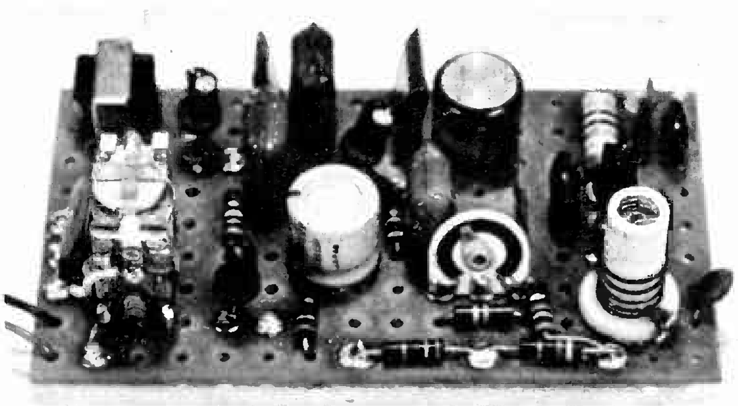
With T2 set to give an indication of 3 to 4 ma, you are ready to tune in a signal. Chances are that if you adjust L2's core over its full range, you might pick up a TV station (channels 4 or 5 if they are in your area). Fully collapse the antenna of your R/C transmitter, turn the receiver on and adjust L2's core for highest indication on the meter. The receiver is designed to tune from around 69 to 77 mc.

Key the transmitter to send a tone or you might miss its frequency. Tuning in an un-

PARTS LIST

B1—1.5 V battery (3 reqd.)
Capacitors:
C1—5 $\mu\mu$f, 500 V silvered-mica (Arco-Elmenco type DM-10. Lafayette 30 R 3504 or equiv.)
C2—100 $\mu\mu$f, 25 V mylar (Lafayette 99 R 6089)
C3,C6—.001 μf, 75 V mylar (Lafayette 99 R 6060)
C4—24 $\mu\mu$f, 500 silvered-mica (Arco-Elmenco type DM-10. Lafayette 30 R 3511 or equiv.)
C5—18 $\mu\mu$f, 500 V silvered-mica (Arco-Elmenco type DM-10. Lafayette 30 R 3508 or equiv.)
C7—50 μf, 6 V electrolytic (Lafayette 99 R 6077)
C8,C10,C16—.1 μf, 75 V mylar (Lafayette 99 R 6066)
C9—.05 μf, 75 V mylar (Lafayette 99 R 6068)
C11,C12—.02 μf, 75 V mylar (Lafayette 99 R 6064)
C13—100 μf, 6 V electrolytic (Lafayette 99 R 6078)
C14,C15—.01 μf, 1,000 V ceramic disc (Lafayette 32 R 0943 C)
*L1—10 μh subminiature molded RF choke (Ace 17K8, 35¢)
*L2—Coil wound on Ace 2175-4-3 coil (form only, 65¢)
Q1—2N3662 transistor (GE)
Q2,Q3—2N2924 Transistor (GE)
Q4—2N3414 transistor (GE)
Resistors: ¼ watt, 10% unless otherwise indicated
*R1—33,000 ohms
*R2—25,000 ohm, subminiature trimmer potentiometer (Ace 29K15, 69¢)
*R3—4,700 ohms, *R4—15,000 ohms
*R5—330 ohms, *R6,R8—470,000 ohms
*R7—3,300 ohms
*RY1—SPDT subminiature relay. 100-ohm coil (Ace 27L17, $4.50)
*T1—Subminiature driver transformer (Ace 17K25, $1.25)
Misc.—Perforated circuit board, eyelets (available from Ace; stock No. SE33, 30 for 10¢)
*Starred items are available at prices indicated plus postage from Ace Radio Control, Higginsville, Mo. 64037. ¼-watt, 10% resistors are 10¢ ea.

Fig. 3—Closeup of receiver. If board did not have to be mounted in the model it could be much larger. Shown here it is about ¾-in. wider than life size. Parts are packed together, but with care you won't have trouble. Relay is at left, white object to right of it is C13, part with round black band is R2. Coil L2 is in right corner.



R/C RECEIVER

modulated but fairly strong signal (like your R/C transmitter with antenna collapsed) will simply cause the test-meter indication to drop from the unsteady 3 or 4 ma to a steady 2 ma. Modulation will cause it to jump to 40 to 48 ma, depending upon battery voltage.

With four freshly charged nickel-cad batteries, it will go well over 50 ma. Relays of higher resistance (up to 300 ohms) will work in the receiver and, of course, battery drain will be much lower. However, the subminiature relay used here is readily available from Ace Radio Control, so you shouldn't have to make a substitution for it.

Once R2 is adjusted, you'll never have to change its setting. In fact, for the general run of transistors, you could use a fixed resistor R2. However, transistors are still highly variable critters, and an adjustment of R2 will enable you to set it for optimum performance from Q1.

Actually R2 can be varied for other purposes. For example, when R2's wiper is near the ground buss (but after the receiver current has taken a decided jump from a steady 2 ma) the receiver is most sensitive. Tuning is also sharpest at this point. If you can call a superregen sharp.

If you do not need as much sensitivity in your application, R2's wiper may be moved toward the positive buss. Noisy servo motors in a model (noisy in the sense that they produce excessive interference from commutator arcing) might make it necessary to cut receiver sensitivity considerably.

If you want to try a different battery voltage, again, you'll need to adjust R2. Generally, you'll want to operate with R2's wiper as close to the positive buss as possible, consistent with reliable reception under all conditions. This includes distance and model position, falling battery voltage, etc.

A transmitter with variable modulation frequency will enable you to peak the receiver for optimum performance. Our model peaked at about 600 cycles—about par for the usual R/C transmitters.

It is too early yet to know just what modulation frequency will be settled upon as the best for 72-mc transmitters. On 27 mc, it's around 600 or 700 cps. Like most superregens, the receiver works best when the received signal is modulated close to 100 per cent. Again, however, the receiver will work well on much less.

When used in a model plane, the receiver should be shock mounted to prevent vibration from rattling the relay armature and to protect the other components from shaking to pieces. The optimum antenna length for this receiver is 15-18 in. It is preferable to operate a servo motor from batteries separate from those powering the receiver.

Magnetic actuators or escapements can usually be operated from the receiver batteries. Many servo motors are supplied with a capacitor across the motor brushes. If the one you wish to use doesn't have such a capacitor, install one yourself. A low-voltage .01 μf capacitor is fine. It should be connected across the brush lugs with very short leads.

Always keep the receiver antenna as far as possible from servo motors, battery leads and other metal parts. Shield the receiver and mount it as far as you conveniently can from servo motors and batteries. Good flying!

Go-Go Guitar Amp

By BERT MANN

NOTHING swings, rocks, rolls or pulses like the sound of a hot electric guitar. But without the lifeline wire running to an AC outlet those steel strings are about as loud as a churchmouse doing a soft-shoe dance in tennis sneakers. Without an amplifier, the loudest string pickers have to make way for fainthearted folk singers. But with our AC/Battery Go-Go Guitar Amp you can make like George Harrison or Tony Matola any time and any place—with or without AC power.

The rig, which includes batteries, AC power supply, amplifier, tremolo and 8-in. speaker fits an inexpensive ($5) attaché case. The three-watt modular power amplifier will produce sound loud enough to pain your ears if you're playing at home. The case includes everything—and there's even room for the guitar's connecting cable, sheet music, two sandwiches and a bathing suit. The amplifier is wired and ready to go and the tremolo is a kit. The AC power supply has about ten components. Essentially, all you do is connect modular units.

The DC (portable) supply is two series-connected 6-V lantern batteries. While the amplifier's output isn't equal to that of a 100-pound rig,

Go-Go Guitar Amp

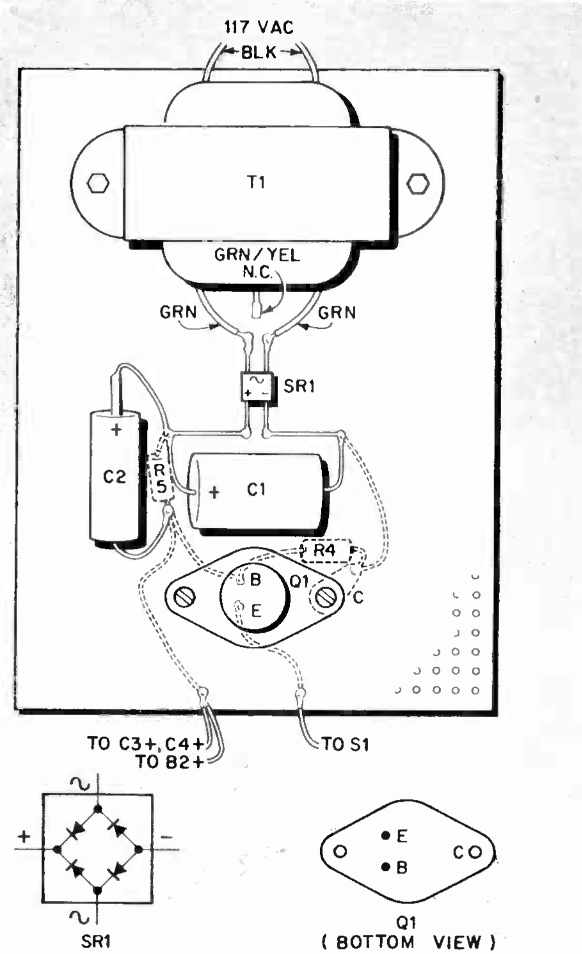
on a quiet beach or park there's enough volume to attract the group on the other side of the hill. The tremolo's intensity is adjustable from off to a heavy pulsation. And the speed is adjustable, too. If desired, a foot switch can be used to turn the tremolo on and off.

Construction

Purchase a cheap attaché case—the $5 variety with a ¼-in. wood frame and cardboard front and back will do nicely. The speaker can be from 6 to 12 in. and either 8 or 16 ohms. The speaker we used and specify in the Parts List is designed especially for musical instruments.

Cut the speaker hole in the center of the front panel, making certain there is clearance for the two batteries on the side or bottom. A clean cut can be made in the cardboard with a saber-saw fitted with a *fine-tooth* metal-cutting blade. A hacksaw blade can also be used in a pinch. But don't use a wood-cutting blade as it will tear, rather than cut, the hole.

Next, build the AC power supply on a 3½ x 5-in. piece of perforated board. You can use flea clips or Vector T28 terminals for



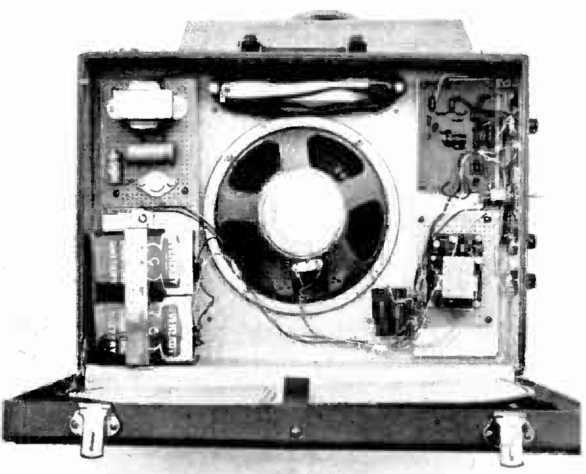


Fig. 1—AC power supply is in upper left corner. Tremolo board is in upper right corner and amplifier is under it. C3,C4 are next to amplifier.

tie points. Do not substitute a different transistor for the type specified.

SR1 is a single-unit bridge rectifier. Note carefully its markings. Connect T1's green leads to the two terminals on the side marked with the symbol ∿ . The output terminals are marked + and −.

When completed, the power supply should be checked out before installation. Connect a DC meter set to read 10 V, or higher, across the supply's output and turn on AC power. The output voltage should be between 9.5 and 10 V. If it is higher than 10 V, substitute a resistor of slightly higher value for R4. If the voltage is less than 9.5 V decrease R4's value. Mount the power supply in the case with ½-in. wood spacers glued to the case at each corner of the perforated board.

The tremolo is a complete kit available

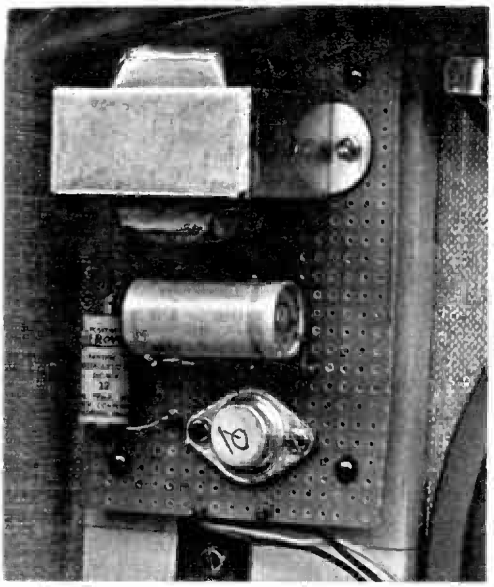


Fig. 3—To avoid putting mounting screws through front of case, glue strips or blocks of wood to inside of case. Then mount AC supply on them.

Fig. 4—Top jack is input, control below is volume. Next jack is for tremolo on/off foot switch. Bottom controls are tremolo speed and intensity

Go-Go Guitar Amp

rect-output lead. Finally, cut the two power on-off switching leads short and solder them together. The exact tremolo connections are shown in Fig. 2.

The Amplifier

The modular amplifier is complete except for the connecting wires. Connect the hot input lead, the speaker leads and the power-supply leads to the points indicated on the amplifier's instruction sheet.

Although the amplifier is pre-drilled for mounting screws, mount it on a 2 x 5-in. piece of perforated board using grommet spacers. Then attach the perforated board to ½-in. blocks which should be glued to the case.

Temporarily mount the tremolo and amplifier boards and mark the positions for the jacks, power switch and controls. Remove the modules, drill the holes on the side and then mount the controls. It will be necessary to undercut the inside of the case because of the short bushings on the controls.

If you build the Amp as an AC-only system, C3 may be eliminated. If you build a battery-only Amp, (no AC power supply) C3 and C4 must still be used.

Note the connections to power switch S1. In one position the batteries are switched into the circuit. When S1 is switched off the AC power supply is automatically connected to the circuit. There is no AC on-off switch. When you're finished playing on AC power, simply pull the plug.

Using the Tremolo

Setting intensity control R1 full counterclockwise shuts off the tremolo. To turn the tremolo on and off while playing, plug a normally-closed foot switch in J2. If the completed Amp fails to work, look for a reversed power connection to the AC and battery supplies.

If the amp breaks into oscillation (motorboats) there is a defective capacitor in the power supply or decoupling network (C3, C4). As a final check, measure the total current consumption. With no input signal, current consumption is less than 25 ma. A loud chord will cause the current to rise to 600 ma. To keep distortion low (some guitar pickups could overload the tremolo), lower the volume with the volume control on the guitar.

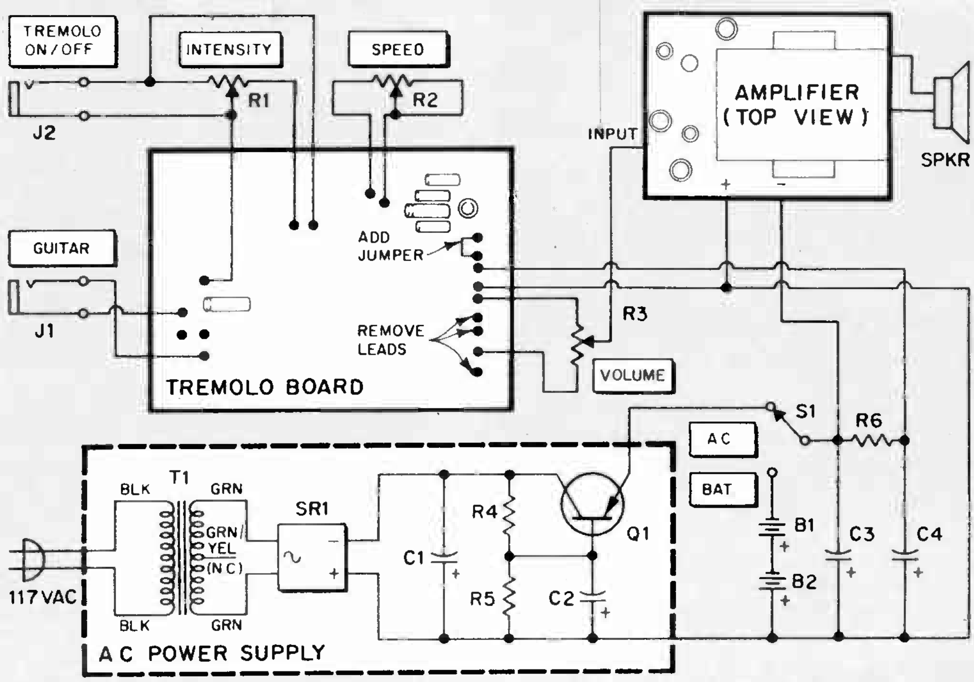


Fig. 2—Complete schematic. Sketch of tremolo board shows location of points to which wires are connected and from which they're removed. Instructions supplied with amplifier show connection points more exactly. Power supply layout on a 3½ x 5-in. piece of perforated board is shown at left. Watch the connections to SR1.

from most EICO distributors. If you have difficulty locating one, note a source of supply in the Parts List.

Assemble the tremolo kit following the instructions supplied with it. If the controls supplied with the tremolo have clip mounts rather than a threaded bushing replace them with standard control which will be easier to install on the case's wood frame. To make final assembly as easy as possible make all connecting leads to the tremolo board at least 12-in. long. They will be cut to size later.

After the tremolo kit has been completely assembled and checked for proper operation (check-out information is supplied with the kit) make the following minor modifications: Cut off the two input switching leads, leaving only the direct-input lead. Cut off the two output-switching leads leaving only the di-

PARTS LIST

AMPLIFIER—3 watt modular transistor (Lafayette 99 C 9132)
B1,B2—6 V lantern battery (Eveready 510S or equiv.)
C1—500 μf, 25 V electrolytic capacitor
C2—100 μf, 15 V electrolytic capacitor
C3,C4—1,000 μf, 15 V electrolytic capacitor
J1,J2—Phone jack
Q1—Medium-power power transistor (Lafayette 19 C 1507)
Resistors: ½ watt, 10% unless otherwise indicated
R1—1,000 ohm potentiometer (supplied with tremolo kit). See text
R2—25,000 ohm potentiometer (supplied with tremolo kit). See text
R3—25,000 ohm, audio-taper potentiometer
R4—470 ohms (see text)
R5—560 ohms R6—1,500 ohms
S1—SPDT toggle or slide switch
SR1—Silicon rectifier bridge; 1 A, 50 PIV (Motorola HEP-175. Available from Allied Radio for $1.45 plus postage. Stock No. HEP-175)
SPKR: 8-in. musical instrument speaker (Utah MI-8JC. Lafayette 32 C 4922. Or, Jensen EM-801)
T1—Filament transformer; 12.6 V @ 2 A (Allied 54 A 1420 or equiv.)
TREMOLO—Tremolo kit, EICOcraft EC-500. (Available from EICO dealers or from Custom Electronics Co., P.O. Box 124, Springfield Gardens, N.Y. 11413. Price including postage is $8.95. N.Y. state and city residents add sales tax.)

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