

ELECTRONICS HOBBYIST

FALL-WINTER 1971 \$1.25

A Science & Mechanics Semi-Annual Publication

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- pep up the BCB
- kill AC hum
- broadcast on FM
- listen to Aero talk
- play electronic games
- probe for circuit faults
- test transistors visually
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- tape 4-channels at once
- win Science Fairs

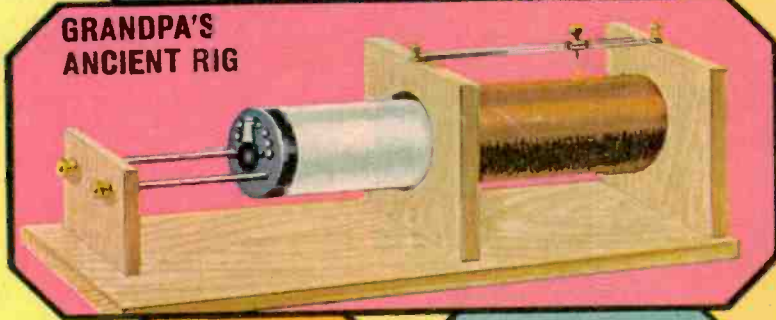
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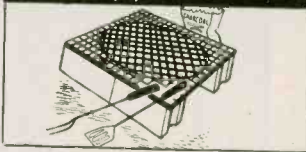
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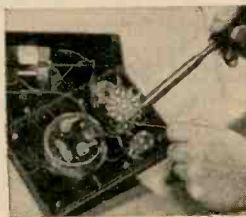
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Dedicated to America's Electronics Hobbyists

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ELECTRONICS HOBBYIST



Turn Off the Old Turntable

I have a 1942 RCA-Victor radio-phonograph which has a 78-RPM turntable. Should I use the existing turntable or buy a cheap 3-speed one? My main purpose is to play old 78-RPM records. When I hear 78-RPM records played over the air, why do they sound much better?

—J.F.G., Washington, D. C.

Your old record changer must be old and tired by now. Parts undoubtedly have become deformed because of aging and others have become worn. Get a new changer, but get a convertible LP/78 cartridge. When you hear 78's played on the air, bear in mind that the radio station might be using a turntable, pickup and filters that may have cost hundreds if not thousands of dollars.

Ask for Help

In one of your construction articles you call for a 2N416 and a 2N374 transistor. I have looked in two catalogs for these, and could not find either one. If you are going to put construction articles in your book, how about suggesting parts that are easy to come by?

—D.G.R., Sidney, Ohio

There are jillions of transistor types, many of them similar. Big-time parts distributors have equivalent transistor directories. Go to your parts distributor or write to a mail-order house and order the transistors you need or their "equivalents." If a mail-order catalog were to list all transistor types, the listing would take up all of the catalog space. The answer is "ask."

Transformer Polarity

On a 6-volt filament transformer, how can I tell which are the positive and negative terminals. Also, I would like to make an antenna for the VHF band (150-176MHZ). How long should the radials be?

—E.G.S., Milwaukee, Wis.

Since the 6-volt output is AC, both terminals are alternately positive and negative. So don't worry about polarity. The radials and radiator of a 150-MHz band ground plane antenna are roughly 18 inches long and not critical for receiving.

TV-Channel Separation

I have a problem with my television tuner. The



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channels run together. Channels 2 and 4 are not bad. Channel 5 is vacant. There are wavy lines when I first turn the set on. Channel 5 clears when the set warms up. Channel 6 is not bad, and the channel 7 picture comes in faintly on channel 8. Channel 9 comes in on 10, channel 11 on 12. Sometimes we get channel 12 (WICU in Erie, Pa.) It is wiped out by channel 11 and its sound comes in on channel 13 which wipes out channel 13 (CKO, Kitchener, Ont.) which we get. When the fine tuning knob is turned properly, it is fuzzy from 7 to 13. We want to use all of these vacant channels which are: 3, 5, 8, and 12. We want to have CATV which would feed us 12 channels. My tuner was factory rebuilt and is still not good.

—J.C., Grimsby, Ont.

It's not your tuner's fault. You are experiencing normal conditions. While they could be, conventional TV tuners are not designed to be selective. In any metropolitan area, adjacent TV channels are not assigned to stations. Even Channels 4 and 5 are not adjacent; they are separated by the 72-76 MHz communications band. When you get CATV, all signals will be strong. You will be able to separate all 12 channels because of the selectivity of the IF amplifier of your receiver, not its tuner.

Receiver Hum

I bought a shortwave receiver and I am quite happy with it except for a hum that drives me crazy. It's not always there. Sometimes it doesn't come on and then sometimes it does. If I turn my radio off and then back on again, it might go away, but then comes back on again in a little while. Sometimes when the hum is



there and I turn my receiver up high, it goes away and when a loud noise (static) comes in, it goes away. As you can see the problem isn't easy to explain. My buddy had the receiver at his house and got no hum. Is the problem in the receiver or the location? There are no high-tension wires near me.

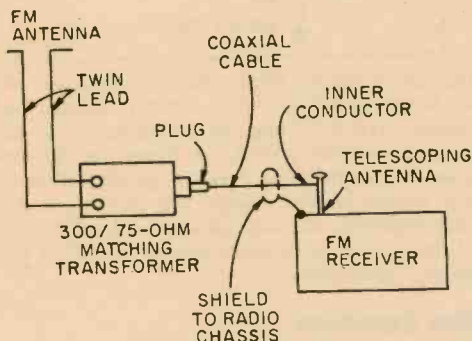
—T.A., Bedford, Ohio

It sounds like a fault in your receiver, perhaps a tube with an intermittent short or inter-electrode leakage. Have your tubes tested on a tester that checks for inner-electrode leakage and grid emission. A drug-store or cheap cathode-emission type tube tester might not detect a subtle tube fault. Or, try a new set of tubes.

Better FM Reception

I have known for years that by wrapping a piece of wire around an AM transistor radio several times and connecting one end to ground and the other to an outside antenna would increase reception considerably and I find it works very well for me. My problem is that my radio is an AM/FM/SW set and there are a couple of very faint stations on FM that I would like very much to hear. Is there any kind of similar antenna hook-up that I could make for FM to bring in these stations? My radio has ten transistors, with a whip antenna for FM.

—R.B., Falconer, N. Y.



Clip a piece of wire, about 6 feet long, to the FM antenna (retracted) and stretch it out horizontally. For far better results, use an external FM antenna, connected through a balun as shown in the diagram.

Long Green for Shortwave

I am now a freshman in high school, interested in the broadcasting business after I am out of high school and college. Planning on this occupation, I need an idea of just what is involved in owning and operating of station. Also, what technical knowledge and other requirements does the FCC ask you to meet? If I ever do go into the broadcast business, I would like to run a small, commercial shortwave station. Wonder

(turn page)

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what the FCC would think about that?

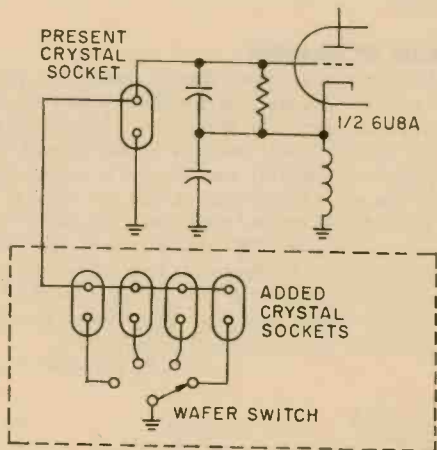
—F.G., Kokomo, Ind.

It takes money, lots and lots of it. You had better think in terms of BCB or FM. Or shortwave, who would be the sponsors who would pay you your income? If you want to be the operator, you should have a First Class Radiotelephone Operator license.

Tuning a Single-Channel CB Transceiver

I have an old Gonset G-11 CB transceiver, single-channel transmit and receive. I would like the receiver to be tunable. What circuit would you suggest?

—W.L.H., Rockwood, Mich.



Instead of making it tunable, why don't you add a channel-selector switch, crystal sockets and receive crystals? They can be connected to the existing receiver crystal, as shown in the diagram. When ordering crystals specify the make and model number. Since the receiver is not very selective, the capacitance and inductance of the added components should not affect frequency significantly.

Body Capacitance

Every time I go near the variable condenser of my shortwave transistor radio I somehow change frequency. What can I do to correct this problem? Any suggestions?

—J.D., Cranford, N.J.

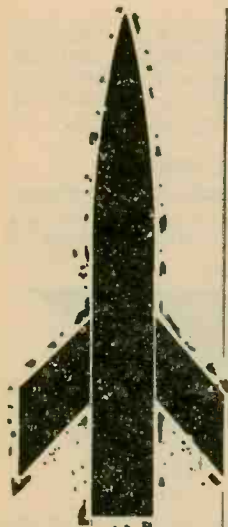
That's normal. Your body capacitance affects the oscillator tuning. If you have to trim the set, use a tuning wand made of plastic.

Improving Cheap Stereo

I am dismayed at the "tinny" sound put out by inexpensive stereo equipment. It seems that a true, deep, powerful bass cannot be had without shelling out mounds of money. Is there some sort of circuitry that I can build into my present equipment to strengthen the bass? My present

(turn page)

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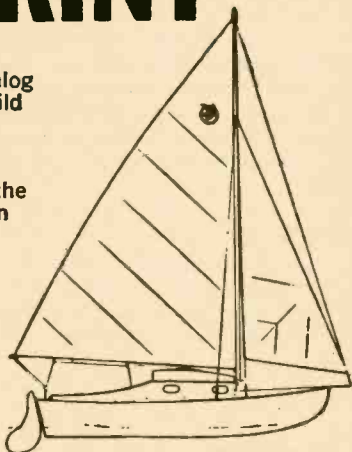
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set came equipped with a "bass-treble" knob that is highly efficient in changing the sound from dull to shrill, but leaves me totally unmoved otherwise.

—M.P.M., Imperial Beach, Calif.

Without a schematic we can't tell you how to modify the circuitry. However, as a general rule, replace the speakers with new ones of the same size but having a heavier magnet. Also replace the one-buck output transformers with better ones.

It Won't Work!

How many ohms should a potentiometer have for controlling the speed of a 78-RPM phonograph motor as shown in the schematic diagram? I would like to play 16, 33, and 45 RPM records.

T.F., Swoyersville, Pa.



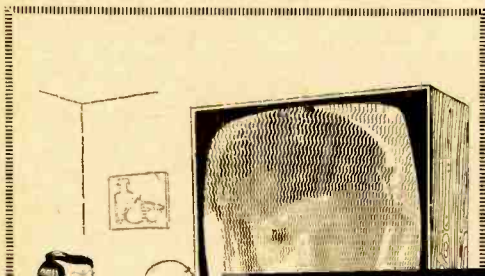
Forget it. The speed of the AC motor in your phonograph is not proportional to the input voltage. Usually, the motor is designed to operate at constant speed when fed from a 60-Hz power line. The speed is changed by varying the frequency. This is impractical in your case. Just buy a 4-speed turntable which uses mechanical means to change speed. The motor speed remains constant and the speed is reduced mechanically.

SOS on the QT

If I happen to hear a distress signal on my shortwave set what should I do?

J.C.O., Independence, Mo.

If it's from other than a ship in distress or an amateur or broadcast station, keep your mouth shut. All other radio transmissions are secret and cannot be revealed! ■



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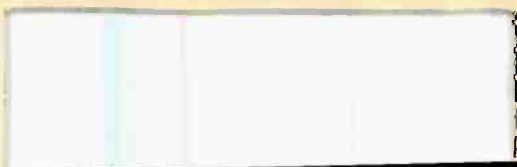


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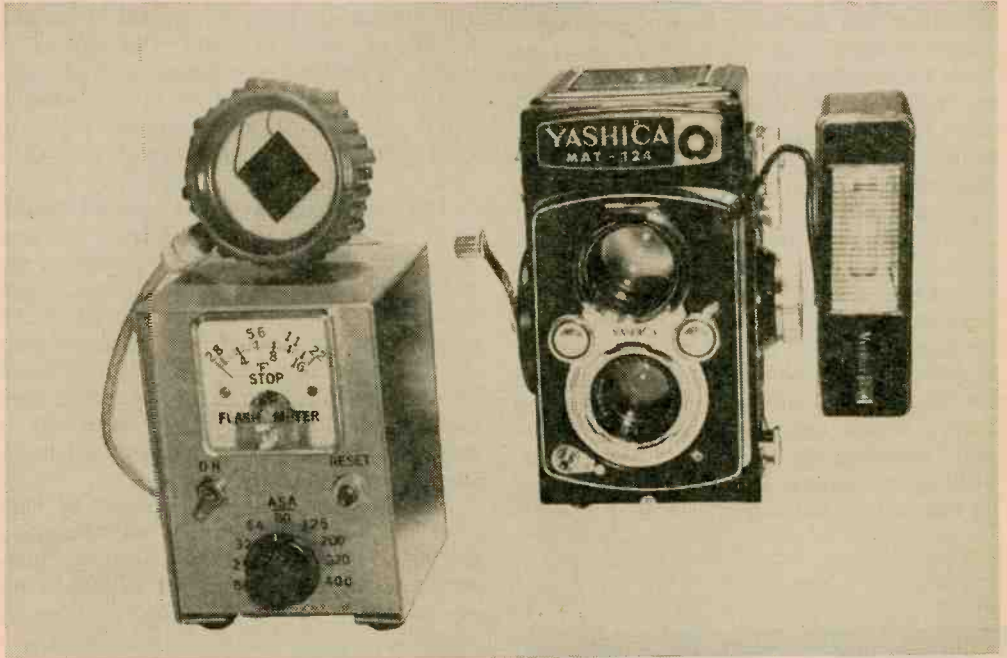
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FLASH MASTER



Our meter stops strobe photography's F-stop fumble

by Charles Green, W6FFQ

Electronic flash units, or strobes, as they are called, are blinking their way into the equipment carry-alls of amateur and pro shutterbug, alike. And, for pretty good reason, too. Low in cost, these compact strobes bring the advantages of professional electronic flash gear to John Q. Hypo. Having made obsolete the conventional you-have-to-slobber-the-end-first flash bulb, an electronic flash's light quality is so close to daylight that it's the perfect Jill for all the Jacks whose cameras are always loaded with daylight rated color film.

But, you can't go strobing yourself into a silver halide eternity, though. Problem with modern electronic flash dojobbies is that you still need to revert back to old fashioned methods to determine your camera F-stop lens setting. Many a pro develops calloused

shoulders hefting his assortment of tape measures, guide estimates, and a whole host of literature give-aways needed each time he goes on a shooting spree with his electronic flash. Worse yet, pity our poor photog busily poring over his not so easily understood tables and guides, all the while missing that one-in-a-lifetime shot he so arduously prepared himself for!

Slaying The F-Stop Dragon. Saint George made short shrift of the mythical Dragon the same way our *Flash Master* takes the fumble out of F-stop calculation. Our electronic meter will give you F-stop readings faster than any published table can. All without the problem of measuring the distance between film plane and subject. And *Flash Master* "remembers" the F-stop needed in the particular scene you want to

Flash Master

capture, too! Just trigger the electronic flash before you take your picture with *Flash Master* at the subject. Our *FM* will indicate the required F-stop you have to set your camera's lens opening to. Exposure bracketing is now a thing of your past!

Take a peek at *Flash Master's* schematic; you'll see our electronic flash meter uses a silicon photo cell and an IGFET (Insulated Gate Field Effect Transistor) in a novel and easily-duplicated circuit. *Flash Master's* ASA ranges are switch selected for performance repeatability. And, the DC power requirements are supplied by a C-size flash-light battery.

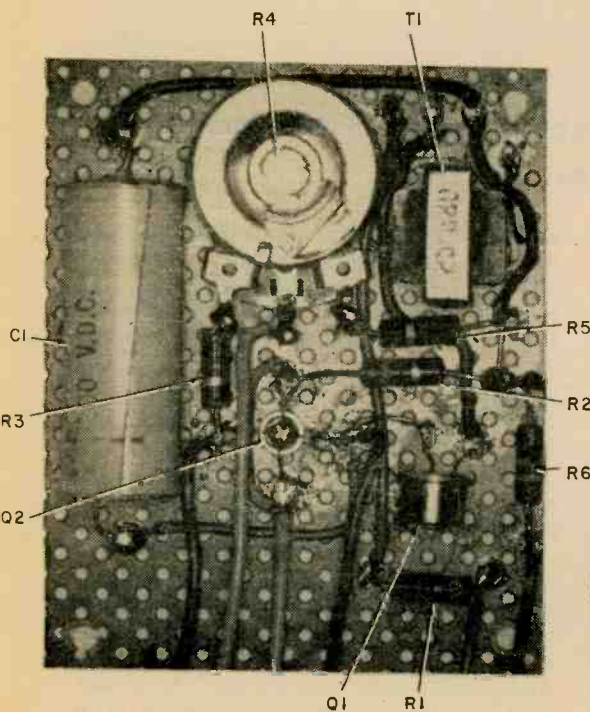
Our *FM* is housed in a compact aluminum cabinet with the silicon photo cell in a probe housing. One of *Flash Master's* advantages over conventional photo light reading devices is that it doesn't respond to incident light. Not only can it be left on for long periods without constant re-zeroing before actual use, but our *Flash Master* only responds to *electronic* strobe light, making its readings accurate either indoors or out of the studio. And the flash meter's

circuit draws less than 1 mA from the self-contained battery, assuring the photographer long battery life.

Flashing Performance. When a brief burst from an electronic flash unit is sensed by the photocell Z1, a pulse is generated and fed via resistor R1 to the 3.2-ohm winding of transformer T1 (an ordinary audio output transformer connected "backwards"). The pulse voltage is stepped up to a higher value in T1's 500-ohm secondary winding. This stepped-up pulse is rectified by transistor Q1, rigged a la diode. The "diode" is really formed by the collector to base junction of Q1. Referring to our schematic, you'll see that no connection is made to Q1's emitter; snip off this lead close to Q1's case.

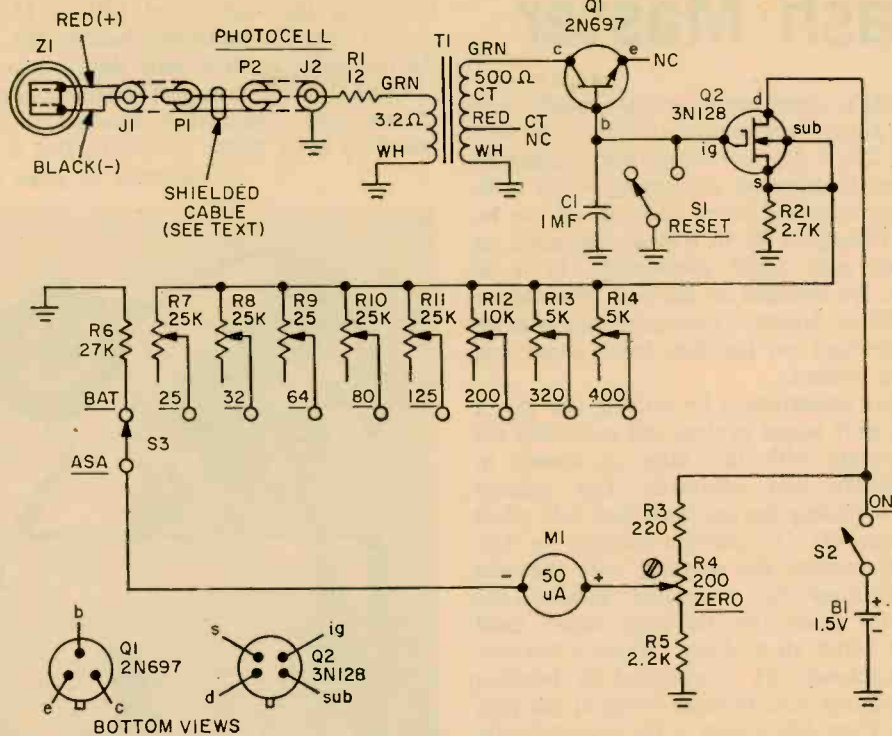
The voltage output of Q1 charges capacitor C1 to a value dependent upon the amplitude of the electrical pulse (which is determined by the light flash intensity). Capacitor C1's voltage charge controls direct current flowing through the insulated gate of field effect transistor Q2 which is wired into a basic super-high-input-impedance voltmeter circuit. Finally, voltage across C1 is read on milliammeter M1, calibrated in F-stops to read directly.

The electrical charge of C1 will be held until the very high internal resistances of Q1 and Q2—measured in terms of thousands of megohms—and the dielectric re-



Perf board, with all of *Flash Master's* components except pots R7-R14 (mounted on separate perf board), is housed in pro-style cabinet, below.





PARTS LIST FOR FLASH MASTER

- B1—1.5 volt C-size battery (Eveready 1035 or equiv.)
 C1—1 uF, 100 volt min. rating, Mylar capacitor (see text)
 J1, J2—Phone jacks (single hole mounting type)
 M1—50 uA panel meter (Lafayette 99F50494 or equiv.)
 P1, P2—Phono plugs (part of 6-inch shielded cable—see text)
 Q1—2N697 silicon NPN transistor (RCA)
 Q2—3N128 Insulated gate field effect transistor (RCA)
 R1—12-ohms, ½-watt, fixed resistor
 R2—2,700-ohms, ½-watt, fixed resistor
 R3—220-ohms, ½-watt, fixed resistor
 R4—200-ohms, linear potentiometer (with slotted shaft)
 R5—2,200-ohms, ½-watt, fixed resistor
 R6—27,000-ohms, ½-watt, fixed resistor
 R7, R8, R9, R10, R11—25,000-ohms, miniature trim pot (from Radio Shack 271-201 Trim Pot

- Assortment)
 R12—10,000-ohms, miniature trim pot
 R13, R14—5,000-ohms, miniature trim pot
 S1—SPDT, miniature pushbutton switch (Calcraft E2-141 or equiv.)
 S2—SPDT, miniature toggle switch (Radio Shack 275-326 or equiv.)
 T1—Output transformer: 500-ohm center-tapped primary; 3.2-ohm secondary. Turns ratio 12.5 to 1 (Midland 25-620 or equiv.)
 Z1—Silicon photo cell, approximate output .5 Volt @ 25 mA (Calcraft J4-800 or equiv.)
 1—Aluminum cabinet 4-inches high x 2¾-inches wide x 2¾-inches deep (LMB 2754-N or equiv.)
 1—plastic flashlight lamp housing (see text)

Misc.—perf board and push-in clips, battery holder for B1, sheet aluminum for photo cell housing, 3/16-in. spacers, hookup wire, sheet foam rubber, decals, solder, etc.

sistance of C1 itself, drains the charge off the capacitor. C1's electrical charge will normally last long enough for you to take your reading on M1 minutes after your strobe light has flashed. After you take the reading, depress switch S1, discharging C1 and resetting M1 for the next light flash.

Potentiometers R7 to R14 are adjusted for specific sensitivities of M1 and are

selected by switch S3 for the eight most popular ASA ranges. Resistor R6 is connected in series with M1 with S3 thrown into the *Bat* position to form a simple voltage divider. Purpose is to provide the photog with some means of checking B1's health. Lastly, switch S2 controls the DC power from B1 to *Flash Master's* circuit.

Flash Master's Bright Boardwork. Most of

Flash Master

our *FM's* components are mounted on a 2½ x 3-inch perf board installed on the rear of the 2¾ x 2¾ x 4-inches high aluminum cabinet. Component placement is not critical; any size perf board and cabinet can be used. Trim pots R7 to R14 are mounted on another perf board measuring 2½ x 2-inches. It's installed on the rear terminals of M1. *Flash Master's* remaining components are mounted on the box front panel and bottom section.

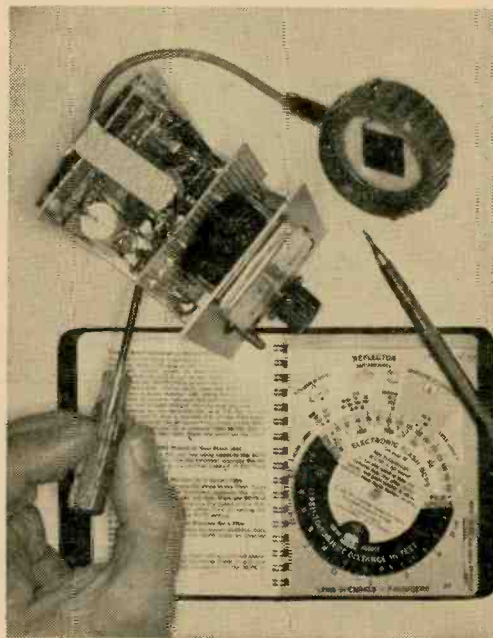
Begin construction by cutting the 2½ x 3-inch perf board to size, and mounting the components with flea clips as shown in our photos and schematic. Use caution when mounting the insulated gate field effect transistor Q2. To prevent damage to Q2, do not remove the shorting wire that the manufacturer has wrapped around the transistor leads (at the body base) until you've wired all of *Flash Master's* circuits.

Transformer T1 is mounted by bending its mounting lugs through holes in the perf board. Then drill a hole in for potentiometer R4 (zero adjust) near the top of the perf board holding *FM's* circuit. Mount and wire the remaining perf board components as in our schematic.

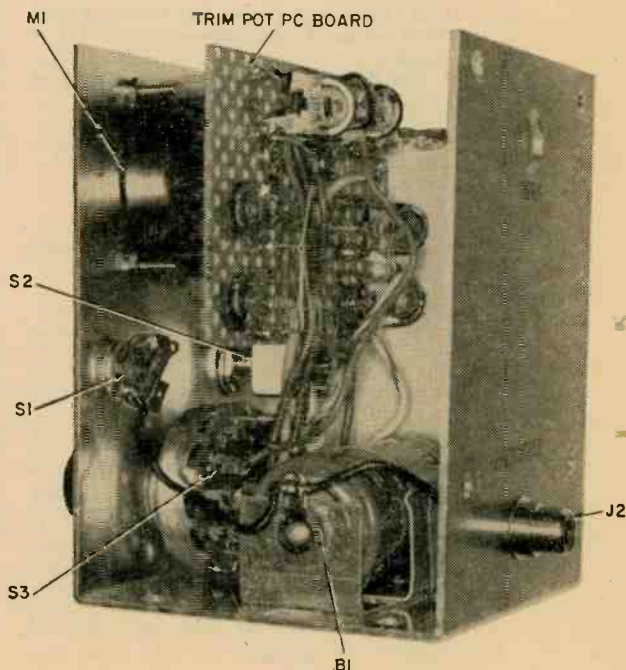
Lay out and mount meter M1 and the remaining front panel components as shown in our photos. Temporarily position the 2½ x 3-inch component board on the rear panel and locate the hole for adjusting R4 zero-adjust potentiometer. Also locate the mounting holes for RCA-type phono jack J2, and B1's battery holder on the bottom of the

box. After you've mounted the circuit perf board on the rear panel with 3/16-inch spacers, slap J2, the battery holder, M1, and the remaining controls onto the front panel.

Cut a 2½ x 2-inch perf board section for all trim pots. The author attached this perf board to M1's meter terminals. But it can
(Continued on page 112)



Trim pot perf board is mounted on rear of meter via M1's lead hardware. Prewire trim pot perfboard first, wire it to S3 next; then mount both units in place. Calibrating Flash Master only requires strobe with known BCPS rating plus Kodak's Master Photoguide AR-21, available at most photo shops. Calibrate Flash Master for incident light.



Super Booster

Add this devilishly simple RF booster to any Broadcast Band rig, and watch the once dead BC Band come alive.

by
Lars Jorgensen



Imagine your receiver's broadcast band dial jammed from end to end with a solid wall of signals! Pip-squeek stations that normally can't be heard with headphones *can* come booming into your shack at S9. A dream? Nope! That's just the kind of performance you'll get with COMMUNICATION WORLD'S Super Booster.

Here's a preamplifier specifically designed for BC DX'ers. Whether you live in a concrete and steel tower, or out in the boondocks with plenty of space for a long-wire antenna, the Super Booster will dig out signals you've never heard before. The average gain of Super Booster is almost 42 dB—that's 7 S-units "extra" sensitivity!

As shown in our figure, the booster can function either as an "electronic antenna", with signals received only by loopstick antenna coil L1, or as a preamplifier, with long-wire antenna signals coupled to L1 through L2. Coil L2 is supplied as part of the specified antenna loopstick; you have no coil winding problems.

Signal voltage appearing across L1 and C1 is coupled to Field Effect Transistor Q1 which provides approximately 20 dB gain on top of the L1/C1 resonant gain. The output of Q1 feeds

transistor Q2, connected as an emitter-follower. This transistor stage provides an additional 10 to 15 dB power gain, and also provides a low-impedance output for connection to the relatively low impedance receiver input.

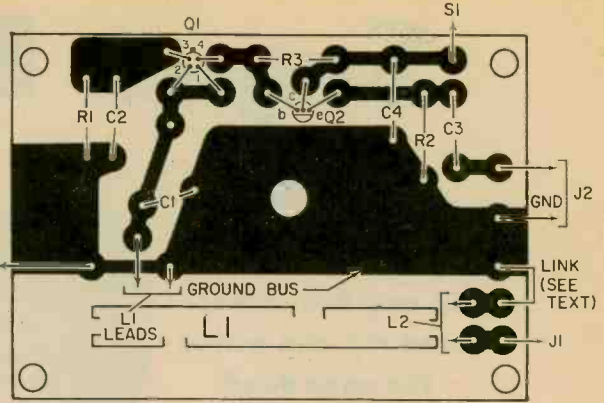
Though intended for direct connection to a receiver's antenna input terminals, CW's super Booster can also be used with "loop antenna radios" by connecting the booster's output to a loopstick antenna (a duplicate of L1), and then positioning this loopstick near the radio. We'll show how both connections are used.

The total current drain of Super Booster is less than 2 mA. Power is provided by a standard 9V transistor radio battery. The 2U6 type will last at least 3 months, even under heavy service. An "activator" type battery can last a year or more. With such low power consumption, there is no reason to build an external AC power supply for Super Booster.

—**Construction.** Though the circuit appears very simple, extreme care must be taken in the circuit board preparation. Reason is, the very high gain can cause total instability if a single component, or printed foil-circuit is out of position. We suggest that no attempt be made to

SUPER BOOSTER

Placement diagram for SB's parts. If the output is fed to an AC/DC-type rig, disconnect the link and ground J2's cold end separately.



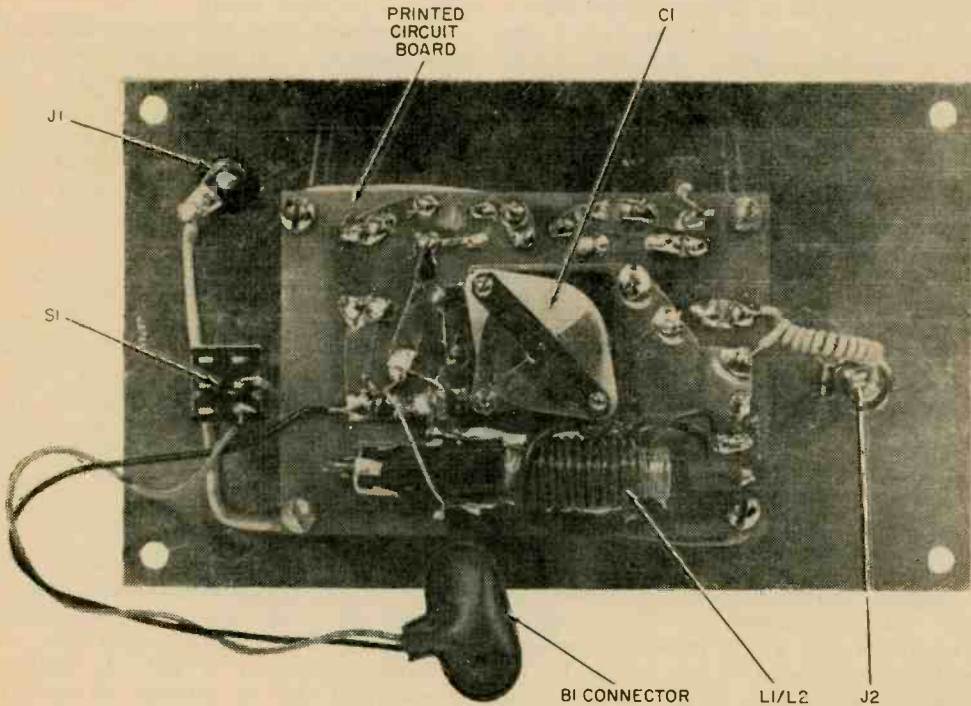
use point-to-point wiring; use a PC board which is an exact copy of the supplied template. The board can be of type XXXP; there is no need for a more expensive board.

Make *no* component substitutions; Q1 and Q2 should be the specified types. Through the circuit might work with some "general purpose replacement transistors," it probably won't work with other dime-a-cheapies. Worse yet, it might work only on very weak signals while distorting on strong signals.

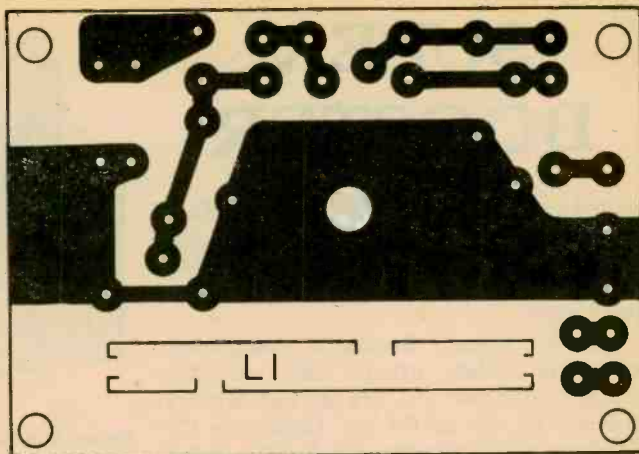
The specified components will provide distortion-free performance on signals as high as 80,000 μ V. You can expect Super Booster to provide its great performance until the battery voltage falls below 6 volts.

The circuit board and a *very short* connection to output jack J2 are the only critical assemblies. You may make mechanical modifications to Super Booster as long as the general layout approximates the unit shown in the photographs. Any cabinet can be used; the PC board has a built-in hand-capacitance shield. For maximum stability, though, a metal front panel will reduce the possibility of RF instability caused by the signal being fed into the receiver radiating back into the booster's input.

—Making the PC Board. Cut a piece of cop-



This is Super Booster's printed circuit board drawn full-size. If you make your own PC board, follow this pattern exactly; RF instability, or regeneration, could result if you don't. Our diagram on page 18 shows where the various components are mounted on this PC board. Follow the layout carefully.



per-clad board to the size of the template and scrub the copper surface clean with a strong household cleanser such as Ajax. Or, use steel wool and a liquid detergent. Place a piece of carbon paper (carbon side towards the copper) over the board and tape the board under the template. Next, find a sharp pointed instrument, such as an ice-pick or scribe, and indent the copper foil at each component mounting hole by forcing the point of the tool through the template

and into the copper. Use only hand pressure, not a hammer. Then, using a ball point pen, trace the outline of each foil area.

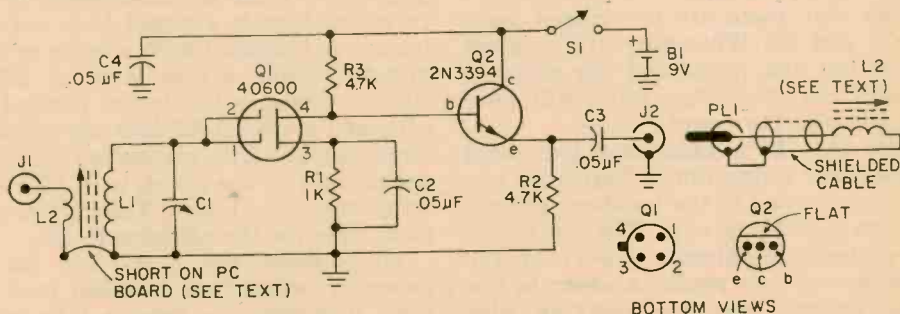
Remove the board, discard the carbon paper, and fill in the outlines with a resist pen such as supplied in the Allied Radio Shack printed circuit board kits. Allow about 15 minutes for the resist to dry and then immerse the board under at least 1/4" of etchant.

When all the excess copper is dis-

PARTS LIST FOR SUPER BOOSTER

- B1—9 volt transistor radio battery (Burgess type 2U6 or equiv.)
- C1—365 pF subminiature poly-type variable capacitor
- C2,C3,C4—0.5 μ F, 50 VDC disc ceramic capacitor
- J1—5-way universal binding post
- J2—RCA-type phono jack
- L1—loopstick antenna
- L2—loopstick antenna (optinal for radios without antenna terminals—see text)
- PL1—RCA-type phono plug—see text
- Q1—dual gate mosfet n-channel transistor (RCA 40600)

- Q2—bipolar npn transistor (G.E. 2N 3394)
 - R1,R3—4,700-ohms, 1/2-watt composition resistor, 10% tolerance
 - R2—1,000-ohms, 1/2-watt composition resistor, 10% tolerance
 - S1—single pole, single throw switch
- A complete set of components, including J1,J2, S1,B1, and an undrilled printed circuit board is available for \$12.95 (includes postage) from the Electronic Hobby Shop, Box 587, Brooklyn, N.Y. 11202. Add \$1 for antenna loopstick L2 if needed. Canadian citizens add \$1 extra. New York state residents must add sales tax. No foreign orders, please.



SUPER BOOSTER

solved—about 45 minutes later—rinse the board thoroughly and remove the resist with a cloth moistened in rubber cement thinner or by scrubbing with steel wool.

All of Super Booster's component mounting holes, except the one for tuning capacitor C1, are drilled with a number 58, 59 or 60 bit. Capacitor C1 requires a $\frac{5}{16}$ " mounting hole. The holes in the corner of the PC board, used for mounting the completed PC assembly, should clear #4 or #6 screws—which-ever you prefer.

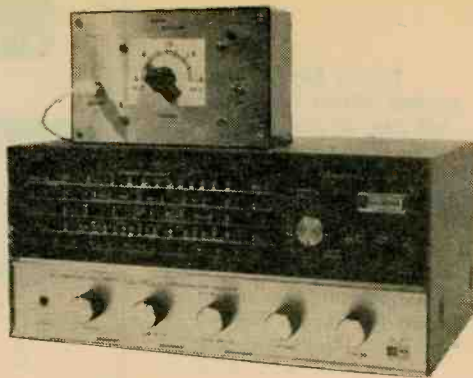
The PC board is best assembled in the following manner: install capacitor C1 first, then all other components except Q1. Then push Q1's leads through the holes in the PC board and solder them home. Finally, solder the two power leads to their respective points if you intend to check out the booster before installation in the cabinet.

Note that Q1 is supplied with a shorting clip around all the leads. *This clip must be left in position until the booster is completed and ready for operation.* If the clip is removed, a high static voltage from the tip of the soldering iron, or a voltage generated through normal handling, might destroy Q1.

Position transistor Q1 so that the tab sticking out from the case faces the nearest edge of the PC board. Position transistor Q2 so that the round side of the case faces the nearest edge of the PC board; the flat side faces the far edge of the PC board.

Note that there are no crossed leads for Q1 and Q2. When they are oriented so the tab and round end are properly aligned, the transistor leads will plug straight into the board.

Note that L2's leads have individual printed foil connections. Normally, one foil is connected to the boosters' ground through a shorting wire. The remaining foil connects to antenna jack J1. If, for some reason, you prefer a separate antenna ground, open the shorting wire and install a "ground" jack on the



Super Booster helps this Realistic DX-120 to run after flea power BCB DX.

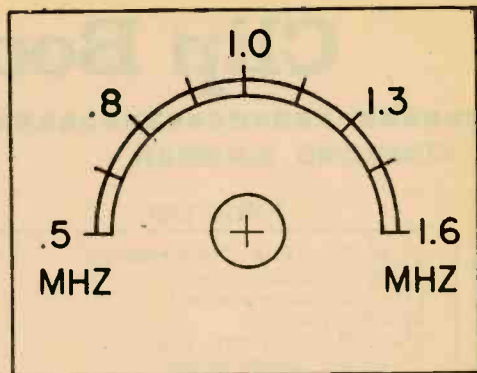
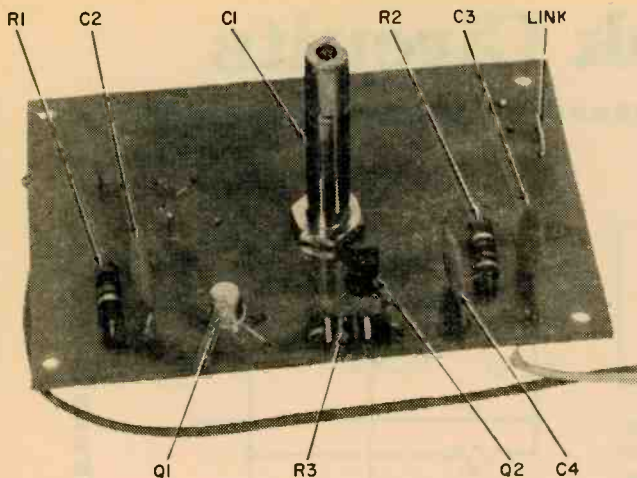
panel. Connect the proper foil to the ground jack.

Because the components are mounted on the side of the pc board facing the cabinet panel, stand-offs must space the board away from the panel. You'll find, however, that C1's tuning shaft will be too short to pass through the panel for application of a tuning knob. But the cure's simple enough; simply cut off a section of shaft from an old potentiometer and epoxy-cement the section to C1's shaft. Or, use a plastic extension sleeve (such as the type supplied for "insulated shaft" potentiometers); the sleeve is sufficiently rigid to support a knob.

The loopstick coil is cemented to the board with General Electric's RTV Silicon Rubber adhesive. Use no other brand or type of adhesive. Other brands, such as Dow-Corning's Silastic, are conductive at RF frequencies, and will ruin the electrical properties of the coil.

Check that the foil area outlined on the board has the indicated "breaks". You don't want a closed loop. If you forgot and made a closed loop, cut four breaks as indicated with a knife or hand grinder. Apply a thin layer of Silicon Rubber adhesive inside the marked coil area and press L1-L2 into the adhesive. Make certain L1's connection terminals are parallel to the board, with L2's leads away from the board. Then allow sufficient time for the adhesive to dry.

We suggest you check out the PC assembly before it is installed in a cabinet. Remember to remove Q1's shorting clip! Simply pull on the end of the



Here's what finished PC board looks like before it's mounted to front panel with standoffs. Tuning dial faceplate can be used as is; just paste it down!

clip with long nose pliers and the clip will unwind from around Q1's leads.

Connect a DC milliammeter rated at 5 mA or higher between the battery's positive terminal and the board's positive foil. Connect the battery's negative terminal to the board's negative foil. The meter should indicate slightly less than 2 mA. If the meter indicates 1 mA or less, or more than 2.5 mA, check for a component mixup or incorrect installation of Q1 and Q2. If the meter reading is correct, disconnect power and install the board in a cabinet.

We recommend a plastic cabinet with aluminum panel such as shown in the photographs. The plastic cabinet allows direct signal pickup by the loopstick, which will be more than adequate for most DX'ing. Keep antenna jack J1 as far as possible from coil L1. Keep output jack J2 as close as possible to the board's output terminals. The power and antenna input leads should be flat against the panel.

Make up a short, shielded output lead by wrapping a solid-conductor, insulated wire around another wire. Keep the wrap turns against each other. Using the shortest possible length of this shielded wire, connect J2 to the board's output terminals. Make certain the "ground" wire goes from J2's ground lug to the ground foil.

Adjust L1's slug clockwise with a small screwdriver until only $\frac{1}{4}$ " of the slug's adjusting screw sticks out of the coil form. The other end of this screw, the slug itself, will protrude about $\frac{1}{4}$ "

out the end of the form. The slug is generally secured with wax, so the first turn or two might require a little extra force; don't be afraid to adjust the slug if it "feels" tight.

Make up a connecting lead to go from output jack J2 to the receiver's antenna terminals. Any shielded wire or coaxial cable can be used. Install a phono plug on one end. For least signal attenuation, the lead should not exceed 15 inches.

If the Super Booster will be used with a transistor radio having a built-in loop antenna and no external antenna terminals, connect the free end of the output lead to a loopstick antenna—merely an exact duplicate of L1! If the loopstick has an antenna winding, such as found on the specified loopstick, simply unwind the few turns and connect the output lead to the coil's solder terminals. Position this coil on the radio's case opposite its built-in antenna and tape the coil in position.

—Using Super Booster. Turn on both the receiver and booster and tune in the desired station. Adjust tuning capacitor C1 for maximum signal strength or highest S-meter reading. As a general rule, the direct signal pickup by L1 will be more than adequate. If greater sensitivity is needed, connect 6 to 15 feet of wire to antenna jack J1. If you have the space needed for an outdoor longwire antenna, take note that the signal level into the receiver can be so high as to overload the receiver.

If there is a strong local station in
(Continued on page 112)

Clip Book Circuits

SIDEBAND SIDEMAN

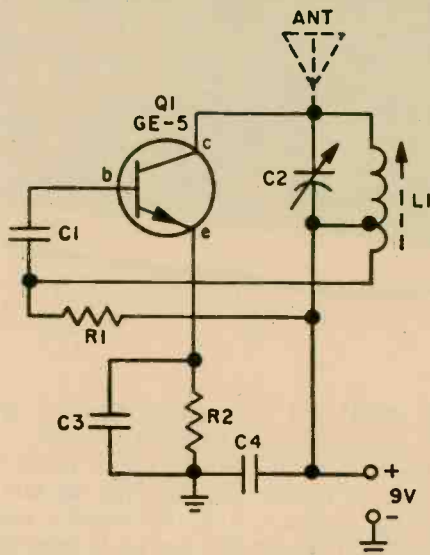
PARTS LIST

- C1, C3, C4—0.05 μ F, 25-VDC capacitor
- C2, 360-pF variable capacitor
- L1—Tapped BC antenna coil
- Q1—GE-5 transistor
- R1—2200-ohm, 1/2-watt resistor
- R2—68-ohm, 1/2-watt resistor

Placed near a multiband transistor portable, this BFO allows reception of CW and SSB signals in addition to the normal reception.

The BFO is a Hartley oscillator tunable across the broadcast band. Oscillator harmonics extend to the higher shortwave frequencies where they "beat" against CW and SSB stations. It provides standard BFO tone reception of CW signals and reasonably good reception on moderate to strong SSB signals.

Once C2 is adjusted to the proper beat frequency, the BFO is positioned near the transistor radio for optimum reception. No antenna is needed if the unit is assembled in a plastic cabinet.



The BFO can also be used as a radio-type code practice oscillator with a range of approximately 20 feet. Connect a 10-ft. antenna on a nearby BC radio. To send Morse code, insert a key in series with one battery lead.

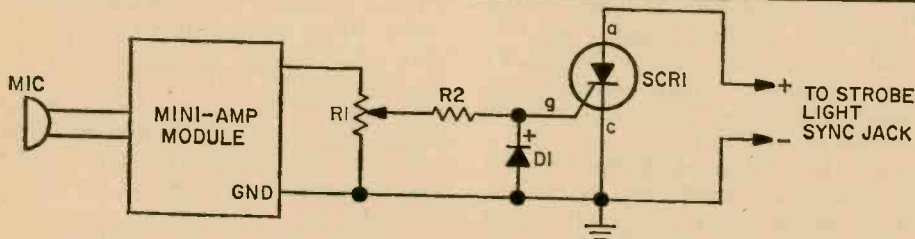
STOP MOTION

You, too, can take strobe-flash pictures the instant a pin pricks a balloon, a hammer breaks a lamp bulb or a bullet leaves a gun. You'll need a mini-amp—one of those transistor amplifier modules of 1-watt rating or less. *It must have an output transformer.* Don't use an "OTL" (no transformer) amplifier. The amplifier is terminated with a resistor on its highest output impedance, preferably 16 ohms. Make certain the connections to the strobe flash sync terminals are correctly polarized.

Darken the room lights, open the camera shutter and break a lamp bulb with a hammer. The sound of the hammer striking the lamp will trigger the flash, and the picture will have been taken at that instant. Adjust potentiometer R1 for the required sensitivity.

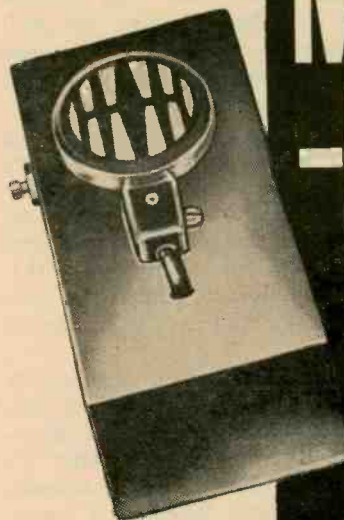
PARTS LIST

- D1—Motorola HEP-154 50-PIV silicon rectifier
- MIC—Ceramic microphone
- R1—5000-ohm potentiometer
- R2—2700-ohm, 1/2-watt resistor
- SCR1—GE C5G silicon-controlled rectifier



MAGIC -MIKE

Use it with any FM set
connected to your PA!
No mike line needed!



by Steve Daniels
WB2GIF

When the FCC opened the FM band to permit legal use of low-powered transmitters for wireless microphones, telemetering and for measurement, they opened a Pandoras Box for many an experimenter. Within the short space of time after the FCC relaxed their regulations, there was a flood of flea-power devices on the market. Some were good, some bad, but most had one basic inherent problem. Body capacity affected the tuning of the device, which, in turn, affected its usefulness.

No doubt about it. For a speaker or performer to be completely free of a fixed position—dictated mostly by the best location for a floor microphone in a PA system—is probably the dream of all would-be orators and very-off-Broadway thespians. So, as soon as the new wireless microphones were introduced, there was a rush to try them out.

It didn't take long before it was discovered that this ideal device was not so ideal. Problem was, when tuned up on the bench, the little devils worked perfectly. But, after the bench tune-up, when concealed in the clothing of a voluptuous young chick, or, for that matter, an uninteresting looking gentleman, the tuning was off.

Just by walking or breathing, the signal quality, as well as its output level changed,

and so at times there was poor sound. Or, no sound at all! This is very disturbing for any performer whose roller-coaster voice levels causes the audience to loose a tomato/egg barrage!

Simple Magic. Our *Magic-Mike* certainly solves the tuning problem and so ultimately solves the major drawback of this equipment. You may well ask what makes *Magic-Mike* so different, especially when we note that a commercially-produced transistorized oscillator is used to generate the signal? Secret is, we added an FET (Field Effect Transistor) buffer stage to the output of the commercial unit. That isolated the tuned elements of the oscillator from the antenna and thereby eliminated the problem of body capacity disturbing the tuning of the oscillator. This buffer stage is comprised of components R1, C1, C2, L2 and Q1. These are wired as an RF amplifier. Transistor Q1 is an *n* channel FET operating in a positive ground circuit which may appear to be a bit unusual.

Microphone Making. Sure, you could wind coils and assemble transistors, resistors and capacitors together into a basic oscillator. But if you're like us—a little on the lazy side—it's much simpler, and cheaper, to buy a commercially-built unit to start your proj-

MAGIC MIKE

ect. We used an Archer model 277-205 FM Wireless Microphone. It's available through *Allied Radio Shack* sales outlets. The module's easier to work with if you use just the printed circuit board without the housing.

Start your module mashery by prying off the bottom plate of the Archer module and removing the printed circuit board with its components from the housing. We mounted this circuit board, along with a $\frac{3}{4}$ X $1\frac{3}{8}$ -in. piece of perfboard (on which the buffer stage components are mounted) and the battery, microphone element and power switch into a 4 X $2\frac{1}{8}$ X $1\frac{1}{8}$ -in. bakelite utility case supplied with aluminum cover panel.

Drill mounting holes for the switch, the microphone, the antenna, the circuit board, and the battery clamp in the plastic utility case. You can see the arrangement we used in the photos. The layout isn't critical; however, we suggest you use the basic arrangement shown in the photos to simplify the construction project.

The crystal lapel microphone was fitted with a metal spring clip that can be bent to pass through a hole in the bakelite face of the utility cabinet. The clip's then crimped to hold the microphone in position. A scrap of aluminum was pressed into service as a battery clamp, holding it tightly inside the case.

The perfboard is mounted on two 6-32

machine screws with $\frac{1}{4}$ -in. spacers raising it off the surface of the case. The printed-circuit board is suspended from the perfboard by soldering a stiff solid wire lead and capacitors C1 and C2 to circuit connecting points between them.

Buffer Stage Assembly. Drill mounting holes in the perfboard to match the spacing of the mounting bolt holes you drilled in the plastic case. Mount three push-in pins on the free end of the perfboard for mounting and making connections to the FET (Q1). Resistor R1 is mounted between the pins that connect to the *gate (g)* and *source (s)* pins of Q1.

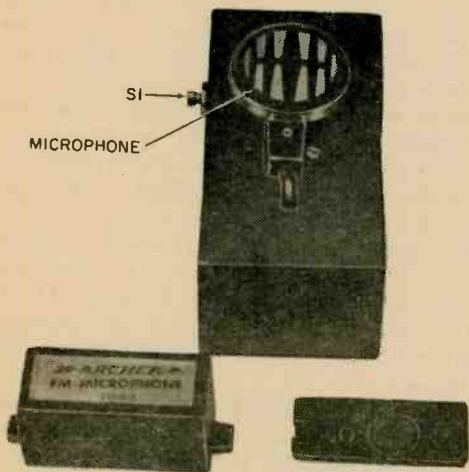
Next comes coil L2, which is made by winding $3\frac{1}{2}$ turns of #22 bare copper wire on a $\frac{3}{16}$ -in. diameter. Use a $\frac{3}{16}$ in. diameter dowel rod to form the coil. After it's wound, spread it out and solder the antenna lead to the center turn. When these operations have been completed remove the dowel rod and discard it. After winding the coil the turns should be spread apart so that total length of the coil is $\frac{5}{16}$ -in.

Solder coil L2 directly to the leads of capacitor C2 and cut off any excess coil lead wire. One end of C2 is connected to the *drain (d)* of Q1, and the other end is soldered to the 9V plus terminal on the printed circuit board that connects to the center tap of the coil (L1) on this circuit board. Except for the minus battery lead which is run from one side of the power switch to the *source (s)* terminal of Q1, the buffer stage is now finished.

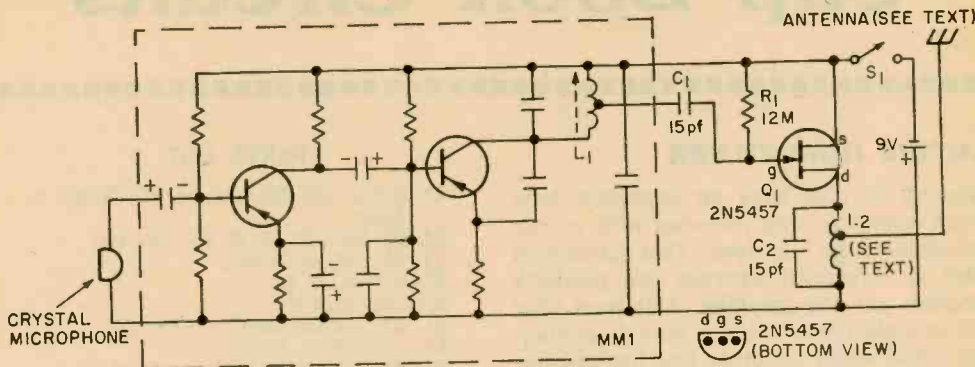
The only other connections required to complete the project are your microphone and the plus battery leads. The shielded microphone cable supplied is cut to a length of about 2-in. Skin back the shielding about $\frac{1}{2}$ -in. Then connect the center lead of this cable to the proper tab on the Wireless Mike module printed circuit board. The shield of the mic cable is soldered to the ground bus at this same end of the pc board.

The 9V battery connector is soldered to the assembly so that the red wire (plus lead) is connected to the tab on the printed circuit board where you connected C2. The black lead (minus lead) is soldered to one side of the power switch.

Now that the hard (?) work has been completed, there's little left to do. Fasten the perfboard assembly and printed circuit board to the case. Then mount S1 into the hole you drilled for it, insert the battery and you're ready to test *Magic-Mike*.



Heart of our Magic-Mike is FM wireless mike module shown with its cover on. We removed pc board from case to make easier assembly.



PARTS LIST FOR MAGIC-MIKE

- B1**—9V Battery (Eveready 216 or equiv.)
- C1, C2**—15 pF, 1000V ceramic disc capacitor (Lafayette 32F01514 or equiv.)
- L2**—3½ turns #22 bare copper wire (see text)
- MM1**—FM wireless microphone module (Allied Radio Shack 277-205 or equiv.—see text)
- Q1**—n channel FET, Motorola MPF103 or HEP 801 or 2N5457
- R1**—12,000,000-ohm, ½-watt carbon resistor

- 1—4 X 2 1/8 X 1 5/8-in. plastic mini utility box with aluminum panel (Lafayette 99F80780 or equiv.)
- 1—Battery connector (Allied Radio Shack 270B325 or equiv.)
- 1—Crystal lapel microphone (Allied Radio Shack 33B100 or equiv.)

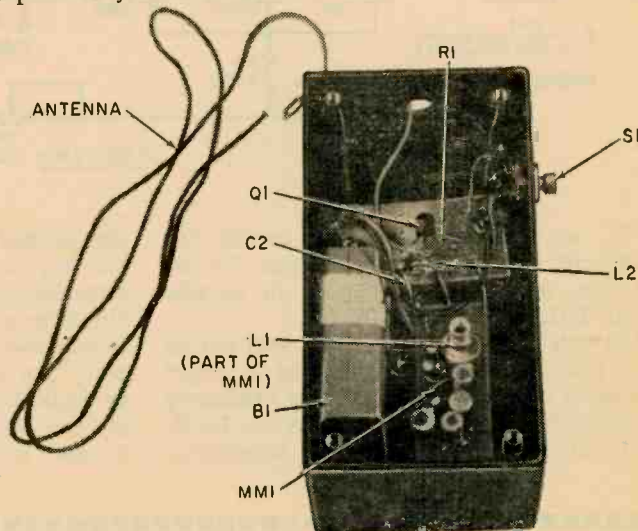
Misc. Wire, solder, bolts, nuts, spacers, perfboard, push-in terminals, aluminum strip for battery clamp, etc.

One thing not mentioned—the antenna discussed above—is soldered to the center tap of coil L2. It should be made from a piece of #22 stranded wire about 18-in. long. You might try points other than the exact physical center of coil L2 as the final connection point for the antenna. A spot a little ahead or perhaps behind the midpoint may produce a better signal.

So okay, already, how does a smart operator like you groove on *Magic-Mike*? Just follow the

instructions that come with the Archer module! We haven't changed the module's basic how-it-works principles. All we've done is to provide a means of eliminating one of the principle drawbacks inherent in all of these units. Namely, the problem of a chick's body capacity broadly detuning the oscillator. ■

It's easier to follow our layout although circuit isn't critical. If you want to make it small enough to hide in performer's clothes go ahead and try it. The case we used may be a little too deep.



Clip Book Circuits

ACTIVE HUM FILTER

Ever try to play back an important tape which somehow was recorded with an objectionably high hum level? This active hum filter is connected between the playback recorder and the amplifier. This hum filter will sharply notch out the hum frequency, with little effect on other low frequencies. The notch filter itself consists of components R1/R2/R3/R4 and C2/C3/C4. The values shown are for a 60Hz filter. If your tapes contain hum of a different frequency, say for example, 50Hz, the proper values for capacitors C2/C3/C4 (which are all the same value) can be calculated from the formula given.

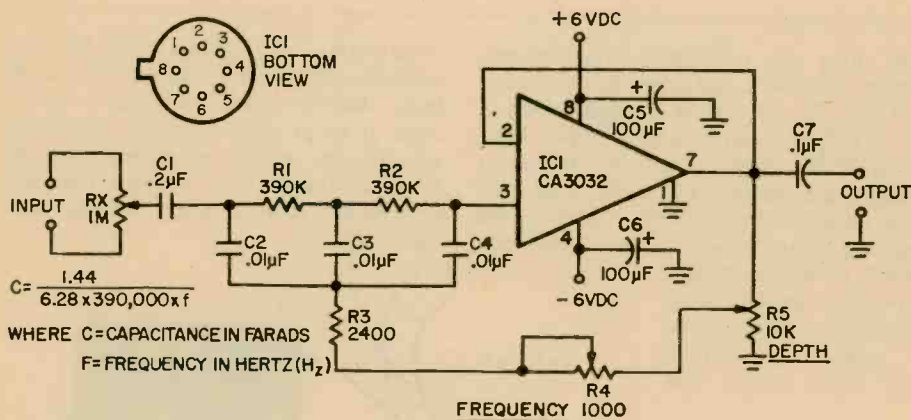
Simply plug into the formula the new value for frequency "f". The answer is in Farads. If you come up with an unusual value for

PARTS LIST

- C1—0.2 μ F, 100 VDC tubular or 75 VDC disc or Mylar
- C2, C3, C4—0.01 μ F, 25 VDC, see text
- C5, C6—100 μ F, 6 VDC
- C7—0.1 μ F, 25 VDC
- IC1—RCA CA3032
- R1, R2—390,000-ohms, 1/2-watt, 5%
- R3—2,400-ohms, 1/2-watt, 5%
- R4—Potentiometer 1,000-ohms linear taper
- R5—Potentiometer, 10,000-ohms linear taper
- Rx—Potentiometer, 1 megohm audio taper

and the self-oscillation point. Adjust R5 for maximum hum suppression.

Potentiometer Rx is needed only if there is no way to control the level of the input signal to prevent overload. If the playback recorder has an output level control, Rx is



$$C = \frac{1.44}{6.28 \times 390,000 \times f}$$

WHERE C=CAPACITANCE IN FARADS

F=FREQUENCY IN HERTZ (H_z)

"C", such as 0.08 μ F, simply parallel two capacitors to get the proper value. For example, a 0.05 μ F capacitor in parallel with 0.03 μ F equals 0.08 μ F.

The notch filter's components need not be of precision tolerance because a slight amount of tuning is provided by Frequency control R4. Potentiometer R5 is the Depth control; it sets the degree of attenuation

not needed. Also, remember to connect one lug of Rx to system ground if the potentiometer's used.

The filter's input can be connected either to line level outputs or across speaker outputs. The filter's output should be loaded by 50,000 ohms minimum. The power supply can be two 6V Z4-type batteries in a bi-polar arrangement.



LEARNING NEW TRICKS FROM AN ANCIENT RIG

**GRANDPA'S LOOSE COUPLER
IS ALIVE AND WELL AND STORMING
OUT OF WIRELESS' GOLDEN PAST /by Art Trauffer**

MANY Americans could vividly remember Lee's surrender of Appomattox when the Age of Wireless was born. As an infant industry, it was weaned by some of the foremost scientists of the day—and countless home-bound experimenters all eager to stretch their ears across the cold, blue Atlantic.

But unlocking the mysteries surrounding this electric infant proved to be a difficult task. It was comparatively easy for scientists to theoretically prove the existence of radio waves in their laboratory. But extracting RF energy from a noisy, spark-belching transmitter was a task beyond most experimenters' abilities.

And receiving gear fared no better on the home-brew front, either. Most rigs depended heavily upon the vagaries of nature to bring man-made ethereal energy down to mile-long antennae. Fact is, much of radio's earliest experimental work was the result of sheer dumb luck! But theory would soon outpace the rabbit's foot with the introduction of a deceptively simple radio frequency tuning device.

The loose coupler is radio's classic tuning device from the heyday of wireless. We don't know exactly who invented it, but we do know that it was one of the most commonly used pieces of gear found in any

well-stocked radio lab—or living room—between the years 1900 and 1922. Perhaps the loose coupler evolved from the combined efforts of several pioneer experimenters. Yet nobody really seems to know for sure; records tell us that the device was manufactured commercially, and home-brewed by most of radio's earliest enthusiasts.

Loose couplers, or receiving-type transformers, as they were also called, are now considered by most collectors of antique radio gear to be in the most-sought-after category. The few remaining models are in museums and painstakingly-assembled private collections.

But unlike other equally-extinct relics from the Wireless Age, you can easily build a replica of the loose coupler. Here's the best way you can recreate for yourself the earliest radio-frequency experiments of the pioneers of wireless. And, as a conversation piece harking back to the dawn's early light of radio's history, the loose coupler is an attention-getter from both Aquarian audiophile and micro-circuit oriented amateur alike!

Grandpa's Energy Grabber. Arizona was still a decade away from statehood when syntony (radio's earliest term describing coil tuning) was stumbled upon. But Grandpa

Loose Coupler

didn't know about coils and capacitors as we know of these tuning components today. He lashed together various forms of brass tubing, Leyden jars and even variable resistors, in an effort to vary the frequency of cumbersome, spark-spitting transmitters and yard-long receivers.

Finally, gramps hit upon the idea of winding a continuous copper wire around a shellacked cylinder, and tapping the coil's wire every ten turns or so. The wire taps were sent to a variable switch; this method was used until someone figured they could build a better radio frequency trap. By winding the same coil on the same cylinder, but substituting a sliding tap for the fixed taps, radio's earliest experimenters found they could wring even more selectivity from the coil. Some of the more intricate slide tuners boasted up to three sliders, but the slider would wear out the coil wire, depositing copper between the turns.

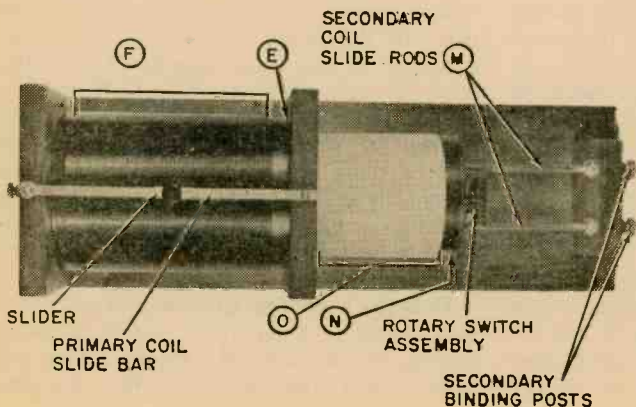
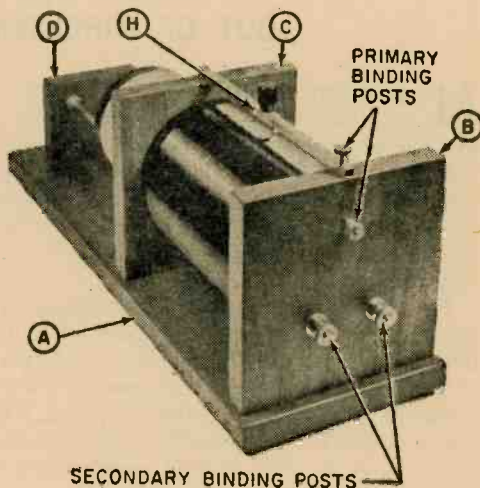
Perfection—as radio's early experimenters thought of it—arrived on the spark-gap-galena-detector scene as the two-circuit, or "loose coupler." No longer was it completely necessary to rely solely upon the vagaries of insulating-today, shorted-tomorrow copper wire insulation. Here was a tuning device that transferred received energy from the antenna circuit to a secondary circuit without actual electrical contact. As you can see by our photos, this device has two cylindrically shaped coils of wire, each wound on tubes of insulating material.

The secondary coil is mounted so it can slide in or out of the primary coil with just enough clearance between the two coils.

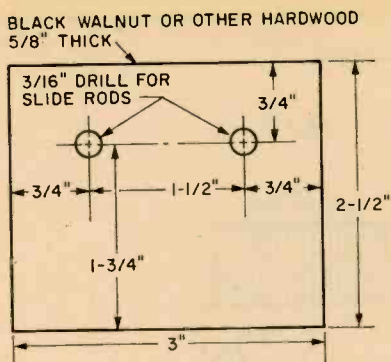
The chief advantage of the loose coupler over fixed, tapped inductances was that the inside coil (in this case, the secondary coil) could be moved with respect to the stationary coil, or primary coil. This effect was first called "coupling" and the name stuck. When the secondary coil was pulled away from the primary coil, it was "loosely coupled." When the experimenter pushed both coils together, the device was then "tightly coupled." By altering the relative positions of the coils within one another, the overall receiver selectivity could be increased or decreased at will.

Slide Bars and White Shellac. The loose coupler described is very similar to the typical couplers of way back when. But, as you build the coupler, you might want to make some minor changes according to the materials you are able to beg, borrow or make.

Let's start with the coupler's foundation, or baseboard, first. The author found a piece



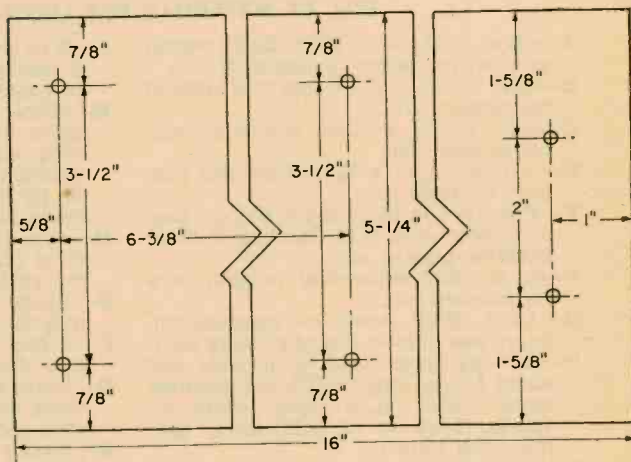
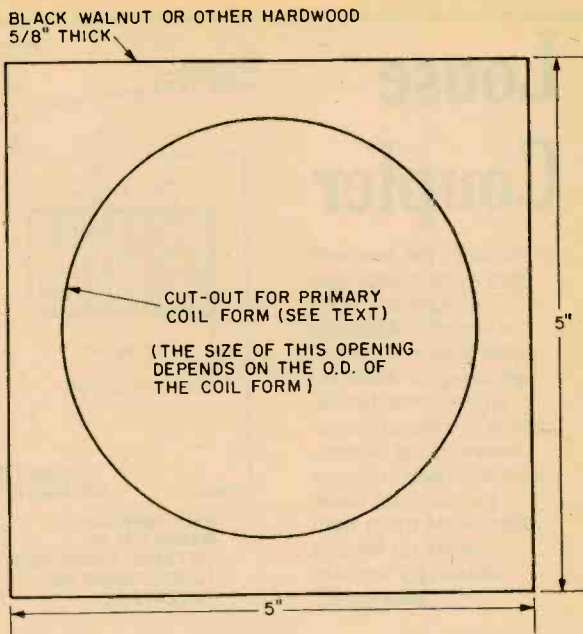
Circled letters in both pictures refer to parts described in Bill of Materials. Comparing loose coupler in both pictures, you'll note that secondary coil binding posts are located on both front, rear end supports. If you don't need second set of binding posts, omit posts on front end support; substitute hex nuts of proper size in their place.



FRONT END SUPPORT
 Correct spacing is vital for secondary tube alignment with primary tube form. Best bet is to place front end support block in C-clamp wood vise; temporarily fasten vise to flat bed of drill press before proceeding to bore holes.

CENTER SUPPORT
 You'll need hole saw, electric drill in order to accurately cut out hole for primary coil form. First bore starter hole in wood with 1/16-in. drill, then proceed to cut hole in wood with hole saw.

BASEBOARD
 Dimensions given in picture to right are for baseboard. As with other wood supports, accurate hole location is extremely important. We suggest you treat baseboard, other wood supports with liberal coats of varnish to prevent warping.



of 5/8-in. solid black walnut for this part, as well as for the three upright supports.

As our drawings show, all visible surfaces of the wood were sanded smooth. Sharp corners and edges were slightly rounded off with a mill file and finished with a medium grade of sandpaper. As a final fillip, all walnut pieces were stained and hand rubbed with facial tissues to bring out the wood grain.

After you've cut the wood base and upright pieces, and finished them to your liking, you'll probably want to make both primary and secondary coils next. The author found a cardboard container with an outside dimension of four inches. Try

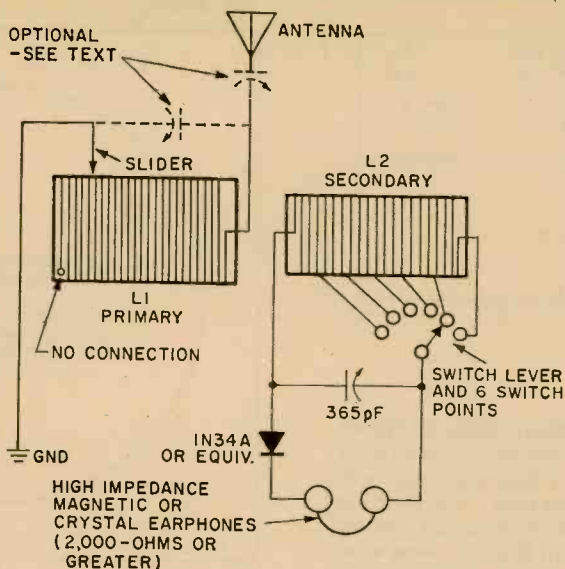
art supply companies or drafting firms in your search for a similar coil form.

The secondary coil form is a piece of 3 1/8-in. cardboard tube originally used to ship large sheets of photo paper. After the tube was cut to size, it was given a coat of white shellac, and allowed to dry before winding the secondary coil onto it. If you can obtain Bakelite or plastic tubes of these sizes, go ahead and use them.

Starting with a half pound of #22 enamelled magnet wire, you'll closely wind 175 turns of the wire onto the primary form. It doesn't make any difference which direction you wind the coil; the important point to remember is that the coil must be

Loose Coupler

You can't tell how well this rig performs just by gawking at its schematic! Although substitution of 1N34A germanium diode for galena detector detracts in eyes of homebrew-or-bust purists, improved performance gained from solid-state diode more than makes up for this seemingly modern "oversight."



BILL OF MATERIALS FOR LOOSE COUPLER

- A—16-in. x 5 $\frac{1}{4}$ -in. x $\frac{5}{8}$ -in. black walnut or other hardwood (baseboard).
- B—5-in. x 5-in. x $\frac{3}{8}$ -in. rear end support for primary coil.
- C—5-in. x 5-in. x $\frac{5}{8}$ -in. center support for primary coil.
- D—3-in. x 2 $\frac{1}{2}$ -in. x $\frac{5}{8}$ -in. front end support for slide rods.
- E—Primary coil form about 6 $\frac{3}{8}$ -in. long and about 4-in. O.D. Cardboard, fiber, bakelite, plastic, etc.
- F— $\frac{1}{2}$ -lb. #22 enamelled magnet wire for primary coil.
- G— $\frac{1}{4}$ -in. thick wood or composition-board disc (fits in end of primary coil).
- H—Springy brass band $\frac{3}{8}$ -in. wide and about 1 $\frac{1}{2}$ -in. long; 6-32 brass machine screw about $\frac{3}{8}$ -in. long; small insulated knob to fit 6-32 screw (primary coil slider).
- I—Binding post for primary coil slide bar: 6-32 rh brass machine screw 1 $\frac{1}{4}$ -in. long; brass hex nut to fit; round knurled brass nut to fit.
- J— $\frac{5}{8}$ -in. rh steel wood screw (holds slide bar to wood center support).
- K—Binding post for primary coil: 6-32 rh brass machine screw 1 $\frac{1}{2}$ -in. long; soldering lug to fit; two brass washers to fit; brass hex nut to fit; round knurled brass nut to fit.
- L—6 rh wood screws about 1 $\frac{1}{4}$ -in. long; 6 washers to fit (hold wood upright to baseboard).
- M—Slide rods for secondary coil: two pairs of $\frac{3}{16}$ -in. dia. brass curtain rods cut 16 $\frac{1}{2}$ -in. long; eight lock-washers to fit; eight brass hex nuts to fit 10-24 threads; four round knurled brass nuts to fit 10-24 threads.
- N—6-in. L x 3 $\frac{1}{8}$ -in. O.D. secondary coil form (cardboard, fiber, bakelite, plastic, etc.).
- O— $\frac{1}{2}$ -lb. #26 cotton-covered enamelled magnet wire for secondary coil.
- P—2 end discs for secondary coil form (see drawing).
- Q—Brass tubing to fit over $\frac{3}{16}$ -in. dia. brass rod (sleeves for secondary coil slide rods).
- R—Switch lever: 5/16-in. dia. brass rod $\frac{3}{4}$ -in. long; 6-32 rh brass machine screw about 1 $\frac{3}{4}$ -in. long; three brass washers to fit; small compression spring; springy brass band for making switch lever blade; insulated knob to fit 6-32 screw.
- S—6 switch points for switch lever (make from 6-32 rh brass machine screws $\frac{3}{4}$ -in. long, with brass hex nuts to fit). Four rubber tack bumpers for bottom of baseboard.

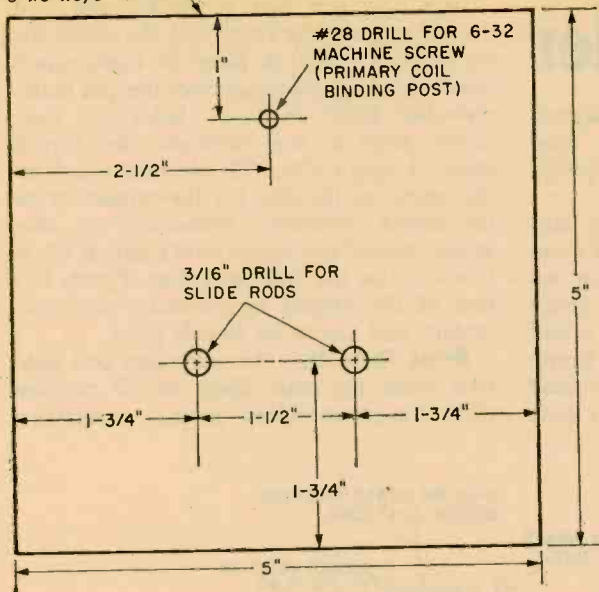
close wound with *no spaces* between the wires.

The secondary coil will need a bit more finagling. After the coil form's been shel-lacked, start by winding the secondary with #26 single-cotton-covered enamelled magnet wire. As with the primary coil, you'll need

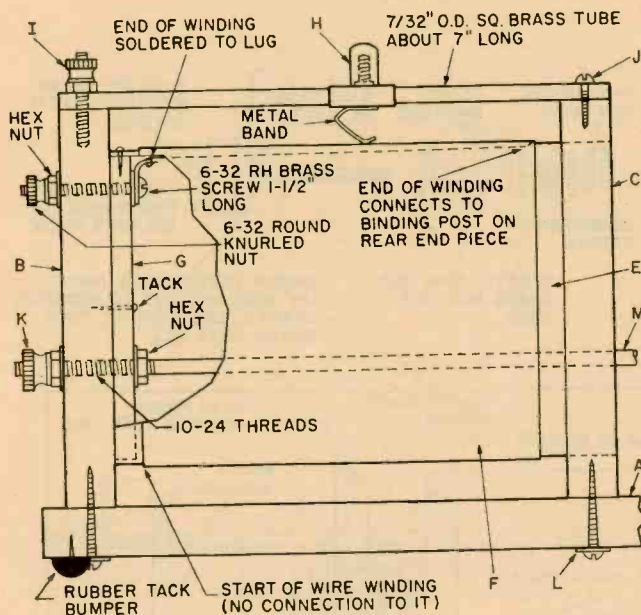
about a half pound of wire for the secondary coil.

Note, however, that the secondary coil is tapped once every 46 turns. Each tap terminates at a separate rotary switch position. Noting our drawing, you'll find this homebrew rotary switch located on the secondary

BLACK WALNUT OR OTHER HARDWOOD
5"x5"x5/8" THICK



Rear end support for primary coil, slide rods is bored, finished with same methods described for other wood pieces. Black walnut stock, while not necessary for loose coupler's performance, adds to unit's good looks—especially when wood's hand rubbed with many coats of stain, then finished off with elbow-grease-furniture-polish treatment. But if one piece of wood looks like any other to you, then by all means hack up plywood stock. We promise not to snitch.



Detailed cutaway of primary coil mounting technique. Note square brass tube in picture—it's what author used for his loose coupler. If you can't find similar brass tubing, cut up third curtain rod as instructed in text, construct primary coil brass band (part H) to wrap snugly around it.

coil's front plate. Be sure to leave a sufficient length of wire at the beginning of the secondary winding so you can solder it to a brass slider sleeve. The end of this winding is soldered to position 6 on the rotary switch.

Homebrew Twister. Don't be frightened

away from this project merely because you've never built your own switch assembly before. After, all grandpa didn't have mail-order-catalog parts ordering convenience in his day. If he could make a rotary switch, well, by jiminy, so can you.

First step's rounding up the parts you'll

Loose Coupler

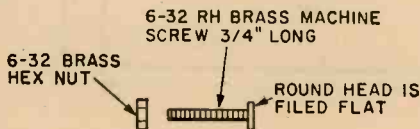
need; then look at our rotary switch diagram for the sequence construction. The most difficult part of this build-it switch is making the actual switch points.

Start by putting half a dozen hex nuts onto each 6-32 x 3/4-in. Round Head brass machine screw. Holding the nut/screw assembly in a machine vise, you file the screw top parallel to the screw's body with a mill file. The nuts serve to hold the screw firmly in place in the vise. After each screw head has been filed flat, smooth them with a sheet of fine emery cloth.

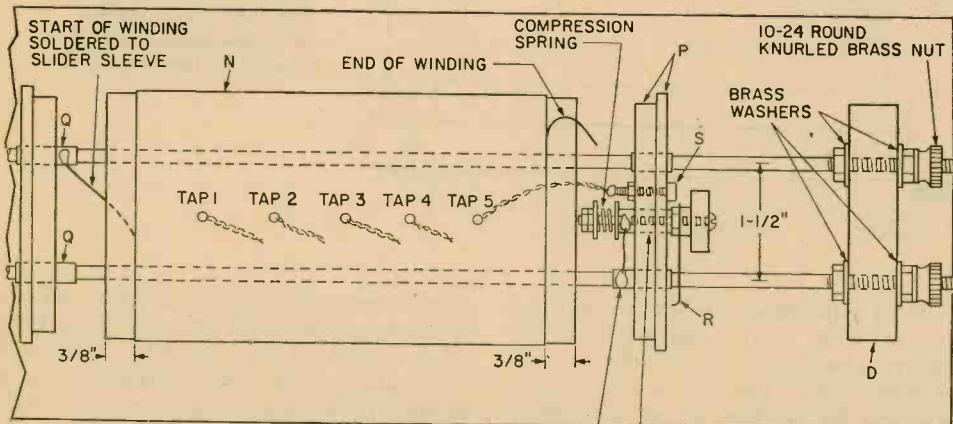
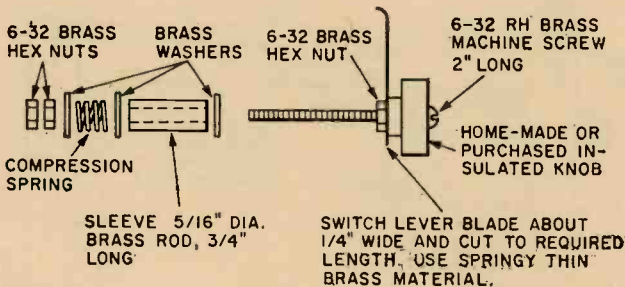
Now cut out two secondary coil end discs; one's for the front and the other sits on the coil's rear. A piece of composition board or 1/4-in. plywood does the job material-wise. Drill six 1/8-in. holes for each switch point as our front-end disc layout shows. Using a #28 drill, you bore a hole in the center of the disc for the remainder of the switch assembly. Following our diagrams, mount the entire rotary switch kit 'n kaboodle on the front-end disc. Finish this part of the project by soldering each secondary coil tap to its switch point.

Brass Rails. Buy the secondary coil slide rods from the least likely of all possible electronic construction project sources—a

Picture to right shows sample switch point, exploded view of rotary switch. While this phase of loose coupler's construction isn't difficult, it separates do-it-yourself men from store-bought boys. All parts required for home brewed switch can be bought in any well-stocked hardware store; any non-shorting rotary job intended for radio frequency switching'll do if you want to take easy way out. Bottom pix shows secondary coil's method of mounting. Note end of winding; it doesn't terminate at any rotary switch point.



SWITCH POINTS (6 REQ.)

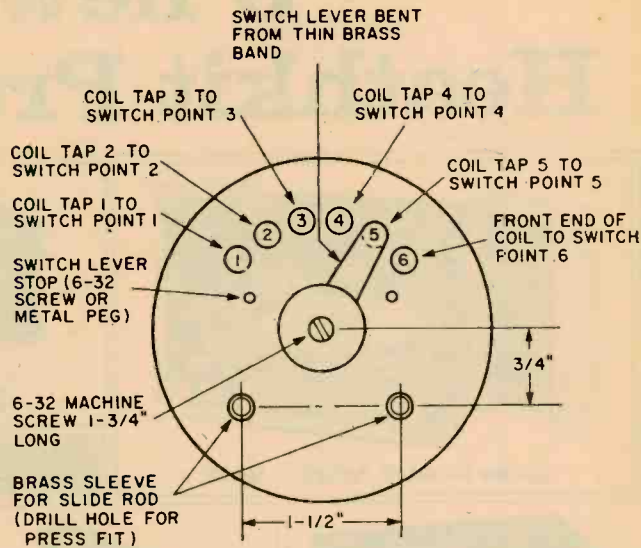


NOTE: FOR CLARITY, ONLY ONE SWITCH POINT IS SHOWN ON FRONT-END DISC.

WIRE LEAD SOLDERED TO SLIDER SLEEVE TO SLEEVE OF SWITCH LEVER SHAFT

SLEEVE FOR SWITCH LEVER. 5/16\"/>

Layout for hardware on front end disc. Note holes for brass sleeves—they must be positioned accurately, then drilled perpendicularly to front disc. Otherwise, secondary coil might not slide completely into primary coil.



dry goods store! Ask for two pairs of $\frac{3}{16}$ -in. diameter, brass curtain rods, each rod at least 18 inches long. Cut two rods down to about $16\frac{1}{2}$ -in. overall length, threading each with a 10-24 die.

The length of the rod's threaded portion isn't critical; two inches on both ends of each rod does the trick. And you'll probably want to drill the end support holes for both slide rods slightly oversize. Reason is this insures that the secondary coil assembly will glide smoothly over the rods when they're adjusted. (Otherwise, any mechanical eccentricity in either pair of end supports or slide rods can't be corrected, and you won't be able to push the secondary coil more than halfway into the primary coil). Assemble both secondary rods and secondary coil tube form as our diagram shows. After you've aligned the rods, tackle the primary coil slide tube.

The author fabricated his primary coil slide tube from a piece of $\frac{7}{32}$ -in. O.D. square brass tube. But for simplicity's sake, make your tube from another length of curtain rod.

After cutting a rod down to seven inches, you drill a hole in both ends. Then fasten the slider to both end supports as shown. Although the author made his own primary tube slider, it's a heck of a lot easier if you made your slider from the same brass material you need for the secondary coil slider.

Countdown to Hookup. By now you should be well on your way toward com-

pleting your loose coupler's construction. And by now you've also strung up a *very long wire antenna*—that's one of the keys to a loose coupler's success.

Referring to our schematic of the complete receiver, you'll see that the loose coupler appears as a crystal rig. You're right! While it looks like a free power rig's schematic, the loose coupler far outpaces the ordinary crystal radio by virtue of its super-selective secondary coil. And, with a 365 picofarad variable capacitor tied across the coupler's secondary coil, you can tune this rig between .2 MHz and 300 kHz. No superhet can match this kind of bandsread in one sweep of its tuning knob!

Although the loose coupler is a reasonably sensitive and selective rig as we've presented it, you can extract outstanding performance from it by adding two variable 365 picofarad capacitors. The first capacitor is soldered in parallel with the primary coil. And the second pico-picker is thrown in series with your antenna's hot lead. Now you can resonate both primary coil and antenna wire, respectively.

Many of you have never built a golden oldie like this one, so we suggest that you get the hang of this rig by starting out with the most basic circuit we've shown. After you've mastered the fundamentals, proceed to soup up your loose coupler's performance with the capacitors we've mentioned. And then get set for some of the most exciting DX performance this side of an Audion tube! ■

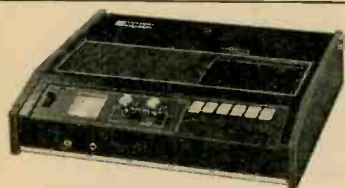
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Retail Heathkit Electronic Center prices slightly higher to cover shipping, local stock, consultation and demonstration facilities. Local service also available whether you purchase locally or factory mail order.

...see 350 more in our new free catalog



(A) The new Heathkit Stereo/Phonograph with AM Radio gets it together in a portable package with a purple plum snake skin that's as far out as today's sounds. Solid-state 18-watt amplifier, fold-down 4-speed automatic changer and swing-out high compliance speakers make it even better heard than seen. Speakers can be placed up to 5' away for maximum stereo separation. A flip of the mode switch and you're into AM radio! 45 spindle adapter included.
Kit GD-111, 50 lbs. **109.95***

(B) The new Heathkit solid-state Shortwave Receiver is the perfect introduction to the world of shortwave listening. Four overlapping bands provide continuous coverage from 550 kHz to 30 MHz, giving you local AM plus international, amateur, marine & weather and citizens band broadcasts. Features bandspread tuning for close station separation; BFO control for receiving code; signal meter; front-panel headphone jack; noise limiter; built-in AM antenna.
Kit SW-717, 10 lbs. **59.95***

(C) The New Heathkit Stereo Cassette Recorder, with a typical frequency response ± 3 dB, 30-12 kHz, brings your stereo system into the cassette age. Features include a built-in bias adjustment to accommodate the new chromium dioxide tape; counter; automatic motor shutoff; preassembled and aligned transport mechanism. The AD-110 permits full fidelity recording and playback of stereo or monaural through any quality hi-fi system.
Kit AD-110, 10 lbs. **119.95***

(D) New Heathkit Automotive Timing Light has a flash so bright you can set up your car's ignition in the sunshine. Completely self-contained, just hook up 2 cables to the battery, 1 to the number one spark plug. A special adapter that permits connection to the distributor is included for cars with hard-to-reach plugs. Features balanced pistol-grip housing of high impact plastic that's impervious to oil, gas and corrosion — protects you from electrical shock.
Kit CI-1020, 2 lbs. **19.95***

(E) New Heathkit Stereo-4 Decoder — It's the soundest approach to 4-channel reproduction yet! Compatible with your present stereo system and FM receiver, it lets you hear all Stereo-4 material currently being broadcast by a number of stations across the country. Additionally, it imparts a 4-channel effect to your existing stereo library. Requires second amplifier and 2 speaker systems for installation with conventional stereo system.
Kit AD-2002, 4 lbs. **29.95***

(F) New Heathkit Solid-State Wireless Intercom — plug two of them into standard 105-130 VAC outlets in your home and you have a 2-way communications system! Three-channel capability lets you carry on 3 separate conversations in a 6-unit system, call one unit without disturbing the others in a 3-unit network. Individual intercoms have channel selectors, spring-loaded "talk" button, slide-action volume control, and "dictate" for extended one-way communication.
Kit GD-113, 5 lbs. **29.95***

(G) New low cost Heathkit Garage Door Opener with all the heavy-duty features: strong chain-drive mechanism, 1/4-hp motor, automatic light, automatic safety reversing. Pocket size transmitter and solid-state receiver come preassembled, ready to use. The GD-309A easily operates all conventional single or double overhead doors up to 8' in height. Kit includes wall-mount switch, 1 transmitter, 1 receiver and door-opening mechanism.
Kit GD-309A, 43 lbs. **99.95***
Kit GD-309B, (w/2 transmitters) 43 lbs. **114.95***
Kit GDA-309-1, (mech. only) 41 lbs. **69.95***

(H) The New Heathkit Electronic Switch provides simultaneous visual display of 2 input signals on a single trace oscilloscope. Has DC coupling and DC-5 MHz ± 3 dB frequency response. Conventional binding posts permit fast hook-up, and the ID-101 can be left connected to scope at all times, if desired. The ID-101 is ideally suited for digital circuit work; amplifier input and output for gain and distribution checks; simultaneous monitoring of 2 stereo channels.
Kit ID-101, 6 lbs. **39.95***

(I) The New Heathkit Automatic Battery Charger is a lifesaver for 12-volt batteries in boats, farm equipment or infrequently used cars. Just plug into a standard 105-130 VAC outlet, hook up the positive and negative cables and leave it! It's virtually impossible to hook up wrong. If wires are crossed it simply won't start up. The GP-21 brings the battery to full charge then shuts down, maintaining just enough current to compensate for normal leakage. There are no charge settings to adjust, and you can leave it hooked up indefinitely for a fresh start every time!
Kit GP-21, 13 lbs. **29.95***

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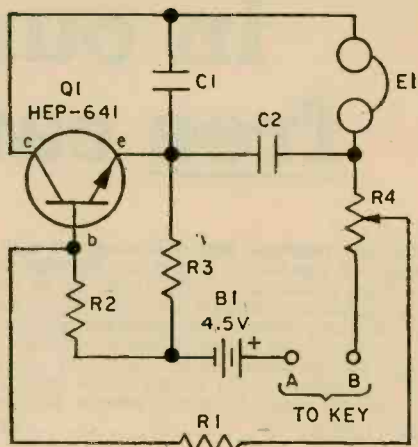
*Mail order prices; F.O.B. factory. **CL-113**
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PARTS LIST

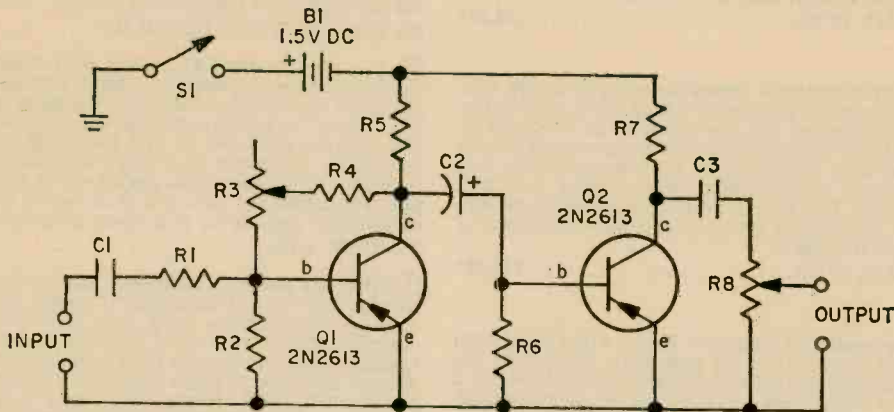
- B1—4.5-V battery
- C1—0.02- μ F, 10-VDC capacitor
- C2—0.22- μ F, 10-VDC capacitor
- E1—2000-ohm magnetic earphone
- Q1—HEP-641 npn transistor (Motorola)
- R1—2700-ohm, $\frac{1}{2}$ -watt resistor
- R2—1500-ohm, $\frac{1}{2}$ -watt resistor
- R3—27,000-ohm, $\frac{1}{2}$ -watt resistor
- R4—50,000-ohm potentiometer



Components you have lying about might make this simple, budget CPO (code practice oscillator). Using component values given, the tone frequency is approximately 800 Hz. It can be changed by substituting different values for C1 and C2, but maintain the same capacity ratio. That is, C2

should always be about 10 times larger than C1. Battery current drain is only about 1 milliampere.

FANTASTIC FUZZBOX



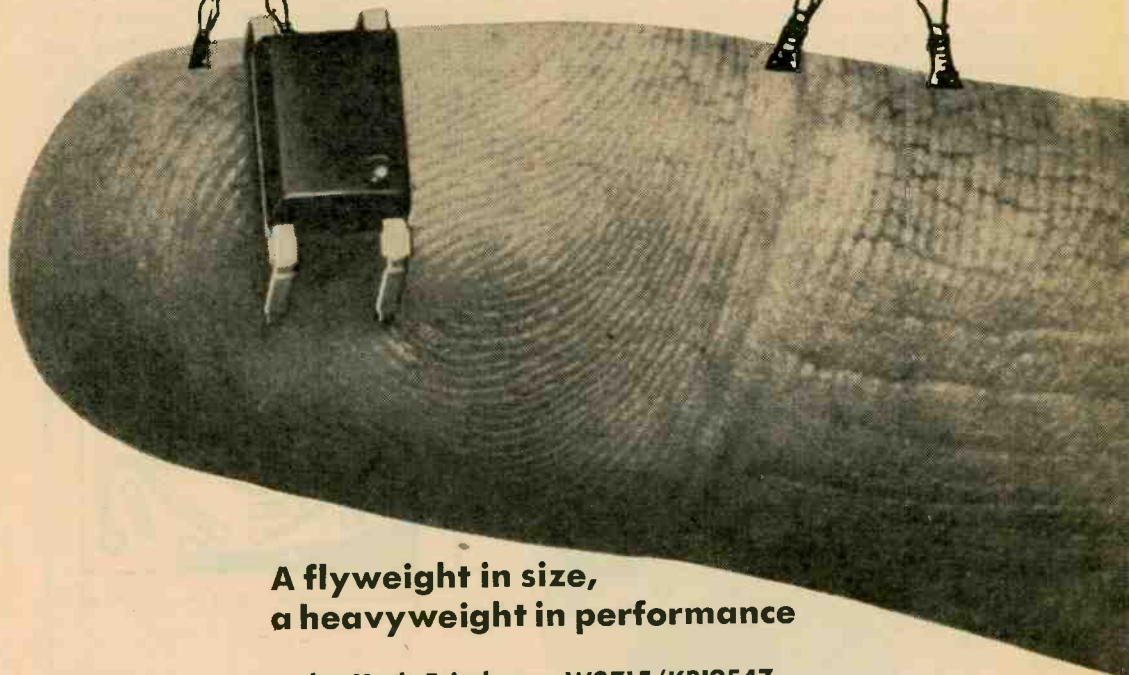
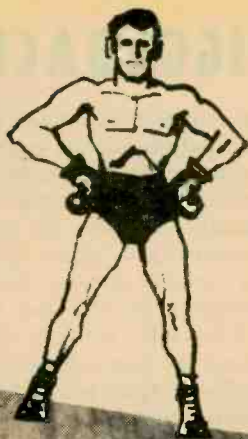
Add that 'way-out NOW sound to any electric guitar by connecting the Fuzzbox between your guitar and amplifier. Potentiometer R3 sets the degree of fuzz, R8 the output level.

Since the fuzz effect cannot be completely eliminated by R3, fuzzy-free sound requires a bypass switch from the input to output terminals. The switch should completely disconnect the fuzzbox output; the input can remain in parallel with the bypass switch.

PARTS LIST

- B1—1.5V AA battery
- C1, C3—0.1- μ F, 3-VDC capacitor
- C2—5- μ F, 3-VDC electrolytic capacitor
- Q1, Q2—2N2613 pnp transistor
- R1, R6—22,000-ohm, $\frac{1}{2}$ -watt resistor
- R2—18,000-ohm, $\frac{1}{2}$ -watt resistor
- R3—1-megohm potentiometer
- R4—100,000-ohm, $\frac{1}{2}$ -watt resistor
- R5, R7—10,000-ohm, $\frac{1}{2}$ -watt resistor
- R8—50,000-ohm, audio-taper potentiometer
- S1—Spst switch

PIGGYBACK AMP



**A flyweight in size,
a heavyweight in performance**

by Herb Friedman, W2ZLF/KBI9547

CAN you imagine a power amplifier no larger than a fly? It's easy—just mount a fly-sized integrated circuit (IC) on a $1\frac{1}{8}$ x $1\frac{1}{2}$ -in. PC board, and along with it add a single transistor preamplifier. The whole bit adds up to a *complete* amplifier small enough to cement right on the back of the magnet of a small speaker. Depending on the input circuit used, our *Piggyback Amp* can be an intercom, a utility amp, a signal tracer, or even a monitor amplifier small enough to be built into a tape deck.

The possibilities for using Piggyback Amp are endless because its power requirement is only 9 V at a minimum of 3.5 mA idling current, which is easily obtained from a small power supply or 9-V battery for a transistor radio. Our photo shows a typical application, the Piggyback Intercom. The

schematic details the input circuit modification for the basic Piggyback Amp when used as a signal tracer, tape monitor, etc.

Secret of such a wide latitude in application is the power amplifier, a Motorola integrated circuit (MFC4000). As shown in our photo, the IC takes up no more room on the tip of your finger than a fly, measuring just $0.26 \times 0.21 \times 0.14$ -in. (HWD). Yet small as it is, this IC develops an output signal up to 250 mW into 16 ohms—that's about equal to a fairly loud transistor radio. The MFC4000 IC consists of an output stage with drivers and an input amplifier stage for a total of six transistors. Five resistors and three diodes are also packed into its fly-sized case.

Unfortunately, you can't get everything for nothing. The MFC4000 requires 150 mV

PIGGYBACK AMP

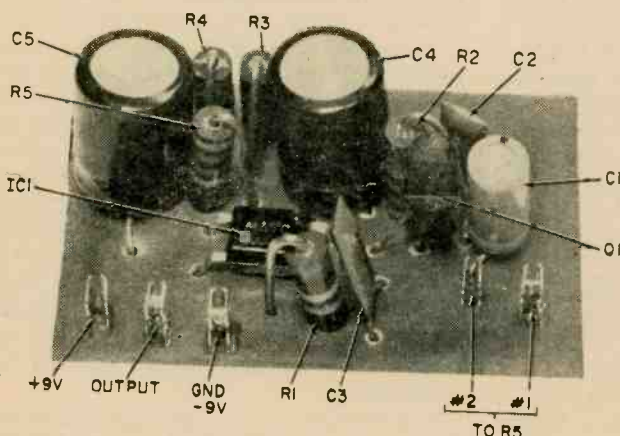
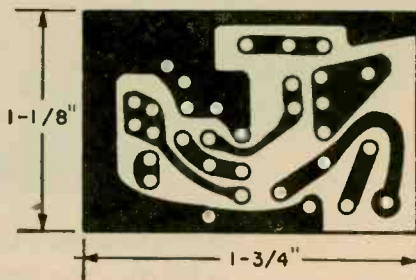
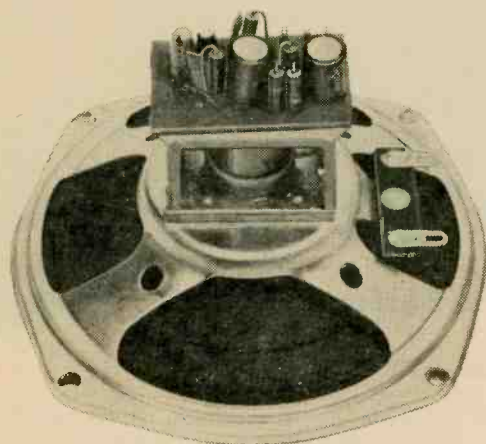
(rms) input drive for full power output. The IC's input impedance appears as 1000 ohms. A preamplifier is needed to increase its sensitivity for universal applications. Our schematic includes the preamplifier stage. Transistor Q1 is biased by R1 and R2 to act as a variable resistor. Bias for IC1's input transistor is derived from its output through the R3/R4/R5 network and Q1.

Since the bias voltage is derived from the amplifier output, the circuit is automatically temperature stabilized. Reason for this is that heating effects on the IC, which result in a change in DC, raise the amplifier's output. Thus the output signal, in turn, controls the amplifier's gain by being fed back to its input. If the DC output voltage attempts to rise because of temperature rise, the feedback to the input biases the amplifier to

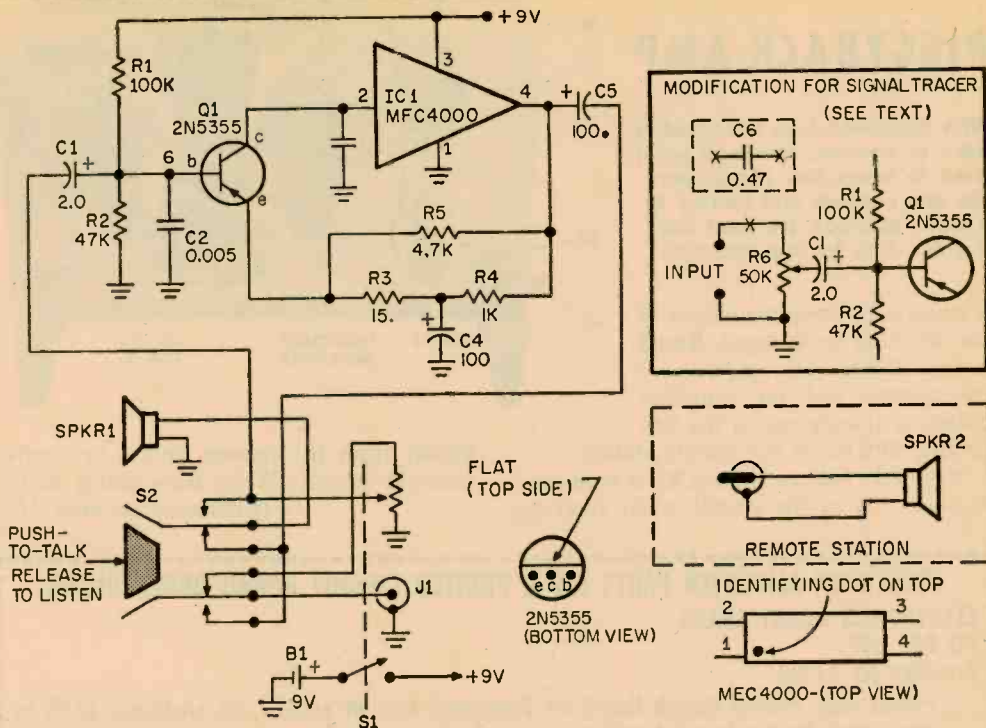
reduce the drive and thus keeps the DC output voltage constant.

Because transistor Q1 is in the feedback loop, you can use just about any pnp *silicon* transistor having gain in the 100 to 300 range (we used a 2N5355). The amplifier will continue to operate even if the power source falls to about 4 volts. Naturally, its output will be lower.

The overall frequency response is established by the capacitance of C5. Response will be essentially flat from 100 to 20,000 kHz when C5 is 500 μ F. Response will be down about 6 dB at 100 Hz when C5 is 100 μ F. However, since Piggyback Amp was intended for use with small speakers which can't reproduce lows, anyway, there's really no need for an oversize and expensive capacitor. Further, if C5's capacity will be greater than 100 μ F, much more will have to be provided on the PC board. Of course, you can use perfboard construction which easily accommodates any size components.



Above—full size pattern for making Piggyback's circuit board. But why bother when factory-made board as well as complete kit of parts for Piggyback universal amplifier can be purchased just by filling out coupon on page 44, thus saving walking and working time. Upper left—see how easy Piggyback Amp fits on back of speaker. Lower left—parts layout for basic amplifier.



Circuit above covers application of Piggyback Amp to a two-way intercommunication system. We've also included a modification when unit is used as signal tracer.

Construction. First step is to order or make the PC board. Easy way out is to order one using our coupon, but those who are venturesome may choose to roll their own. To help we've included a full-scale pattern for etching, and we refer you to page 32 of the September/October 1969 *ELEMENTARY ELECTRONICS* for detailed instructions in the art of etching printed circuit boards.

Drill the holes for the components to be mounted on the board. The IC's leads require a hole made by a #55 drill; the rest of the components need holes drilled by a #58 drill. Type T-28 terminals or flea clips are used for terminating external connections and you'll need a #50 drill for mounting them.

Mount all components, saving the IC for the last. All resistors are end mounted in a position perpendicular to the board; the capacitors are the printed circuit type with both leads on one end. Transistor Q1 is mounted using the full length of its leads. After the T-28 terminals or flea clips are soldered, the excess lead wire protruding through the foil side of the board is cut off.

Final step is to mount the IC.

After doublechecking for correct polarity of capacitors, the orientation of Q1 and IC1, and making sure there are no cold solder joints, you can now cement the PC assembly to the back of a speaker. Use a silicon rubber adhesive such as GE's RTV or Silastic Bathtub Calk. To prevent the leads that stick out from the foil side of the board from shorting to the speaker frame, insulate the bottom of the board with a single layer of plastic electrical tape. Place a small blob of RTV adhesive on the foil side of the board, cover the board with tape, and then apply it against the speaker magnet. Pack the RTV around the edges of the board, using a screwdriver to tamp it down. Allow the adhesive to dry for at least 24 hours.

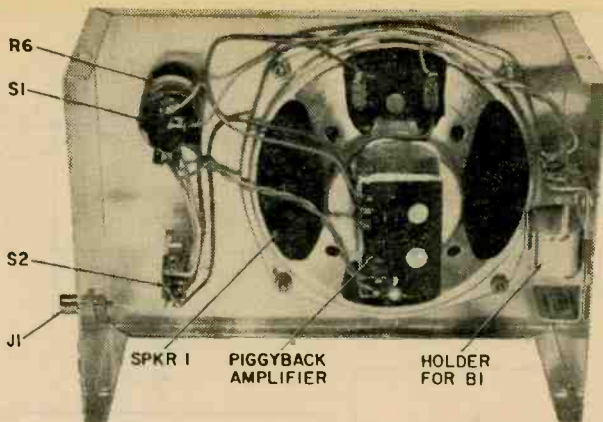
Piggyback as an Intercom. The speaker can be mounted in any convenient enclosure. Talk listen switch S2 is a spring-loaded pushbutton type; the N.C. (normally closed) contacts are the listen connection, connecting remote speaker SPKR2 as the microphone. The sound originating at SPKR2 is amplified by the Piggyback Amp and monitored through SPKR1. When S2 is pushed, SPKR1

PIGGYBACK AMP

With Piggyback Amp cemented to back of speaker, about all you'll need to house this combo plus the few controls and battery is a small Mini-box. We used one 7 x 5 x 3-in. for our intercom.

is transferred from the output of the amplifier to its input. Result is that SPKR1 now serves as a microphone and the amplifier output is transferred to the line feeding SPKR2 at the remote station.

Note that volume control R6 is connected so that it is in the circuit when receiving



signals from the remote station to control received volume. When transmitting to the
(Continued on page 111)

PIGGYBACK AMPLIFIER PARTS KIT & PRINTED CIRCUIT BOARD ORDER BLANK

ELECTRONICS HOBBY SHACK

PO BOX 587

Brooklyn NY 11202

- Please rush Printed Circuit Board for Piggyback Amp at once. I am enclosing \$2.95 to cover costs for the board, handling, and postage.
- Please rush Amplifier Kit (parts that mount on the PC board) at once. I am enclosing \$6.95 to cover costs for the parts, handling, and postage.
- Please rush Printed Circuit Board and Amplifier Kit (parts that mount on PC board) for the Piggyback Amp at once. I am enclosing \$8.95 to cover costs of board, parts, handling, and postage.

Name _____

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City _____

State _____

Zip _____

Sorry, this offer expires January 31, 1972

PARTS LIST FOR PIGGYBACK AMP

Amplifier Parts Kit (parts mounted on PC Board)

- C1**—2- μ F, 3 to 50-VDC electrolytic capacitor for PC board (Aerovox BCD-5002 or equiv.)
- C2, C3**—0.005- μ F, 75-VDC subminiature square ceramic capacitor (Lafayette 33E69048 or equiv.)
- C4, C5**—100- μ F, 12 to 15-VDC electrolytic capacitor for PC board (Aerovox BCD-15100 or equiv.)
- C6**—0.47- μ F, 100-VDC dipped mylar capacitor—see text (Lafayette 34E67248 or equiv.)
- IC1**—Silicon monolithic integrated circuit (Motorola MFC4000)
- Q1**—Pnp silicon transistor (GE 2N5355)
- R1**—100,000-ohm, 1/2-watt resistor
- R2**—47,000-ohm, 1/2-watt resistor
- R3**—15-ohm, 1/2-watt resistor
- R4**—1000-ohm, 1/2-watt resistor

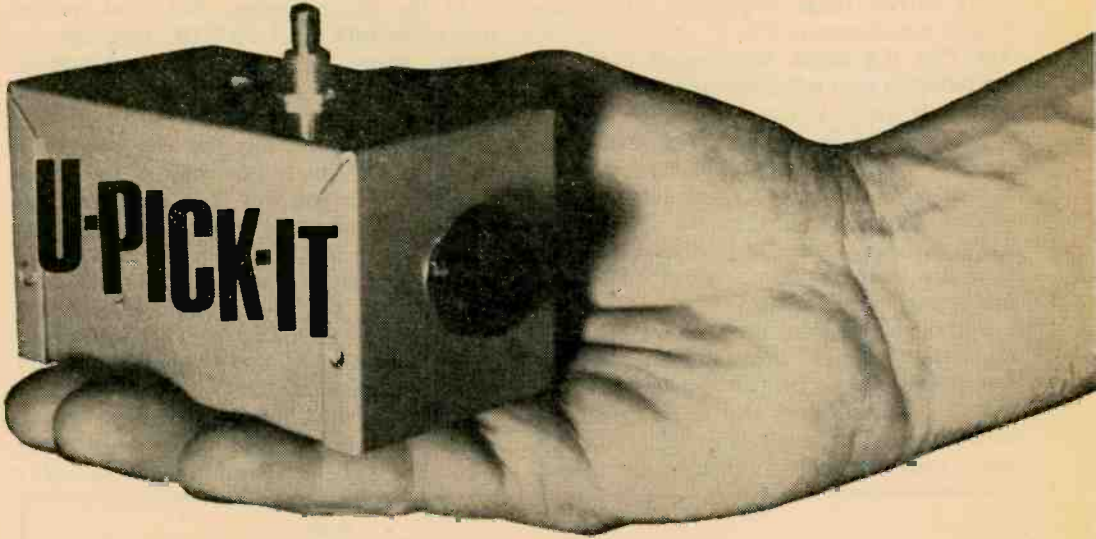
- R5**—4700-ohm, 1/2-watt resistor
- R6**—50,000-ohm, audio taper potentiometer with spst switch (Mallory U-33 control with US-26 switch or equiv.)

Intercom Parts

- B1**—9-V transistor radio battery (Eveready 216 or equiv.)
- J1**—RCA type phono jack (Lafayette 99E62341 or equiv.)
- P1**—Single-contact jack for J1 (Lafayette 32E64579 or equiv.)
- S2**—Dpdt momentary pushbutton switch (Lafayette 30E41167 or equiv.)
- SPKR1, SPKR2**—16-ohm, 5-in. diameter PM speaker

Misc.—Wire, hardware, perfboard or other grille screening, solder, interconnecting cable, etc.

Your axe swings to a different beat with a six buck gizmo we call . . .



by Steve Daniels, WB2GIF

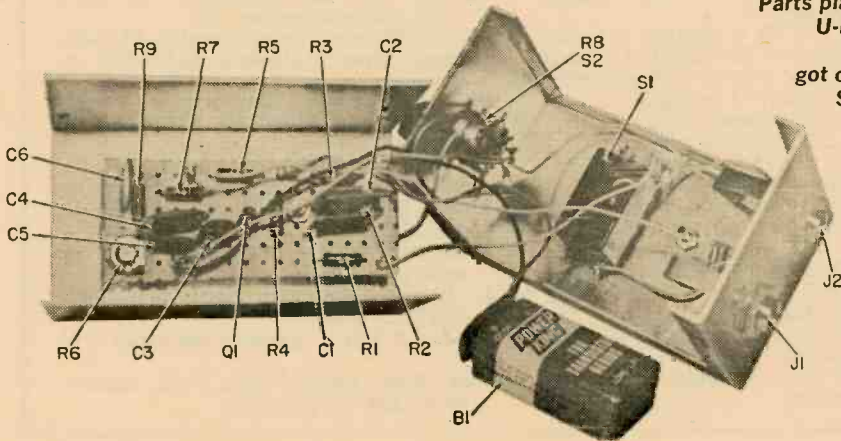
Would you spend about six bucks to tailor the sound of your guitar? Especially if you knew you'd have the great sound of that group you know is heading to the top. Or, maybe, you're not satisfied with the sounds you're getting, and want to be able to change the tone of your guitar to suit the mood of your music. We're not saying that our *U-Pick-It* will make a Segovia out of you. But it sure will make your guitar sound great, and who knows, maybe it will help you on to fame and fortune.

What does *U-Pick-It* do for your instrument? It gives you a choice of bass, treble or midrange boost just by turning a single knob. You can make that old guitar sound

twangy, smooth or raunchy at the twist of your wrist. Furthermore, *U-Pick-It's* bass boost will allow a regular guitar to be used as a string bass by giving those low notes an extra boost.

PSO With a Difference. Check the schematic; it will ring a bell for many of you. Basically, you'll see a phase shift oscillator with a few necessary changes. Note the network consisting of components R1, R2, and R3 isolates transistor Q1 from the loading effect of the guitar pickup. Also, potentiometer R6 is used to lower the stage gain to the point where the transistor will be amplifying rather than oscillating. The phase shift network peaks the response within a

Parts placement within *U-Pick-It* presents no problems got choice of switch S1 in Parts List.



U-PICK-IT

fairly narrow range, depending on the setting of potentiometer R8.

You Pick it's parts. We housed *U-Pick-It*, including its own self-contained battery power supply (a 9 V transistor battery) in a 4 X 2¼ X 2¼-in. Minibox. All of the components with the exception of the input and output jacks, the *IN-OUT* switch, potentiometer R8 and the battery are mounted on a 3¼ X 1¼-in. piece of perfboard. Push-in clips are used for input, output, battery + and ground terminations.

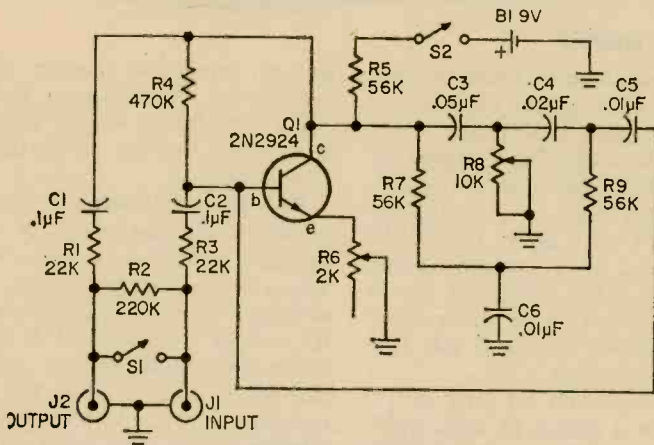
Although the transistor doesn't have the usual triangular pin orientation, if you follow our layout, it can be mounted without having to cross over any of its leads. A word of caution now: this circuit won't work with low gain transistors. So please,

no substitutions! Besides, the one we used isn't expensive, so there really isn't a good reason to fiddle with dime-a-dozen transistors.

In the phase section, use good quality disc capacitors rated 50 VDC minimum or better. Seems we found that low voltage ones sometimes may leak too much for this application.

Drill mounting holes for the two jacks in one end of the bottom half of the Minibox. Whether you buy a commercial battery holder, or make one from a scrap of aluminum, locate the battery so that it will clear the other components when the Minibox is closed. Drill two mounting holes; one for the battery holder, and the other to support the perfboard that's raised ¼-in. off the bottom with a spacer.

IN-OUT switch S1 is located in the center of the top half of the Minibox. It's a push-
(Continued on page 111)



PARTS LIST FOR U-PICK-IT

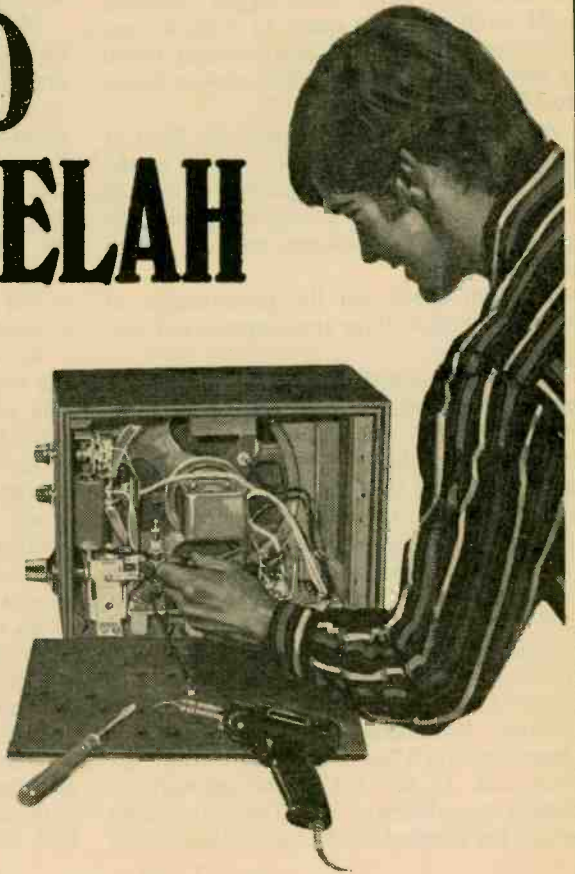
- B1—9 V transistor radio battery (Burgess type 2U6 or equiv.)
- C1, C2—0.1 µF, 75 V ceramic disc capacitor (Lafayette 33F69089 or equiv.)
- C3—0.05 µF, 75 V ceramic disc capacitor (Lafayette 33F69071 or equiv.)
- C4—0.02 µF, 75 V ceramic disc capacitor (Lafayette 33F69063 or equiv.)
- C5, C6—0.01 µF, 75 V ceramic disc capacitor (Lafayette 33F69055 or equiv.)
- J1, J2—Standard open circuit phone jack (Lafayette 99F2135 or equiv.)
- Q1—Silicon, npn, high gain transistor (GE type 2N2924 or Motorola HEP 724)
- R1, R3—22,000-ohms, ½-watt, 10% composition resistor
- R2—220,000-ohms, ½-watt, 10% composition resistor
- R4—470,000-ohms, ½-watt, 10% composition resistor

- R5, R7, R9—56,000-ohms, ½-watt, 10% composition resistor
- R6—2,000-ohms potentiometer, ¼-watt, linear taper (Lafayette 33F16452 or equiv.)
- R8—10,000-ohm potentiometer, 1-watt, linear taper (Lafayette 33F11255 or equiv.)
- S1—Spst rocker switch (Lafayette 34F34164 or equiv.) See text
- 1—4 X 2¼ X 2¼-in. Minibox (Lafayette 12F83878 or equiv.)
- 1—Battery holder (Keystone #203P or equiv.)
- 1—Battery connector (Lafayette 99F-62879 or equiv.)
- 1—3¼ X 1¼-in. piece of perfboard
- Misc. Wire, solder, bolts, nuts, spacer, knob, push-in pins, etc.

MOD METHUSELAH

Hark!
Ye olde tyme
BCB regen rig
grooveth anew
with
high-voltage
transistors

by Charles Green



Back in Radio's early days, receivers were practically chained down to heavy, unwieldy batteries for their circuit's electrical power. After a while, someone got the bright idea to convert the electrical energy coming from Mr. Edison's power plant to energy suitable for their radio. That economy-minded inspiration was one of the straws that broke the lead-acid-battery camel's back. For with the perfection of AC to DC power supplies came the universally-accepted receiver—one that could be played wherever line current was available.

Solid-state gear has followed the same power-supply evolutionary process. Remember how the first transistors sold to the experimenter literally fell apart at their junctions if you tried to juice them with an old radio B-battery you might have had lying around the shack? You soon got

(Turn page)

Mod Methuselah

the idea that those three-legged wonders could swallow but a mere 12 volts at one gulp. Soon after, the AC power supply found its way to your transistorized-project laden workbench.

And today? Seems to us that the hero of today's shrinking solid-state world is the high voltage transistor. Especially a transistor that can easily withstand the peak voltages found at the business end of an a-c line cord.

You can check out the performance of these new high-voltage transistors—and easily, too.

Build our simplified, two transistor, regenerative rig, and discover one of the most popular receiver designs ever bench-tested! Called *Mod Methuselah*, it'll tune the Broadcast Band with a stability never before found in line-operated, regen receivers. No drift's only part of *Mod Methuselah's* story; our rig's powerful enough to drive a built-in 6½-in. speaker to room-filling volume. And, like the Biblical character our Aquarian-Age rig is named for, *Mod Methuselah* will find a place in your shack for, what appears to be, an eternity!

Magic Methuselah. Looking at *MM's* schematic, you'll see that signals from antenna jack J1 are fed to the primary of antenna transformer, T1. These incoming signals are coupled to the parallel-tuned cir-

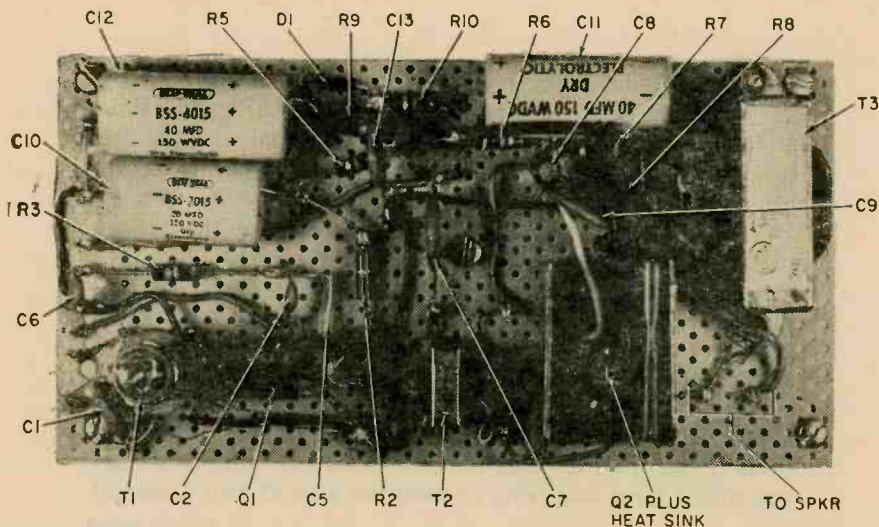
cuit consisting of T1's secondary, and series-connected capacitors C3 and C4. Thanks to mutual inductance, the signal from T1's secondary is coupled to the transformer's base winding.

Now we've come to the point where the leading characters are introduced in this RF drama. Capacitor C5 and resistor R2 team up to play two parts at once. The capacitor provides a low-impedance path for the RF signal to the base of transistor Q1. It also acts as an integral part of the detection process found in every regenerative detector. The resistor R5 provides not only the proper dc forward bias for Q1. It also works as the other half of the grid-leak-detection component pair.

By now you must certainly be wondering what the heck is "grid-leak detection." The name, by itself, doesn't give the circuit's function away. If anything, it might serve only to confuse the electronics experimenter—there's really no *grid* involved here at all!

Grid-leak bias, or detection, harks back to *Mod Methuselah's* earlier days when electronics experimenters spent the better part of an evening building their own tubes and other components. This bias system is a means of developing a direct bias voltage between the base and emitter of Q1 by rectifying the incoming signal for the purpose.

When the a-c polarity of the incoming RF signal is such that Q1's base is positive with respect to the emitter, there is a current flow in the base. This current flow is limited

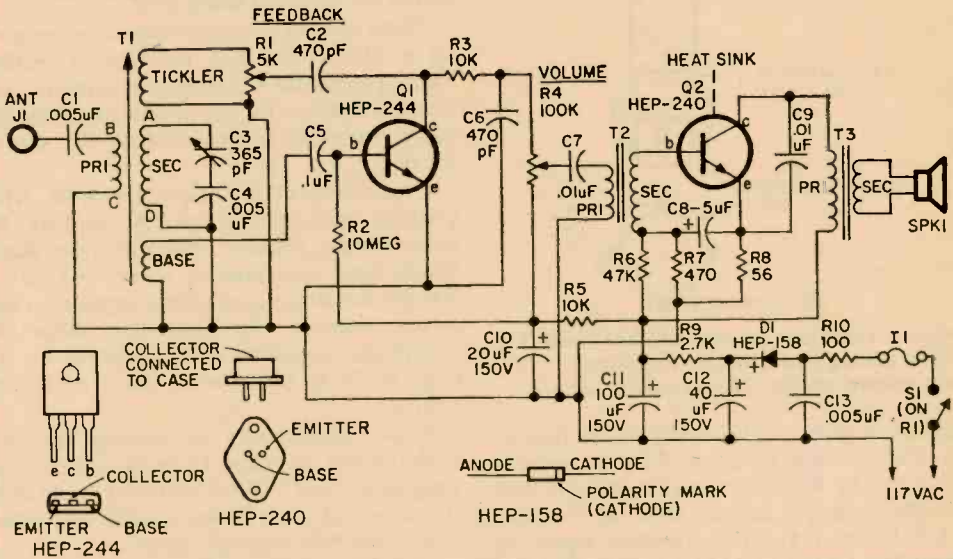


Author's pc prototype of *Mod Methuselah*. Capacitor C11's size is critical: grab smallest one you can buy. Flea clips at lefthand-most side of pc board terminate R1, R4 leads.

PARTS LIST FOR MOD METHUSELAH

- C1, C4, C13**—.005 μ F, 500 VDC disc ceramic capacitor
C2, C6—450 pF, 500 VDC disc ceramic capacitor
C3—10 to 365 pF, single-gang variable capacitor (Lafayette 32F11034 or equiv.)
C5—.1 μ F, 25 volt disc ceramic capacitor
C7, C9—.01 μ F, 400 VDC disc ceramic capacitor
C10—20 μ F, 150 volt electrolytic capacitor
C11—100 μ F, 150 volt electrolytic capacitor
C12—40 μ F, 150 volt electrolytic capacitor
D1—Silicon rectifier: 600 PIV @ 1 Amp (Motorola HEP-158 or equiv.)
I1—Fuse: 1/4 Amp @ 250 volts (Lafayette 13F10085 or equiv.)
J1—Fahnestock clip terminal (Lafayette 33F71028 or equiv.)
Q1—Silicon high voltage npn power transistor (Motorola HEP-244 or equiv.)
Q2—Silicon npn power transistor (Motorola HEP-240 or equiv.)
R1—5,000-ohms audio taper potentiometer with switch S1 (Lafayette 32F22510 or equiv.)

- R2**—10-megohms, 1/2-watt, 10%
R3, R5—10,000-ohms, 1/2-watt, 10%
R4—100K-ohms audio taper potentiometer (Lafayette 32F22536 or equiv.)
R6—47,000-ohms, 1/2 watt, 10%
R7—470-ohms, 1/2-watt, 10%
R8—56-ohms, 1/2-watt, 10%
R9—2,700-ohms, 1-watt, 10%
R10—100-ohms, 1/2-watt, 10%
S1—SPST switch (part of R1)
SPK1—6 1/2-in., 8-ohm extension speaker mounted in wood enclosure (Lafayette 99F02032W or equiv.)
T1—antenna coil; 540-1700 kHz (J.W. Miller A5495-A or equiv.)
T2—audio driver transformer; primary, 100,000-ohms; secondary, 1,000-ohms (Lafayette 99F61251 or equiv.)
T3—audio output transformer; primary, 10,000-ohms; secondary, 4-ohms (Stancor A3879 or equiv.)
1—fuse mounting assembly (Lafayette 13F62045 or equiv.)
1—perforated board cut to 3 1/4-in. x 6 1/2-in. (Lafayette 19F36061 or equiv.)
Misc.—sheet aluminum, flea clips, decals, AC line cord, knobs, solder, hook-up wire, #28 enameled wire, 1/2-in. dia. wood dowel for spacers (see text), etc.



by the ohmic value of R2. A direct voltage is developed across R2.

Since the DC resistance of the signal source (the base winding of T1) is, for all practical purposes, zero ohms, the capacitor C5 is in parallel with R2. The charge across C5 soon reaches the peak value built up across R2. Capacitor C5 discharges through R2 whenever the applied signal falls below the peak value. The base winding of T1 supplies just enough voltage to keep C5 re-

charged during each cycle.

Since the value of R2 (10 megohms) is large by comparison with the value of C5 (.1 μ F), and the time constant of the circuit is long in comparison with the time constant of one cycle of RF energy, the energy absorbed by the grid leak is small. As the incoming signal changes in level, the bias developed by components R2 and C5 changes automatically.

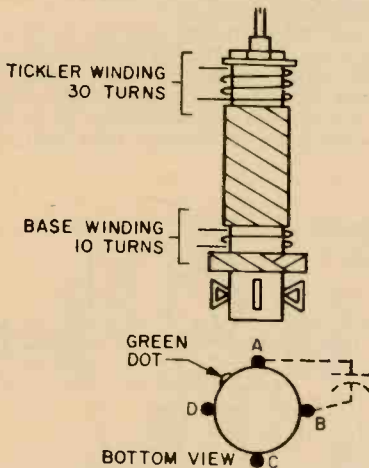
The alert experimenter has, by now, fig-

Mod Methuselah

ured out the key to *Mod Methuselah's* detection process. Since the incoming signal is amplitude modulated, the average DC voltage level will exactly follow the peak envelope pattern of the RF waveform! Voila—recovered audio from the RF incoming signal!

A portion of Q1's output signal, derived at the collector of Q1, is fed back to the antenna coil's *Tickler* winding. Capacitor C2 acts as the feedback coupling capacitor, while potentiometer R1 controls the amount of regeneration—or positive feedback—returned to T1.

You'll find that if you've wired the tickler coil into the circuit properly, this feedback



Remove capacitor (shown dotted) from T1 before adding base, tickler windings. Both consist of No. 28 enamelled wire.

signal is in phase with respect to the incoming voltage appearing at T1's secondary. Crank up the Regen control far enough, and enough feedback causes *Mod Methuselah* to break into that all-too-familiar regen rig "howl."

After the recovered audio signal emerges from Q1, it's routed through rf filter components consisting of R3 and C6. *Volume* control, R4, acts as Q1's audio-frequency load; the signal is coupled via components C7 and T2 to the base circuit of transistor Q2. Resistors R6 and R7 form a voltage divider supplying Q2's base drive. Resistor R8 provides a small degree of emitter self-bias which tends to stabilize Q2's current flow as it warms to the sounds of *Mod*

Methuselah's success. And finally, transformer T3 couples the audio signal to *MM's* speaker.

Mod Methuselah's power supply is as conventional as fireworks on the Fourth of July. It's a half-wave, transformerless affair; with only about six milliamperes being drawn from it, the power rectifier, D1, won't ever warm to your touch. Heaps of power supply filtering is used in *Mod Methuselah*. The results give our *MM* a sound almost as good as if this rig was battery powered!

Methuselah, Modly Manufactured. *Mod Methuselah's* physical layout and circuitry are relatively uncritical, 'cause we're only working with the medium RF frequencies. Take care, though, to use good wiring practices as you construct *MM*; keep the RF leads short, and remember to route audio output wiring away from the power supply section. For best results follow our layout as shown in the photos. And keep our patriarch's Number-One Rule uppermost in your mind: to prevent accidental electric shock, keep all wiring and components enclosed within the specified wood box!

Most of the rig's components are mounted on a 3/4 x 6 1/2-inch perf board section. Tuning capacitor C3, *Regen* control R1 and Volume control R4 are mounted in the author's prototype on brackets on the side of the box.

Capacitor C11 is critical, size-wise. After slogging through a couple of catalogs, the author finally decided upon Lafayette Radio Electronic's part number 34F55441. It's a 100 uF miniature electrolytic capacitor rated at the required 150 Volts. Any other size electrolytic capacitor will probably be too large to fit in its allotted space on the pc board.

Begin construction by cutting the perf board down to size. Then mount 1/2-inch long sections of 1/2-inch diameter wood dowel spacers at each board corner and board center with self-tapping screws.

Lay out, mount, and wire the perf board components as shown in the board photo and schematic. A handful of push-in clips help to secure the component's leads. Transistor Q2 is mounted upside down through a hole in the perf board; its heat sink is made from sheet aluminum as we've shown in the drawing. Transformer T2 is mounted on the perf board by bending its mounting tabs through holes in the board. Simple? You bet!

Transformer T3 is mounted on the perf

board with machine screws and nuts. Antenna coil T1 is anchored to the board by soldering flea clips to its terminals.

Unsolder the small capacitor that comes with T1 before mounting the antenna coil. Then make the base winding from 10 turns of number 28 enameled wire on the coil form between the coil's original primary and secondary windings. Cement with a good grade of coil dope to hold the base winding in place. Leave approximately 1½ inches of wire hanging free to solder the leads to the rest of the circuit. The tickler winding is made by scramble-winding 30 turns of number 28 enameled wire on the top of the coil form adjacent to the top of the secondary. Again, a good grade of coil glop holds down this added winding. Remember to leave approximately 1½-inch leads for soldering purposes.

Fabricate the mounting brackets for pots R1 and R4, and tuning capacitor C3. The actual size and shape of the mounting brackets are up to you, so do your own metal mashing to suit yourself. Drill the holes and mount the components and brackets on the side of the box with small wood screws. Make sure that the wood screws do not protrude through to the outside world! If necessary, cut both potentiometer and tuning capacitor shafts to size before mounting. Reason is, you want all knobs to fit as close to the box surface as possible.

And, while we're on the subject, use knobs with recessed set screws, making sure to fill all recessions with wax to prevent body contact with the metal control shafts. All of these steps are taken to insure precaution against electrical shock.

Last, but not least, connect 6-inch leads to the flea clips which make eventual connection to both potentiometers and the tuning capacitor. Cement the perf board in place to the box bottom. The author found that hot glue squirted to the bottom of the wood dowel spacers worked for him, but any fast-acting cement does the job.

Make sure that the board is cemented in far enough. Otherwise, you'll never get the box's back cover to seat itself properly. After you've cut the board leads to size, connect them to the components as mounted to the box. The author mounted capacitor C4 on a terminal strip screwed to the tuning capacitor's frame.

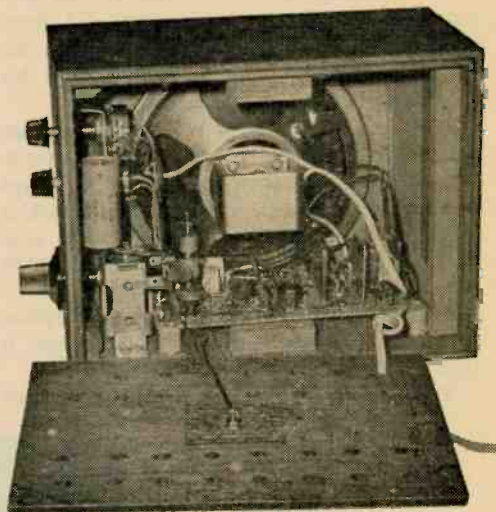
Install fahnestock clip J1 on the box cover back panel and connect it with a 5-inch lead to capacitor C1. Run the AC line cord

through a hole in the cabinet's rear cover. Then knot the line cord and connect one lead of it to the power supply common lead and one to switch S1 located on the rear of R1.

Connect the other end of the AC line cord to the plug, and install fuse I1 in its holder. Install the rear cover on the box, making sure that it has been well endowed with ventilating holes. Take a deep breath—your construction chores are over!

Making Methuselian Music. After you've checked out our *MM*, connect an antenna to J1. For local stations, a 20 foot inside antenna is adequate. But if you're trying for distant station DX, try rigging a high, inverted-L antenna cut to the broadcast band.

Mod Methuselah obtains its RF ground through the AC power lines. Do not connect a ground lead to the receiver. As with all types of AC/DC power-transformerless re-



Potentiometers, tuning capacitor are mounted on aluminum brackets. Capacitor you see is larger C11 remounted off pc board.

ceivers, do not attempt to connect any grounded surface to the internal circuits.

With all of our warnings and *do-nots* staring you down, we want to tell you how to properly ground *Mod Methuselah*. First, plug *MM* into an AC wall socket and turn on the rig. Connect one lead of a VOM (set to read AC Volts) to the negative lead of capacitor C12.

Touch the VOM's free test probe to the metal screw holding the AC socket wall plate in place. If this isn't feasible, touch the free test probe to any metallic surface you know for *sure* is grounded. The VOM's meter

Mod Methuselah

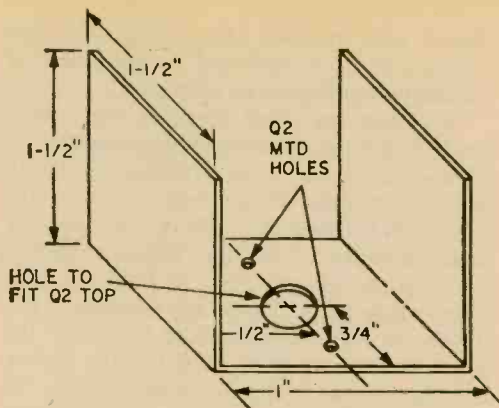
needle will either indicate full line voltage, or it will barely budge off zero Volts.

The trick is to get the VOM to indicate the lowest of the two readings with *Mod Methuselah* powered. Reverse the AC plug in the wall socket: the lowest reading obtained on your VOM indicates that the receiver's power supply common return is connected to your power utility's common, or "ground" lead. Okay, we've given you a good dose of the electric heebie-jeebies. Let's put *Mod Methuselah* through its paces.

Connect the AC line plug to the juice, and play switchies with the plug until you've properly grounded the rig the way we've instructed. Advance Volume control R4 fully clockwise and adjust Regen control R1 to its midrange position. After you've connected your antenna to J1, tune C3 from one end of its travel to the other end, adjusting the Regen control as necessary for maximum sensitivity and selectivity.

If the Regen control is turned too far, there will be strong squeal. Adjust the control until this squeal disappears. If no chirps or squeals are heard, reverse *only* the tickler winding connections on the antenna coil. Both Regen control and Volume controls have a certain amount of interaction; they'll both have to be adjusted for best reception as each station is received. This feature is typical of all regenerative receivers.

Tune to the high end of the broadcast



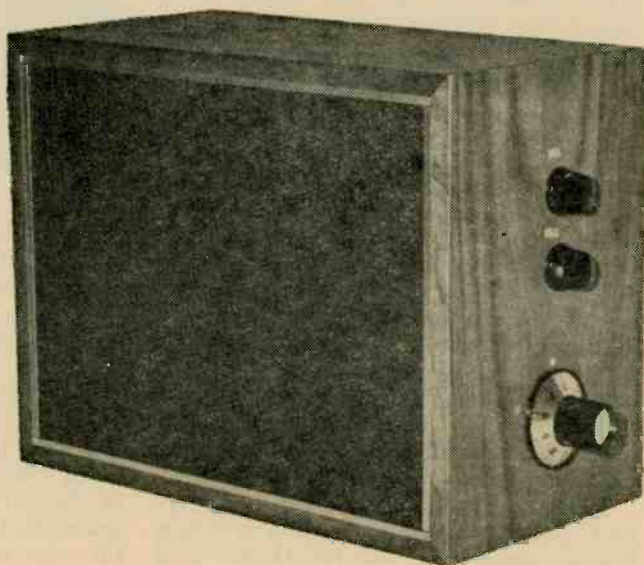
Make heat sink for transistor Q2 out of sheet aluminum. Deburr before mounting Q2.

band, and turn T1's slug with an insulated screwdriver until the volume of the station that you're tuned to (or the background QRM level) increases. Back off the Regen control as you adjust T1. Now tune C3 to the BCB's low end; adjust the trimmer on C3 for maximum sensitivity. You may also have to slightly re-adjust T1's slug to complete this test procedure.

With this initial—and only—test procedure taken care of, make a tuning scale for your rig. You may choose a suitable vernier logging scale found in any electronics catalog—Lafayette's model 99F25660 is as good as any. Finish *Mod Methuselah* by applying decals to both Volume and Regeneration controls. After you've applied the decals, calibrated and lettered the tuning scale, close

(Continued on page 111)

You can't ask for cleaner styling than what you see here from any homebrew project. In MM's case, however, form has to follow function; wood case, non-conductive knobs help to keep your mitts off *Mod Methuselah's* potentially "hot" innards! Author applied decals to finished model. He apparently chose not to calibrate dial scale.



FLEX-JET VHF RIG

e/e's on-board
VHF receiver
makes flying
fun again

by James G. Busse



"**American One ready for takeoff,**" reports the pilot of American Airlines' Flight 1, as the giant 747 jumbojet's mighty engines whine impatiently for the takeoff. "American One cleared for takeoff," confirms the pilot over the radio, and the huge ship hurtles down the runway on its journey across America.

"That's funny," comments the passenger in the seat next to you. "I thought there were at least four planes ahead of us waiting to take off."

"No," you reply with an authoritative smile, "we were first in line."

You ought to know. After all, you've been listening to the patter from the 747's elevated cockpit for the last quarter of an hour. By means of a paper-thin VHF receiver you slipped into the breast pocket of your shirt, you knew your exact departure time. And after you heard the pilot test his radio equipment and get last-minute in-route weather information, you listened

while he obtained approval of the first leg of his flight plan. You heard him ask for permission to back away from the terminal and taxi to the departure runway. Only you and the pilot knew that there wouldn't be any delays this morning—a fact that the other 400 or so passengers on board didn't learn about for at least another five minutes.

In between the pilot talk from your own plane, you heard occasional chatter from other aircraft nearby. A high frequency radio beacon identified the airport, by broadcasting its three-letter abbreviated name in International Morse Code and providing weather information every half hour.

You looked out of your window, and saw a large radar antenna rotating in the distance. A fleeting buzz from the earphone you were wearing told you each time its beam passed through the ship. Whiz . . . ping . . . whiz . . . ping. Sounds like your 747 was probably being "illuminated" by no less than four different radars, including the "weath-

Flex-Jet VHF Rig

er radar" in the nose of a 707 taxiing past the terminal.

The Rigless Wild Blue Yonder. Personal VHF aircraft receivers are nothing new. There are dozens on the market, but most are too big to fit inside your pocket and cost upwards from \$20. What's more, the basic design and construction of some superhet-type receivers—primarily cheap AM/FM units—has resulted in an FAA ban on the use of all radios by airline passengers while the aircraft is in flight. Apparently, Uncle Sam believes that some receivers might put out enough of a signal to interfere with an airplane's navigational equipment.

Although such an argument appears to be somewhat lacking from a technical standpoint, it has the support of both the airlines (all those radios are a nuisance, anyway), and a small number of pilots who aren't particularly enthusiastic about passengers eavesdropping on pilot/control tower conversations.

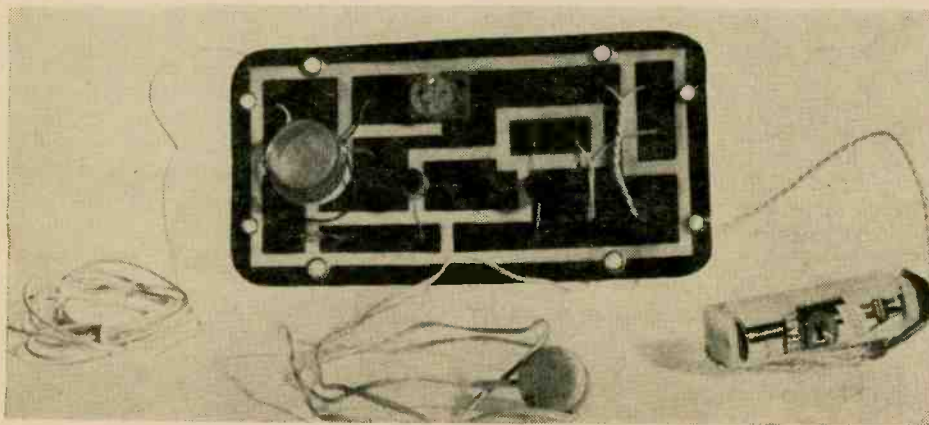
And, to make matters worse, some passengers regard anything that even faintly resembles an "electronic-looking" thing with as much apprehension as if it was a bomb. On the other hand, you, Mr. Accomplished Electronics Buff, can hold an elaborate receiver laid out in breadboard fashion on a piece of perfboard on your lap—and nobody will pay the slightest amount of attention to it. Except, perhaps, another electronics buff who will want to know if he

can build one, too.

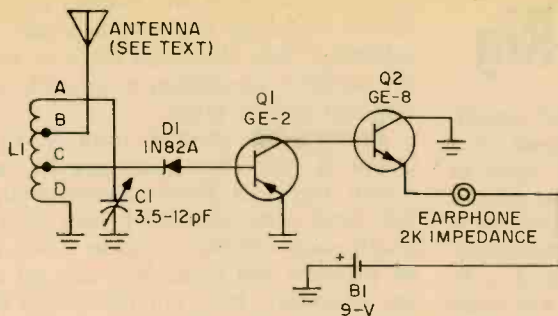
The Rig That Earned Its Wings. Our *Flex-Jet VHF Rig* was designed to meet all of the requirements for on-board jetliner DXing. Permitting passengers to inconspicuously monitor all of their aircraft's VHF radio transmissions, e/e's *Flex-Jet VHF Rig* gives today's jetset traveller an ear on the goings-on. Actually, there is no way our *Flex-Jet Rig* can generate any electronic noise to interfere with flight operations. Reason is, it is a completely "passive" receiver. And, while Section 91.19 of the FAA regulations dealing with "portable electronic devices" specifically authorizes airlines to approve the use of receivers on their aircraft, it looks like it would take an Act of Congress to get them to do just that.

How Flex-Jet Works. Our *F-J VHF Rig* uses a tuned antenna circuit to pick up strong local signals in the 80-150 MHz range. These signals are then rectified by a special VHF diode and amplified by a two-stage, direct-coupled transistor amplifier. An efficient, high-impedance earphone lets you in on the action. A miniature, trimmer capacitor provides some degree of tuning control, although it's not necessary to adjust it once you find the optimum setting for maximum signal strength.

The pilot must constantly switch frequencies to talk to the support personnel who help him guide his craft across country. Ground Control monitors all aircraft traffic on the ground, while the Tower controls takeoffs and landing. Approach Control supervises those aircraft approaching the airport, and Departure Control guides aircraft departing from the airport once they're off



Finished Flex-Jet rig. Coiled wire to left of pc board is antenna. Experiment with its position for best signal pickup after you are seated in plane.



You must connect D1 as shown; Q1 depends upon D1's output voltage polarity for its proper bias. Letters A-D refer to pictorial instructions on page 68 showing how to solder L1 onto pc board.

PARTS LIST FOR FLEX-JET VHF RIG

- B1—9-V battery (Eveready 216BP, Mallory M1604 or equiv.)
- C1—3.5-12-pF miniature trimmer capacitor (Lafayette 33E25305, Centralab 827-B or equiv.)
- D1—1N82A diode (vhf-type detector—no substitutes)
- Earphone—2,000-3,000-ohm impedance, dynamic-type earphone (Lafayette 40E78010 or equiv.)
- L1—4 turns No. 16 plain enameled copper wire (Belden 8048 or equiv.) on a 3/4" diameter coil form spaced 1/2" long. Antenna tap is located 1/2 turn down from the high end. Diode tap is located 2 turns up from the grounded end (see text).

- Q1—GE-2 (or equiv.) PNP transistor
 - Q2—GE-8 (or equiv.) NPN transistor
 - Misc.—4' length of No. 22 stranded hook-up wire (for antenna), battery clip, hook-up wire, eyelets (optional), hot-melt glue, 3" x 6" piece of self-adhesive vinyl covering material, 3" x 6" piece of flexible copperclad printed circuit material (Westinghouse Industrial Plastics Division 5K02 or equiv.)
- Note:** An etched flexible copperclad printed circuit, plus an unetched 3" x 6" piece of the same material for experimenting with other flexible circuits, are available for \$2.50 post-paid from: 2520 Company, Box 45, Pittsburgh, Pa. 15230. Offer expires January 31, 1972.

the ground. The *Flex-Jet VHF Rig* enables you to hear everything your pilot says (and often the other side of the communication as well) without having to re-tune your receiver. And, once outside of the shielding effect of the airplane's hull, your *Flex-Jet Rig's* range is greatly increased to include many FM stations and even an occasional TV station.

Flex-Jet's Twist. The receiver employs a revolutionary "flexible" printed circuit to allow you to slip it into your shirt or coat pocket—or to sew it inside your favorite tie. You can also wrap it around your wrist or arm, holding it in place with a couple of rubber bands. Here is a working electronic circuit that rolls up like a piece of heavy paper!

Called 5K02 by its inventors, the material consists of a layer of copper foil permanently bonded to a thin polyester film. It was developed by *Westinghouse Electric Corporation* for use in limited space or contoured shape applications where rigid copperclad PC board is out of the question. If you could take apart the 747 you're riding in, you'd see flexible copperclad has found a home within the last few years in aircraft by being able to squeeze hundreds of cir-

cuits into tight spaces around the bulkhead.

Expose, Develop, and Etch. Let's start with the etching of the flexible circuit. A flexible copperclad PC kit containing several small pieces of Westinghouse 5K02 coated with a photoresist and the chemicals necessary to develop and etch it is listed in the *Kepro Printed Circuits* section of the 1971 *Allied Radio Shack* catalog. Or, you can purchase an etched *Flex-Jet* printed circuit from 2520 Company (see Parts List) along with an additional 3 inches x 6 inches piece of 5K02 to experiment with for building other flexible circuits.

If you etch your own flexible circuit, use a small wad of 000 steel wool to polish the exposed surface of the copper foil. Avoid touching the copper with your fingers until after it has been coated with resist and etched. The 5K02 precoated with photoresist in the *Kepro Printed Circuits* kit is ready to expose, develop and etch. Flexible copperclad is etched the same way you etch ordinary rigid copperclad PC board. After etching, thoroughly wash the circuit and remove the resist with 000 steel wool. Wash the circuit again, wipe it with a clean paper towel and allow it to air dry.

Clean and bend the leads of components

Flex-Jet VHF Rig

D1, Q1 and Q2 to fit the printed circuit. Use the point of a drawing compass or a similar instrument to make small holes in the circuit for the leads. Place the circuit copper foil side down on a magazine while making the holes. Make each hole no larger than necessary for the particular lead to fit tightly in it—this is important and will make soldering easier. Capacitor C1 requires two 1/16 inch slits for its leads. Use the tip of an *X-Acto* blade or a sharp razor blade for this purpose.

Next, insert all components leads (with the exception of antenna coil L1) through the holes and turn the circuit over to expose the copper foil side. Using a small "pencil" soldering iron (30 watts or less), carefully solder each lead to the circuit. Keep the circuit cool by laying it on a flat piece of sponge rubber saturated with ice water. Avoid excessive amounts of molten solder on the tip of the soldering iron.

Some discoloration of the bonding material between the copper foil and the polyester film may occur, but this is normal. Excessive heat, however, can melt the plastic film and ruin the circuit. It's best to prac-

tice on a scrap of the flexible copperclad before soldering the actual circuit. After soldering, trim off excess leads as close to the soldered connection as possible with a diagonal cutting pliers.

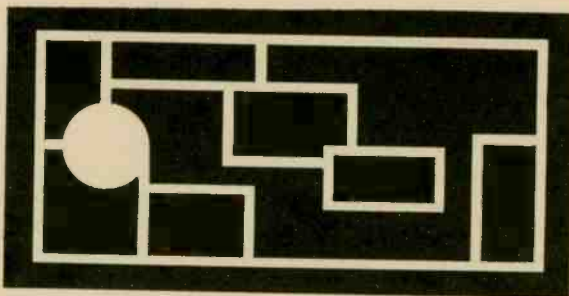
Remove the enamel from a 15 inch length of No. 16 copper wire by rubbing it with steel wool. Wind it evenly around the coil form. The bottom 1/2 inch of a clear plastic coin collector's "dime tube" makes an excellent coil form. You can get one in any dime store. Now cut the coil to exactly four turns and solder leads to the appropriate points. Mount the coil form on the flexible circuit with hot-melt glue. Slip the coil over the form and solder its leads into the circuit.

Also solder a three-foot-long battery lead to the proper points on *Flex-Jet's* pc board. This terminates in a battery clip and the 9-Volt transistor radio type battery, which you can conveniently drop into one of your pockets. No on-off switch is needed—simply disconnect the battery. The earphone wires are about the same length as the battery leads.

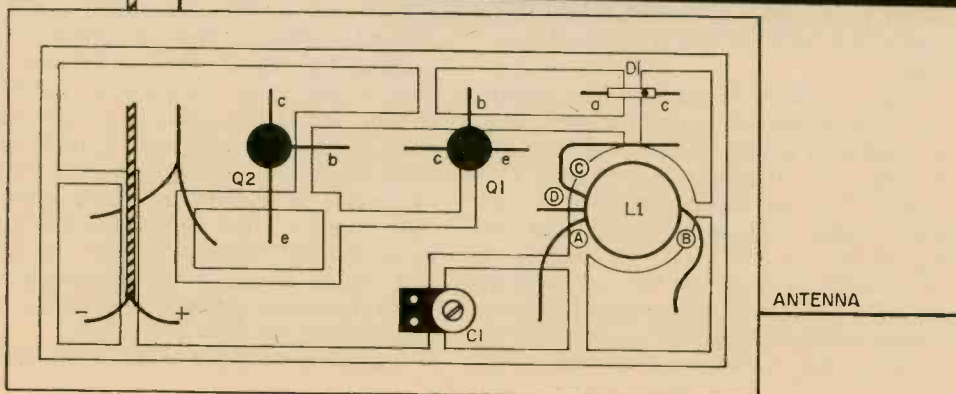
If you like, you can equip your *F-J* with a whip antenna made from a 4 1/2 inch length of stiff No. 10 or 12 wire. Because of the variable shielding effects of

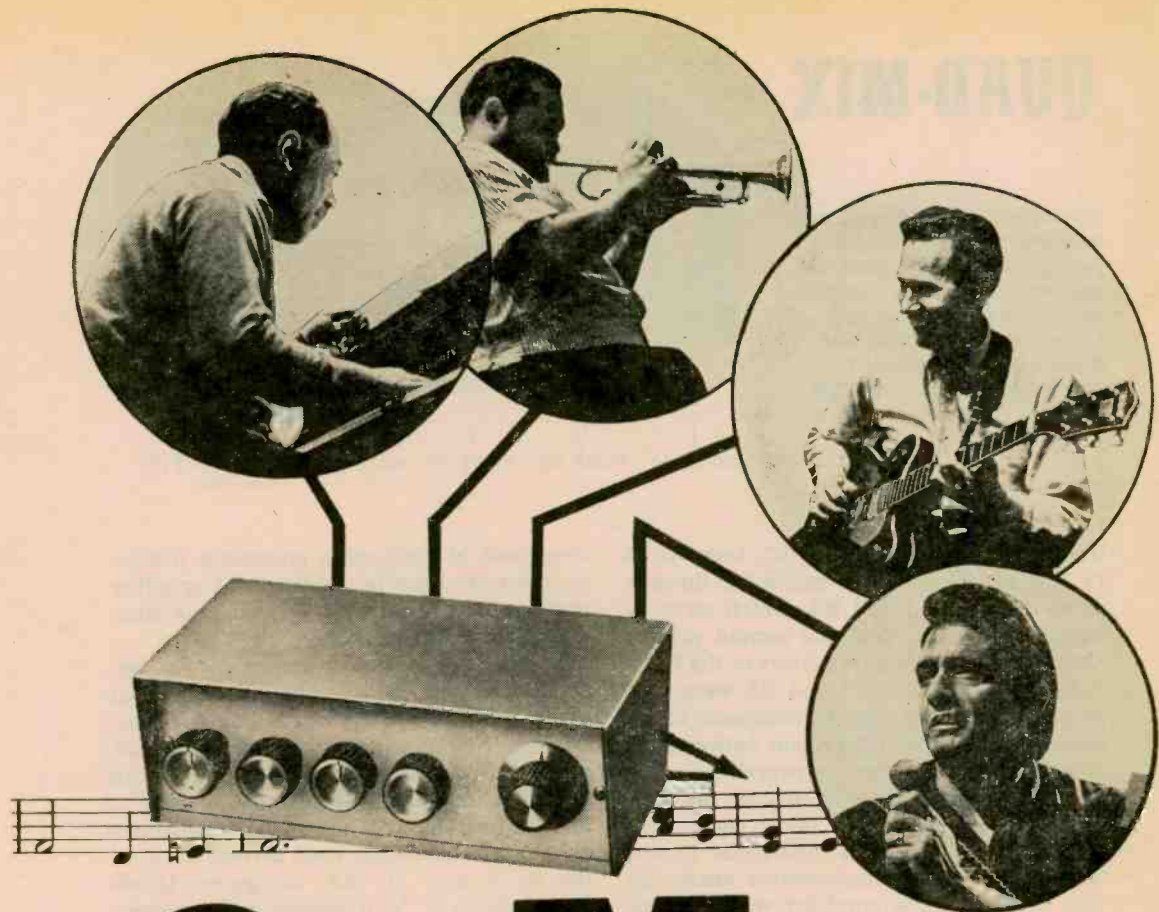
(Continued on page 110)

Right—PC board foil pattern reproduced here one-half its full size. You may order etched board from 2520 Company, Box 45, Pittsburgh, Pennsylvania 15230 for \$2.50 postpaid. Below—PC board topside view showing parts placement, L1's tap soldering locations. Connect antenna lead to tap B on coil L1.



TO BATTERY TO EARPHONE





Quad-Mix

Mix-up
the boys
in the band

by Joseph J. Carr

No, we're not in the genetics business! We've got an interesting four position audio mixer, designed around an RCA integrated circuit (IC), that can be built for just a few dollars worth of parts and about one evening's worth of your leisure time.

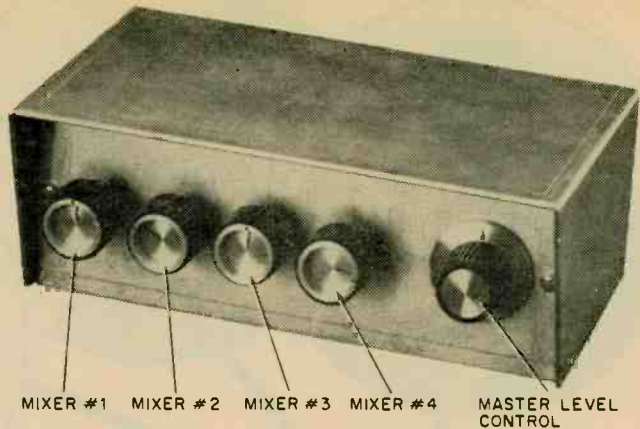
What can you do with it? It's an excellent pre-amplifier/mixer that will let you feed four different audio signals into a single input of your power amplifier and individually adjust their volume levels. You may have organized a new rock group that owns up to four guitars that you want amplified to get that solid sound the group is capable of producing. Easy to do with Quad-Mix. Just feed the outputs from the electrical pickups on the guitars to the individual input jacks

of Quad-Mix and feed the output of Quad-Mix to the input of the PA amplifier. If your group doesn't use four guitars, you can connect one or more microphones to the unused inputs on Quad-Mix and blend the volume level of instruments and/or voices for the specific effects you want. Quad-Mix has sufficient gain to raise the low level output of musical instrument pick-ups and most microphones to drive the average PA to full power and perhaps, even beyond into distortion.

How It Works. Input jacks J1 and J2 are connected through potentiometers R1 and R2, which serve as series mixers, to feed one of the two pairs of Darlington connected

QUAD-MIX

This handy, portable, self powered four position mixer lets your group sound its best over any PA. Each of four instruments or vocalists can be individually blended and the overall level adjusted and fed to a simple amplifier input via the master level control



transistors that make up the IC. Input jacks J3 and J4 are similarly connected through potentiometers R3 and R4, which serve as series mixers, that feed the second pair of Darlington connected transistors of the IC.

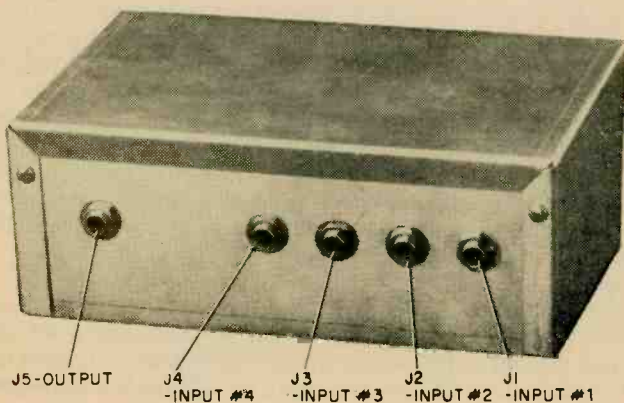
Resistors R5, R6, R7 and R8 were purposely made fairly high in resistance to assure freedom from interaction between the potentiometers or affecting overall gain due to variations in setting of any of the controls. If they were not a fairly high resistance, it is possible that differences in settings of the two potentiometers associated with their common amplifier would be effected. This would be particularly true in the event one of the potentiometers in the pair should be set at minimum gain (near or at ground).

The RCA KD-2116/CA3036 integrated circuit (IC) contains two low-noise, wide band amplifier circuits in one package. It has two isolated inputs and a common output connection. Each of the amplifiers is

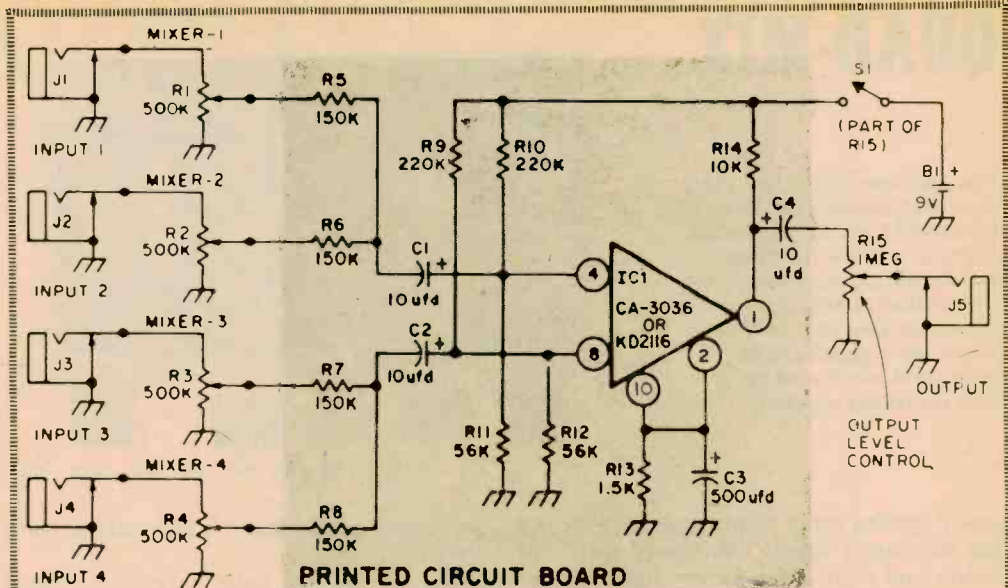
comprised of Darlington connected transistor pairs arranged in a differential amplifier configuration. The IC is housed in a standard 10 lead TO-5 package.

When used as an audio mixer in our Quad-Mix, the IC is employed as a dual input active mixer. By combining two passive mixer circuits, one dual passive for each of the active sections of the IC, the unit can mix, and individually adjust, the level of a total of four different transducers (pickups) or microphones. Since total current drain of the IC is only 50 mA, we power Quad-Mix from a 9 V transistor radio battery mounted in Quad-Mix's cabinet. Another advantage of the battery supply is that it makes Quad-Mix portable and independent of the 117 VAC power lines. This also results in a much quieter hum free operating mixer.

Making A Quad-Mix. Since the mixer is small and designed for portable use, we housed it in an attractive hooded front alu-



Connections from microphones and/or pickups are easily and quickly made to Quad-Mix by regular easily available phone plugs as is output lead to PA amp. Input and output jacks neatly arranged on rear apron.



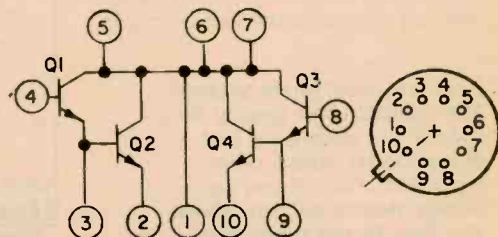
**PRINTED CIRCUIT BOARD
PARTS LIST FOR QUAD-MIX**

- B1**—9V transistor radio battery (Eveready 216 or equiv.)
C1, C2, C4—10 μ F, 12 VDC electrolytic capacitor. (Calectro A-1-10A or equiv.)
C3—500 μ F, 25 VDC electrolytic capacitor (Calectro A1-132 or equiv.)
IC1—RCA KD2116 or CA3036 dual darlington array, monolithic silicon integrated circuit.
***J1, J2, J3, J4, J5**—Standard closed circuit jack (Switchcraft 112A or equiv.)
P1—Standard 2-conductor flat phone plug (Calectro F2-819 or equiv.) (As many as needed for input and output—maximum of 6)
R1, R2, R3, R4—500,000 ohm, audio taper, potentiometer (Calectro B1-688 or equiv.)
R5, R6, R7, R8—150,000 ohm, $\frac{1}{2}$ -watt resistor
R9, R10—220,000 ohm, $\frac{1}{2}$ watt resistor
R11, R12—56,000 ohm, $\frac{1}{2}$ watt resistor
R13—1,500 ohm, $\frac{1}{2}$ watt resistor
R14—10,000 ohm, $\frac{1}{2}$ watt resistor
R15—1,000,000 ohm, audio taper, potentiometer with s.p.s.t. switch (Calectro B1-692 or equiv.)

- 1**—Battery Connector (Calectro F3-052 or equiv.)
1—Battery Holder, (Keystone 203P or equiv.) (See text)
1—Hooded aluminum metal cabinet 3 x 5 x 8-in. (Lafayette 12F85956 or equiv.)
4—Knobs black with silver trim, 1-in. diameter, (Calectro E2-720 or equiv.)
1—Knob black with silver skirt and silver trim, $1\frac{1}{16}$ -in. diameter (Calectro E2-717 or equiv.)
1—3 x 6-in. piece copper clad, phenolic printed circuit board (Calectro J4-605)
 Misc. Hookup wire, bolts, nuts, solder lugs, solder, spacers, printed circuit material (See text) etc.
***Note:** You can get a 6 or 12 ft. shielded lead fitted with standard phone plug on one end and pig tails on other end (6 ft. Calectro 30-450S 12 ft., Calectro 30-451-S or equiv.) to use for an output lead. If either of these cables are purchased one less plug may be all that are required.)

minimum cabinet that's only 3-in. high, 8-in. wide, and 5-in. deep overall. Although we haven't finished the aluminum cabinet of our model, you can, if you have a more artistic nature, paint yours an appropriate attractive color or you can cover it with pressure sensitive plastic sheeting (CONTACT or equiv.) that comes in either in woodgrains, solid colors or patterned prints.

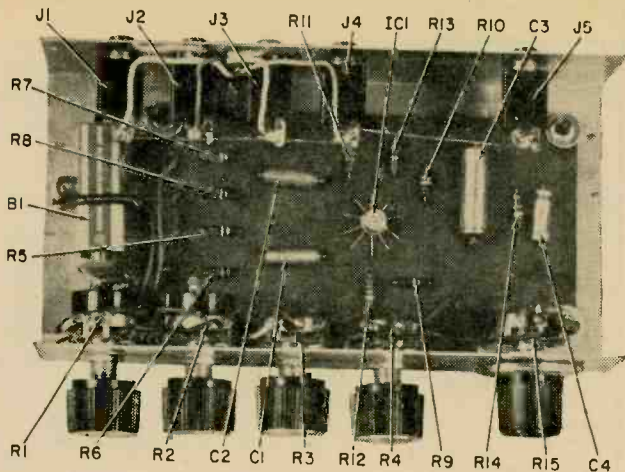
We suggest you identify each of the controls and input jacks by applying transfer letters and digits (Datak or equiv.) once the



Ever wonder what's crammed into the TO-5 case of an IC? Here's a schematic, base pin arrangement of CA3036.

QUAD-MIX

You can appreciate how well planned Quad-Mix has been conceived from this view showing what's inside its attractive housing. Each component is identified to help you in laying out your own unit. Just follow our suggestions for wiring and you'll wind up with surprising success.



newly applied spray paint or plastic sheeting has thoroughly dried. You should spray the letters and digits with a very light coat of clear plastic to protect them from scratches etc.

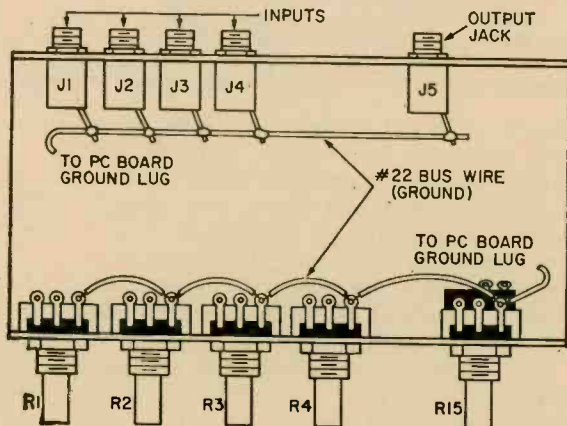
First step in fabricating your Quad-Mix is to make the printed circuit board. We have included a full sized pattern to assist you. Rather than repeat instructions on how to make printed circuit boards we refer you to the construction article titled *Touchdown Twinhaler* in the September-October issue of *ELEMENTARY ELECTRONICS*. Detailed steps for making printed circuit boards are outlined on pages 32 and 33 of that issue. Or, you may prefer the more simplified method made available in the kit reported on in the *November-December 1970* issue of *ELEMENTARY ELECTRONICS*.

While the etching process for the printed circuit board is in progress you can spend this time in laying out and drilling the chassis. Since you are dealing with very high gain units, we suggest that you follow our layout. A great amount of thought has been put into it to reduce, to a minimum, input-output coupling. With this layout you are assured of maximum separation of

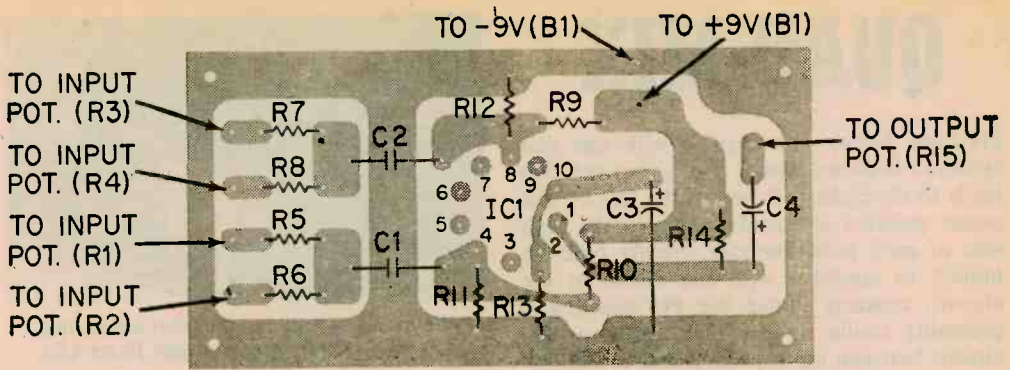
input and output leads, which makes for a stable amplifier.

By the time the holes have been located and at least partially drilled, the etching of the PC board will have been completed. If, by chance, layout and drilling takes longer than the recommended etching time, follow those etching timing instructions explicitly in preference to completing the drilling which can be completed after the etching. Once etching is completed rinse the board thoroughly, dry it, and put it aside.

Finish the drilling and de-burring of all holes then apply either the vinyl covering or the spray paint to the cabinet and front panel. During the time the finish is setting thoroughly, mount all components to the PC board and the chassis. Save the mounting of the IC on to the PC board for the last task. Double check to be sure that you have it properly oriented before applying heat from the soldering iron. Use a small, low wattage



Because actual photo of Quad-Mix doesn't show ground buss details too clearly we had this pictorial layout drawing made. From it you can readily determine just where and how to run grounding leads between components.



Here's a foil side view of printed circuit board showing where each component is located. Components mounted on top side of board and are soldered to foil on bottom.

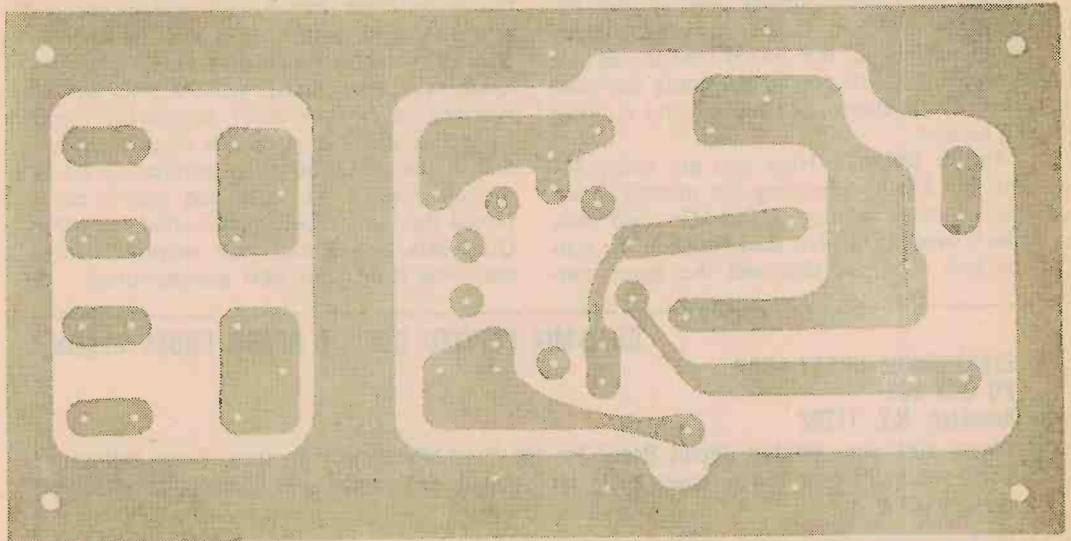
iron to avoid damage to the IC, the capacitors and the PC board from excess heat. Make certain too that electrolytic capacitors are properly polarized before soldering them into the circuit.

A short scrap of coiled spring, extended between two solder lugs makes up the battery holder on the inside of the chassis. You may prefer to buy a standard battery holder since they are inexpensive and do a good job of holding the battery in place. We've listed one in the parts list along with a standard battery connector.

Bond the ground side of the four input jacks to a common ground point on the PC board. Do the same for the ground point of the five potentiometers. Easiest way to do this is to loop a bus wire from ground lug

to ground lug of each of the components involved and terminate the loop on a ground point of the PC board. Use separate loops for the jacks and potentiometers and make each loop as short and direct as possible.

A bundle, or harness, made of four different colors of insulated hookup wire connects the high side of each jack to the high side of its respective potentiometer. Clamp one end of four lengths of different colored wire, each about 2-ft. long, in the jaws of your bench vise. Clamp the other ends into the chuck of your hand drill. Twist them together to make a neat tightly twisted bundle; once removed from the vise and chuck they'll hold together. To assure their holding together you may wrap the bundle at several points with 1/8-in. wide strips of insulat-



Easy way out is to order completely etched printed circuit board by filling in coupon on opposite page. If you're a brave or venturesome soul you may want to roll your own. There've been several articles in previous issues of this magazine telling you how.

QUAD-MIX

ing tape. Locate the harness with one end centered between pots 2 and 3, fan out two leads to the right and two to the left of this center position and solder them to the high side of each potentiometer. Neatly fold the bundle to conform with the bends in the chassis, crossing under the PC board and coming inside up the rear apron of the chassis between input jacks 2 and 3. Following the color scheme used in connecting the pots match the fan out and connection to high side of the jacks so that the same color used for a potentiometer is used for the corresponding numbered jack. (i.e. Jack 1 to pot 1 etc.) Center contact of each input pot is connected to its respective resistor, mounted on the PC board, through connecting pods on the left hand side of the board (see photo). The output lead from the center of the master control potentiometer to the outjut jack is dressed under the PC board's right edge, close to the chassis. The lead to the high side of this pot is connected to a pod on the PC board near the right edge.

Once the four input, one output and the battery connector leads are soldered to the PC board it can be fastened to the chassis. Use 1/4-in. spacers or extra 8-32 nuts to raise the board above the bottom of the chassis to avoid shorting any of the PC board ribbons or solder mounds. Before tightening down the board check out the circuit to be sure you've not made any mistakes. If all checks out mount and connect the battery.

You've Done It. Now you are ready for *The Big Thrill*—checking the mixing action and actually putting Quad-Mix into use. You'll need a shielded lead between the output jack of Quad-Mix and the input con-



*We made battery holder from old spring.
If you'd rather, buy one per Parts List.*

ductor of your amplifier. In all probability the plugs for both the Quad-Mix output and the amplifier input jack will be the same, standard tip-sleeve phone plugs. Before purchasing parts to hold Quad-Mix check for the correct input plug so you can add this to your parts purchase and have everything available at the same time. It is best to keep the interconnecting lead between Quad-Mix and the main power amplifier as short as possible; in any event never longer than 25-ft. The shorter this lead is the less chance there will be for picking up electrical interference. Also, by keeping the lead short capacity between ground (shield) and the hot side (center conductor) will be small to reduce high frequency attenuation. After all you want to get the widest band of frequencies from the instruments to the amplifier.

You might also check the connectors on the leads from the guitars and/or microphones you're going to use with Quad-Mix. You do want to be able to plug them into Quad-Mix after doing such a fine job of building it. If they don't match the input jacks buy suitable plugs for them as specified in the parts list when purchasing all of the other parts. So now that you've completed the construction and tested out your Quad-Mix—go ahead and surprise everyone—use it on your next performance. ■

QUAD-MIX PRINTED CIRCUIT BOARD ORDER BLANK

ELECTRONICS HOBBY SHOP
PO BOX 587
Brooklyn, N.Y. 11202

Please rush your Printed Circuit Board for the Quad-Mix project at once. I am enclosing \$4.50 for board plus 75¢ to cover costs for handling and postage. \$1.00 extra for mailing outside U.S.A.

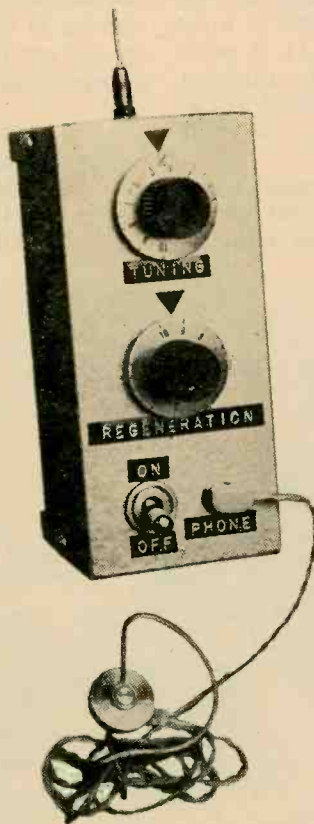
Name _____
Address _____
City _____ State _____ Zip _____

Sorry, this offer expires January 31, 1972

OUR MINI MAXI is a novel superregenerative receiver, covering the 80 to 175 MHz band. Though designed with minimum circuitry, it provides good sensitivity and output. This simple and easy-to-build receiver is unique in that no coupling capacitors or transformers are used between stages and almost any impedance speaker or earphone can be connected to the output. Of course, a low-impedance one will have higher output. Another feature is the use of non-critical components which can vary in value to permit using a wide range of readily available parts without impairing performance of the receiver. The Mini-Maxi will receive television, FM, aircraft, amateur, and police transmissions with just a 2-ft. whip antenna. A smaller version of the receiver, using sub-miniature components, was built into a little metal cuff-link box that could be carried in a pocket.

How It Works. Transistor Q1 is a superregenerative detector. The resonant circuit (inductor L1, capacitor C5, and tuning capacitor C4) is tunable over the frequency range mentioned above. Capacitor C3 provides feedback for oscillation and capacitor C2 couples the signal from the antenna to the tuned circuit. Potentiometer R3 is used as the regeneration control to set transistor Q1 to the point of oscillation.

BUILD MINI- MAXI



by William F. Splichal, Jr.

**A novel vhf
superregen receiver
that can tune in
stations from
50 to 200 MHz**

The audio signal developed across resistor R4 is directly coupled to the base of transistor Q2, which is in a complementary configuration with transistor Q1. Output of transistor Q2 is developed across R6 and is coupled via transistor Q3, which takes the place of a coupling capacitor between transistors Q2 and Q4. A high beta silicon transistor used for Q3 will provide a small amount of gain as well as a means of coupling transistors Q2 and Q4. The audio is further amplified by transistor Q4 and its output is applied across a suitable earphone or speaker that may be plugged into jack J2.

Construction. The recommended layout and wiring of Mini-Maxi as shown in the photograph can be followed provided components identical to those specified in the Parts List are used and it will fit in a 2 1/4 x 2 1/4 x 5-in. minibox. If you build the receiver in a different container, it must be a metal one to avoid hand capacitance effects detuning the receiver. Mount J1, R3, C4, S1, and J2 before wiring in the remaining components. The lead lengths on Q1, L2, C2, C3, C4, C5, and L1 should be kept as short as possible to minimize stray capacitance effects. Layout and lead length of the other components are not as critical and can be varied to suit the builder. (Turn page)

MINI-MAXI

Transistor Q1 can be almost any pnp germanium vhf type transistor capable of oscillating at 175 MHz. Many types of small signal npn germanium audio transistors can be substituted for Q2 and Q4 with satisfactory results.

The battery is connected to a battery plug obtained from an old discharged 9-volt battery. One terminal of the plug is soldered to one of the switch terminals via a small strip of flexible metal which is insulated with tape to prevent shorting out to the box.

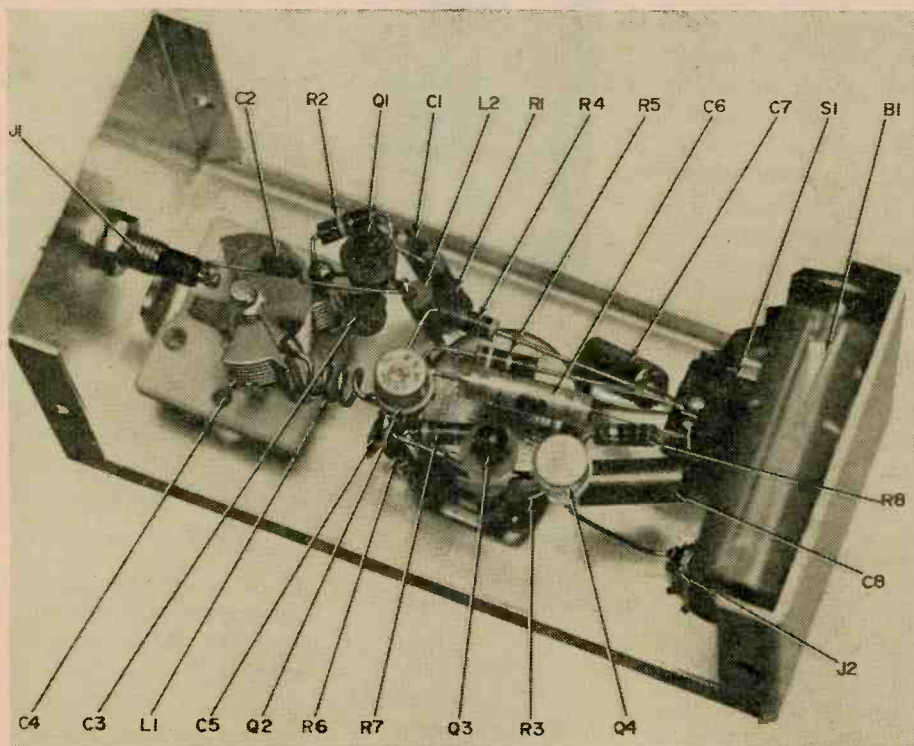
The 2-ft. whip antenna was made by removing the insulation from a length of #14 wire and soldering it into the end of a tip plug (P1) which will plug into J1. A more compact antenna can be made by attaching a small telescoping antenna (similar to Lafayette 18E54009) to a tip plug which will plug into J1.

Overall tuning range of the receiver can be changed by using different sizes for inductor L1. By making it with six turns in-

stead of the three previously specified, the receiver will tune from 50-100 MHz, and with two turns it will tune from 100 to 200 MHz.

Receiver Operation. Almost any speaker or earphone having an impedance from 4 and 2000 ohms can be connected across Mini-Maxi's output. The lower impedances will give higher output. After turning switch S1 *on*, regeneration potentiometer R3 is set by first turning it clockwise until oscillations are heard and then turning it counterclockwise until the oscillations stop and hissing is heard. Tuning capacitor C4 is then tuned to a station. The setting of the regeneration control will vary with the frequency to which the receiver is tuned and will require resetting for optimum operation. By experimenting in tuning in various type stations, the dial can be marked where the following different types of transmissions occur:

54-88 MHz	Television
88-108 MHz	FM
108-136 MHz	Aircraft
144-148 MHz	Amateur
148-175 MHz	Police and Fire



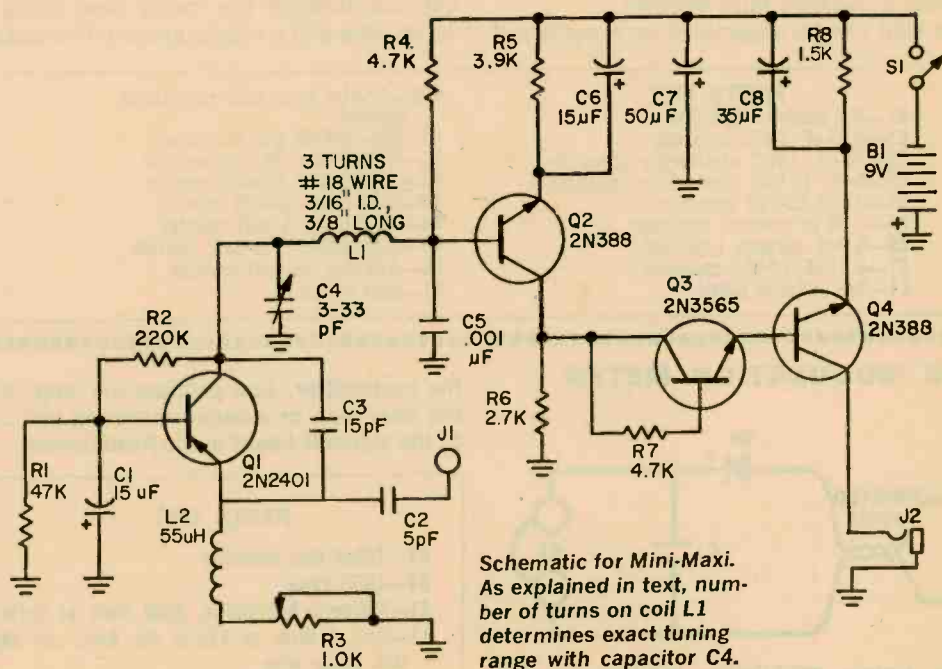
Underside view of Mini-Maxi reveals location of virtually every component it contains. Whip antenna plugs into jack J1 at left.

When receiving very strong stations, the regeneration control may have to be turned counterclockwise to reduce volume and produce an undistorted output. In some cases it may also be necessary to slightly detune the

station to reduce volume further. A nice finishing touch is to identify the controls, using press-on letters (Datak or equiv.) covered with several coats of clear, spray-on lacquer for protection.

PARTS LIST FOR MINI-MAXI SUPERREGEN RECEIVER

- B1—Transistor radio battery (Eveready 216 or equiv.)
- C1, C6—15- μ F, 15-VDC electrolytic capacitor (Sprague 1152 or equiv.)
- C2—5-pF, 1000-VDC ceramic disc capacitor (Sprague 5GA-V50 or equiv.)
- C3—15-pF, 1000-VDC ceramic disc capacitor (Sprague 5GA-Q15 or equiv.)
- C4—3.7 to 52-pF variable tuning capacitor (Hammarlund HF50 or equiv.)
- C5—0.001- μ F, 1000-VDC ceramic disc capacitor (Sprague 5HK-D10 or equiv.)
- C7—50- μ F, 15-VDC electrolytic capacitor (Sprague 1160 or equiv.)
- C8—35- μ F, 15-VDC electrolytic capacitor (Sprague 1159 or equiv.)
- J1—Tip jack, nylon insulated (H.H. Smith 240 or equiv.)
- J2—Subminiature phone jack (Lafayette 99E62119 or equiv.)
- L1—3 turns #18 bare copper-tinned wire, 3/16-in. ID x 3/8-in. long (see text)
- L2—55- μ H RF choke (J.W. Miller 4629-E or equiv.)
- Q1—Pnp germanium vhf transistor (Sprague 2N2401) (see text)
- Q2, Q4—Npn germanium audio transistor (RCA type 2N388) (see text)
- Q3—Npn silicon, high beta audio transistor (Motorola type 2N3565) (see text)
- P1—Plug to fit tip jack
- R1—47,000-ohm, 1/2-watt resistor
- R2—220,000-ohm, 1/2-watt resistor
- R3—1000-ohm, linear taper, potentiometer (Mallory U4 or equiv.)
- R4, R7—4700-ohm, 1/2-watt resistor
- R5—3900-ohm, 1/2-watt resistor
- R6—2700-ohm, 1/2-watt resistor
- R8—1500-ohm, 1/2-watt resistor
- S1—Spst toggle switch (Cutler-Hammer 8280-K-14 or equiv.)
- 1—2 1/4 x 2 1/4 x 5-in. minibox (Premier PMC 1004 or equiv.)
- 4—Transistor sockets (Lafayette 32E42211 or equiv.)
- Misc.—Wire, solder, bolts, nuts, earphone or speaker (any low-impedance unit—see text), press-on letters or embossed tape, etc.

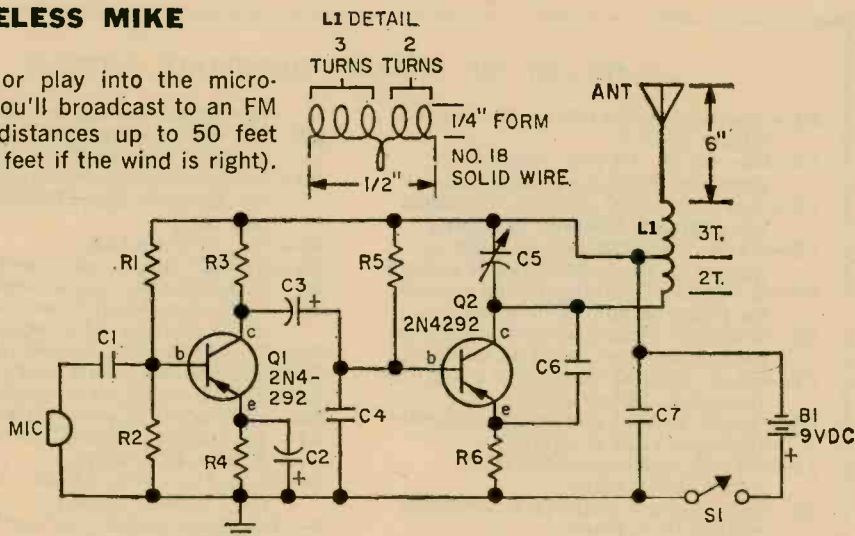


Schematic for Mini-Maxi. As explained in text, number of turns on coil L1 determines exact tuning range with capacitor C4.

Clip Book Circuits

FM WIRELESS MIKE

Just speak or play into the microphone and you'll broadcast to an FM receiver at distances up to 50 feet (maybe 100 feet if the wind is right).



Use standard RF wiring precautions and make coil L1 exactly as shown. Best speech clarity is obtained by using a crystal or ceramic mike. For music reproduction, substitute a dynamic mike element. The Unit can be assembled on a perfboard

using push-in terminals for tie points. The case must be metal to prevent hand capacitance from continuously changing the output frequency. Pass the 6-in. solid wire antenna through the metal case using a 1/4-in. hole and a rubber grommet insulator.

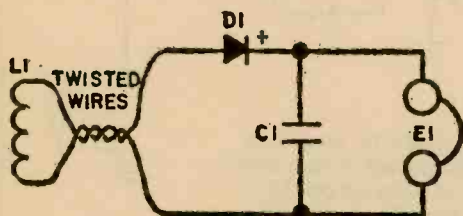
PARTS LIST

- B1—9-V battery, Type 2U6
- C1—0.05- μ F, 3-VDC capacitor
- C2—20- μ F, 3-VDC electrolytic capacitor
- C3—5- μ F, 12-VDC electrolytic capacitor
- C4—47-pF, 25-VDC capacitor
- C5—5.30 pF trimmer capacitor
- C6—6.8-pF ceramic capacitor
- C7—0.01- μ F, 10-VDC capacitor
- L1—See pictorial detail

MIC—Crystal or ceramic microphone element

- Q1, Q2—2N4292 pnp transistor
- R1—47,000-ohm, 1/2-watt resistor
- R2—33,000-ohm, 1/2-watt resistor
- R3—1500-ohm, 1/2-watt resistor
- R4—3300-ohm, 1/2-watt resistor
- R5—100,000-ohm, 1/2-watt resistor
- R6—470-ohm, 1/2-watt resistor
- S1—Spst switch

AM MODULATION METER



the transmitter. Just position the loop near the final tank or antenna matching coil until the signal is heard in the headphones.

This simple modulation monitor for AM ham transmitters requires no connection to

PARTS LIST

- C1—100pF disc capacitor
- D1—1N60 diode
- E1—Magnetic headphone, 2000 ohms or better
- L1—Coil, 3 turns on 1/2-in. dia. form, use any thin gauge wire

THE LOVE GAME



A
fun device
that's easy to build

by James Squires

Your darkened living room is the scene for the *Love Game* and the actors are you and any cute chick you pick to sit beside you. You certainly know the rules already. In the few minutes that follow, you'll do your level best to put out the lights in the room, since we all do our best work in the dark. Being a real sport, though, you give her a fighting chance. With the *Love Game* placed between you and the chick it is the center of illumination and counter illumination. Frantically you turn this switch; now it's her turn, she turns that switch; you reach for another switch and brush her hand; your heart races, well,—that's the risk of the game. Now you turn another switch—all the lights dim but in frustrating defiance of the bigger game, they are still lit. And—oh well, the rest must wait until you have built your very own *Love Game*.

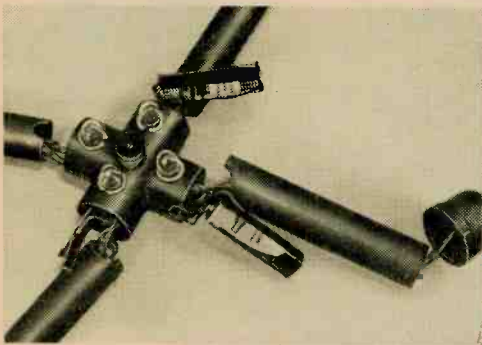
Game Rules: As in any game of love, it is best to become thoroughly familiar with all of the tricks, so you should get acquainted with the schematic diagram and the wiring diagram of our *Love Game*. This is necessary if you want to keep the upperhand and be a consistent winner. The rules, however, state that you take turns with your partner, operating one switch per turn. The game starts with all lights *ON*. Don't worry about memorizing

LOVE GAME

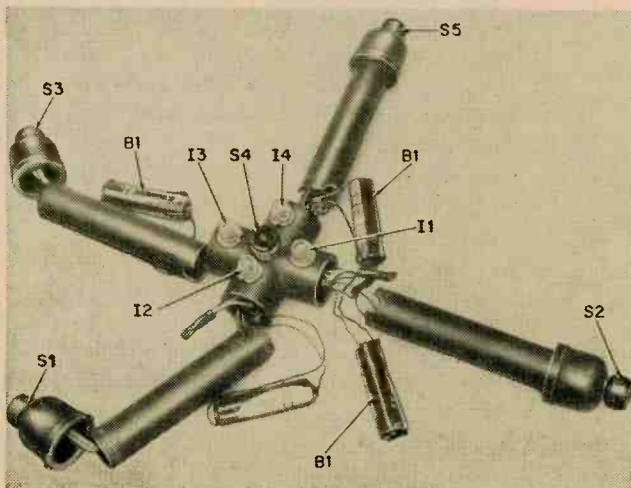
the various switch combinations, unless, of course, you must take every advantage, for with each move their effect changes. In fairness to chicks of the world, perhaps you, the builder of this fiendish game, knowing its innermost secrets, shouldn't play.

How It Works: Considering that *Love Game* involves switches, lights, batteries and, oh, yes, girls, it becomes extremely complicated and therefore warrants explanation, the game, that is, not the girls. As you play you will notice that each of the lights has two levels of illumination, bright and dim. The dim level occurs when L1 and L2 are switched on in parallel with L3 and L4 thus dividing the available battery current between the two sets of lamps, (see schematic diagram).

Each lamp draws 300 MA, therefore, the four of them draw 1.2 amps from the four paralleled AA cells making up B1. Taking into consideration the life of the batteries,



Above, *Love Game* in disarray shows you how we tucked batteries, splices, inter-connecting wires and lamps into the arms of the game. Below, this full, exploded view is presented to show exactly how the switches are oriented within the arms and center piece of the chassis (plastic pipe and fittings). Circuit diagram on opposite page can easily associated with this view.

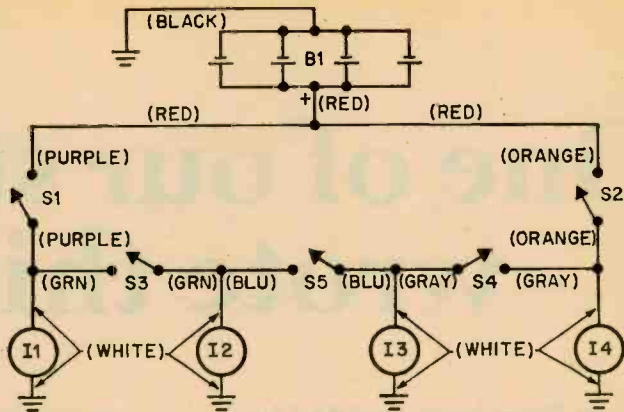


lamps and switches plus a modicum of success on your part (that is, the lamps *OFF* more than they are *ON*.) the single set of batteries should let you play the *Love Game* with all of the girls in the neighborhood before having to replace batteries. The lamps are PR 6's and are rated at 2.47 volts and 300 mA drain per lamp.

Building the Game: The chassis for the *Love Game* is somewhat unconventional, utilizing a new medium, one half inch plastic pipe of the kind used in underground sprinkler systems. Four plastic end caps, four pieces of plastic pipe 4-in. long for four arms, and a center cross piece, all fabricated from standard plastic pipe and associated parts, make up the chassis. Normally, plastic tubing is joined to fittings with a solvent that softens the plastic surfaces and, when it dries (fairly fast), results in the two surfaces joining together, but this proved unnecessary for the *Love Game*. The normal snug fit of the pipe into the end caps and cross piece is made snuggier by the spray painting that is also used to provide an even colored surface to the pipe and pipe fittings. The added thickness of the paint provides the sufficiently tight fit needed for joining all parts in the assembly of the *Love Game*.

Drill a $\frac{3}{8}$ -in hole centered on its flattened surface in each plastic end cap to accept the Leviton Rotary SPST Switch (see drilling diagram). Before mounting the switches in the end caps, cut switch wires to a $3\frac{1}{2}$ -in. length and splice a pair of 8-in long, color coded No. 22 solid, insulated wires to each pair of switch leads. If at all possible use a different color for each pair of leads to help identify each switch, as we did in the model.

You don't have to use identical color scheme we did so long as you match up lamps and switches according to our plan in schematic and identifying locations shown in photo on opposite page. How else can you learn how to enter the game with an advantage to assure you success? Unless, of course you're a "Jack Armstrong-All American Boy who wouldn't think of taking advantage of a girl, especially in a Love Game.



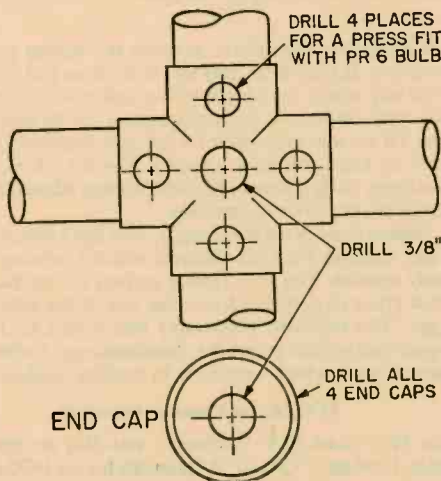
Mount the switch and insert the spliced wires into the plastic tubular arms and attach the end caps to the arms. The splices will be hidden within the tubes that are inserted each into an end cap and eventually one of the sections of the cross piece.

A 1½ volt AA cell battery is also housed in each of the four arms. As shown in the schematic, these four cells are connected in parallel to provide sufficient capacity for a minimum of 50 hours intermittent duty, if you can possibly call *playing the game* duty. Each of the four AA cells are individually wired by soldering a separate black wire to the can (negative terminal) of a battery and a separate red wire to each center post (positive) of a battery. Be careful to use as little heat as possible on the battery terminals and

wires and do the soldering job quickly in order not to overheat the battery, as excessive heat will shorten its life. Wrap black vinyl plastic electrical insulating tape lengthwise around the battery to hold in position the negative lead which is brought up towards the positive end of the battery, and also to insulate its terminals. Next, insert each battery into its respective arm of the *Love Game*, negative end first. You now have two sets of leads extending from each arm-end cap combination. They are the two switch wires and the two battery wires. Refer to schematic diagram if necessary.

Mount the fifth Leviton switch, S4, in the center hole drilled in the cross piece. Solder a separate No. 22 gauge insulated wire to the base button of each of the four PR6 lamps, again being careful not to use too much heat. Strip ¼-in. of insulation from four separate pieces of solid wire and insert one stripped end through each of the four holes where the lamps are to be mounted. The pressure of the slip fit (see drilling diagram) between the metal base of a lamp, the bared wire and the plastic of the cross piece will form the ground contact and complete the circuit for each lamp. Be careful not to press on the fragile glass bulb or to use the bulb as a handle when inserting the lamps into the plastic cross piece.

Connect all the black (negative) wires from the batteries to the ground contacts of the bulbs, just wired, by feeding them all together through one of the openings in the plastic cross piece. Twist, solder and tape the ground bundle. Do the same with the red (positive) wires, bundling, soldering and taping. Continue following schematic, being careful that no wires are left exposed which might short out the batteries during construction. (Continued on page 109)



Core for a solid construction of Love Game chassis is standard cross piece used for branches in underground sprinklers. Lamp mounting holes are drilled for snug fit of PR6 Lamps. Switch holes are 3/8-in. diam.

One of our students wrote this ad!

Harry Remmert decided he needed more electronics training to get ahead. He carefully "shopped around" for the best training he could find. His detailed report on why he chose CIE and how it worked out makes a better "ad" than anything we could tell you. Here's his story, as he wrote it to us in his own words.

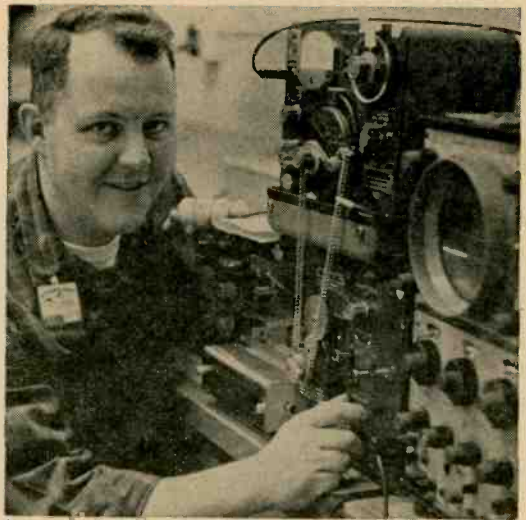
By Harry Remmert

AFTER SEVEN YEARS in my present position, I was made painfully aware of the fact that I had gotten just about all the on-the-job training available. When I asked my supervisor for an increase in pay, he said, "In what way are you a more valuable employee now than when you received your last raise?" Fortunately, I did receive the raise that time, but I realized that my pay was approaching the maximum for a person with my limited training.

Education was the obvious answer, but I had enrolled in three different night school courses over the years and had not completed any of them. I'd be tired, or want to do something else on class night, and would miss so many classes that I'd fall behind, lose interest, and drop out.

The Advantages of Home Study

Therefore, it was easy to decide that home study was the answer for someone like me, who doesn't want to be tied down. With home study there is no schedule. I am the boss, and I set the pace. There is no cramming for exams because I decide when I am ready, and only then do I take the exam. I never miss a point in the lecture because



Harry Remmert on the job. An Electronics Technician with a promising future, he tells his own story on these pages.

it is right there in print for as many re-readings as I find necessary. If I feel tired, stay late at work, or just feel lazy, I can skip school for a night or two and never fall behind. The total absence of all pressure helps me to learn more than I'd be able to grasp if I were just cramming it in to meet an exam deadline schedule. For me, these points give home study courses an overwhelming advantage over scheduled classroom instruction.

Having decided on home study, why did I choose CIE? I had catalogs from six different schools offering home study courses. The CIE catalog arrived in less than one week (four days before I received any of the other catalogs). This indicated (correctly) that from CIE I could expect fast service on grades, questions, etc. I eliminated those schools which were slow in sending catalogs.

FCC License Warranty Important

The First Class FCC Warranty* was also an attractive point. I had seen "Q" and "A" manuals for the FCC exams,

*CIE backs its FCC License-preparation courses with this famous Warranty: graduates must be able to pass the applicable FCC License exam or their tuition will be refunded in full.

and the material had always seemed just a little beyond my grasp. Score another point for CIE.

Another thing is that CIE offered a complete package: FCC License and technical school diploma. Completion time was reasonably short, and I could attain something definite without dragging it out over an interminable number of years. Here I eliminated those schools which gave college credits instead of graduation diplomas. I work in the R and D department of a large company and it's been my observation that technical school graduates generally hold better positions than men with a few college credits. A college degree is one thing, but I'm 32 years old, and 10 or 15 years of part-time college just isn't for me. No, I wanted to *graduate* in a year or two, not just *start*.

If a school offers both resident and correspondence training, it's my feeling that the correspondence men are sort of on the outside of things. Because I wanted to be a full-fledged student instead of just a tagalong, CIE's exclusively home study program naturally attracted me.

Then, too, it's the men who know their theory who are moving ahead where I work. They can read schematics and understand circuit operation. I want to be a good theory man.

From the foregoing, you can see I did not select CIE in any haphazard fashion. I knew what I was looking for, and only CIE had all the things I wanted.

Two Pay Raises in Less Than a Year

Only eleven months after I enrolled with CIE, I passed the FCC exams for First Class Radiotelephone License with Radar Endorsement. I had a pay increase even before I got my license and *another* only ten months later. I'm getting to be known as a theory man around work, instead of one of the screwdriver mechanics.

These are the tangible results. But just as important are the things I've learned. I am smarter now than I had ever thought I would be. It feels good to know that I know what I know now. Schematics that used to confuse me completely are now easy for me to read and interpret. Yes, it is nice to be smarter, and that's probably the most satisfying result of my CIE experience.

Praise for Student Service

In closing, I'd like to get in a compliment for my Correspondent Counselor who has faithfully seen to it that my supervisor knows I'm studying. I think the monthly reports to my supervisor and generally flattering commentary have been in large part responsible for my pay increases. My Counselor has given me much more student service than "the contract calls for," and I certainly owe him a sincere debt of gratitude.

And finally, there is Mr. Tom Duffy, my instructor. I don't believe I've ever had the individual attention in any classroom that I've received from Mr. Duffy. He is clear, authoritative, and spared no time or effort to answer my every question. In Mr. Duffy, I've received everything I could have expected from a full-time private tutor.

NEW... Electronics Engineering Course

... Covers steady-state and transient network theory, solid-state physics and circuitry, pulse techniques, computer logic and mathematics through calculus. A college-level course for men already working in Electronics.

I'm very, very satisfied with the whole CIE experience. Every penny I spent for my course was returned many times over, both in increased wages and in personal satisfaction.

Perhaps you too, like Harry Remmert, have realized that to get ahead in Electronics today, you need to know much more than the "screwdriver mechanics." They're limited to "thinking with their hands" . . . learning by taking things apart and putting them back together . . . soldering connections, testing circuits, and replacing components. Understandably, their pay is limited—and their future, too.

But for men like Harry Remmert, who have gotten the training they need in the fundamentals of Electronics, there are no such limitations. As "theory men," they think with their heads, not their hands. For trained technicians like this, the future is bright. Thousands of men will be needed in virtually every field of Electronics, from two-way mobile radio to computer testing and troubleshooting. And with this demand, salaries have skyrocketed. Many technicians earn \$10,000, \$12,000 or more a year.

Send for Complete Information—FREE

Many men who are advancing their Electronics career started by reading our famous book, "How To Succeed In Electronics." It tells of the many electronics careers open to men with the proper training. And it tells which courses of study best prepare you for the work you want.


If you're "shopping around" for the training you need to move up in Electronics, this 44-page book may have the answers you want. We'll send it to you FREE. With it, we'll also include our other helpful book, "How To Get A Commercial FCC License."

To get both FREE books, just fill out and mail the bound-in postpaid card. If the card is missing, send the coupon below.

CIE Cleveland Institute of Electronics

1776 East 17th Street, Cleveland, Ohio 44114

Accredited Member National Home Study Council



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Please send me without cost or obligation:

- Your illustrated 44-page book, "How To Succeed in Electronics."
- Your book on "How to Get A Commercial FCC License."

I am especially interested in:

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<input type="checkbox"/> Electronics Technology with Laboratory	

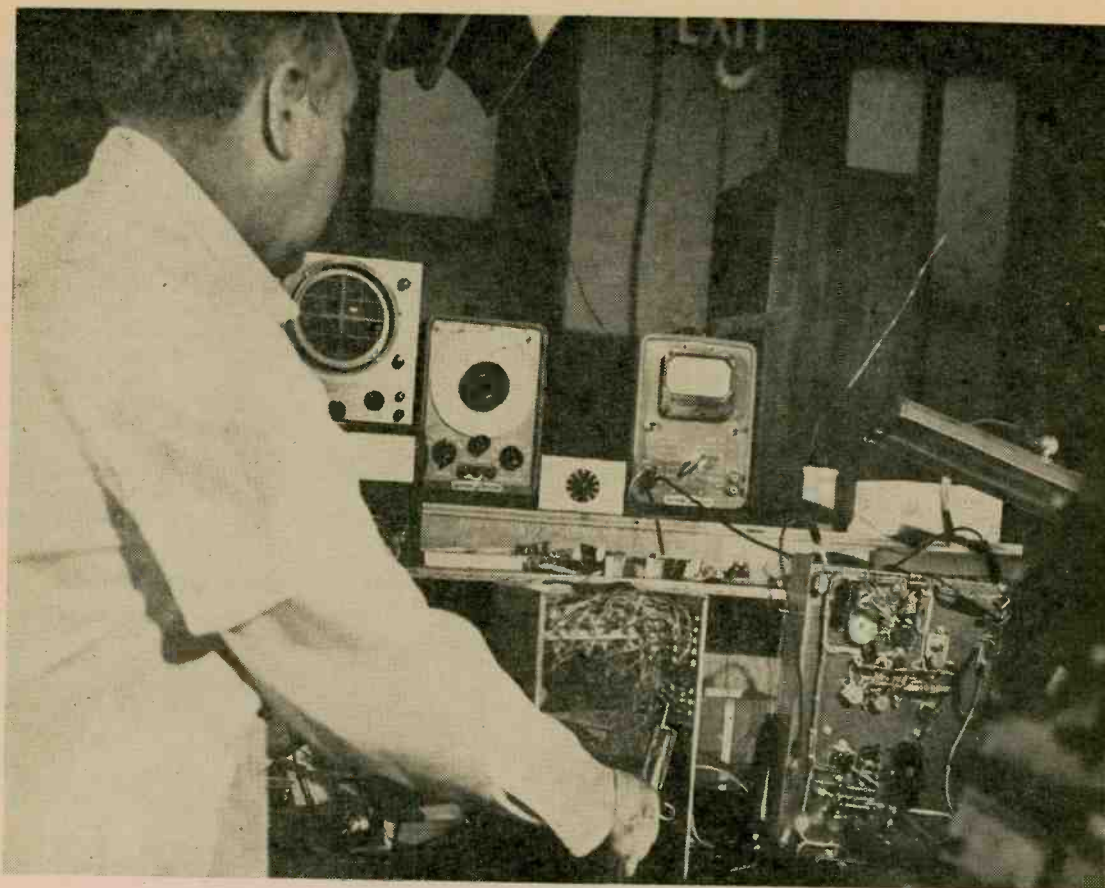
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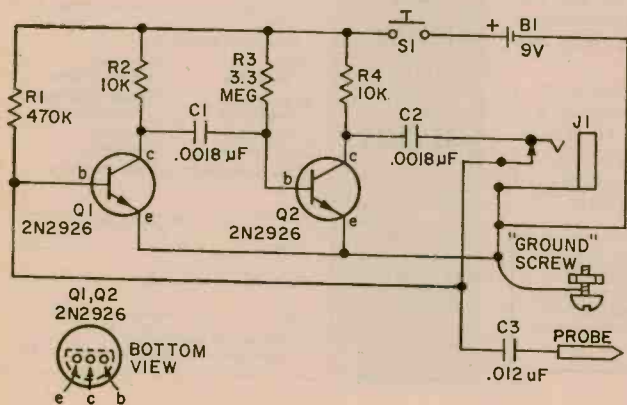
State _____ Zip _____ Age _____

Veterans and Servicemen: check here for G.I. Bill information. EB-7



EVER run up against a set with a printed-circuit board that you couldn't get to work for love or money? Ever wish you could x-ray the circuit to find the trouble quickly? We're not pushing x-ray gear, but we have come up with a little gizmo that's almost as good. And while we can't guarantee it'll work every time we've had nearly 100% results using on *Sig-Prob*.

What It Is. Sig-Prob turns out to be about the handiest service tool any serviceman or electronic gadgeteer can have. It can be used to inject its rich-in-harmonics signal into a set, or you can turn it around and trace through the set a signal from another source to locate the stage that's not working. Either technique will quickly pinpoint the trouble.



It's easy to trace the two stage RC amplifier circuit as part of Sig-Prob's overall schematic. Also note that when phones are plugged into J1, C3, feedback capacitor for signal generation is disconnected (see text).

SIG-PROB

**Eliminate those service headaches
without taking a pill
out of our pill-box test instrument**

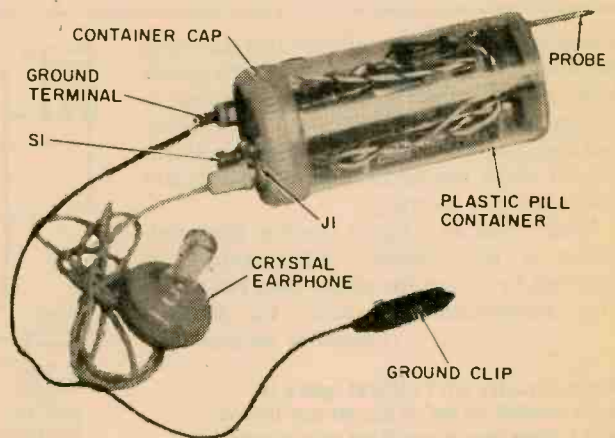
by Rudolf Graf
and
George Whalen

Sig-Prob is a small, hand device that contains a transistorized RC amplifier. It becomes a signal generator with the addition of a small capacitor in a feedback circuit. Whenever the headphone, used when signal tracing to check the presence of signal, is jacked into the probe, this capacitor is disconnected and the two stage RC amplifier is then used to raise the level of signal

being checked through a specific point in a circuit so that it can be heard in the headphone.

The two transistors and other small components are mounted to a small piece of perfboard. This assembly is slid into a plastic pill container (obtainable from your favorite drugstore), fitted with a probe and energized by a standard 9 V transistor radio

Here's the complete package, which includes pill-box housing circuit board, battery, probe, headphone jack, power switch and ground terminal. Crystal earphone needed when listening for circuit continuity is fitted with a plug for insertion into jack on housing.

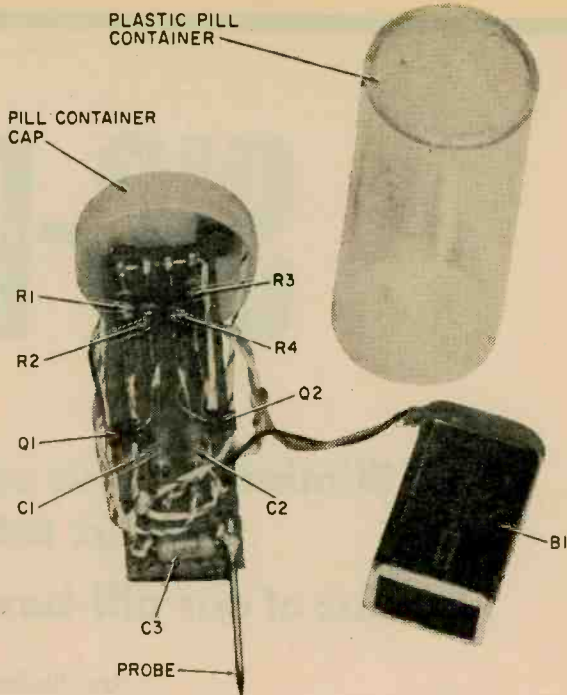


SIG-PROBE

battery that also is slid into the pill container along with the circuit board. The probe tip is fixed to the circuit board and passes through a hole drilled into the bottom of the pill container. By this sardine-packing-technique all of the components as well as the battery are held snugly in place when the cap is put on the container so that you wind up with a rugged, self contained service instrument that is most useful.

How It Works. By referring to the schematic you will be able to follow the circuit of *Sig-Prob* easily. When used as a signal tracer the crystal headphone is plugged into Jack J1. This connects the phone across the output stage of the 2-stage RC transistorized amplifier, and, at the same time, dis-

You can see there are no pills in our pill box, just resistors, capacitors, transistors and a 9V battery for energy.



PARTS LIST FOR SIG-PROB

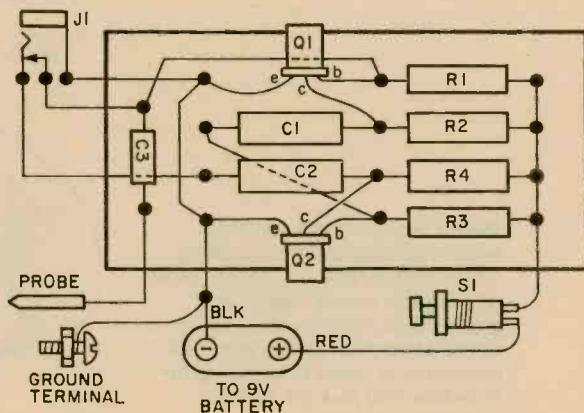
- B1—9 V. Transistor radio battery (Eveready 216 or equiv.)
 - C1, C2—0.0018 μ F, 600 V dipped mylar-paper capacitor (Lafayette 34F82346 or equiv.)
 - C3—0.012 μ F, 600 V dipped mylar-paper capacitor (Lafayette 34F82528 or equiv.)
 - J1—Subminiature closed circuit phone jack (Lafayette 34F60383 or equiv.)
 - Q1, Q2—Silicon Planar npn transistor (GE Type 2N2926)
 - R1—470,000 ohm, $\frac{1}{2}$ watt resistor
 - R2, R4—10,000 ohm, $\frac{1}{2}$ watt resistor
 - R3—3,300,000 ohm, $\frac{1}{2}$ watt resistor
 - S1—Spst NO Subminiature momentary push button switch (Lafayette 34F60011 or equiv.)
 - 1—Battery connector (Lafayette 99F62879 or equiv.)
 - 1—Crystal earphone and phone plug (Lafayette 99F25157 or equiv.)
 - 1—Plastic pill container with plastic cap, $1\frac{3}{8}$ " dia. x 3" long (your favorite drug store is best source)
 - 1— $\frac{7}{8}$ x $2\frac{3}{4}$ -in. piece of perfboard (Lafayette 19F83113 or equiv.)
- Misc: Wire, solder, 4 penny nail, bolt and nut and alligator clip for ground connection etc.

connects the feedback circuit that converts the amplifier to a multivibrator. The probe feeds signal from the circuit under test to the input of the amplifier, where it is amplified and coupled to Q2 for further amplification to drive the headphone with sufficient power for easy listening.

When used as a signal injector the headphone is not needed, and therefore, is removed by taking the phone plug out of J1. This automatically connects C2 through

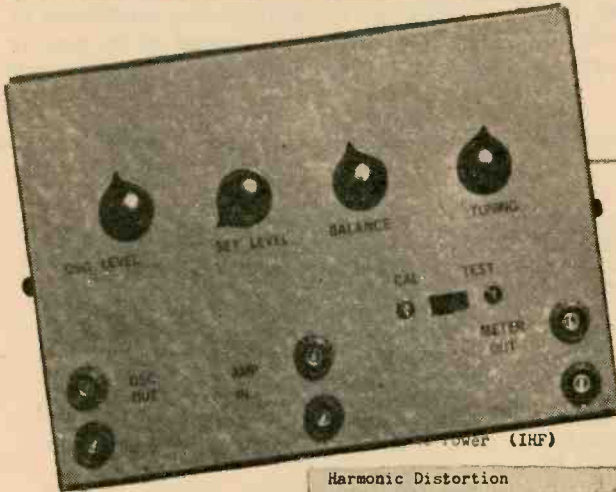
(Continued on page 116)

While circuitry isn't critical space is quite limited so we've drawn our layout which uses space available advantageously.



DMS

Suspect your hi-fi of sounds a-sour? Check it out with our Distortion Measurement Set.



Harmonic Distortion

Intermodulation Distortion
(60 Hz & 7,000 Hz, 4:1)

Frequency Response
Main Amp Only
High Level Input

at any frequency from 20 Hz to 20,000 Hz

64/64 watts at 4 ohms load

58/58 watts at 8 ohms load

42/42 watts at 16 ohms load

41/41 watts at 4 ohms load

45/45 watts at 8 ohms load

34/34 watts at 16 ohms load

180 watts at 4 ohms load

170 watts at 8 ohms load

less than 0.5% at rated output

from 20 Hz to 20,000 Hz

less than 0.3% at rated output

or any level of less than rated output or less than 0.1% at -3-dB rated output

10 Hz to 50,000 Hz ± 1 dB

20 Hz to 50,000 Hz ± 1 dB

by Herb Cohen

Now that you've purchased that super duper hi-fi set and enjoyed its pure, distortionless(?) reproduction for nearly a year, you'd like to be able to check it out against its ballyhooed specs. Naturally, since you have become so interested in hi-fi, you've digested all the technical material that's been published. So now, you feel that you are technically qualified to run the required tests to prove out the equipment. If your ears tell you that your set no longer performs at its advertised level of performance, you'll want to correct it. Then you'll re-check your work to be sure you've brought it back up to snuff. But, you say, I don't have a distortion meter to prove that it's as good as it was originally. Or, now that I've "improved" it, how do I know it's working better, you ask. And besides, commercial

distortion meters are expensive and complicated to operate.

Why not build a distortion measuring set? Our *DMS*, as we call it, is easy to calibrate, easy to use, is reliable and, best of all, can be built for about \$50. Not only will our *DMS* permit you to check your audio equipment whenever you want, but, *DMS'* construction will also help advance your technical skill. The components for our *DMS* are relatively easy to find in an electronics supply house, and construction is not difficult.

Low Distortion Buzz. This test set is comprised of two sections; an ultra-low-distortion 1 kHz signal generator, and a Wein Bridge filter. And *DMS* has been designed around the latest Op Amps (Operational

DMS

Amplifiers) and FETs (Field Effect Transistors).

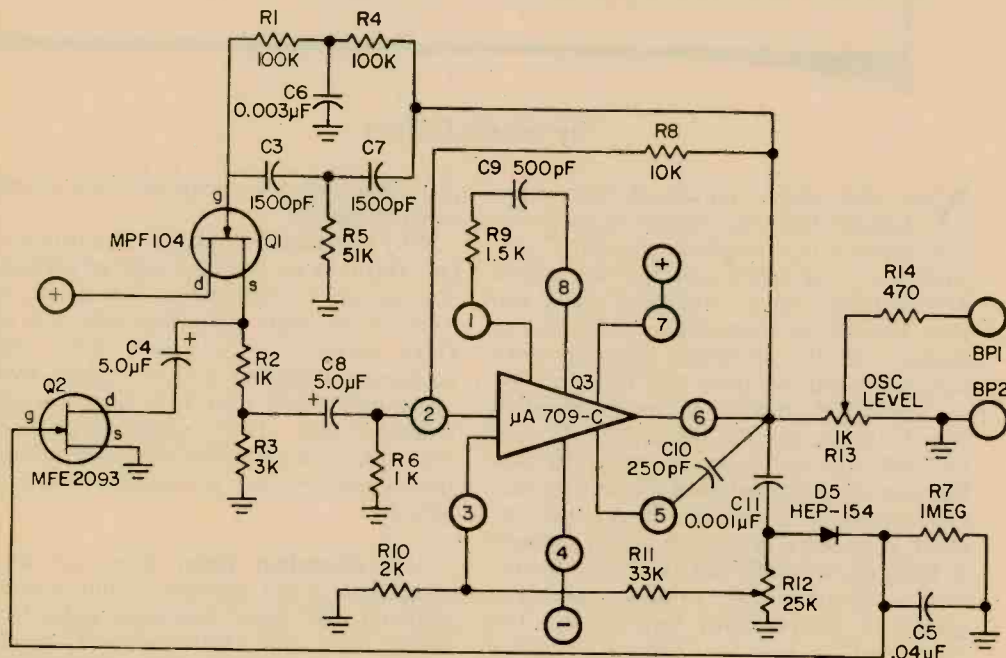
The signal generator portion of *DMS* employs an FET in an automatic gain control, or AGC, circuit and an Op Amp for signal generation, voltage gain, and rejection of power supply ripple. A "twin tee" filter, acting as a rejection type, serves as

a frequency-determining element for the oscillator by rejecting all frequencies but the desired one—1 kHz in this instrument. With the filter, comprised of components R1, R4, R5, and C3, C6, and C7, placed in the negative feedback loop, it greatly decreases the gain for all frequencies except the one to which it is tuned. The Op Amp will oscillate at the frequency established by the "twin tee" filter because of its positive feedback loop consisting of components

PARTS LIST FOR DMS

- C1, C2**—250 μ F, 25 volt electrolytic capacitor (Lafayette 34F55235 or equiv.)
C3, C7, C15, C16—1500 pF, 500 volt, silver mica capacitor, 5% (Lafayette 30F35722 or equiv.)
C4, C8—5 μ F, 12 volt electrolytic capacitor, PC board leads (Calectro A1-103 or equiv.)
C5—0.04 μ F, 1000 volt ceramic disc capacitor (Lafayette 33F23425 or equiv.)
C6—0.003 μ F, 500 volt silver mica capacitor, 5% (Lafayette 30F35540 or equiv.)
C9—500 pF, 50 volt ceramic disc capacitor (Calectro A1-028 or equiv.)
C10—250 pF, 1000 volt ceramic disc capacitor (Lafayette 32F01720 or equiv.)
C11—0.001 μ F, 1000 volt ceramic disc capacitor (Calectro A1-064 or equiv.)
C12, C14—100 μ F, 12 volt, electrolytic capacitor, PC board leads (Calectro

- A1-111 or equiv.)
C13—50 μ F, 12 volt electrolytic capacitor, PC board leads (Calectro A1-109 or equiv.)
D1, D2, D3, D4, D5—Silicon rectifier, 50PIV @ 1 amp. (Motorola HEP 154 or equiv.)
Q1—n type FET, Motorola MPF 104 or HEP 801
Q2—n type FET, Motorola MFE 2093
Q3—Op Amp, Fairchild type μ a 709 (see note)
Q4, Q5—npn silicon, general purpose audio transistor, Motorola HEP 726
R1, R4—100,000-ohm, 1/2 watt, 5% resistor
R2, R6—1,000-ohm, 1/2 watt resistor
R3—3,000-ohm, 1/2 watt resistor
R5—51,000-ohm, 1/2 watt 5% resistor
R7—1-megohm, 1/2 watt resistor
R8, R26—10,000-ohm, 1/2 watt resistor



parts C11, R12, R11 and R10.

The AGC circuit stabilizes the output voltage waveform. Diode D5 rectifies a sampling of the output waveform, and, after filtering it through components C5 and R7, presents this smoothed-out voltage to the gate of transistor Q2. Since this voltage varies with the signal, it varies the drain-to-source resistance of the FET in direct proportion to the output voltage. Since this resistance is across the source of Q1, it will

vary the gain of the system. It's almost as if somebody's holding his hand on a potentiometer, keeping tabs on *DMS's* output level. By adjusting R12 to provide a maximum output of 1.5V at R13 assures signal generator distortion of less than 0.2%.

The second half of *DMS* is a Wein bridge filter. Commonly used for measuring harmonic distortion, it works as a rejection filter cancelling out the fundamental frequency to which it is tuned. Since voltage

- R9—1,500-ohm, 1/2 watt resistor
- R10—2,000-ohm, 1/2 watt resistor
- R11—33,000-ohm, 1/2 watt resistor
- R12—25,000-ohm miniature potentiometer, printed circuit board mounting (Lafayette 33F16536 or equiv.)
- R13—1,000-ohm linear taper potentiometer (Lafayette 33F11149 or equiv.)
- R14—470-ohm, 1/2 watt resistor.
- R15—25,000-ohm potentiometer, linear taper (Lafayette 33F11313 or equiv.)
- R16, R17—68,000-ohm, 1/2 watt resistor
- R18—2,000-ohm, 1/2 watt resistor
- R19—5,000-ohm potentiometer, linear taper (Lafayette 33F11222 or equiv.)
- R20—5,600-ohm, 1/2 watt resistor
- R21—3,900-ohm, 1/2 watt resistor
- R22—5,100-ohm, 1/2 watt resistor
- R23, R25—91,000-ohm, 1/2 watt, 5% resistor
- R24—Dual 10,000 linear taper potenti-

ometers (Allied Radio Shack 875-1301 or equiv.)

S1—Spst slide switch (Calectro E2-104 or equiv.)

T1—Power transformer: primary, 117 V 50-60 Hz; secondary, 12.6 V @ 0.1 Amps (Calectro D1-750 or equiv.)

1—7 x 5 x 3-in. Minibox (Lafayette 12F83928 or equiv.)

1—4 1/8 x 6 3/8-in. perfboard (Calectro J4-616 or equiv.)

4—Instrument knobs (Calectro E2-705 or equiv.)

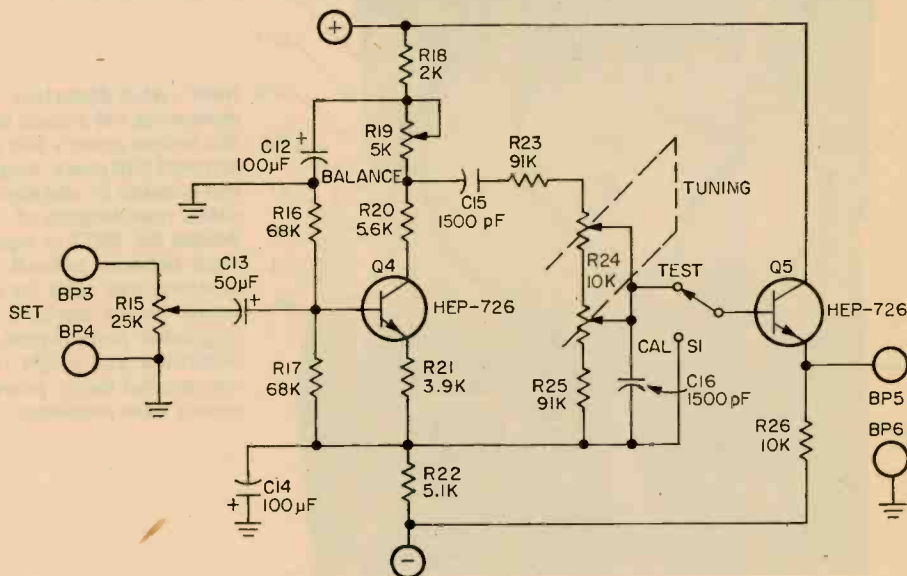
3 sets—Red and black 5-way binding posts, insulated (Calectro F2-926 or equiv.)

1—Power cord and plug (Calectro L3-717 or equiv.)

Misc.—Bolts, nuts, spacers, wire, solder, press on letters (Datak or equiv.) push-in pins, etc.

NOTE: Fairchild μ 709 is available from Custom Components, Box 153, Malverne, NY 11565 for \$5.00

Post Paid. New York State residents add sales tax, Canadian and foreign add \$1.00 extra.



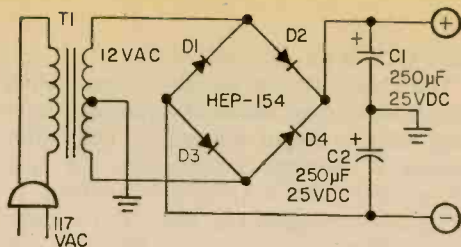
DMS

levels within this filter are very low, *DMS* requires an amplifier, transistor Q4, to provide two boosted voltages that are 180° out of phase and have an output ratio of 2:1. Potentiometer R19 is a *balance* control that sets this voltage ratio. Potentiometer R24 serves as a *fine tuning* control for the Wein bridge.

The *Cal/Test* switch, S1, switches the emitter follower amplifier from the source voltage into the Wein bridge to the output of the bridge. The ratio of difference of these two voltages expresses the percentage of distortion.

Drill, Mount, and Solder. We succeeded in stuffing all of the components, as well as a self contained AC power supply, into a 7x5x3-in. Minibox. Most of the components with the exception of the controls and binding posts are mounted on a 4 1/8 x 6 3/8-in. piece of perfboard. From our photos you can readily follow the basic layout.

Resistors, capacitors and transistors are self supporting by feeding their leads through the holes in the board and soldering



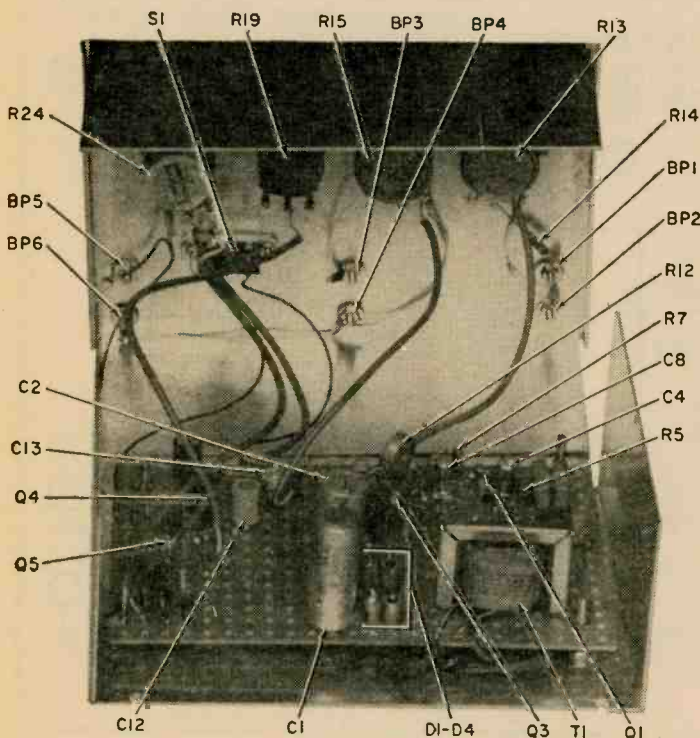
Power supply looks like bridge rectifier— but look closer. *DMS*'s ps is really two full-wave supplies connected back-to-back.

them to feeder busses or directly to each other where possible. You may prefer to use push-in pins as anchor and connection points.

The power transformer is held on the perfboard with small machine screws and nuts. The board itself is mounted to the bottom half of the Minibox with long machine screws and raised about 1/4-in. from the bottom to prevent shorts in the wiring. You can use either 1/4-in. spacers or extra lock nuts to hold the board above the bottom of the box.

Drill out the holes in the top half of the box for mounting the four potentiometers, the *Cal/Test* slide switch, and the six binding posts.

(Continued on page 115)



Here's what distortion measuring set should look like before cover's slid on, screwed into place. Ample use is made of shielded cable; runs lengths of Belden No. 8411 or equivalent between potentiometers, flea clips on pc board. Follow author's suggested parts layout. Otherwise, you might run into ground loops, power supply hum problems.

by Francois Markette

THE BEEPER



Doctor your gear with a pocket-sized injection of signal

One of the easiest ways to troubleshoot a defective amplifier or radio is with a signal injector. Here's a device that generates, simultaneously, AF and RF signals. You feed the injected signal into the stage closest to the speaker, and then work back towards the input or antenna. At the point where you can no longer ram a signal through the equipment, you've found the defective stage. Then you proceed with standard volt-ohm measurements to determine which component is disabling the stage.

A simple, easy-to-use signal injector, dubbed *Beeper*, costs about \$6, exclusive of the battery and power switch. *Beeper* is a simple blocking oscillator, like the garden variety found in early TV receiver vertical oscillators. The fundamental frequency of this oscillator type is in the audio range, but since the output waveform is so distorted, it's output voltage contains harmonics well up into the RF spectrum.

Fact is, *Beeper's* output extends from approximately 1kHz to the top of the standard AM Broadcast Band. Our little tube shaped injector's ideal for servicing tube or transistorized radios.

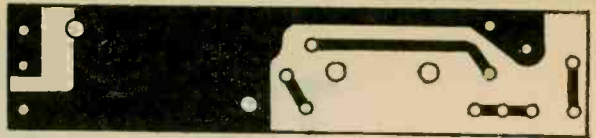
In the model shown, a mercury cell supplies power rather than a flashlight-size battery. Seems the small batteries, such as the AA and N size, which would fit into the probe, are highly prone to leakage which would destroy the components. A mercury cell will last several years without leaking, so it's the author's choice and is, therefore, suggested. In the model shown, a standard mercury cell holder is used. Reason is, you want to avoid soldering leads directly to the mercury cell, which could destroy the cell.

Except for battery B1 and push-button switch PB1, all component values are critical and *no* substitutions should be made. Push-button switch PB1 can be any nor-

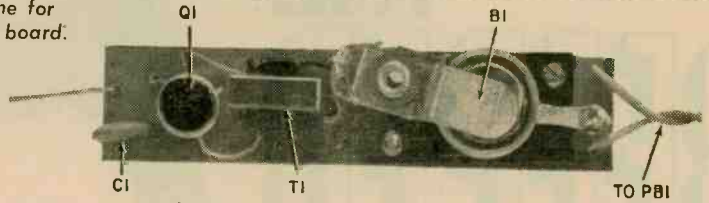
Check out Beeper for shorts, other wiring errors, before slipping unit into its case.



THE BEEPER!



Top Right—Full-size foil outline for Beeper's printed circuit board.
Right—Topside view of printed circuit board showing location of components. Hold board with foil pattern as shown; flip over for correct parts placement.



mally open (NO) type you have lying around. The probe handle is supplied pre-drilled with a 13/32-in. hole for a standard 3/8" PB switch. But, by using a 3/8-in. grommet to fill the hole, a miniature type 3/8-in. PB switch can be used. If you prefer, an on-off miniature switch can be substituted to avoid having to hold the switch down when using our *Beeper*.

Construction. The *Beeper* is assembled on a 5/8-in. x 3-in. printed circuit board for which a template is supplied. To make the PC board, cut a piece of copper-clad board (any type) to the specified dimensions and clean the copper surface thoroughly with a coarse household cleanser; then rinse the board and dry.

Place a piece of carbon paper, carbon side towards the copper foil, on the board and tape the board under the supplied template, or a copy of the template. Using a sharp instrument, indent the copper at the indicated component mounting holes by forcing the point of the instrument through the template into the copper. Then, using a ball-point pen, trace the foil outlines.

Remove the PC board, and using a resist pen, or a brush dipped in resist, fill in the

outlined areas of foil to be protected. Let the resist dry for a few minutes and then immerse the board under at least 1/4-in. of etchant.

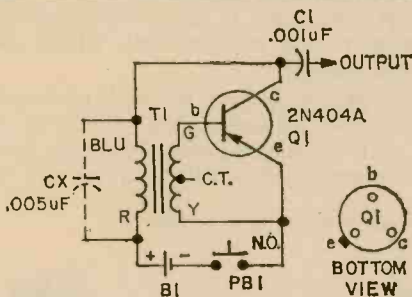
Etch for about 45 minutes, agitating the board frequently. Then check to see if all undesired copper is removed. If it isn't, reimmerse the board for 5 minute intervals until every trace of the undesired copper has been etched away.

Rinse the board thoroughly under running water and then drill the component mounting holes, which are indicated in the copper foil by the indents.

The holes for the mercury cell holder requires a #39 bit for #2 or #3 screws. The holes for transformer T1's mounting tabs use a #27 bit. The remaining component holes are made with a #57, #58 or #59 bit.

Install transformer T1 first. Note that the secondary is center-tapped. The center-tapped lead is not used; cut it off at the transformer. Though we have given the color codes for T1's leads in the schematic, note that manufacturers do change their color codes, so double-check the particular transformer you use before installation. Re-

(Continued on page 114)



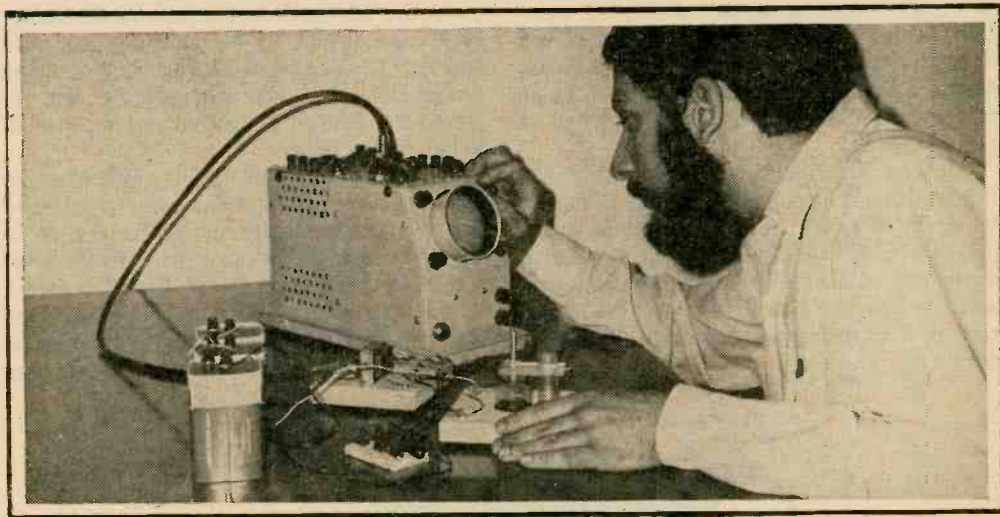
If *Beeper* doesn't oscillate, reverse T1's secondary leads. Or, add Cx (see text).

PARTS LIST FOR THE BEEPER

- B1—Mercury cell, Mallory type RM625 or PX-13
 - C1—.001 uF, 500 VDC disc capacitor
 - Cx—.005 uF, 25 VDC capacitor, see text
 - PBI—Push-button switch, see text
 - Q1—Transistor, 2N404A
 - T1—10000 ohm primary, 2000 ohm C.T. secondary sub-miniature transistor transformer. (Custom Electronics 442-3390).
 - 1—Keystone type 117 mercury cell holder
 - 1—Keystone test probe kit
- A kit containing all the above components except B1 and PBI is available for \$5.85 plus 75¢ postage and handling from the Electronic Hobby Shop, Box 587, Brooklyn, N. Y. 11202. Outside U. S. shipments add \$1 extra.

LIQUID NOISE GENERATOR

Join the old timers, experiment with an electrolytic interrupter



by Charles Green, W6FFQ

In the early days of radio, at the beginning of the 20th century, experimenters tried weird and wonderful ways to solve their problems. Before the electron tube was discovered by DeForest, most radio transmissions were generated by spark coils. These spark coils required an interrupted DC input which was usually achieved by mechanical interrupters.

Another method of interrupting DC was the electrolytic interrupter. The electrolytic interrupter used lead and platinum electrodes immersed in dilute sulphuric acid. Electric current flowing through the circuit caused bubbles of gas to form on the platinum electrode that temporarily interrupted the circuit.

You can experiment with the electrolytic interrupter by using our Liquid Pulse Generator, a modified unit that employs salt water as an electrolyte, and lead wire solder and a sewing machine needle as the electrodes. We have included information for the construction of an experiment board that

can enable you to observe generated pulses on your oscilloscope.

How-It-Works. Pure water is a poor conductor of electricity. When ordinary table salt is dissolved in water, some of its molecules are split up and the resultant ions of chlorine and sodium cause the water to become a good conductor of electricity.

When electric current flows between the lead wire-solder electrode immersed in the salt water electrolyte and the point of sewing machine needle (serving as the other electrode), gas bubbles are created. These gas bubbles form at the junction of the needle point and the electrolyte. Since at these low voltages gas is an insulator, the DC current flow through the circuit is interrupted by the bubble. When the DC current flow stops, the gas bubbles no longer form and they are dissipated. When the gas bubbles are gone, electrical contact between the needle point and the electrolyte is remade, and the process is repeated indefinitely.

Construction. The Liquid Pulse Generator

Noise Generator

unit and the Experiment Board unit are both built on 5-in. squares of $\frac{3}{4}$ -in. thick white pine. Begin construction by cutting these pieces to size.

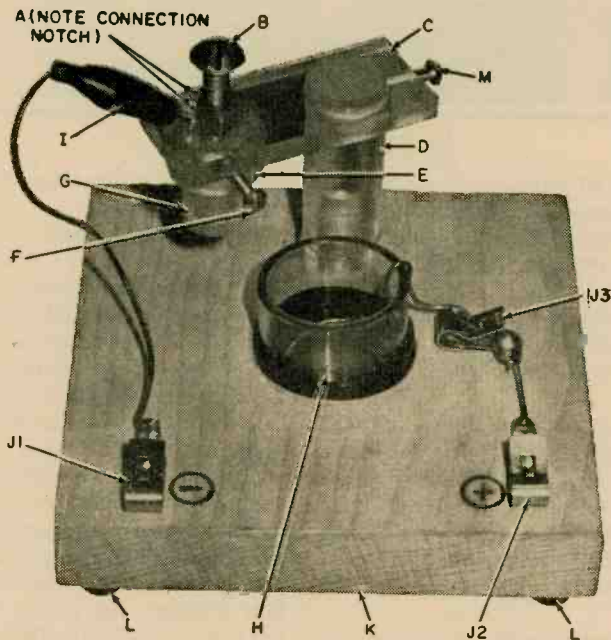
Pulse Generator. The Liquid Pulse Generator is an assembly of units made of clear plastic cut to the sizes shown in the drawing. This assembly is mounted on a 2-in. length of $\frac{3}{4}$ -in. diameter clear plastic rod (*D*). After cutting support *C* to size, carefully drill a hole at one end so that *C* will fit over *D* and can be moved up and down. Mount a small set screw in a tapped hole on this end of *C* so that it can be locked in position on *D*.

Cut and drill *G* to size shown in the drawing and then cut collar *E* so that *G* can fit inside *E*. Mount a small set screw in a tapped hole in *E* to lock *G* in place. Cement *E* to the end of *C* as shown, and carefully drill and tap hole in *C*, to fit the $\frac{1}{4}$ -20 threaded rod of *B* in the exact center of the space within *E*.

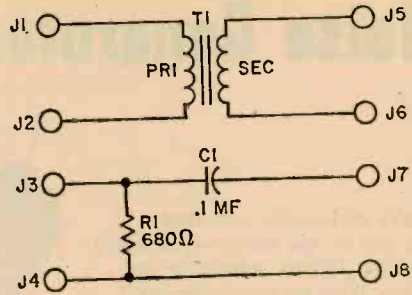
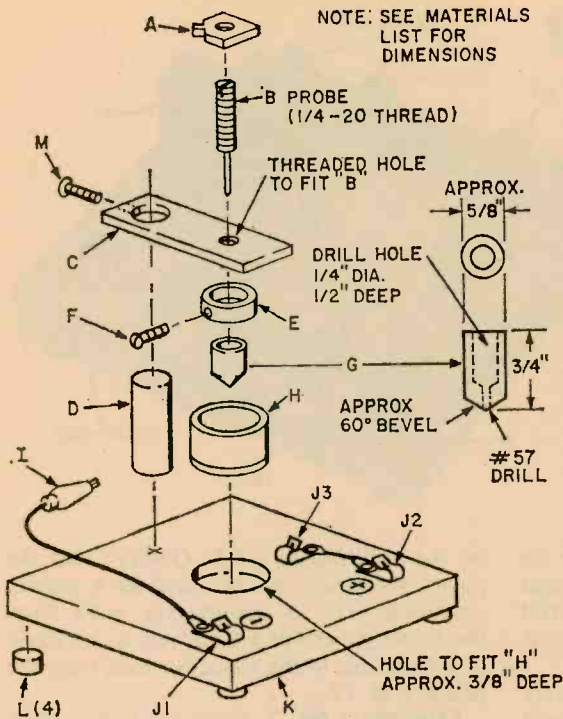
Feed screw *B* is a 2-in. piece of $\frac{1}{4}$ -20 threaded rod cut from a longer piece. Solder a sewing machine needle to the exact center of *B* at one end and cut a slot for a screwdriver at the opposite end of the threaded rod. Insert the threaded rod into the hole in section *C*, making sure that the sewing machine needle tip passes freely through the small hole drilled in the end of *G*, as *B* is turned with a screwdriver. Notch one corner of machine nut *A* so that clip *I* can be fastened to it. Install *A* on *B*.

Cut the plastic cup *H* to size specified in parts list. Mount it in the hole in the center of the wood, base *K*. We used a plastic coin tube cut to the size needed for our unit and wrapped several layers of plastic tape around the base of *H* so that the cup will fit snugly in the hole.

Position the needle holding assembly so that *G* is directly over the center of *H* and fasten it permanently by cementing *D* to the wood base *K*. In our model we threaded a hole in the base of *D* and bolted *D* to the wood base *K*. Connect the clip lead *I* to Fahnestock connector *J1*, and wire leads to *J2*, and *J3* using solder lugs, wood screws



This neat, easy-to-make Pulse Generator is the heart of your experiments with Liquid Noise Generator. All materials should be readily available; they are easy to work with so with a little patience and care you should come up with a perfect duplicate of our model shown here. Full dimensions and a description of material required for each piece is given in Materials and Parts List. Each part identified by letter in photo can be found in Parts List.



Schematic above makes an interesting experiment board, which, when added to Liquid Pulse Generator, batteries and your oscilloscope, provides a means of experimenting by changing circuits and/or components and then observing their effects on the scope. Full dimensions and instructions for the critical parts of the Liquid Pulse Generator are included on this exploded diagram shown to the left.

MATERIALS AND PARTS LIST FOR LIQUID NOISE GENERATOR

(1) LIQUID PULSE GENERATOR UNIT (See Dwg.)

- A— $\frac{1}{4}$ -20 nut to fit threaded rod(B).
- B— $\frac{1}{4}$ -20 threaded rod, approx. 2-in. long.
- C— $2\frac{1}{2} \times 1 \times \frac{1}{4}$ -in. clear plastic sheet.
- D—2-in. long $\times \frac{3}{4}$ -in. diameter clear plastic rod.
- E— $\frac{1}{4}$ -in. long, $\frac{7}{8}$ -in. diameter clear plastic tube. (See drawing for drilling details.)
- F—6-32 $\times \frac{5}{8}$ -in. set screw for E.
- G— $\frac{3}{4}$ -in. $\times \frac{5}{8}$ -in. diameter clear plastic rod (shaped and drilled as in drawing.)
- H—Clear plastic cup, approx. $1\frac{1}{2} \times 1$ -in. high (see text).
- I—Insulated alligator clip with 4-in. lead.
- J1, J2, J3—Fahnestock clips. (Lafayette 33F71028 or equiv.)
- K— $\frac{3}{4}$ -in. white pine 5-in. square.

- L—Small rubber bumpers.
- M—6-32 $\times \frac{5}{8}$ -in. set screw for C.

(2) EXPERIMENT BOARD UNIT (See Dwg.)

- C1—.1 μ f, 600V ceramic disc capacitor (Centralab DF-104 or equiv.)
- J1, J2, J3, J4, J5, J6, J7, J8—Fahnestock clips (Lafayette 33F71028 or equiv.)
- R1—680 ohms, $\frac{1}{2}$ watt, 10% resistor.
- T1—Audio transformer, single plate to single grid, turns ratio 1:3 (Allied 54D2062 or equiv.)
- MISC.— $\frac{3}{4}$ in. white pine 5-in. squares, small rubber bumpers, solder lugs and hookup wire, pure lead wire-solder.
- Oscilloscope
- Spst Knife Switch
- Batteries (approx. 18 volts—see text)
- Table Salt (see text)
- Wire Solder (see text)

as shown in schematic and drawing. Position the components as shown in the drawing and photo.

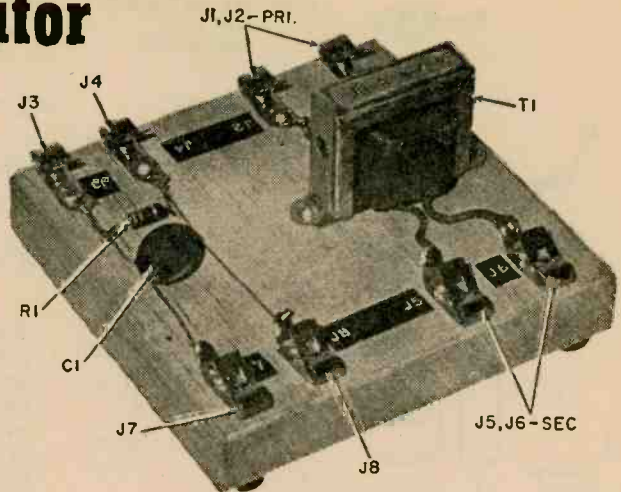
Experiment Board. Next mount the components on the wood base as shown in the photo and schematic of the Experiment

Board. Mark the fahnestock clips with their respective designations of J1 to J8. We mounted small rubber bumpers on the four corners of the bottom of both wood bases.

Experiment No. 1. Connect the Pulse Generator unit, Experiment Board, batter-

Noise Generator

We're all familiar with that old cry of the usher—you can't tell the players without a program. Well, we claim you can't experiment without the proper setup—so—we made the experiment board for you eager beavers to make your experimenting meaningful. It's simple to build and worth the effort.



ies. knife switch and on oscilloscope as shown in Block Diagram No. 1. We used three 6-volt lantern batteries for an 18-volt supply, but any voltage from 12 to 24-volts will be adequate for the experiments.

Place a length of wire-solder (preferably plain, pure lead solder—*do not* use acid core solder) coiled inside the bottom of the plastic cup of the pulse generator, and connect the end of the wire solder to *J3*.

Mix approximately $\frac{1}{4}$ teaspoon of table salt (sodium chloride— NaCl) with enough water to fill the plastic cup to about $\frac{1}{4}$ -in. from the top. Remove plastic shell *G* from the assembly and adjust the probe so that the needle point just touches the surface of the salt water electrolyte. Finger tighten nut *A* on this probe to prevent movement of the needle and attach the alligator clip lead from *J1* to the nut.

Close the knife switch (*ON*) and adjust the probe for maximum pulse amplitude as seen on an oscilloscope. Adjust the oscilloscope's vertical sensitivity for a convenient display height on the CRT. Adjust the oscilloscope's time base for a slow sweep for best display of the pulses. Observe that the pulse display is comprised of many small spikes and few large pulses. This indicates a high noise output.

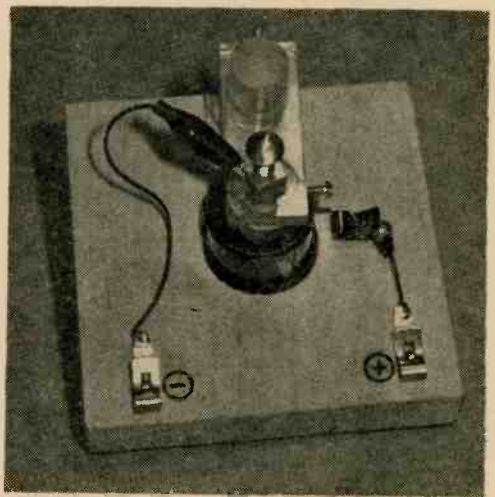
Experiment No. 2. Open the knife switch (*OFF*) and disconnect the pulse generator lead and oscilloscope leads from the experiment board. Reconnect them as shown in Block Diagram No. 2.

Close the knife switch (*ON*) and again adjust the probe for maximum pulse display

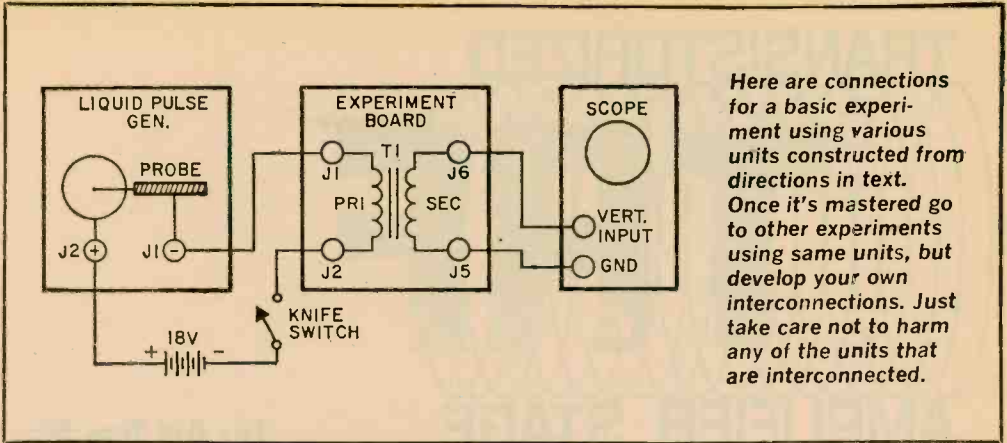
on the oscilloscope CRT. Observe that the pulses are much sharper, and have greater amplitude. This is because the pulse from the liquid generator DC circuit is increased in voltage due to the inductive kick from the primary of *T1*.

Experiment No. 3. Open the knife switch (*OFF*) and remove the probe from the liquid generator assembly. Install the plastic nozzle *G*. Adjust position of *C* until the nozzle tip just touches the surface of the salt water electrolyte.

Insert the probe *B* into the assembly, and adjust it so that the needle tip is protruding



Here's an uncluttered view of our Liquid Pulse Generator. It's versatility shows through its neat design.



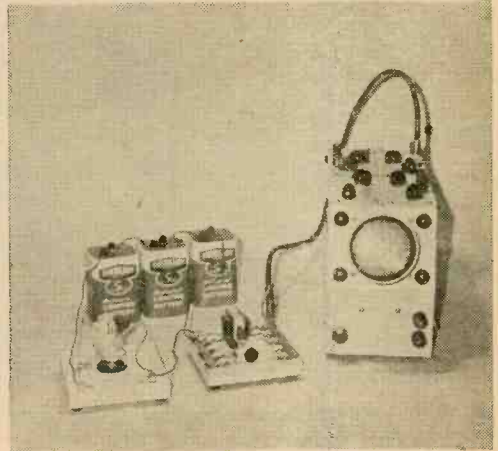
into the small hole in the nozzle. Connect the clip to the nut and close the knife switch (ON).

Adjust the probe B for maximum pulse amplitude on the oscilloscope. Also adjust the nozzle assembly G at the point where it touches the electrolyte. Observe that the pulse display has a much sharper waveform, at a lower display rate, than without the plastic nozzle in the previous experiments.

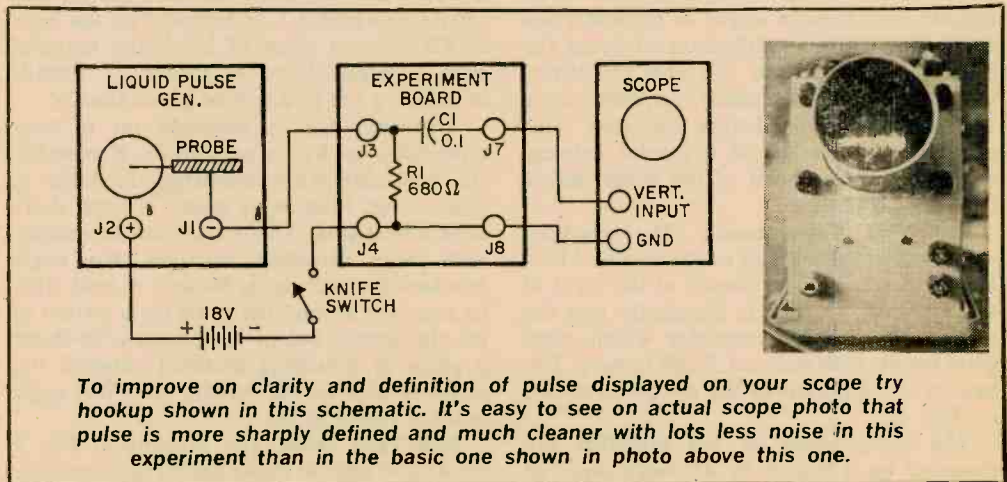
Reason for this is that in Experiments 1 and 2, although the needle was adjusted so that its tip was just touching the electrolyte, the shank of the needle was exposed so that bubbles of gas surrounded by a thin film of electrolyte produced a profusion of interruptions. Whereas in Experiment 3, the plastic nozzle prevents this build-up of bubbles on the needle shank. Just one bubble forms at one time; therefore, it takes longer to form and it will be larger in size.

You can make further experiments with the Liquid Noise Generator by substituting

plastic nozzles with different sized holes, and probes with broader points in place of the needle point.



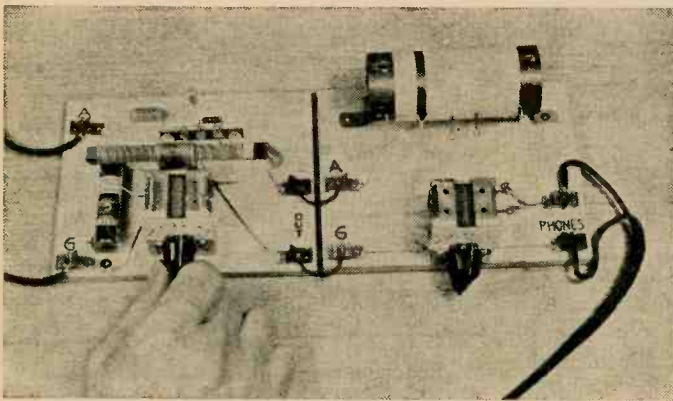
Here's how schematic shown in above basic experiment looks in the flesh.



TRANSISTORIZED TRF AMPLIFIER STAGE

by Art Trauffer

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



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

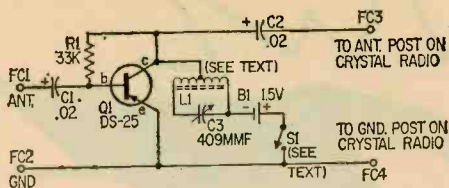
Matching Components. The amplifier stage was breadboarded to match the Allied Knight-Kit crystal set shown at the right of the amplifier in Fig. 1. Simplicity was the rule in building the amplifier which gives good results with only a 1.5 volt battery. The battery is connected in the circuit as shown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

The components of the amplifier are mounted on a 6-inch by 4½-inch piece of

¾-inch plywood and located as shown in Fig. 3. The 409 mmf variable capacitor, C3, is mounted using small angle brackets. Use short screws to secure the brackets to C3 so the screws don't touch the rotor plates. The ferrite core coil, L1, is mounted on the back of C3 using a strap of insulating material such as fibre, plastic or cardboard. Details of winding the coil will be given shortly.

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

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



PARTS LIST

- B1—1.5-volt battery
- C1, C2—.02 mf, 200-volt capacitors
- C3—409 mmf variable capacitor (Allied Radio 13L524 or equiv.)
- L1—Self-wound ferrite core coil (see text)
- Q1—RF amplifier transistor (Delco DS-25, Lafayette 19R4220, or equiv.)
- R1—33,000-ohm, 1/2-watt resistor
- S1—See text
- 1—3/8" x 6" x 4 1/2" plywood base board
- Misc.—Fahnestock clips, terminal strip, pointer knob, solder lugs, Litz wire and 3/8" ferrite rod (see text), scrap sheet metal, hardware, hookup wire, solder, etc.

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

Estimated cost: \$6.00
 Estimated construction time: 2 hours

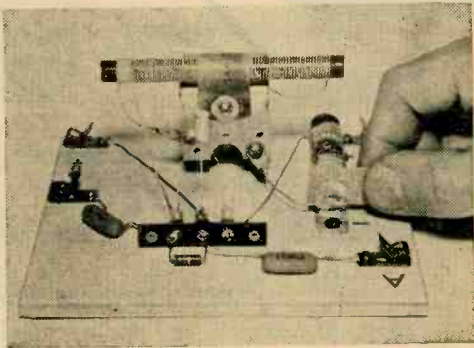
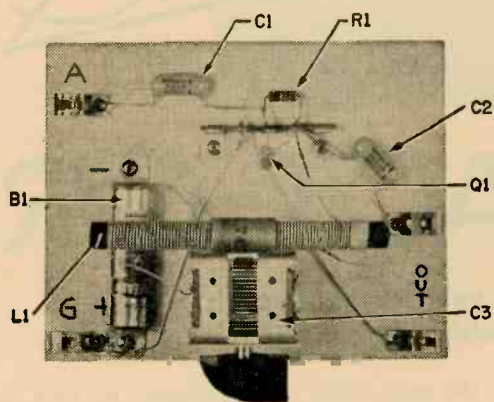


Photo above illustrates breadboard layout used by author. At left, piece of cardboard is used as switch to disconnect battery.

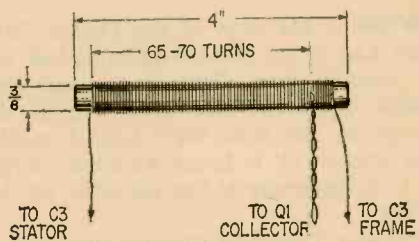


FIGURE 5

L1. The coil works fine as an RF coil and you can also use it as an antenna coil in another project. A length of 10-38 Litz wire and a 3/8-inch diameter ferrite core was used in this project, but alternate materials can be used. For example, Belden 7-41 Litz (Lafayette 32G1485) can be wound on .33-inch ferrite core (Lafayette 32G6102). Or simply use No. 26 enameled cotton-covered magnet wire instead of Litz. Note from Fig. 5 that the first 10 turns of the coil are close-wound while the remainder of the turns are slightly spaced. Use Duco or coil cement to hold the wire at the ends of the coil and to secure the twisted tap to the collector of Q1 from the tenth turn on the coil.

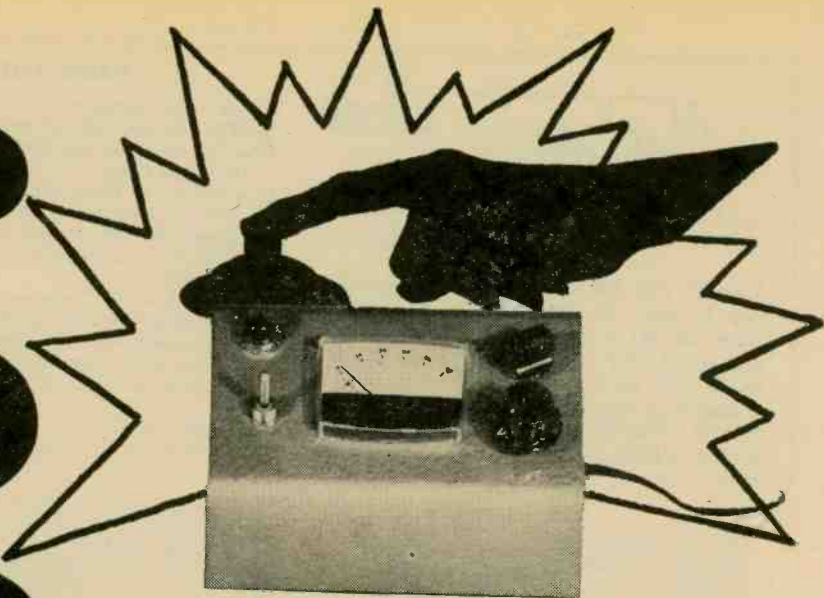
Detail drawing of fabricated coil L1. Make no substitutions and follow plan carefully.

Circuit Operation. The antenna input to the amplifier is through capacitor C1 which blocks DC and passes RF in case your antenna accidentally contacts a power line. Resistor R1 is the base bias resistor for transistor Q1. Coil L1 and variable capacitor C3

form the RF-tuning tank in the collector circuit of Q1. The collector is tapped close to the ground end of the coil to better match the transistor's low output impedance; this gives better selectivity. Capacitor C2 blocks DC and passes the amplified RF signal to the antenna post of your crystal radio.

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

PDQ REACT-OR



It brain-boggles while your tactiles tease it
by Stephen Daniels, WB2GIF

LIVING in the days of old Dodge City a feller had to be greased-lightning-fast with his shootin' iron. Few men dared draw against characters like Jesse James; they figured by the time their hand'd reached their holster, ol' J. James would've emptied his Colt, generally in the direction of their person.

Peculiar Twentieth Century situations involving the horseless carriage turn most mortals into modern-day Wyatt Earps. For instance, how quickly can you maneuver your Brakeless Wonder out of the path of another tired missile attempting a land speed record? Fact is, your reaction time is often your sole defense on a crowded pike. Or, driving along Main Street, U.S.A., you're confronted with a child darting unaware between parked cars in chase of an errant soft-ball. The difference between a safe child and a sorrowful driver is three-quarters of a second—your reaction time under *ideal* conditions.

Whether you drive a 3000-lb. auto or a 3-oz. golf ball, chances are your timing could stand some improvement. And better timing can be yours not by practicing on

the open road, or golf course, or even in a shooting gallery, but seated in an easy chair at home. Pretty Darn Quick is the name of our reaction-time improver. Built into a compact sloping-panel cabinet, our PDQ swiftly and accurately indicates your reaction time. It sports a novel no-cheat circuit, so you (or the person you're testing) can't run up a better score than deserved. Twenty-five clams, plus a few tin-lead acrobatics, assembles PDQ. And that should hasten your workshop reaction time!

How it Works. Take a look at our schematic of PDQ. You'll see that it's divided into four distinct sections. Let's start with unijunction transistor, Q1, and associated circuitry. This gizmo's lashed up as a relaxation oscillator; capacitor C2, resistor R2, and *Time* pot R5 determine the time interval between output pulses. In this case, the RC components selected give up a pulse every 15 to 35 seconds depending upon R5's setting. One sawtooth-shaped pulse blips out of Q1's base 1 and knocks at the gate of Q2, a silicon controlled rectifier.

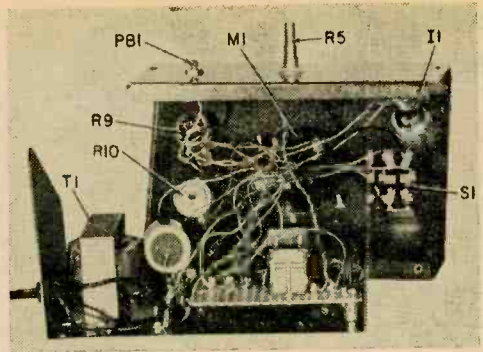
Note switch S1 wired in series with SCR's anode and relay K1. It's a spring-loaded

affair contributing to PDQ's no-cheat accuracy.

Glancing over at the third circuit section, we see that Q3, a field effect transistor, is connected along with the neighboring electron-caters as a high-impedance voltmeter. This mini FET-VM measures the voltage in the first remaining on C3. Here's how C3 gets this voltage in the first place: when S1's held down by PDQ's operator, the SCR's anode makes connection with K1. An incoming pulse arriving from Q1 triggers off the SCR. As this happens, the relay energizes, simultaneously extinguishing lamp I1 and switching capacitor C3 to resistor R6. The combination of C3 and R6 forms a simple RC network which serves to discharge C3.

Now let's see why you need a spring-loaded switch for S1. Immediately after I1 goes out, our nimble-fingered operator lets S1 zap back to its original position; Q2's anode connection is broken with the relay, and S1 connects the FET-VM to capacitor C3. Remember, you might be faster than a speeding locomotive, but it'll take you a finite amount of time to react to I1's disappearing act. In the meantime, of course, C3 merrily discharges through R6. That's how your bullet-quick reaction time's measured. Simple, isn't it!

Now let's delve into the last circuit section. You won't need to get hot under the collar over this conventional power supply. Consisting merely to stepdown transformer T1, encapsulated bridge rectifier Z1, filter capacitor C1, dropping resistor R1, and zener diode D1, this supply gives you oodles



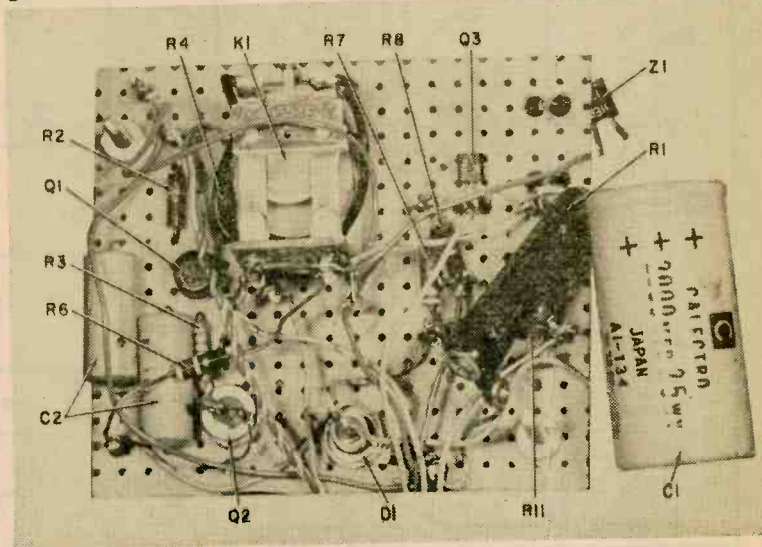
Author mounted meter M1, dpdt switch S1 on front panel of prototype reaction timer.

of room to switch n' swap your spare parts. If you've a handy 12-volt source gathering dust in the workshop, save yourself a chunk o' change by making the substitution.

Construction Capers. Start your construction efforts by wiring the power supply if you're building it in. Drill a 1/4-in. hole for the power-cord strain relief. Then ream it out slowly until the relief fits snugly. The power transformer is mounted close to the panel wall. A 6-lug terminal strip sits in front of it.

Wire T1's secondary and primary leads to the terminal strip. Note that Z1's AC side connects to the transformer's secondary leads; the positive and negative rectifier leads connect to push-in terminals conveniently located on the perf board. Solder the power-supply filter capacitor leads to the remaining terminal strip lugs, running wires from Z1 to C1's leads. Don't forget your polarity rules here; positive rectifier output

Note author substituted two parallel 100- μ F capacitors for part C2. He also raided spare-parts box for stud-mounted 10-watt zener diode, D1. Part C2 makes connection to terminal lugs found between board, transformer T1.



PDOQ

terminal connects to positive filter capacitor lead.

Now solder one leg of R1 to C1's positive terminal. Resistor R1's other wire hangs fancy-free until it's eventually connected to

diode D1 and the positive power-supply bus.

Start work on the circuit board by cutting out a 3½-in. square piece of perfboard. You've scads of wiring freedom, so don't be bashful about raiding your spare-parts collection. Stick flea clips into the perf board between your point-to-point parts. After drilling a 3/16-in. hole for Q2, scrounge up a solder lug for it. The lug's wedged between the SCR and perf board, so's to make con-

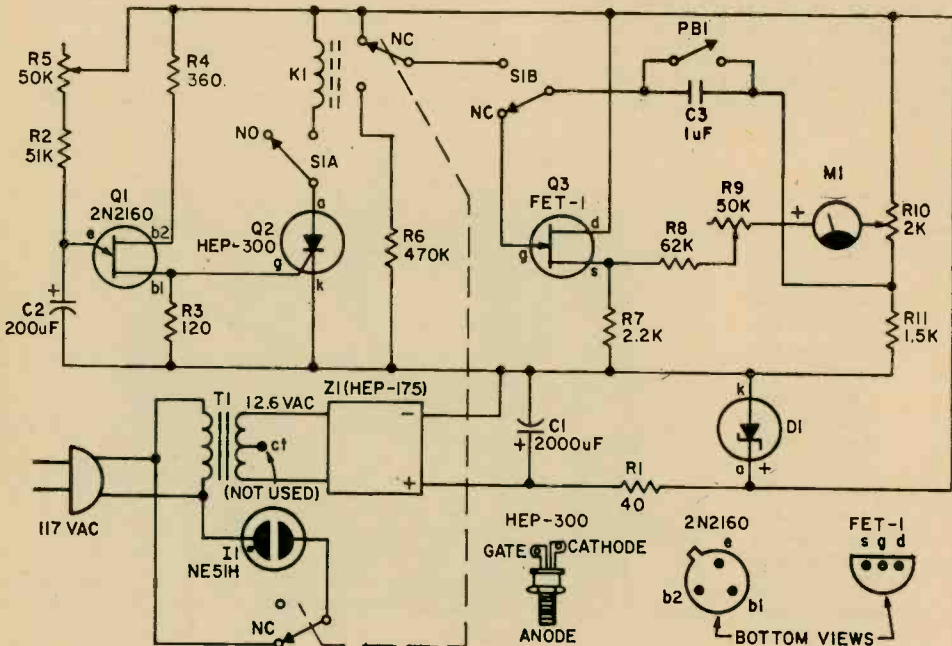
(Continued on page 108)

PARTS LIST FOR PDQ

- C1—2000- μ F, 25-VDC electrolytic capacitor (Cornell-Dubilier BR 2000-25 or equiv.)
- C2—200- μ F, 15-VDC electrolytic capacitor (Sprague TE 1164 or equiv.)
- C3—1- μ F, 200-VDC mylar capacitor (Cornell-Dubilier 2W1 or equiv.)
- D1—12V, 1 Watt zener diode (Motorola HEP 105 or equiv.)
- I1—NE-5 H neon pilot lamp
- K1—Dpdt relay, 12-VDC (Magnecraft W88-X7 or equiv.)
- M1—0-50 μ A. meter movement (Lafayette 99E 50429 or equiv.)
- PB1—Spst miniature pushbutton switch, normally open (Lafayette 99E 62184 or equiv.)
- Q1—Unijunction transistor, GE 2N2160 or equiv.
- Q2—50V @ 5 amps SCR (Motorola HEP 300 or equiv.)
- Q3—Field effect transistor, GE FET-1
- R1—40-ohm, 10-watt wirewound resistor
- R2—51,000-ohm, ½-watt resistor, 5% tol.
- R3—120-ohm, ½-watt resistor
- R4—360-ohm, ½-watt resistor

- R6—470,000-ohm, ½-watt resistor
- R7—2,200-ohm, ½-watt resistor
- R8—62,000-ohm, ½-watt resistor
- R11—1,500-ohm, ½-watt resistor
- R5, R9—50,000-ohm, linear taper potentiometer (IRC Q11-123 or equiv.)
- R10—2,000-ohm, linear taper potentiometer (IRC Q11-110 or equiv.)
- S1—Dpst momentary spring return switch (Lafayette 99E 61830 or equiv.)
- T1—Filament transformer; primary 117 VAC, secondary 12.6 VAC @ 2 amps (Stancor P-8130 or equiv.)
- Z1—50 PIV @ 1 amp bridge rectifier (Motorola HEP 175 or equiv.)
- 1—Line cord
- 1—Neon lamp housing with clear lens (Dialco 52-0463-0997-211 or equiv.)
- 1—4¼ x 7 x 4-in. sloping panel cabinet (Bud AC-1613 or equiv.)
- 1—6 lug tie strip (H.H. Smith or equiv.)

Misc.—hardware, knobs, perforated board, flea clips, wire, solder, etc.





go with...

SPEEDY-FLASH

Stay with the action—
fast cycling keeps you snapping

by Herb Friedman, W2ZLF/KBI9457

It always happens! Sis blows out the birthday candles, and then the whole party has to count ten while you wait for the ordinary electronic flash to recharge before you can take the next picture. It's even more embarrassing at a wedding. You shoot the couple just as they are declared man and wife, and then

SPEEDY-FLASH

they must stand by for their first kiss as your electronic flash recharges.

Fact is, the early models of electronic flashes (improperly called *strobes* by many photography buffs) were called *speedlights*, and for good reason. Unlike a flashbulb, a speedlight produces all its light in about 1/1000 second. Then too, speedlights recharge almost instantly; in fact by the time

the photographer has racked the film advance, the speedlight is recharged and is ready for the next picture.

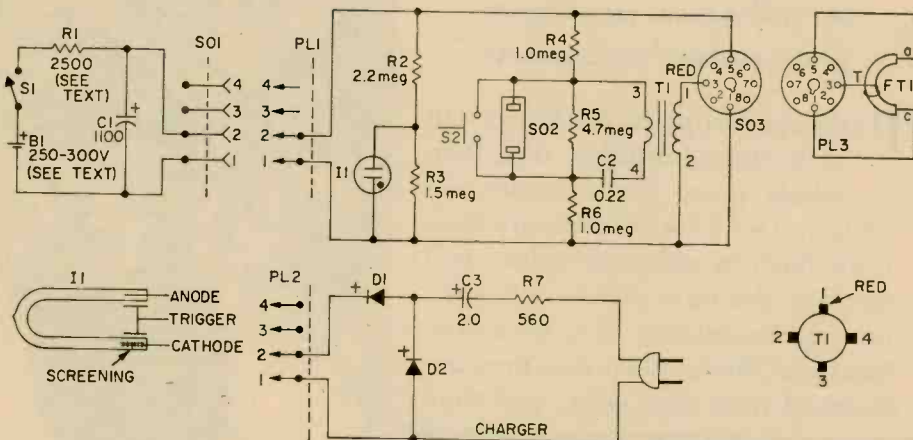
The secret of success in what appears to be almost instant recharging of the speedlight is the use of a high-voltage battery of the magnitude of the one we used in our *Speedy Flash*. Since it's the high voltage, at very low current, that fires the lamp, it takes just two or three seconds to recharge the storage capacitor. Low voltage supplies, on the other hand, take from 15 to 25 seconds to recharge the capacitor, depending on the

PARTS LIST FOR SPEEDY FLASH

- B1—300-V photoflash battery, Eveready 493 or equiv.
- C1—1100- μ F, 350-V electrolytic capacitor, Sprague 36D112F350 (Newark Electronics 18F2511 @ \$7.38)
- C2—0.22- μ F, 100-V ceramic capacitor
- C3—2- μ F, 250-V electrolytic capacitor (see text)
- D1, D2—300-PIV, 400-ma (or higher) silicon diode rectifier
- *FT1—MFT-110 flash tube (do not substitute—see text)
- I1—NE-2 neon bulb
- PL1, PL2—4-pin cable connector (Amphenol 91-MPM46 or equiv.)
- PL3—Octal plug (Cinch-Jones 8B8 or equiv.)
- R1—2500-ohm, 1/2-watt resistor (see text)
- R2—2.2-megohm, 1/2-watt resistor
- R3—1.5-megohm, 1/2-watt resistor
- R4, R6—1-megohm, 1/2-watt resistor
- R5—4.7-megohm, 1/2-watt resistor
- R7—560-ohm, 2-watt resistor
- SO1—4-pin socket for PL1, PL2 (Amphenol 78-PCG4 or equiv.)
- SO2—2-prong, non-polarized socket (Cinch-Jones 2R2)

- S03—Octal socket (Amphenol 77MIP8 or equiv.)
- S1—Spst toggle switch
- S2—Spst normally-open pushbutton switch (Switchcraft 201 or equiv.)
- *T1—6-kV trigger transformer TT-6 (do not substitute—see text)
- **1—7-in Telephoto reflector
- 1—Minibox, 2 $\frac{3}{4}$ x 2 $\frac{1}{8}$ x 1 $\frac{1}{8}$ in.
- 1—Bakelite utility case with aluminum panel 4 x 2 $\frac{1}{8}$ x 1 $\frac{1}{8}$ in. (Lafayette 99E80780 or equiv.)
- 1—Rowi or equiv. photo accessory case 7 $\frac{1}{4}$ x 5 x 2 $\frac{3}{4}$ in.
- Misc.—Banana plugs, reflectors, RTV cement, hardware, wire, solder, ect.

* MFT-110 flash tube and TT-6 trigger transformer available from Custom Components, Box 153, Malvern, NY 11010. Total cost for both \$13.95 plus 75¢ postage and handling in U.S., \$1.75 to Canada, no orders outside North American continent. NY State residents must add sales tax.
 ** Available from Edmund Scientific Co., 555 Edscorp Building, Barrington, New Jersey 08007-catalog #71,224 @ \$2.95, Ppd.



Charger, for C1 when Speedy-Flash isn't used for several days, isn't isolated from 117VAC line so take care be sure PL2's plugged into SO1 before connecting to AC.

condition of the battery's charge.

Our *Speedy Flash* has another very useful feature, interchangeable flash heads. This was common to early professional speedlights that somehow lost favor along the way. By using several sizes of interchangeable flash heads the photographer can more or less tailor the light to his specific needs. For example, he can plug in just the flashtube less reflector for bare-bulb, non-concentrated lighting; or he can mount the flashtube in a plug-in 3-cup aluminum saucerpan size reflector and have a standard coverage reflector with an ASA25 guide number of approximately 56. If he places the flashtube in a cheap deep-dish reflector, similar to the one shown in the photos, he can have a *telephoto* electronic flash packing all its light into the correct angle for the 135-mm lens of a 35-mm camera, and then be able to work with an ASA25 guide number of approximately 110. Naturally, the exact guide numbers depend, to a large extent, on the particular reflector used and how the flash-

tube is mounted in the reflector.

Speedy-Flash consists of three units. The battery capacitor pack (carried on a shoulder strap); the flash head, which takes plug-in flashtubes; and a charger, a device used for reforming the storage capacitor so the battery doesn't have to literally spill its guts out trying to reform a capacitor that hasn't been used for weeks or months.

Construction is not critical, especially if the general layout we used is followed. Most important, none of the wires between storage capacitor C1 and flashtube FT1 should be smaller than #18 gauge (you can use zipcord). Number 16 wire is even better since the larger the wire the lower the voltage loss. Then when C1 discharges it gives a little more light output.

We built the flash-head in a 4 x 2½ x 1½-in. Bakelite utility case. No parts are mounted on the aluminum cover plate supplied with the utility case. All wiring must be inside the Bakelite case for maximum safety. Mount octal socket SO3 as close to

Here's complete Speedy-Flash package showing camera ready for action including charger for forming C1. Only time it's needed is if you don't make shots every day (it takes a load off expensive battery). Surplus battery case from old flash gun makes neat support for Speedy-Flash flash head. Plug-in reflectors add versatility to use best flash concentration for effective lighting of scene you're shooting.



SPEEDY-FLASH

one of the ends as possible. Though only three connections are needed for flashtube FT 1, the 8-pin octal socket is used because the unused terminals provide convenient tie points for other components. Install SO3 so the keyway points to the side of the case. Place a large blob of silicon rubber (RTV) adhesive inside the case adjacent to pin connection 3 of SO3 on the Bakelite bottom of the case and press trigger coil T1 into the blob. Make sure the red terminal of T1 is directly opposite pin connection 3 of SO3.

T1 is a special high-voltage trigger trans-

even though only two pins are used. The reason for this is because when inexpensive miniature plugs are used, the extra pins, when seated in the socket, provide a firm, rigid seating and tend to hold the plug tighter in the socket.

Ready Light. The ready light for the next flash pilot, I1, is an NE-2 neon lamp wired to the terminal strip using full length leads. To avoid shorts, place a piece of sleeving on each lead. Run the leads straight up from the tie strip and then fold the lamp over at right angles. Drill a 1/4-in hole in the cover plate that will allow viewing the ready light.

Finally, install a standard camera tripod socket on the bottom of the case so the



Full 300 volts from battery specified and large, 1100- μ F capacitor produces more than adequate light at fairly high recycling time so you can make really speedy action shots. Portable photo accessory case makes for easy shoulder-strap carrying of power unit. If you have a different sized case that's surplus, use it. You may prefer using different battery; that's OK, just remember, it's the higher voltage we used that makes fast recharging of C1 possible. Current drain is small so battery lasts a long time.

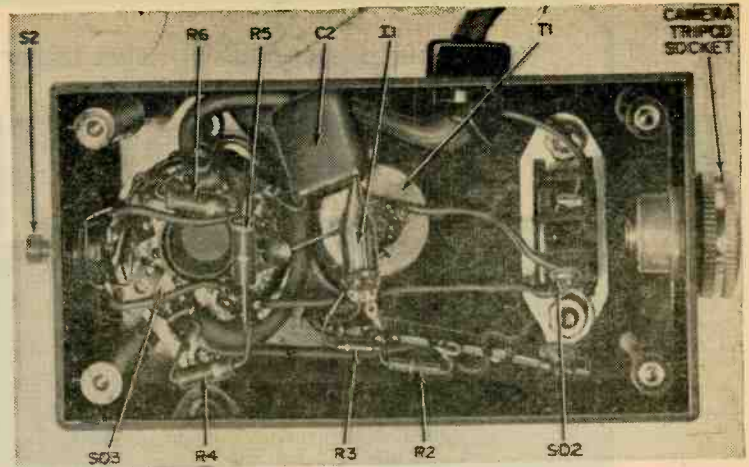
former and no other type should be substituted. The flashtube may not fire at low battery voltage with a trigger transformer having different characteristics. For that matter, don't substitute a different flashtube than the one listed, either.

When the adhesive holding T1 is completely set, install the remaining flash head components. For maximum convenience, the connecting cable should be about 50 inches long, and should be firmly secured to the inside of the case. If available, use a good-quality strain relief for this purpose. Connecting plug PL1 should be a 4-pin type

flash head can be mounted on a flash bracket, or an accessory shoe bracket, or the battery holder from a conventional flash gun like the one shown in the photos.

The Flash Tube. The flash tube is connected to pins 1, 3, and 5 of octal plug PL3. First, and most important, identify FL1's cathode terminal. Note that FL1 is an U-shaped glass tube with a lead sticking out each end of the glass U tube. A third lead connects to a metal band encircling both the open ends of the U. By careful observation of both ends of the U, you will also note that the lead on one end is at-

Undercover work in flash head detailing location of various parts. Note ready light supported by its leads to position it near viewing port drilled in metal cover of bakelite housing. S2 let's you fire flash manually if needed.



tached to a small piece of screening inside the tube. The lead attached to the screen is the cathode and connects to the B- through pin 1 of PL3. Anode of FT1 connects to the B+ through pin 5, while its trigger lead, the third lead, connects to pin 3.

In order to use just a bare flash tube (FT1) without a reflector, it should be mounted in an octal plug, or the salvaged octal base from an old tube. If you use either the saucerpan type standard reflector, (actually a 3-cup aluminum saucerpan with a hole drilled in the middle of the dome for flashtube socket) or a deep-dish type telephoto reflector (see Parts List), mount a Cinch-Jones 8PB-8 octal plug in the center of the reflector and then install FT1.

High Voltage Battery. Battery B1 and capacitor C1 are housed in any standard photo accessory case. The one used for *Speedy Flash* is a Rowi, measuring $7\frac{1}{4} \times 5 \times 2\frac{3}{4}$ in. Capacitor C1 is secured to the case with a heavy blob of silicon rubber (RTV) adhesive. Battery B1, a 300-volt Eveready 493, comes equipped with banana jacks. You may substitute a 250-volt photoflash battery if you want to lower the battery cost (it lasts for hundreds of flashes, depending on its age). Or you can series-connect any other type of battery to obtain the high voltage between 250 and 300 volts (e.g., four $67\frac{1}{2}$ -volt miniature batteries could be used).

Resistor R1 is used only to quench the flash tube. When the tube fires the voltage across C1 falls and the tube turns off. Though it appears R1 does nothing, it ac-

tually supplies current limiting for C1. R1 can be any 4- to 10-watt resistor rated from 500 to 5000 ohms. The higher the resistance the longer the battery life, because C1's charging current is held to low values. However, the higher the resistance the longer the time to charge C1. A good compromise for R1 is 2500 ohms. It charges C1 in about 2 seconds as indicated by the ready light. A 5000-ohm R1 will take about 5 seconds to recharge, whereas a 500-ohm R1 will recharge before you can wind the film.

C1 Charger. No, the purpose of the charger isn't to recharge battery B1; the charger is used to reform C1 after it has been idle for more than 7 days. We housed the charger shown in the photo in a $2\frac{1}{4} \times$

(Continued on page 108)

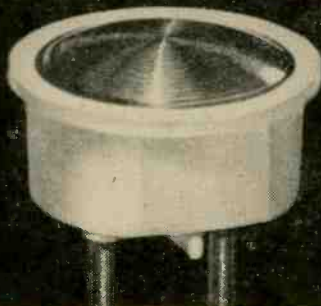


He's plugging in telephoto reflector to flash head. This plug-in arrangement gives user many options to get best lighting for his shot.



Let our peeper-pleasin' wallet teaser
doll up your test gear!

NO-SQUINT



MOST of us have unintentionally allowed some test equipment to roast on our workbench overnight at some point in our electronics career. You thought the darn thing was turned *off*; a red-hot power transformer told you otherwise upon your return to the scene of the crime next day. If you're tired of searching high and low for unmistakable *power-on* indications every time you plug in line-operated equipment, then swivel your baby blues toward our *No-Squint*.

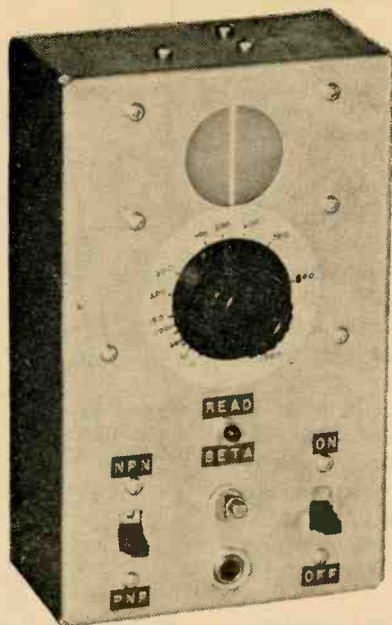
Our neon super-shiner lobs its rays at you under all indoor (or outdoor!) lighting conditions. Magnifying glasses you won't need to gaze upon this almost inch-wide pilot lamp; unlike ordinary line-operated neon indicators, this baby practically stands up and waves its orangey self at you.

No-Squint also passes the buck—back into your wallet. Four bits, give or take a few pence, entitles you to one of these $\frac{7}{8}$ -in. diameter white plastic beauties. And you can install our penny-pinching pilot light in a half hour, easily making *No-Squint* the fastest and cheapest means of protecting all of your plug-in gear from those unnecessary stew-ins.

Drill 'n' Fill. It'll take less time to mount *No-Squint* than it does to read about its virtues. Cut a $\frac{7}{8}$ -in. hole in the instrument's panel with a chassis punch. Before you actually mount *No-Squint* in this hole, squish a bead of plastic cement around the base of the hole. Press the pilot-light assembly into the hole and place some pressure on it until the glue's dry. Solder connections can be made directly to the metal prongs emerging from the business side. For safety's sake, slip a short length of spaghetti tubing over the prongs after soldering.

Plunk down 59 cents and you can pick up *No-Squint* from Lafayette Radio Electronics. They stock it under number 34—52448.

—Elmer Carlson ■



DUO-LITE Q CHECKER

LET DUO-LITE REMOVE THE SHADOW OF DOUBT—
IT TELLS ALL ABOUT SURPLUS OR JUNK BOX TRANSISTORS

TRANSISTORS in your junkbox will turn into usable items when tested on our Duo-Lite. It will tell you whether a transistor under test is shorted, leaky, or open, and whether it's pnp or npn. What's more, it will also give you a beta reading.

Beta, as you may recall, is the current gain of a transistor from the base to the collector when the transistor is connected in the common-emitter configuration. Beta is perhaps the most significant parameter of a transistor and is used, for example, in determining overall stage gain. The standard notation for beta is h_{fe} .

Circuit Operation. As shown in Fig. 1, lamp I2, resistor R3, switches S2 and S3, and battery B1 form a simple series circuit. Current flow in that circuit can be determined by using Ohm's Law ($I = E/R$). E in this case is the battery voltage (4.5 V) and R here is the sum of the individual resistances of I2 (33 ohms) and R3 (43

by George A. Ellson, W7EKH

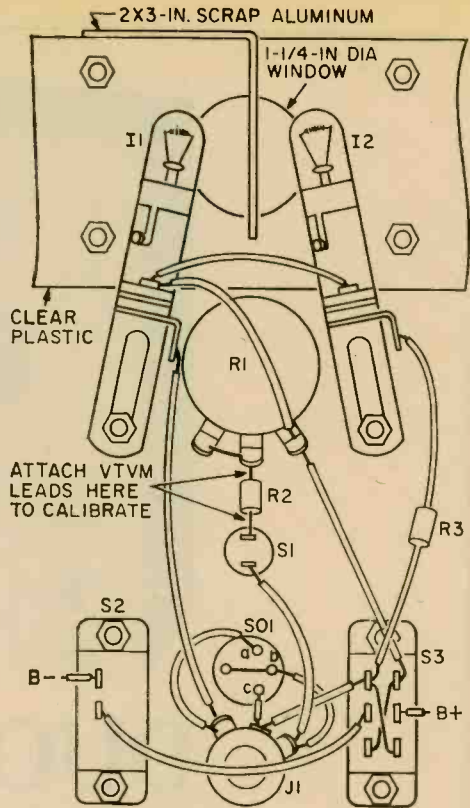
Duo-Lite Q Checker

ohms). Therefore I (circuit current) is $4.5/76$ or roughly 60 mA.

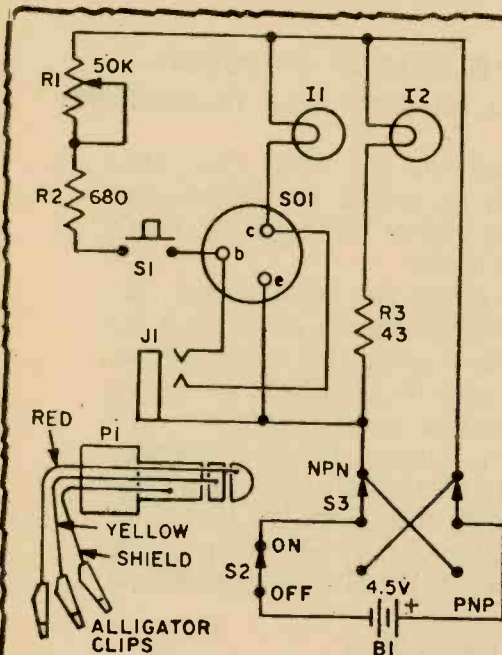
The remaining part of the circuit consisting of switches $S1$, $S2$, and $S3$; resistors $R1$ and $R2$; lamp $B1$; and the transistor under test is a common emitter amplifier. Transistors to be checked are plugged into socket $SO1$ or connected to the alligator clip leads. The base current is controlled by adjusting $R1$ ($S1$ closed). This varies collector current and therefore the intensity of $I1$ —which can be made equal to $I2$. When this occurs, 60 mA is flowing through the collector circuit. If at this point, we could determine the base current, we'd be able to determine beta as the quotient of Ic/Ib —where Ic and Ib refer to the collector and base currents respectively. The base current for any position of $R1$ is tabulated in the calibration procedure.

The circuit determines a shorted transistor by the presence of a very high collector current and therefore a brilliant $I1$ with $S1$ open (zero base current). Leaky transistors are also spotted in this way, but the collector current is much less.

Switch $S3$ reverse biases the collector junction, which is a necessary condition if

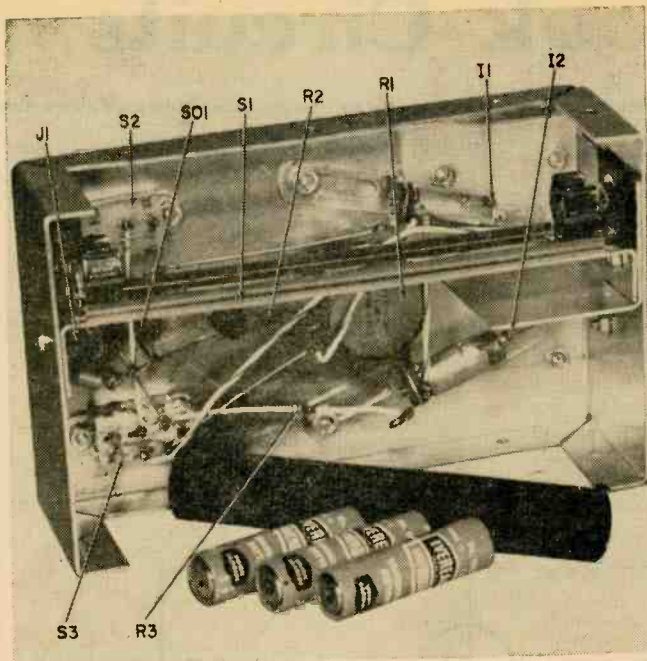


You can locate all of the parts on this pictorial which reveals neat layout of unit.



PARTS LIST FOR DUO-LITE

- B1—4.5-V battery (3 Eveready 915 or equiv. in series)
- I1, I2—#49 pilot lamp
- J1—3-conductor phone jack
- P1—3-conductor phone plug
- R1—50,000-ohm, linear taper potentiometer
- R2—680-ohm, 1/4-watt resistor, 5%
- R3—43-ohm, 1/4-watt resistor, 5%
- S1—Spst normally open miniature pushbutton switch (Lafayette 34E60011 or equiv.)
- S2—Spst slide switch
- S3—Dpdt slide switch
- 1—6 1/4 x 3 1/2 x 2 1/8-in. interlocking chassis (LMB 138 or equiv.)
- 1—Battery holder (Keystone 2191 or equiv.)
- 1—Translucent plastic soap dish or soft plastic freezer carton
- 2—Pilot lamp sockets (Cramer 7-06 or equiv.)
- Misc.—Transistor socket, hookup wire, solder, paper for dial, cement, knob, shellac, alligator clip leads, 3-conductor cable, etc.



Bend tabs at each end of 7 X 1-in. bracket to form full length shelf to hold 3 penlite cells. From rear, RH tab 1 X 9/16-in. LH tab 1 X 3/4-in.

With R1 set at minimum, press S1 and measure ER2. Base current (I_B) can be calculated using Ohm's law; the equation in this instance is $I_B = ER2/R2$. I_B can be readily found since R2 and ER2 are known quantities. Assuming a 60-mA collector current, beta can be calculated by using the equation $\beta = I_c/I_B$. Mark this value of beta on the dial next to the knob pointer fitted onto R1. Repeat this procedure for as many different beta readings as you desire spaced

we want to know whether a transistor is open, pnp or npn, and what its beta is. Open transistors show no collector current regardless of the base current. With S1 pressed therefore, lamp I1 remains dark for all settings of R1.

Construction. As shown in our photo, all parts are mounted in a 6 1/4 x 3 1/2 x 2 1/8-in. interlocking chassis. Lay out all parts on the surface of the box and mark their locations. Drill and punch all holes. Mount the plastic window first, using 4-40 hardware. Next, install all remaining parts. The L bracket for separating the window into two sections is formed from a piece of 2 x 3-in. scrap aluminum. The battery holder is mounted on a 7 x 1-in. piece of scrap aluminum. Place a piece of electrician's tape at each end of the chassis before mounting the battery holder to prevent accidental grounding. The dial is made of paper cemented to the chassis and shellacked after calibration.

Beta Calibration. To start with you'll need a transistor that you know to be good (not shorted, leaky, or open). Plug it into the socket or attach it to the clip leads and connect a VTVM or VOM across R2. The higher the resistance of the meter the less loading there will be of R2 (and the more accurate the reading), so a VTVM is preferred.

around the dial. The author calibrated his dial with 15 positions from minimum to maximum but there's no reason why you couldn't use more or less.

Check Out. Plug in your transistor to be tested or connect to the alligator clip leads. Refer to a manual to determine the positions of the collector, emitter, and base of your transistor so that you can properly connect it in the circuit.

Turn on the Duo-Lite. If I1 glows brightly, the transistor is shorted. A dim glow indicates leakage. A shorted transistor is of no value to you but a leaky one can often be used in switching circuits. If the transistor isn't shorted or leaky, you should next check for opens. Set R1 to minimum and press S1 using first one and then the other position of S3. If I1 remains unlighted in both positions of S3, the transistor is open. Open transistors can be used as diodes (one junction is probably good—surprise, heh?).

If the transistor isn't shorted or open, now is the time to determine its makeup (pnp or npn). Refer back to the test for opens and note that in one of the positions of S3, lamp I1 is lit. This position of S3 is marked either pnp or npn (see photo), and *voila*, that's what your transistor is. Now you can determine beta by pressing S1 and rotating R1 until I1 and I2 are of equal brilliance. Beta is read off the previously calibrated dial.

Clip Book Circuits

PHOTOFLOOD DIMMER

All the flexibility of a professional photo studio's variable lighting can be yours with this 500-watt lamp dimmer.

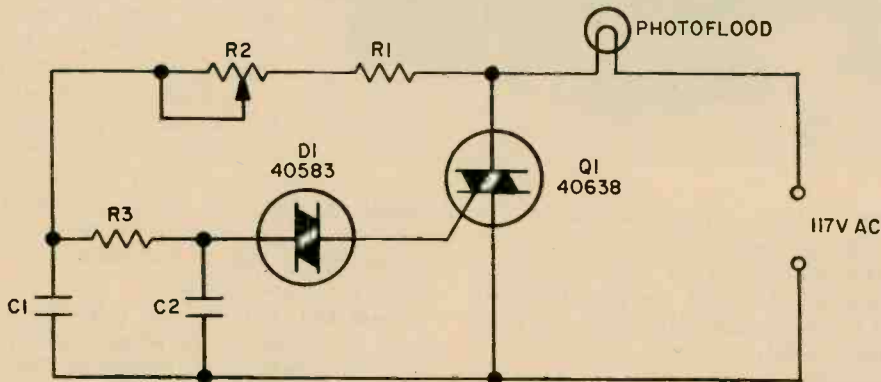
Triac Q1 is supplied with a heat sink which must, in turn, be connected to a larger heat sink. The entire unit is assembled in a metal cabinet with Q1's heat sink epoxy-cemented to the cabinet for heat dissipation.

Fusing must be employed. Otherwise, the surge current when 500-watt photo lamps burn out will instantly destroy Q1. Connect

an 8AG (fast-action) 5 ampere fuse in series with the lamp or any other fuse of equal action, or faster. In this circuit 3AG fuses cannot be used. Potentiometer R2 will adjust the lamp's intensity from full off to essentially 100% full on.

PARTS LIST

- C1, C2—0.01- μ F, 300-VDC capacitor
- D1—RCA 40583 Diac
- Q1—RCA 40638 Triac
- R1—1000-ohm, $\frac{1}{2}$ -watt resistor
- R2—100,000-ohm linear taper potentiometer
- R3—15,000-ohm, $\frac{1}{2}$ -watt resistor



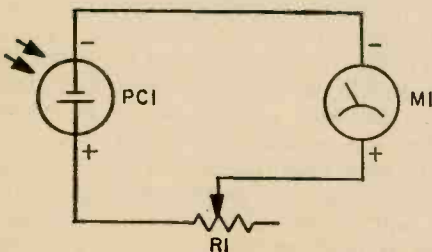
ENLARGER METER

Every print a good print! That's what you get with the Enlarger Meter.

Meter M1 can be just about anything up to 0.1 DC mA. But if you prefer low light levels and long exposures, install a sensitive meter of 500 μ A or less.

When light from the enlarger falls on the solar cell (PC1), a voltage is generated that is in proportion to the amount of light. Sensitivity control R1 allows the user to set the meter indication to a convenient value.

To use the meter, first make a good normal print in your normal manner from a No. 2 or No. 3 negative. Then, do not disturb the enlarger setting, but integrate the light by placing a diffusing disc or opal glass under the lens. Place the solar cell on the easel and adjust R1 for a convenient meter reading, say, full scale. The meter is now calibrated. When using it, focus the enlarger, use the diffuser, and adjust the lens diaphragm until you get the reference meter reading. Then use the exposure time previously found for the calibration print. Suggested reading: Ilford Manual of Photography, obtainable from any photo store. Also, check Kodak publications available at the same place.

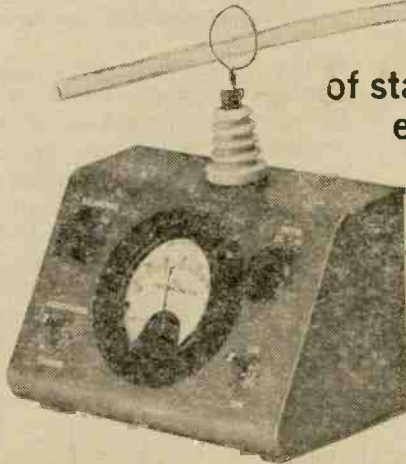


PARTS LIST

- M1—100, 250, or 500-mA DC meter
- PC1—Solar cell (Radio Shack 27-1710)
- R1—5000-ohm potentiometer linear taper

Electro-Snoop

Measure
both polarity
and intensity



of static
electricity
with our
modern
IC electroscope

by George Mulfinger
W4CNR

Here's an ideal Science Fair project. *Electro-Snoop* is a static electricity detector that instantly discloses whether a static charge is positive or negative. What's more, it also gives a relative indication of the charge's strength. Operation of the unit is simplicity itself. The meter reads to the left for negative charges and to the right for positive charges; the extent of deflection is dependent on the magnitude of the charge. *Electro-Snoop* will tell you what kind of charge you acquire walking across a wool rug, what the polarity of the charge on your car becomes as you drive down the street on a dry day, or what the polarity and magnitude of atmospheric electricity your ham antenna is picking up from the surrounding air.

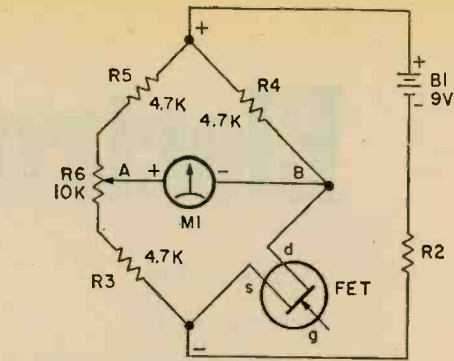
The author found the instrument extremely useful around a physics laboratory. On one occasion it was desired to know the polarity of the dome of a newly constructed Van de Graaff generator. The *Electro-Snoop* was placed about eight feet from the generator. The generator and *Electro-Snoop* were both turned on and the meter went off-scale to the right, indicating a strong positive charge. This proved that electrons were being removed from the dome, as had been desired.

Electro-Snoop's Advantages. The old gold leaf

Electro-Snoop

electroscope has its problems. The gold leaves are hard to maintain and the instrument can't distinguish directly between a plus and minus charge. The Braun electro-scope represents a considerable improvement over this, but still requires an external neon lamp to determine polarity. Vacuum-tube electroscopes work nicely for negative charges, but a positive charge placed on the grid is quickly neutralized by electrons from the filament. This problem is completely circumvented by the use of a field effect transistor (FET). The absence of a filament coupled with its extremely high input impedance allows a charge of either polarity to remain undisturbed on the gate (g) while the meter is being read.

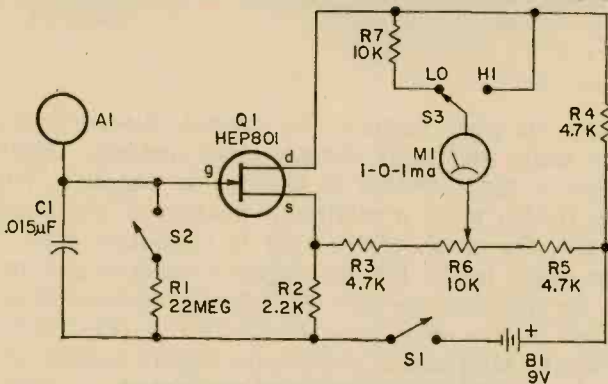
The unit forms a neat self-contained package—no external connections or power source are needed, and it can be used anywhere, indoors or out. Battery drain is quite low, less than 1 mA when the bridge is balanced. It increases to something better than 1 mA with a positive charge and drops to



Redrawn *Electro-Snoop* shows Wheatstone Bridge formed by resistors R3-R5, pot R6, and FET.

½ mA or even less with a negative charge.

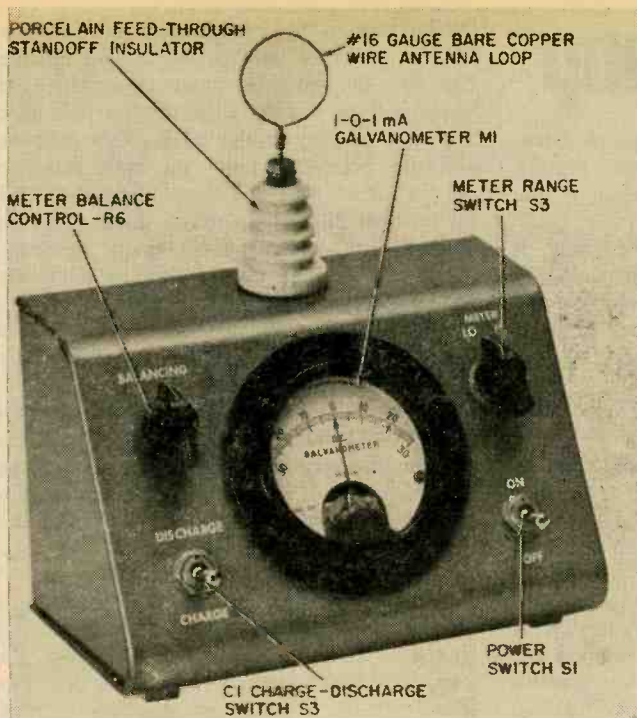
How Electro-Snoop Works. We've redrawn the heart of *Electro-Snoop's* circuit into a conventional Wheatstone Bridge configuration, as shown in our simplified circuit drawing. From this it can be seen that current flows in two separate paths. Using the negative input at the bottom of the diagram as a starting point, it can be seen that electrons may travel up the left side through resistors R3, R6, and R5 to the positive, or up the right side through the FET and R4, and



PARTS LIST FOR ELECTRO-SNOOP

- A1—Wire loop antenna, made from #16 bare copper wire, loop 1½-in. diam.
- B1—9 volt transistor radio battery (Burgess 2U6 or Eveready 216, or equiv.)
- C1—0.015 uF, 600 volt tubular capacitor (Lafayette 34E82536 or equiv.)
- M1—1-0.1 DC galvanometer Weston model 375 or equiv.)
- Q1—Field effect transistor, Motorola HEP801
- R1—22-megohm, ½-w resistor
- R2—2200-ohm, ½-w resistor
- R3, R4, R5—4700-ohm, ½-w resistor
- R6—10,000-ohm, linear-taper potentiometer, Lafayette 33E11255 or equiv.)
- R7—10,000-ohm, ½-w resistor
- S1, S2—Spst toggle switch (Lafayette 34E33026 or equiv.)

- S3—Single pole, two position rotary switch (Lafayette 30E49202 or equiv.)
- 1—Battery connector (Lafayette 99E62879 or equiv.)
- 1—Battery holder (Keystone 203P or equiv.)
- 1—Porcelain stand-off feedthrough insulator (Lafayette 33E32012 or equiv.)
- 1—7 X 4 X 4¼-in. utility cabinet (Bud AC1613 or equiv.)
- OPTIONAL** (see text)
- 1—Transistor socket and mounting ring (Lafayette 32E42195 & 32E42260 ring or equiv.)
- 1—4¾ X 4 X 4¼-in. universal meter case (Lafayette 12E83175 or equiv.)
- MISC.**—Perf board, push-in pins (Lafayette 19E83022 or equiv.), rubber feet knobs, wire solder, spacers, bolts, nuts, etc.



Don't like antenna loop topside?
Metal foil square also works.

point A. Again, because there is a difference in potential, current will flow through the meter, this time deflecting the pointer to the right. By using a value for R2 specified in the Parts List there will be latitude for good deflection in both directions.

Referring back to *Electro-Snoop's* complete schematic, it will be noted that a capacitor (C1) and a resistor (R1) are in the input circuit. When S2 is closed (*Discharge* position) these form a DC RC circuit having a time constant of about 1/3 second. This provides sufficient time for the meter to be read when a

meet at the positive pole at the top of the diagram.

The purpose of R2 is to limit the voltage on the FET to approximately 2V. By adjusting R6 a balance position can be found at which points A and B in the diagram are both at the same potential, approximately 6.5V. Therefore, since there is no potential difference across the meter, it will read zero. In this balanced state, whenever a charge is placed on the gate of the FET, the bridge will respond, with the meter swinging either to the right or left depending on the polarity of the charge.

Whenever a negative charge is placed on the gate of the FET, electrons will be inhibited from passing through the FET. This in effect is equivalent to raising the resistance in this arm of the bridge, which, in turn, increases the voltage drop across the FET proportionally. Point B now assumes a higher potential than point A, and since there now is a difference in potential across the meter, current flows through the meter, deflecting the pointer to the left.

When a positive charge is placed on the gate, electrons will flow more easily through the FET, thus in effect lowering its resistance. The voltage now divides between R4 and the FET in such a manner that the voltage of point B is lowered with respect to

charge is placed on the antenna of *Electro-Snoop*. The circuit then quickly returns to normal as C1 discharges through it.

Capacitor C1 also prevents the meter from oscillating unduly as a charged object is being withdrawn from the antenna loop. With S2 open (*Charge* position), C2 merely stores cumulatively whatever charges are placed on the antenna until switch S2 is again closed to discharge the capacitor through R1.

Switch S3 is a meter sensitivity switch. With S3 in the *high* sensitivity position the meter is connected directly to the bridge. When S3 is placed in the *low* sensitivity position the meter is connected in series with R7 to limit current through it.

Construction. Our model *Electro-Snoop*, shown in the photos, was housed in a 7 x 4 x 4 1/4-in. sloping panel utility cabinet. You'll have to punch out a big hole (size dependent on the meter you use) to mount the meter in the sloping front panel. If you don't want to work so hard punching out this hole, buy a standard sloping panel meter case. It comes with a hole ready punched for a 2-in. meter and a knockout to enlarge it to 3-in., if need be. However, it doesn't come in the 7-in. width so you'll have to use a smaller piece of perf board to mount the FET, resistors, and capacitors used in the

Electro-Snoop

circuit. Even so, this should present no hardship since they are small and don't require as much space as was actually used in the model.

If you don't want to go to the expense of a special sloping panel cabinet the unit will work just as well in any case you have available since the circuit isn't critical to parts placement beyond the normal good wiring practices.

In addition to the meter hole, two 1/2-in. holes for the toggle switches are drilled near the bottom of the sloping panel, one on either side of the meter. Another 1/2-in. hole is drilled in the top of the case for the feed-through insulator for the antenna. Two 3/8-in. holes are drilled near the top of the front panel spaced to line up with the two bottom holes, one to the right of the meter for the meter-range switch and one to the left of the meter for the balance-potentiometer. When these holes have been drilled and de-burred you are ready to mount the various components in their respective mounting holes.

The antenna is a length of #16 bare copper wire formed into a closed loop with a continuing lead-in long enough to attach it by the top nut of the feed-through insulator.

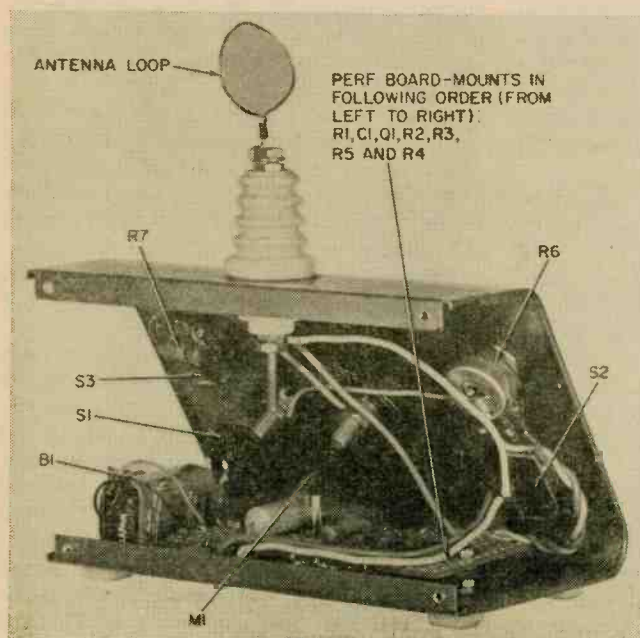
For the model in the photos we mounted

the balance of the components on a 4 1/2 x 2 1/4-in. piece of perf board. If by chance you use the smaller meter case, the perf board will, of necessity, be smaller. We used a socket to plug-in the FET. This isn't an absolute necessity, and you may want to mount all of the parts, including the FET on push-in pins (they make good supports and also make it easier to replace soldered-in parts). Should you decide to eliminate the socket for the FET, be sure to protect the FET with a heat sink, made from a small alligator clip temporarily slipped on the lead being soldered.

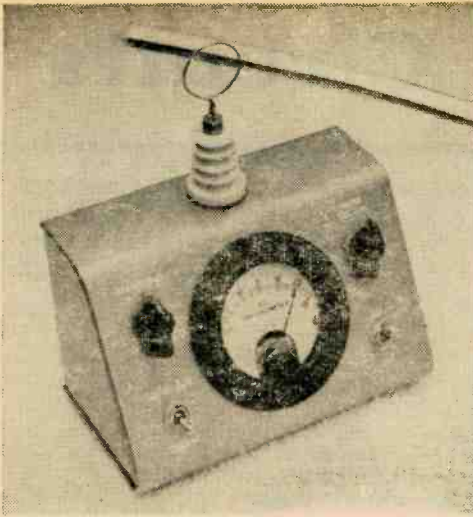
The perf board is fastened to the cabinet by two 6-32 machine screws and nuts. Raise the board away from the base of the case either by using 1/4-in. spacers or extra nuts on the mounting bolts to avoid possibility of shorts between the board and the case. The interconnecting leads are now wired to the proper points. Leave the leads long enough for the circuit board to be lifted out of the cabinet if the need should arise. Resistor R7 in connected directly to S3. The lead from the lower end of the feed-through insulator should be connected directly to S2 rather than to the circuit board. The battery holder is mounted near one end of the circuit board. Trim the leads from the battery connector to fit the location.

If the high cost of the galvanometer specified in the Parts List deters you from building *Electro-Snoop* we've found an inexpensive alternative instrument. Lafayette Radio offers an edgewise balance and tuning meter in which the pointer rests center scale when no current is flowing. It will swing either right or left of center, depending on the polarity of the current flow.

The sensitivity of this meter is $\pm 100 \mu\text{A}$, which is considerably more sensitive than the meter we used in the model. You should use this meter with the meter



Electro-Snoop's neat innards bared to show parts placement.



Bringing positively charged lucite rod near antenna loop, you'll see meter swing to right.

sensitivity switch in the *Low* sensitivity position at all times.

One point to consider: if you build *Electro-Snoop* for classroom or other large group demonstrations this alternate meter is harder to read from a distance a few feet away from the meter. Also, if you do use the alternate meter, remember not to punch the large round hole in the front panel. It mounts in a slot 1 $\frac{5}{16}$ -in. long by $\frac{1}{2}$ -in. high. Lafayette's part number for this tuning meter is 99E50346; it's priced at \$2.50. The meter we used, in contrast, is about \$18.00 new and about half that price used.

Calibrating and Operating. The only calibration necessary is to balance the bridge before using the instrument. With S3 in *High* sensitivity position, and S2 in the *Discharge* position, turn S1 to *on* and proceed to operate *Balance* control R6 until the meter is centered on zero. This completes the balance calibration and you're ready to experiment with *Electro-Snoop*.

A negatively charged object held near the antenna will deflect the meter pointer to the left while a positively charged object will deflect it to the right. You may hear a slight sparking sound as the charge jumps across the gap between the object and the antenna.

A negative charge can be generated by rubbing a hard rubber (ebonite) rod with wool; the minus charge appears on the rod. This is the classical method and is hard to beat. It is best to stroke the rod repeatedly in the same direction rather than rubbing back and forth. The rod is then touched to the antenna, or better still, pulled along the

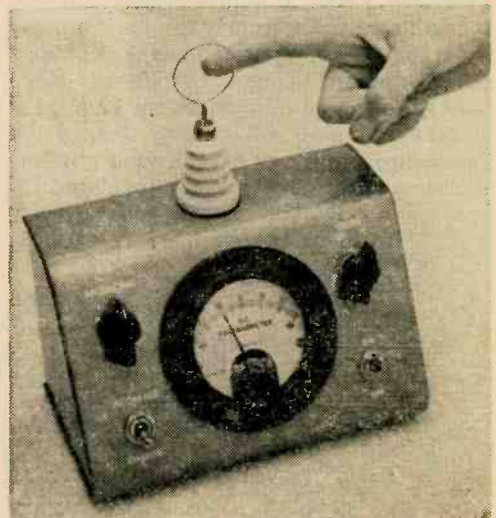
antenna in order to build up the charge.

Another way of developing a negative charge is by combing the hair with a nylon comb; the nylon will acquire a fairly respectable negative charge. Still another method is walking across a thick carpet, then, when holding a finger near the antenna a spark will jump from the finger to the antenna sending the meter pointer strongly to the left.

The old textbook method of rubbing glass with silk to produce a positive charge isn't recommended. Too often only a very feeble charge will be the result. A good healthy positive charge can be generated by rubbing a lucite rod with wool or cotton. Thus the same piece of cloth can be used to develop both positive and negative charges by alternating a lucite rod (which will produce positive charges) with an ebonite rod (which will produce negative charges).

With S2 placed in the *Discharge* (closed) position, charges placed on the antenna are merely sampled and the bridge quickly returns to normal. However, with S2 in the *Charge* (open) position, charges will be accumulated on C1 and the meter reading will hold constant until the next charge is applied. Several consecutive charges of the same polarity will increase the meter reading up to a maximum high value. Then, closing S2 returns the reading to zero even though the battery is left turned *on*.

Editor's note: The author wishes to express his thanks to Bill Greaves, Chief Engineer of station WMUU, who suggested the basic idea for this project. ■



Find out what state of charge your horoscope is in. Leo's positive while Aries's negative.

Clip Book Circuits

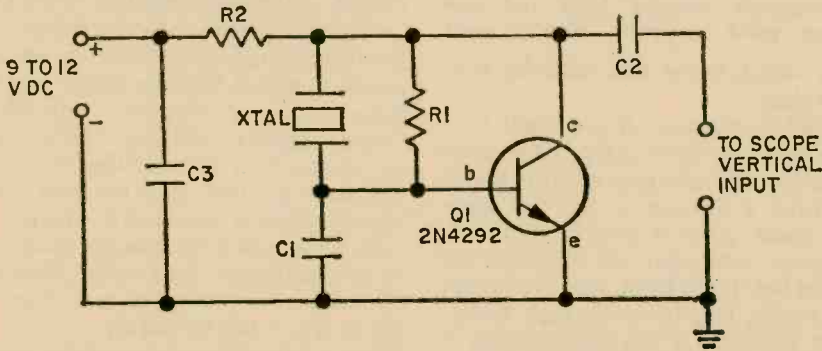
SCOPE CALIBRATOR

Operating on exactly 100 kHz, the Scope Calibrator provides a reference for calibrating the variable time base oscillator of general purpose scopes. If the scope is set, for example, so one cycle of the signal fills exactly 10 graticule divisions, each division represents 1 MHz, or 1 microsecond. If the scope is adjusted for 10 cycles on 10 graticule divisions, or 1 cycle per division, each division represents 100 kHz or 10 micro-

seconds. Now if the scope's time base oscillator is sufficiently stable so it doesn't drift too far off, you can make precise measurements of an unknown pulse width, length and frequency.

PARTS LIST

- C1, C3—0.01- μ F, 25-VDC capacitor
- C2—0.002- μ F, 25-VDC capacitor
- Q1—2N4292 npn transistor
- R1—100,000-ohm, $\frac{1}{2}$ -watt resistor
- R2—1000-ohm, $\frac{1}{2}$ -watt resistor
- Xtal—100-kHz crystal



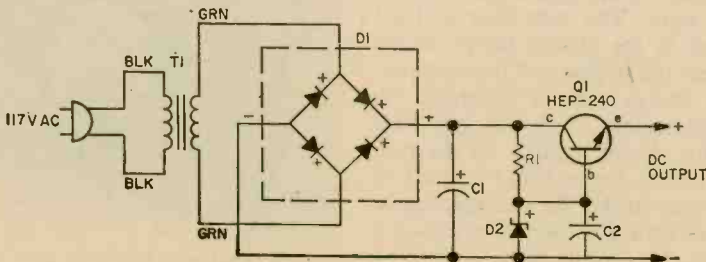
9-V REGULATED SUPPLY

Providing 9 volts at approximately 250 mA, this lab-type power supply will handle many experimenter projects. Actually, T1 can be a 6.3-V imported filament transformer since they usually give approximately 12 V peak at less than 500 mA output. Change the Zener diode to 12 or 6 volts (and possibly the value of R1) and you get a regulated 12- or 6-volt supply. For 12 volts you must use a 12-V filament transformer. Filtering is

very good since the electrical filter capacitor equals the value of C2 times the gain of Q1. It can add up to thousands of μ F.

PARTS LIST

- C1—500- μ F, 25-VDC electrolytic capacitor
- C2—100- μ F, 15-VDC electrolytic capacitor
- D1—Motorola HEP-175 50-PIV diode bridge rectifier
- D2—Motorola HEP-104, 9.1-V Zener diode
- Q1—Motorola HEP-240, 10-watt npn transistor
- R1—560-ohm, $\frac{1}{2}$ -watt resistor
- T1—12-V filament transformer (see text)





LITERATURE LIBRARY

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FW71

Speedy Flash

Continued from page 95

1 $\frac{5}{8}$ x 2 $\frac{1}{8}$ -in. Minibox. The charger is connected directly to the AC power line without any isolation from a power transformer, and, therefore, no ground connections should be made to the metal cabinet. The charger is a half-wave voltage doubler. Make certain to connect PL2 to SO1 before connecting the charger to the power line.

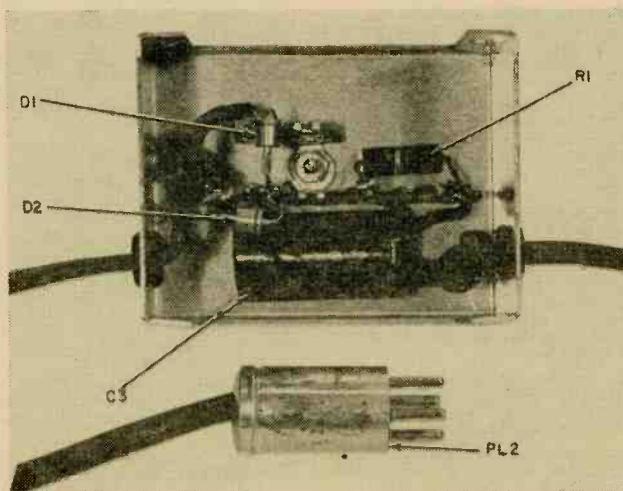
Photog's charger doesn't have feet but it gets him where he wants to go insofar as good pictures are concerned. This charger's used to form capacitor C1 after Speedy-Flash has been idle for more than a day.

AC Operation. In anticipation of the question, yes, the charger can be substituted in place of the battery to make an AC-powered speedlight. You'll have to change C3. An 8- μ F will provide a 7-second charge time and 25 μ F will give approximately 4 seconds of charge time. Remember that R1 must still be used in series with C1. Also, to double the Speedlight's watt-second rating, a second storage capacitor can be connected in parallel with C1.

Using the Super Speedlight. Plug the charger in to SO1, apply power to the charger and allow C1 to "form" for at least 15 minutes. *S1 must be off when using the charger.* Now disconnect the charger, plug a flash tube into the flash head and plug PL1 from the flash head into SO1 on the battery

pack. Because C1 is charged, the ready light I1 will probably go on when the flash head is plugged in. Fire off the flash with open-flash button PB1. To use the flash, simply set S1 to on; the flash will be ready to go before you can reach for the shutter release.

Although the average flash uses a polarized flashcord socket, this isn't necessary for *Speedy Flash*. Synchronized connection socket SO2 is non-polarized and the flashcord can be plugged in irrespective of polarity.



One note of caution: high-voltage flash batteries often sit on the shelf for months at the electronics dealer's, and may be half dead due to shelf-life deterioration by the time they get to the user. It is, therefore, suggested that if possible you obtain the battery from a photo equipment dealer known to have a professional clientele (pros use high-voltage flash equipment). ■

PDQ Reactor

Continued from page 95

tact with the case. Finish up your perfbording process by taking care not to roast the semiconductors and making sure you've wired the relay in properly.

The seeds of your labor are soon to bear fruit. A little more drilling n' filing whips the case's front panel into shape. If you don't feel like hassling through steel case ironmongery, try outboarding the meter,

Calibrate pots R9 and R10, PB1 and Time pot R5 into an aluminum mini-box, interconnecting the cases with a suitable cable.

This arrangement also serves an important purpose if you're considering PDQ's use in a psychology lab or any other controlled-experiment environment. Now the person being tested sees only a neon lamp and a switch. There's no superfluous knobs to twiddle or distracting meter face to subconsciously try to "beat." If you go this route, mount the lamp holder and S1 onto the front of the case.

Let 'er Rip. By now you're chomping at

PDQ's bit—but hold back for a moment. Calibrate the darn thing first! Adjust for meter zero by turning R10 with PB1 depressed. Now depress and quickly release S1; the meter should read near, or over, full scale. Adjust R9 so it reads exactly full scale. Press PB1 again and the meter'll zero. If it doesn't zero the first time, repeat the preceding operation.

Okay, you've waited long enough for the moment of truth. Sit comfortably in front of PDQ. Press S1 and hold it down until I1 extinguishes, then release S1 as quickly as possible. The author tested several people and found that readings averaged from

10 uA. (pretty slow) to 35 uA. with the listed values for R6 and C3.

Setting up the meter movement to read *seconds* requires that you can get your hands on a super-accurate power supply. First, you'll need to refer to a universal capacitor charging curve found in any good engineering text and set up a graph of *Voltage* across C3 versus *Time*. Then connect the accurate voltage supply between circuit common and Q3's gate terminal. Apply a voltage corresponding to several charging time constants (for C3). You'll wind up with a meter face that's calibrated in terms of time. ■

The Love Game

Continued from page 67

Starting the Game Love: Unless you insist on stacking the game against a *Stacked Partner*, and who could blame you, the only switch you might remember is S4 in the center of the plastic cross. S5 is isolated from the battery in either direction by two switches (S1, S3 and S2, S4) and it is therefore more difficult to guess whether it is open (*OFF*) or closed (*ON*).

However, the *Table of Darkness* will assist you in determining which switches will most quickly get the lights *OFF* and turn your *action ON*.

Prior to starting the game, the switches are set so that with a flick of one switch, either S1 or S2, all lights will come *ON*. The *Love Game* is ready to begin. Now—darken the room, set the *Love Game* between you and some willing lovely chick.

Caution: It is not considered good form

to use to undue advantage any special knowledge you might have gained during the construction of this game during your encounter. However, if by some stroke of faith she finds *your* special switch and turns *you ON* ahead of time, well—from there on you are on your own and—in the *Love Game* you play it by heart.

Just a suggestion, you may want to memorize the identity of the switches and lamps so you, the constructor can cheat, if you want to be sure of winning every round rather than to trust to luck that you'll remember all the positions of the switches and lights. (See photo for identity) One other bit of information. The Leviton (or equiv.) switches are obtainable from most hardware or electrical supply departments as are the PR6 lamps and AA cell batteries. The plastic pipe and associated fittings are easily obtained from garden supply shops or from dealers who sell underground sprinkler systems. You probably have the wire, solder and tape; the only other materials required in your workshop. ■

TABLE OF DARKNESS

SWITCH ACTION

- S1, S2 (a) Will light lamps I1 and I2 respectively when either S1 or S2 is closed (*ON*), regardless of the position of the other switches.
 (b) Either one can light all four lamps if S3, S4, and S5 are closed (*ON*).
- S3 (a) Will light I2 if S1 is closed (*ON*) and S3 and S5 are open (*OFF*). Of course, I1 will also be lit when S1 is closed (*ON*).
 (b) Will light lamps I2, I3, and I4 if either S1 or S2 is closed (*ON*) when S4 and S5 are closed (*ON*).
- S4 (a) Will light I3 if S2 is closed (*ON*) and S3 and S5 are open (*OFF*).
 (b) Will also light I2 if S5 is closed (*ON*).
 (c) Will also light I1 if S3 is closed (*ON*).
- S5 (a) Will light I2 if S1 and S3 are closed (*ON*).
 (b) Will light I2 if S2 and S4 are closed (*ON*).
 (c) Will light I1 and I2 if S2, S3, and S4 are closed (*ON*). When S2 is closed I4 will be lit and when S4 is closed I3 will be lit.

Flex-Jet VHF Rig

Continued from page 54

people and aluminum seat frames, however, we favor a flexible antenna. A four-foot-length of No. 22 stranded hook-up wire will be fine.

Finally, insulate the exposed printed circuitry with a 3 inch x 6 inch piece of self-adhesive vinyl covering material (also available from any dimestore). You can round the corners of the flexible circuit with a pair of scissors. That way, it won't snag on your clothes. For those hobbyists who want to take a James Bond approach, a few eyelets placed around the edge of the circuit will enable them to sew their *F-J Rig* inside the lining of their suit or tie without any noticeable bulge.

Preparing F-J for Flight. Since the printed circuit greatly reduces the possibility of wiring errors, any defect in the circuit can generally be traced either to a faulty soldering connection or a defective component. Attach the battery to its clip, and put the earphone in your ear. You should immediately hear the soft hiss of the transistor's amplifying noise. If there is a strong FM radio station in your area, you may be able to pick it up. Move around your home. Take the receiver outside. Move the antenna near your TV set. *Flex-Jet* should pick up a loud hum from its oscillator circuitry.

Take the receiver to your office building. You ought to be able to hear a variety of signals downtown including FM radio and the audio portion of TV, radio telephone systems, local weather radar and even John Law's anti-speeder radar on the freeway. Adjust tuning capacitor C1 with a small screwdriver; note the effect on reception. If you can't pick up anything with the receiver, remove the vinyl covering and the solder connections. You may have to re-heat several to correct them.

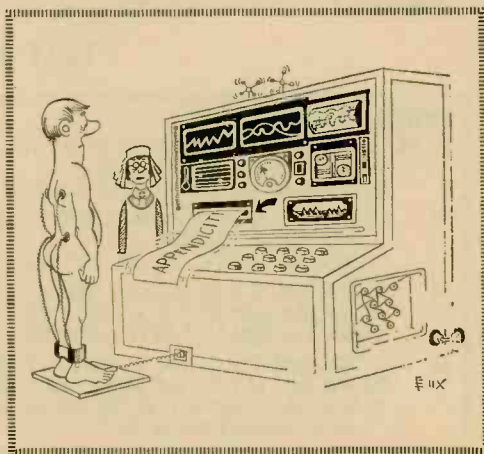
Up, Up, and Airborne. Until you get used to using the rig, put it in your shirt's left breast pocket or the inside pocket of your suitcoat. Put the battery in the same pocket. Bring the earphone out of your collar next the left side of your neck and stick the earphone in your left ear (reverse these directions, if you plan to sit on the right side of the aircraft). Let the antenna drop down. Shove the excess wire into your trouser pocket. It's a good idea to connect the battery before you get on the plane.

As you get on the aircraft, study its belly. You'll see two or more knife-like shafts extending straight down from the fuselage. These are radio antennae. While the *Flex-Jet* will provide acceptable reception in just about any section of the typical airplane, optimum reception will be obtained when you sit somewhere in the vicinity of one of the antennae.

A window seat is best. Anyone seeing the earphone will naturally assume you are hard of hearing—not much of a disadvantage if you're more interested in listening to the pilot receive his instructions than to your fellow passenger's difficulties in getting a last-minute reservation. Besides, a window will help you to relate what you hear to what is going on outside the aircraft.

Take the end of the antenna wire and wrap a couple of loops with it around your hand. By squeezing on the wire, you'll effectively couple your body to the antenna circuit and more of the available signals. Locating your hand near the metal end of the armrest on your seat will boost signal strength another notch.

Keep in mind your Flight Number. The pilot uses it to identify himself. For example: "United 237 ready for push-back" means United Flight 237 is ready to be pushed away from the terminal (by a tractor) in preparation for taxiing to the runway for takeoff. If you cannot pick up the tower from inside of the airplane, that's no problem since pilots almost always repeat their instructions from the tower just to be doubly sure they're correct. Remember: abbreviation is the rule. After a little practice, though, you'll feel at home tuning in on the cockpit crowd. Almost, it would seem, as if you were a member of the flight crew! ■



Mod Methuselah

Continued from page 50

up *MM's* rear cover with the supplied screws.

Mod Methuselah can easily be modified to suit your needs. For instance, an antenna tuner connected ahead of J1 would greatly enhance sensitivity. A standard phone jack

connected across T3's secondary adds headphone provisions; so necessary when you're DXing during the early-morning hours! And a variable 10-365 picofarad capacitor wired in place of C1 will do wonders with a not-so-efficient long-wire antenna, especially if you can't get your hands on plans for a good antenna tuner. And last, but not least, a steady hand—with the patience of a Job—twisting C3 through its paces ensures maximum performance from *Mod Methuselah!* ■

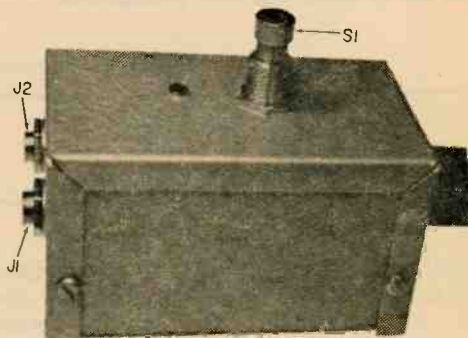
U-Pick-It

Continued from page 44

button ON-OFF switch that we picked up in the electrical supply section of the local hardware store. This kind of switch is normally used on desk lamps and the like. We have listed in the parts list, however, a rocker-type switch because, on second thought, we feel it is more practical since you can tell at a glance whether it's ON or OFF. Don't care to make a rectangular opening to mount a rocker type, either? Then use a regular toggle switch mounted with a marker plate to indicate its status.

After mounting and wiring all of the components on the perfboard, check your work to be sure you've wired it correctly. Then mount it in position in the bottom half of the Minibox as shown in our photo.

Getting to the Gig on Time. Connect the battery, plug your guitar into the input jack, and connect the output jack to the *normal* guitar input on your power amplifier. Standard patch cords in varying lengths are available with a phone plug on one end to match the input jack on *U-Pick-It* and a choice of plugs on the opposite end so you can match the input jack of your amplifier.



Author's U-Pick-It has input, output jacks mounted on minibox's end. We suggest you mount R6 so it's adjustable from outside.

Turn both units on, and open switch S1 so that the short circuit it places across *U-Pick-It's* input/output jacks is removed. After the amplifier has warmed up, adjust trimmer potentiometer R6 with a small screw driver to a point just below feedback with potentiometer R8 set at its midpoint position.

Once the setting is achieved, turning the knob on R8 to the right or left of center should now change the sound of the guitar. One extreme in rotation will favor bass and the opposite extreme will favor the treble while R8's midpoint setting will favor the midrange. ■

Piggyback AMP

Continued from page 42

printed circuit board is used as is; however, the input connections are modified as shown in the schematic. Actually, all that's done is to connect the volume control ahead of the amplifier at its input. Volume control R6 can be a potentiometer from 25,000 to 50,000 ohms. If the Piggyback Amp is to be used as a signal tracer, it will probably

be connected into DC circuits and therefore a DC blocking capacitor should be used ahead of R6 as shown by the dotted lines as C6 in the schematic; in 0.47- μ F capacitor rated at 200 or 400 VDC is adequate.

With no signal the amplifier idles at approximately 3.5 mA, peaking up to almost 100 mA at full power output. An ordinary transistor radio 9-volt battery such as type 2U6 can be used, though larger batteries naturally give longer life. For permanent installations a small 117-VAC power supply such as a 9-V battery eliminator for tran-

sistor radios, can be used. Under no conditions should the voltage applied to terminal 3 of the IC exceed 9 volts.

Unlike many IC power amplifiers, Piggyback Amp is rock-stable—provided the unit is built as shown in our photos using the layout as designed into the printed circuit board. ■

In case cut-out for speaker opening isn't perfectly round use a piece of perboard as we did to make unit look professional.



Super Booster

(Continued from page 21)

your area, it is possible that its signal strength will be so greatly boosted that it might swamp the receiver when listening to a weak signal on the other end of the dial. If this occurs, simply detune the booster away from the strong local until its interference is gone. While this might sacrifice some gain on the desired station, the actual loss will be slight.

It is possible that the booster's output might radiate back into the input (particularly when using a loopstick coupling coil). You'll know when this happens—the booster breaks into self-oscillation—as evidenced by receiver blocking, or signals being tuned

in and then "lost" when C1 is adjusted. If this happens, position the booster as far away from the receiver as possible. And, keep an external antenna, if used, well away from the receiver and the booster's output. Under normal conditions, there should be no instability.

Under certain conditions Super Booster will provide an additional benefit which should not be construed as improper operation. Some inexpensive rigs are highly prone to marine band "image" interference when signals at the high end of the BC band are received. The booster, by providing tuned pre-selection, will eliminate or suppress these images while providing signal amplification. Do not assume the loss of image interference means reduced sensitivity; actually, the desired signal will be getting full boost while the image signals are squashed. ■

Flash Master

Continued from page 16

also be mounted with small bracket or long screws attached to the front panel on either side of M1. Mount and wire FM's ASA trim pots R14 to the perf board, before installing it into the flash meter. Incidentally, you can mount your trim pots on both sides of the pc board for easier wiring, instead of on the rear side as in our unit. Last step's installing a C-size 1½ volt battery into its holder.

Flash Master's Big Red Eye. We mounted the photo cell made from a red plastic lamp housing cannibalized from an inexpensive flashlight. Jack J1 fits into a hole in the

lamp housing's side. Photo cell Z1 is held against the ex-flashlight's glass or plastic faceplate by a section of foam rubber. Finally, after you've soldered Z1's leads to J1 cut a section of sheet aluminum and press-fit it into the lamp bottom.

A plastic strap was also mounted on the aluminum section to fit an aluminum bracket. Install it on the *Flash Master's* case as shown in the photos. If you don't need this feature, it can be left out of your model. Only problem is that the photo cell housing would have to be hand-held while you're working with *Flash Master*.

Normally, a short shielded lead (approximately 6-inches long) connects the probe assembly to J2. But longer pickup probe lead lengths can be used as well. After you've made sure that your wiring chores are

completed—and correct—set S2 to its off position. Then depress the reset button (that's S1), and remove Q2's shorting strap while keeping S1 depressed.

BCPS and Tape Measure, too. To calibrate *Flash Master*, you need an electronic strobe unit with a known guide number BCPS rating (Beam-Candlepower-Seconds). Also, scout up a tape measure and a flash exposure distance guide (similar to the one in Eastman Kodak's Master Photoguide AR-21 Manual). You'll find the Photoguide available in most photo stores.

Make sure that M1's pointer is at zero; if not, adjust the meter's mechanical zero until the pointer sits on the goose egg. Set the ASA switch (S3) to bat, turn S2 on, and observe that the pointer of M1 swings nearly full scale. Mark the M1 scale at this point to indicate a fresh battery's voltage reading. Next, set the ASA switch to the position that is connected to R14 (full clockwise position), depress S1, and electrically "zero" M1 by adjusting R4. If M1 cannot be adjusted to zero, change the resistance value of R3 or R5. Set S2 to its off position.

We calibrated our flash meter for the eight most popular ASA film ratings. If you desire, the meter can be calibrated for other ASA values to fit your special needs (up to ASA 400). All you need is a large room, or long hallway, to properly calibrate the flash meter. Set your *Flash Master* on a window ledge or table at one end of the room or hallway and position the photo cell toward you. Attach one end of the tape measure near the photocell and extend the other end outward.

Turn your strobe power switch on, and let its capacitor charge for the proper time up to full charge. If you are not sure how much time is necessary for a full charge, allow at least one minute after each flash, during the meter calibration.

Adjust the dial of the flash exposure chart in the Master Photoguide Manual to either the electronic flash BCPS or flash guide number at the ASA 125 setting. Position your electronic flash at the designated distance (from the photocell) for f/22. (Our unit was set at four feet.) Aim the flash directly at the photo cell.

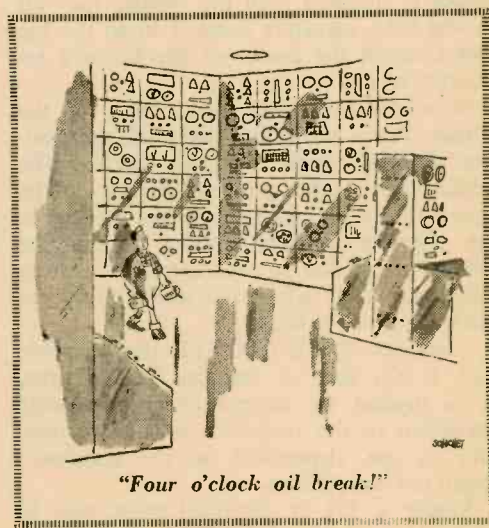
Set the flash meter ASA switch (S3) to the position connected to R11, and adjust R11 for maximum resistance. Turn S2 on, then press the reset switch (S1). Ensure that M1 indicates exactly zero. If not, adjust R4. Press the open flash switch on your

electronic flash unit and observe that M1 indicates upscale. Adjust R11 until M1 indicates exactly at the 50 microampere meter marking (full-scale meter indication). Then press the reset switch (S1) to discharge C1 and return M1 to zero indication.

Position your flash unit back from the photo cell at the designated distance given in the manual flash exposure dial for f/16, and press the open flash switch. Note M1's indication, and then press the reset switch (S1). Operate your electronic flash at each distance indicated by the manual flash exposure dial for F11, F8, F5.6, F4, and F2.8 (depressing the reset switch after each operation). At each one, note the M1 indication. You can now remove the M1 meter face and use rub-on numbers to calibrate the dial at the F-stop indications noted previously, or you can just make a chart of the meter indications for each F-stop instead of marking the M1 dial.

Set the ASA switch (S3) to the position connected to R7 and depress the reset switch (S1). Set the manual flash exposure dial to the ASA 25 setting, and select an F-stop at a convenient distance. Ours was at five feet. Operate your electronic flash at the selected distance, and then adjust R7 for the selected F-stop indication of M1 (at the noted or marked M1 F-stop previously calibrated for the ASA 125 range). Calibrate the other ASA positions of S3 at a selected F-stop indication of M1 by adjusting R8 for ASA 32, R9 for ASA 64, R10 for ASA 80, R12 for ASA 200, R13 for ASA 400, and R14 for ASA 400.

Watch the Birdie. The *Flash Master* is



designed to work only with very short light pulses—like electronic flash or strobe light bursts. The unit will not operate with the longer light pulses generated by conventional flash bulbs. Normally, the reset switch (S1) should be depressed after each operation to discharge C1 and return M1 to zero indication, ready for your next picture.

If desired you can measure successive light flashes, as if you were “painting with light.” Do not depress the reset switch (S1); now C1 builds up a cumulative voltage charge and M1 will indicate the total amount of light pulse energy for the series

of light flashes.

Usually, a short length of shielded cable connects the photo cell housing to the main unit, with the photo cell mounted on the flash meter cabinet. But, it may be more convenient to hang the main unit on the camera tripod, and temporarily hold the photo cell on the subject being photographed, with a long shielded cable connecting the photo cell to the flash meter. As always, make sure that the photo cell is aimed directly at your electronic flash; and that the ASA switch is set to the corresponding value of the film you’re working with. ■

Beeper

Continued from page 80

Regardless of the color codes, the secondary is center-tapped, and the leads on both sides of the center-tap are the secondary leads.

Orient the PC board horizontally so that you face the top of the board (copper foil is underneath) with the holes for the mercury cell holder to the right. The extreme right side of the board has three component holes—one for the holder connection and two for the switch.) Hold T1 so you face the top of the transformer with the center-tap lead on top. Then push T1’s mounting tabs into their respective holes.

Using a screwdriver or long nose pliers, fold the tabs over so that T1 is secured to the board. Then install T1’s leads, C1, Q1 and the battery holder in that order. If the holder is supplied with the “solder lug” off to one side, carefully bend it in so the lug cuts through the center of the holder’s insulating block.

Note carefully the construction of the holder. When the cell is installed, the positive terminal seats into the holder. The solder lug is the positive terminal. The heavy spring clamp that secures the cell is the negative terminal. Make certain the holder is installed so that the heavy spring clamp faces T1 while the solder lug faces the end of the PC board.

Capacitor Cx, a 0.005 uF disc ceramic unit, is not used or installed at this time. It is needed to compensate for possible variations in the transistor or transformer, and its use, depending on the checkout, might not be required.

Solder a 1½-in. stranded twist pair to

switch PB1; then connect the free ends to the appropriate PC board terminals. Solder a 1½-in. bare solid wire to the output PC terminal.

Checkout. Using an amplifier, tape recorder, or any other audio device, check out the *Beeper* by touching the output wire to the amplifier input. You should hear a tone of approximately 1 kHz. If you get a deep growl, connect capacitor Cx across T1’s primary terminals on the *under-side* of the board—the foil side. (Tack solder Cx’s leads to the foil.)

Using the BEEPER. Since the peak output of the *Beeper* is 2V—a voltage that can damage some transistors—always try to inject the signal without directly touching a transistor lead. Bring the probe tip *near* the appropriate transistor lead until the signal is heard in the speaker. If this “capacity” coupling does not inject the signal, you can then bring the probe tip in contact with the transistor lead. Tubed circuits aren’t critical in this respect and the tube pins can be touched directly with the probe tip.

In RF circuits, such as a superhet radio’s IF amplifier, *Beeper’s* signal can often be injected by simply placing the probe tip near an IF can or connecting wire.

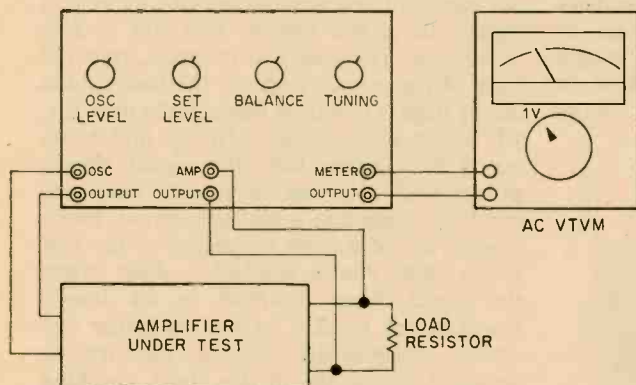
If you work primarily with tube circuits, or any high-impedance-type circuit, and find that touching the probe tip to a low-level amplifier grid causes excess hum in the amplifier, install a ground lead for the *Beeper* by soldering a short flexible wire to Q1’s emitter PC tab. Drill a small hole in the probe body, bring the wire through the hole and install an alligator clip to the free end. The ground lead has not been made part of the basic *Beeper* since accidental contact of the ground lead when working on solid-state gear will disable the *Beeper*. ■

DMS

Continued from page 78

ing posts for making external connections. Now you're ready to mount the controls and wire them to the parts on the circuit board. Use two conductor, shielded plastic jacketed, wire for leads from each potentiometer to its termination in the circuit. The plastic jacket will protect the assembly from shorts that may be caused by unjacketed shielding when the box is closed.

Press-on letters and numerals, such as Datak, make a neat way to identify the



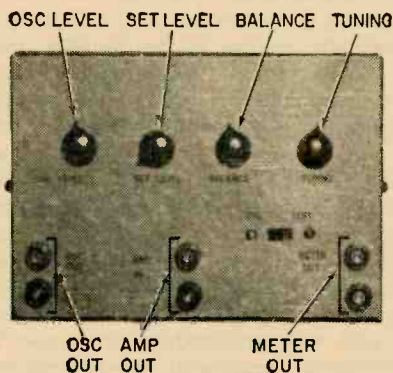
In addition to *DMS* you'll need an AC vtvm, and a non-inductive load resistor across the output of the amplifier as a substitute for the speaker. This resistor is a necessity for accurate measurement, and it is especially

Here's how to connect *DMS* to AC vtvm, amplifier. Load resistor must match output impedance, RMS wattage of amplifier under test.

controls and binding posts. Before plugging in the power cord to check out your *DMS*, be sure there are no wiring errors. Double check the connections to all transistors before soldering. They are sensitive to too much heat and can easily be destroyed. A small alligator clip serves as a good heat

necessary to protect the output transistors if your amplifier is solid state. So be sure to connect to a 50-watt or higher resistor (of 4, 8, or 16 ohms depending on the impedance of your speakers) across the amplifier output before turning it on.

Connect your *DMS*, the AC vtvm and the load resistor as shown in our test set-up diagram. Place the *Cal/Test* switch, S1, in the *Cal* position. The VTVM should be set to read 1V full scale. Now, adjust R13, *oscillator output level* control, so that the output of your power amplifier under test is at the desired output power level. Now adjust *DMS level* control R15, until the voltmeter, connected to binding posts BP5 & 6 reads one volt full scale. *DMS* is now calibrated. Slide the *Cal/Test* switch S1 to *Cal* position. Adjust both the *balance control*, R19, and the *tuning control*, R24-R25, for the minimum reading on the voltmeter. This minimum reading is the distortion of the amplifier. Remember, 1 volt full scale is 100% distortion, 0.1 volt full scale is 10% distortion and 0.01 volt full scale is 1% distortion. ■



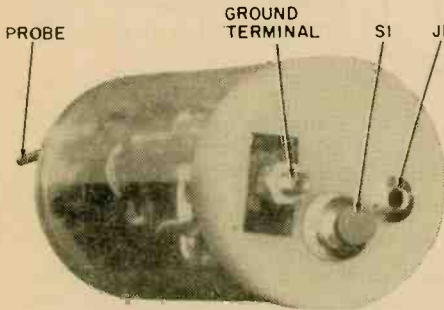
Front panel of *DMS* showing major control, binding post location. Vernier-type knob on *Balance* pot helps to get exact reading.

Sig-Prob

Continued from page 74

closed circuit J1 back to the input of the amplifier, thus setting the circuit into oscillation, and feeds the signal thus generated out through the probe. This signal is of sufficient magnitude to brute force its way through most any circuit. Because it is rich in harmonics it can be used on both audio and RF circuits.

How To Make Sig-Prob. We used a clear plastic pill container 1 $\frac{3}{8}$ -in. in diameter and 3-in. long. This will accommodate the circuit board and the 9-V battery without having to resort to any special clamps or set screws to hold these components snugly in place and still permit easy removal to change the battery. Since the unit draws



We used plastic cap to cap off our project in style. Lid of pill case serves as mount for phone jack, power switch and ground lug.

but 1.25 mA when in the signal trace mode and 0.75 mA in the signal injector mode, and the battery isn't turned on except when either of these modes are actually being used, you can expect extremely long battery life.

The two 2N2926 transistors, 3 capacitors and 4 resistors are mounted on a $\frac{7}{8}$ x 3-in. piece of perfboard as shown in our diagram. The probe, which is made from a 4 penny nail is anchored to the perfboard so that when the board is inserted into the pill container the nail probe will extend through the bottom of the container. The push-button switch S1 and the closed circuit jack J1 along with a grounding terminal all are mounted on the plastic cap normally supplied with the container. Once the parts are mounted on the board and the circuit is checked out, cover the bottom of

the board with a layer of plastic insulating tape to keep the metal case of the battery from shorting out any of the circuits on the board when the board and battery are slid into the pill container.

How To Use Sig-Prob. Since Sig-Prob will provide two different functions, (a) signal tracing, and (b) signal injection it should be obvious that you employ two different approaches in using it.

When used as a signal injector, you start by touching the probe first at the speaker and then progressing towards the *front end* of the set, if the trouble hasn't been located up to this point, eventually injecting a signal into the antenna. Starting at the input to the speaker, you should be able to hear a signal out of the speaker that will be low in volume. Then, as you progress from the base of the output stage to the base of the driver stage(s), and on through the detector, RF mixer and oscillator, (if the unit being tested is a super het) the signal should progressively increase in volume until you reach the stage that is malfunctioning, which is why you're tracing the signal in the first place. Once you've reached a stage where the signal from *Sig-Prob* is no longer heard in the speaker of the set under test you've undoubtedly located the trouble maker. Concentrate on this stage, checking resistance, voltage and current. Once you've found the defective component and replaced it, the set should work as good as new again.

When using *Sig-Prob* to trace a signal, provide a signal from an external source, such as a broadcast station or signal generator or other signal source, as the signal to listen for as you move *Sig-Prob* through each succeeding stage, starting at the input (antenna if unit under test is a radio) and eventually ending at the speaker, unless, of course, you find the offending stage before tracing that far through the set. In this application the headphone is plugged into J1 and you listen for the signal, you are using for test purposes, in the headphone as you move from point to point and stage to stage in the set. Again, at the point where you do not hear the test signal is where you'll find the offender. This indicates that the last stage checked is malfunctioning and you concentrate your search for a defective component (open resistor, shorted or open capacitor or diode, defective tube or transistor) by resistance, voltage and current measurements. ■

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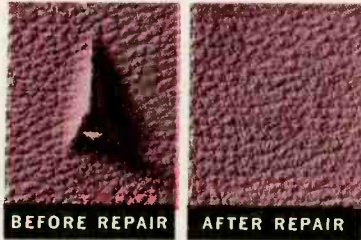
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