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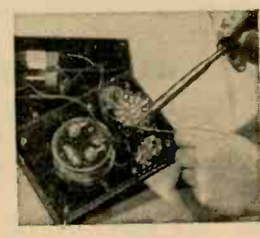

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ELECTRONICS HOBBYIST

Dedicated to America's Electronics Hobbyists

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UNDERSTANDING ELECTRONICS

FUNDAMENTALS are, by definition, essential to the understanding of any subject. Electricity is no exception. This article will build up your knowledge storehouse and serve to refresh your memory in areas that were forgotten or poorly understood.

The Lingo. Unless we state before hand exactly what we mean by *volt, ampere, watt, ohm,* etc., we could never be sure we are talking about the same thing. If each state in the Union had a different definition for the volt, 1.5 volts in Maine might just barely cause a #47 pilot lamp to glow red, and 1.5 volts in California might be too much—the lamp's filament could even be vaporized. Hence, electrical definitions determine the electrical standards that are used throughout the world today.

Volt. The volt is the unit of pressure or difference of potential, the practical unit of electromotive force (EMF). One volt is that potential which will maintain a current of one ampere through one ohm of resistance. Voltage is measured with a voltmeter, an instrument that is always connected across (in parallel with) a line or at that point in a circuit where the potential exists.

Ampere. The ampere is the practical unit of current. If one volt is impressed on a circuit with one ohm of resistance, one ampere of current will flow. When one ampere of current is flowing, 6,280,000,000,000,000,000 electrons are moving past a given point in a circuit each second. Current is measured with an ammeter; ammeters are always connected in series with one side of the line and the load.

Ohm. Resistance to current flow in an electrical circuit can be compared to resistance offered to water flow in pipes. The unit of resistance is the ohm. If a circuit has one volt impressed on it, and an ammeter indicates that one ampere of current is flowing, the circuit has a resistance of one ohm.

A length of #14 copper wire (.064 in. dia.) 400 feet long, has a resistance of 1 ohm, but 400 feet of #27 wire (.014 in. dia.) has a resistance of over 20 ohms. The smaller the diameter of wire, the greater its resistance per foot. Wire that is forced to carry current in excess of its rated capacity becomes hot. Heat not only presents a fire hazard but also increases the wire's resistance. Long lengths of wire offer increased resistance to current flow, just as a long pipe line offers increased resistance to water flow, and it is often necessary to increase wire diameter of long lines which are to carry much current, over that which would otherwise be used.

While current-carrying wire is usually selected for low resistance, some types of materials are used electrically because of their high resistance. For example, an alloy of nickel and chrome, *Nichrome*, has a very high ohmic resistance and is used in heating elements of toasters, irons, room heaters, and other appliances. Since Nichrome has a high resistance per foot, a shorter length of it can be used to make up a heating element, and because it has high tensile strength, it can become very hot and still retain its form.

Resistors of many kinds are used in electrical circuits to control current flow and to "drop" voltage. These are usually made of high-resistance wire or of carbon, another high-resistance material. A set of simple formulas expresses the relationship of volts, amperes, and ohms in an electrical circuit. These formulas comprise *Ohm's Law*. In the formulas, I stands for current in amperes; E, for volts; and R, for resistance in ohms. Suppose that 110 volts is impressed on a circuit and we have a 20-ohm resistor in the circuit: how much current will flow through the circuit? Using the second formula, the answer is found to be 5.5 amperes. When any two units are known, the third can always be found using one of the formulas of Ohm's Law.

Watt. The watt is the unit of electrical power. Multiplying volts by amperes gives watts. Many household appliances are rated in watts; electric meters record the number of watt-hours used. A kilowatt is 1000 watts, and 1000 watts used for 1 hour is 1 kilowatt hour. 746 watts equals one horse power.

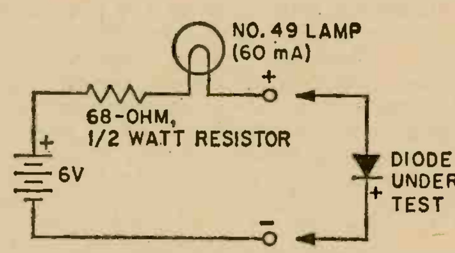
Watt value can be obtained by multiplication, as stated, in DC circuits, and in alternating current (AC) circuits also—if there is no inductance in the AC circuit. Any device that has wound coils (such as induction motors, chokes, relays) introduces inductance into circuit, however, and when a circuit is inductive, volts times amperes will not give true watts. Incandescent lamps, heaters and other pure resistance devices, are not inductive to any appreciable extent, and in these instances Ohm's Law may be used.

In fluorescent lamp units, a transformer and a choke—both wound units and highly inductive—are used as part of the ballast control unit. As a result, current lags behind voltage in fluorescent lamps, gets out of step with it, that is, in the rise and fall from zero to maximum value during an alternating cycle and multiplication of volts times amperes will not give true watt value. Therefore, a wattmeter—which has two terminals internally connected to a current coil and placed in the circuit in series with one side of the line, and two other terminals connected across the line, and is designed to record the true watts of an AC circuit—is used to measure true watts regardless of the power factor of a circuit. ■

Low Voltage Diode Tester

Low voltage signal diodes are easily tested with this "go/no-go" checker. The only restriction is that a diode under test be rated to handle at least 60 mA. Diodes such as the IN34 cannot be checked since test current is too high.

If the diode is good, the lamp will light in one direction, and remain dark when the



diode is reversed. If the lamp stays on when the diode is reversed, the diode is shorted. If the lamp stays dark when the diode is reversed, the diode is open.

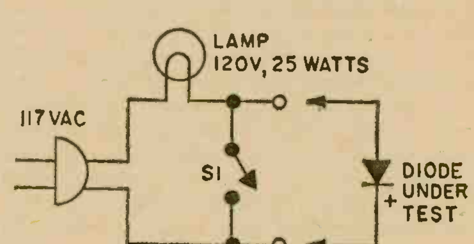
To test diodes rated under 60 mA, a lower current lamp must be substituted in the checker.

Silicon Rectifier Tester

This simple GO/No-GO tester spots defective rectifier diodes before they are connected into a circuit. It is intended only for silicon rectifiers rated higher than 200 mA and indicates open and shorted conditions.

The lamp must be as specified: 120 V at 25 watts. Do not use a larger lamp or the diode might be destroyed.

Close switch S1 to check the lamp by turning it on. Connect the diode both ways, opening S1 for the test. One way the lamp should go on; reversing the diode should



cause the lamp to extinguish. If the lamp stays on in both directions, the diode is shorted. If the lamp stays out in both directions the diode is open.

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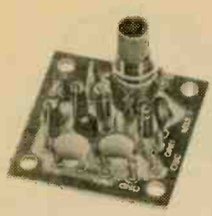

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STOP LIGHT STROBOSCOPE

by Steve Daniels, WB2GIF

It didn't take you very long to discover that a little NE-2 neon lamp strobe may be OK for checking the speed of your turntable, if you don't mind working with it in a darkened area and then squinting. But it just isn't satisfactory for checking motors, such as those used in appliances, or those running at odd speeds.

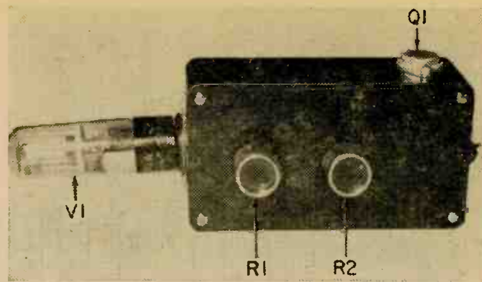
Our StopLight Stroboscope, which combines a single transistor and a Strobotron flashing tube, will meet most of your speed-determining needs. True, its output is not as

Here's a compact stroboscope that takes only one evening to build and many more to enjoy!

STOP LIGHT STROBOSCOPE

brilliant as the expensive units using Xenon lamps. However, its simplicity of design and moderate cost will more than offset this major difference and certainly make this a worthwhile project to build.

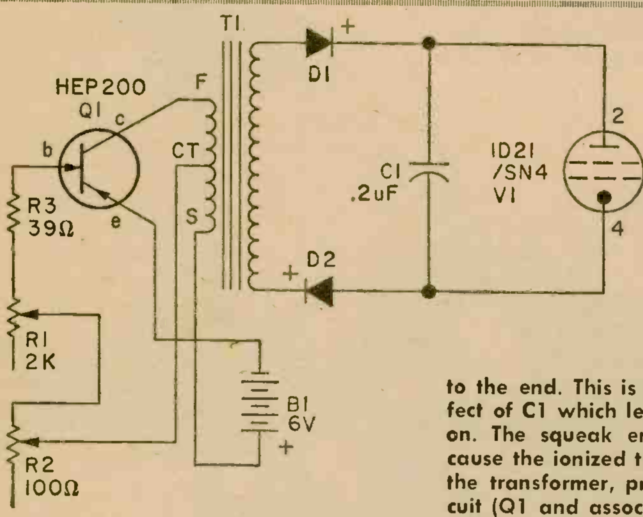
How It Works. Transistor Q1, acting as an audio oscillator, generates AC voltage in the primary of transformer T1. The secondary steps up the voltage which is rectified by diodes D1 and D2 to supply DC current to capacitor C1. When the voltage builds up high enough V1 fires, discharging C1 and the whole process is repeated. The frequency and output voltage of the oscillator is controlled by varying the base bias of transistor Q1 through R1, R2, and R3. This varies the DC pulsing, which, in turn, determines the charging of C1 and the rate of flashing of the Strobotron tube, V1.



All wired up and ready to go, the StopLight Stroboscope looks simple enough to wire in one evening. Motorola transistor can be mounted inside box—but looks exotic outside.

Note that transformer T1, designed to step down the 117 VAC (normally applied to its primary) to 6.3 V in its CT secondary, is connected in just the reverse manner. In our StopLight Stroboscope the 6.3V CT primary is the tank coil of the oscillator, and the normally 117V primary becomes the secondary, in our circuit, providing a step-up ratio of better than 18.5 to 1.

How to Make It. We used a 6¼ x 3¾ x 1⅞-in. molded black bakelite case with



Hearing is believing! You can verify the "How It Works" notes on this page by placing your ear next to the plastic box of the unit. You'll hear an audio tone that will stop with each flashing. With the stroboscope set for a slow flashing rate, you can detect a slight tone increase from the beginning of each squeak to the end. This is caused by the loading effect of C1 which lessens as a charge is taken on. The squeak ends when V1 flashes, because the ionized tube is a short circuit across the transformer, preventing the oscillator circuit (Q1 and associated parts) from working.

PARTS LIST FOR STOPLIGHT STROBOSCOPE

B1—6-V battery (Eveready #731 or equiv.)
C1—0.2-uF. 600-V capacitor
D1, D2—1.0 Amp, 1000 PIV silicon diode rectifier (International Rectifier 5A10 or equiv.)
Q1—HEP-200 Motorola transistor
R1—2000-ohm, linear taper potentiometer (Allied 46E3785 or equiv.)
R2—100-ohm, linear taper potentiometer (Allied 46E1102 or equiv.)
R3—39-ohm, ½-watt resistor
T1—6.3-V @ 1.5 amp CT filament transformer (Allied 54E1419 or equiv.)
V1—1D21/SN4 Sylvania Strobotron tube ($7.30 from Allied Radio)
1—6¼ x 3¾ x 1⅞-in. molded plastic box and panel (Allied 42E7885 or equiv.)
1—4-prong tube socket (Allied 47E0024 or equiv.)

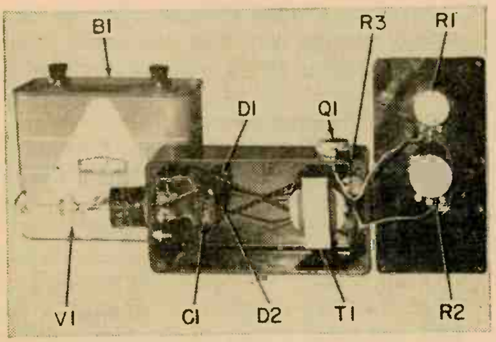
Misc.—Tie strips, knobs, hardware, hookup wire, solder, etc.

matching panel to house our StopLight. Drill a 1¾₁₆-in. hole in one 3¾ x 1⅞-in. end to mount the 4-prong socket for the Strobotron. Use a circle cutter in a slow-speed drill to cut this hole. Drill holes to mount the transistor in the right-hand 6¼ x 1⅞-in. side of the case near the end opposite the one in which the Strobotron socket is mounted.

Transformer T1 is mounted in the bottom of the box near the transistor terminals. A three-terminal tie strip is also mounted on the bottom but near the Strobotron socket. Resistor R3 is mounted to a tie strip fastened to the end of the box opposite the one in which the socket is mounted.

Potentiometers R1 and R2 are mounted centered on the panel of the box in the clear space between the 4-prong socket and transformer T1. Battery leads are brought out through a small hole in the end opposite the socket. The battery lead is fabricated by twisting together two pieces of different colored hook-up wire. Solder alligator clips to the leads on the ends outside the box.

Be sure to wire the potentiometers so that speed increases with clockwise rotation of R1 (course adjustment) and with counter-



With the front cover removed, the StopLight Stroboscope reveals all of its electronics. If you care to, mount the parts in a larger case and include battery holders for four D cells. Sure as shootin', the D cells will not last as long as the Eveready #731 job listed in the Parts List, but they will do the job just the same—and in one small pórtable box, too!

clockwise rotation of R2 (fine adjustment). If either control operates just the opposite, reverse the leads to it.

Testing StopLight. After mounting and wiring all of the parts in accord with the schematic, double-check the wiring, making sure of the polarity of diodes D1 and D2. Plug the Strobotron in its socket.

Before connecting the battery, set the controls at the midpoint of rotation. Prolonged operation at highest speed could damage the Strobotron. As soon as the battery is connected the Strobotron should start to flash off and on. Rotate R1 full counter-clockwise and the flashes should slow down.

It may be difficult to notice any change created by the fine adjustment control unless you are actually observing a rotating device; then it will appear to stop the motion if the coarse control has been adjusted to the point where the motion appears to slow down almost to stopping. The flashing lamp should be brought as close as possible to the rotating object in order to shine as much light from the lamp onto the rotating object. However, remember that the Strobotron tube, V1, is made of glass. Don't jam it into a moving fan blade or gear drive.

Another operation note: do not run the StopLight so that the Strobotron tube burns continuously.

Calibration. There are several ways that can be used to calibrate the controls. One method would be to connect a frequency meter across the Strobotron and read the frequency directly which would be the same as the speed of rotation. If a frequency meter is not available, you may use an oscilloscope that has a calibrated time base. Connect the oscilloscope the same as the frequency meter was connected and count the number of pulses displayed on the oscilloscope screen. This will give an indication of the frequency.

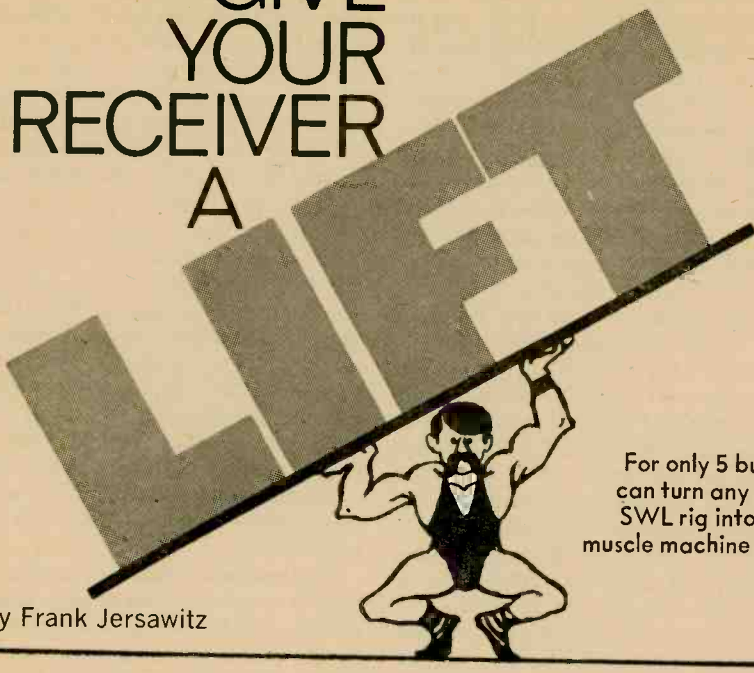
If these lab instruments are not available to you, it's possible to shine the flashing lamp on a turntable or other rotating device whose speed is known and then adjusting the controls until the device appears to stop. This will then be your major calibration point.

Another way to calibrate your StopLight Stroboscope is to use an audio oscillator, amplifier, and speaker. Set the oscillator to a low audio frequency and shine the flashing lamp on the cone of the speaker. When the speaker seems to stop its motion, the flashing rate will be the same as the frequency of the audio oscillator.

Of course you can always borrow a General Radio Strobotoc, if you are fortunate enough to know some one who owns one and will be agreeable to your borrowing it.

A word of caution: remember when you have apparently stopped the motion of a rotating device by shining your StopLight stroboscope on it, the device is still running full speed, so keep your fingers away. ■

GIVE YOUR RECEIVER A



For only 5 bucks you can turn any scrawny SWL rig into a hairy muscle machine with Vari-C

by Frank Jersawitz

THERE are many transistorized SW receivers available today in the price range from less than $15 to several hundred dollars. The author owns one of these low priced versions that, after a little diddling turned in a pretty good record in receiving DX.

One reason for this success with a low priced receiver is the fact that the listening point is located in a rural community away from big city areas that are congested with electrical interference from machinery, appliances and an overabundance of radio stations in the immediate vicinity. Also, the house is atop a hill at least 100-ft. high, with the antenna somewhat higher than this since its installed on the roof. All are conditions known to be ideal for SWLing.

Of course, knowing a thing or two about what it takes to wring the most out of a set helps too. Following are a few tips that have helped tremendously and are in easy reach of the average experimenter.

Grounding. One major aid to improve reception is to use a good earth ground. If your set doesn't have a ground terminal, check out the circuit for the common ground bus and connect a lead to this bus and thence to a cold water pipe. Or, run a ground wire to a rod sunk at least 4-ft. into the earth. To be effective the ground wire must make a good contact with the water pipe or ground rod. You can buy a ground clamp designed to dig past the dirt and oxidation on the pipe or rod, thus ensuring a good ground connection.

Using An Outside Antenna. Certainly a properly erected antenna, the higher the better will bring stronger signals to the set's input. In the event your set doesn't have a terminal to connect an external antenna, you can connect the lead-in to the whip antenna built into the set, with an aligator clip. This will make it easy to disconnect so you can take the set with you on an outing.

Boosting Sensitivity. Next, let's consider a way to improve the sensitivity of the receiver. In all probability, because the set is an economy model and was rushed through the production line to keep down the cost of manufacture, the IF transformers may not be peaked for maximum tuning to track with the output of the set's mixer oscillator. A simple aligning tool, similar to GC type 5000, long enough to reach the tuning screws and small enough to fit into the openings for them, will help to overcome this deficiency. Initially, just tune the set to a weak BCB signal (if the set tunes the BCB) and then slowly rotate the adjusting screws,

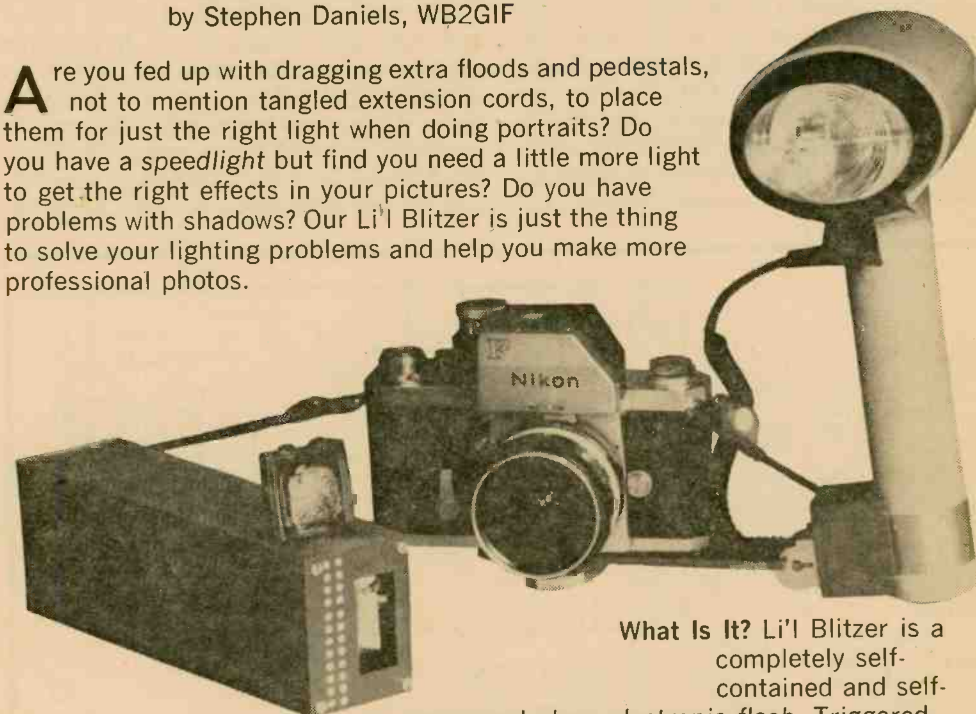
(Continued on page 114)

A slave flash to
wash out shadows and make your
photos like the pros

LI'L BLITZER

by Stephen Daniels, WB2GIF

Are you fed up with dragging extra floods and pedestals, not to mention tangled extension cords, to place them for just the right light when doing portraits? Do you have a *speedlight* but find you need a little more light to get the right effects in your pictures? Do you have problems with shadows? Our Li'l Blitzer is just the thing to solve your lighting problems and help you make more professional photos.



What Is It? Li'l Blitzer is a completely self-contained and self-powered *slave electronic flash*. Triggered through its solar cell (SC1)/silicon-controlled rectifier (SCR) circuit by light from the master flash, it provides that extra illumination needed to make your photos look like they were taken by a pro! It's a relatively inexpensive photo accessory you can easily build that will repay you many fold by improving your photographic techniques.

How It Works. A transistorized oscillator (Q1), energized by a 6-VDC battery (B1) develops the high voltage AC through transformer T1. Transformer T1 is a 117 VAC to 12.6 VCT filament transformer whose normal primary and secondary windings have been operationally reversed for this application. The 12.6 VCT secondary is used as a primary and the 117 V primary becomes the secondary in Li'l Blitzer's oscillator. Thus the 6 VDC from B1 is stepped up many times to produce required high voltage. This high voltage AC is rectified to high voltage DC required to charge storage capacitor C1 by diodes D1 and D2. When the charge voltage approaches approximately 350 volts, NE-2 neon bulbs I1, I2, and I3 fire. This stabilizes the charging voltage and also serves as a *ready light*. All but I1 are covered to avoid confusion. Resistors R3 and R4 from a voltage divider to charge C2 to approximately 150 VDC. *(Turn page)*

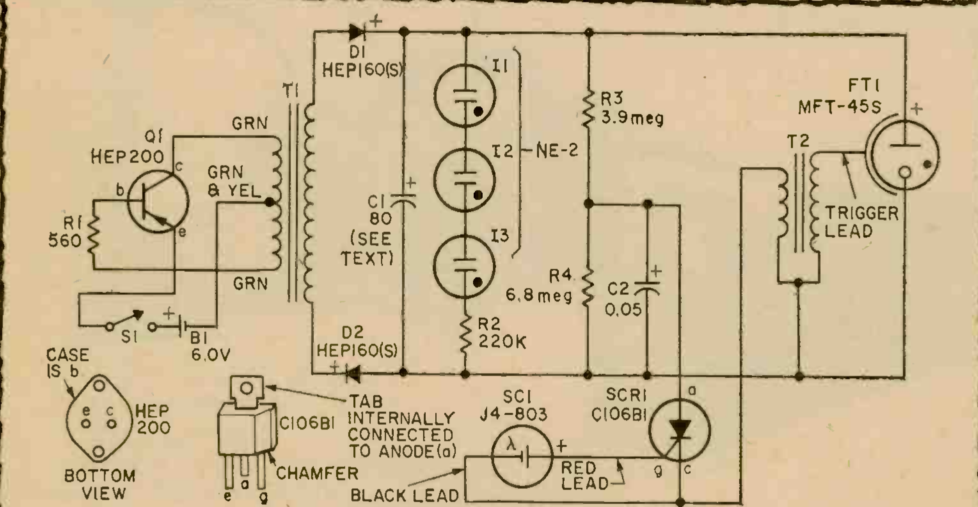
LI'L BLITZER

Silicon solar cell SC1 generates a voltage pulse when exposed to the flash of the *master electronic flash*. This triggers SCR1, discharging C2 through the primary of *trigger transformer* T2 and produces a pulse of approximately 4 kV that ionizes the gas in flash-tube FT1, firing it.

Thus is produced the auxiliary flash used as secondary lighting for the scene being photographed. Reaction time of the SCR with respect to the initial flash from the master flash lamp is extremely fast; therefore it's not necessary to synchronize the flashes from the master and slave flash lamps. (You might even call them self-synchronizing.)

Construction. The author housed Li'l Blitzer in an attractive, practical metal cabinet. Unfortunately the size he used is not readily available from parts supply houses. Since component placement is not too critical, and you may have to make substitutions for other components (e.g., T1, C1, etc.), it's not absolutely necessary to use the housing tabulated in our Parts List. You can build your unit in any size to suit your particular desires. In any event the size of the housing will be determined basically by the physical size of C1 you use.

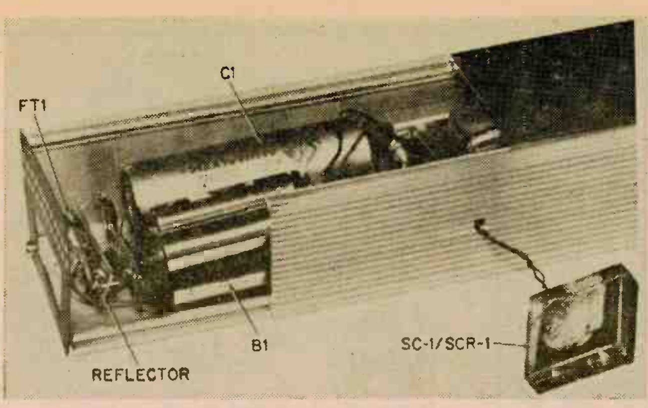
The Mini-Cool box shown in the photos is 8 x 2 x 2½-in. and is easy to use since the four sections that make up the box are extrusions that slide into one another forming a fairly rigid rectangle. This permits mounting all components except for S1 on the base of the box. In detailing construction we will assume you're using the Mini-



PARTS LIST FOR LI'L BLITZER

B1—6-V battery, 4 AA cells in series
C1—80uF, 450-V electrolytic capacitor (C-D BR 80-450 or equiv.)
C2—0.05 uF, 600-V dipped paper or mylar capacitor
D1, D2—1000-PIV 1-A silicon diode, Motorola HEP 160 (S)
*FT1—Flashtube, Mura MFT-45S
I1, I2, I3—NE-2 neon bulb
R1—560-ohm, ½-watt resistor
R2—220,000-ohm, ½-watt resistor
R3—3,900,000-ohm, ½-watt resistor
R4—6,800,000-ohm, ½-watt resistor
S1—Spst slide switch (Calectro E2-110 or equiv.)
SC1—Silicon solar cell, 1.4 V @ 25 mA output from bright sunlight (Calectro J4-803 or equiv.)
SCR1—Silicon-controlled rectifier (GE C106B1 or equiv.)
T1—117-VAC pri, 12.6 VAC CT sec @ 100 mA filament transformer (Calectro D1-750 or equiv.)
*T2—Trigger transformer, 4 kV (Mura TR2 or equiv.)
1—8 x 2 x 2½-in. Mini-Cool aluminum box (see text)
1—Battery holder (Calectro F3-059 or equiv.)
1—Battery connector (Calectro F3-052 or equiv.)
1—1⅞ x 6⅛-in. piece perfboard
1—4-point tie strip (Calectro F3-214 or equiv.)
Misc.—Wire, solder, solder lug, hardware, press-on letters (Datak or equiv.), push-in pins, pen holder swivel, tripod socket, floodlamp clamp and swivel, etc.

*These two items available from Tridac Electronics Corp., P.O. Box 153, Malverne, N.Y. 11565. Total cost for both $10.60 plus 75¢ for handling and mailing in USA. Add $1.00 for shipments to Canada.



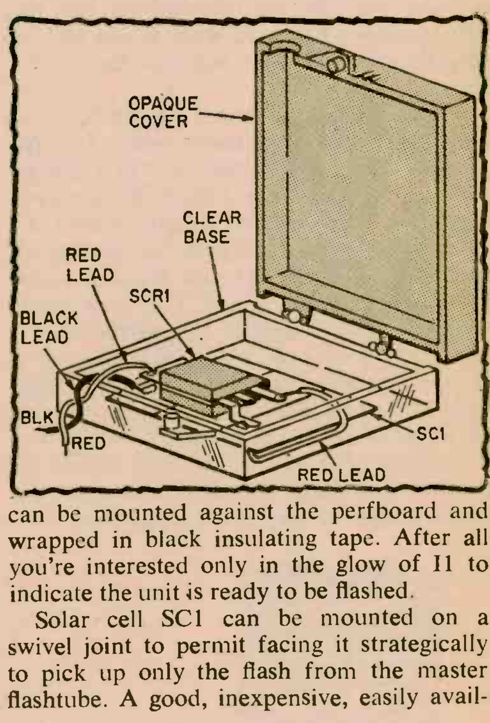
Two-conductor cable connecting SCR1, SC1 to perfboard may be any length you wish. Studio photographers'll perch this sub-assembly on tripod in immediate vicinity of main flash source; this guarantees positive snyc between Li'l Blitzer, main flash assembly. Li'l Blitzer draws 'bout 175 mA from B1, so you might want to substitute line-operated 6V supply in its place especially if you're doing lots of indoor portraiture work.

Cool box used by the author.

In our unit a 1⅞ x 6⅛-in piece of perfboard was used to mount and wire all of the components except for S1, SC1, and FT1. When mounting the board on the cabinet base raise it above the metal with spacers so that none of the wiring can be shorted by the metal of the cabinet. Switch S1 is mounted on the rear end of the box. Flashtube FT1 is mounted on a tie strip (4 point with center mounting foot. A scrap of aluminum or stainless steel is curved slightly and held in place behind FT1 by a solder lug mounted on the same bolt that holds the tie strip in place. Notch out the end to clear wire connections to FT1.

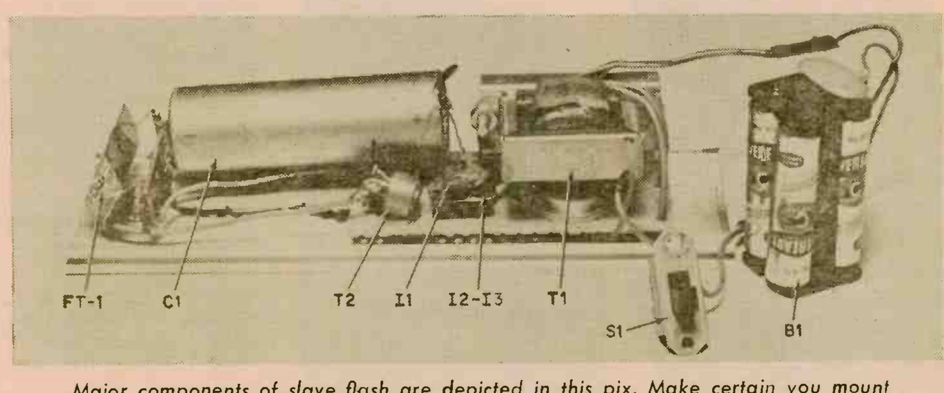
Mount all parts as shown in our photos. We suggest you use push-in terminals for mounting and connecting the resistors, capacitors, neon bulbs, etc. for neater and stronger construction. At the time our model was built the author didn't have them available but we strongly recommend that you use them.

Position I1 so that it can be easily seen through the hole marked *indicator*, I2 and I3



can be mounted against the perfboard and wrapped in black insulating tape. After all you're interested only in the glow of I1 to indicate the unit is ready to be flashed.

Solar cell SC1 can be mounted on a swivel joint to permit facing it strategically to pick up only the flash from the master flashtube. A good, inexpensive, easily avail-



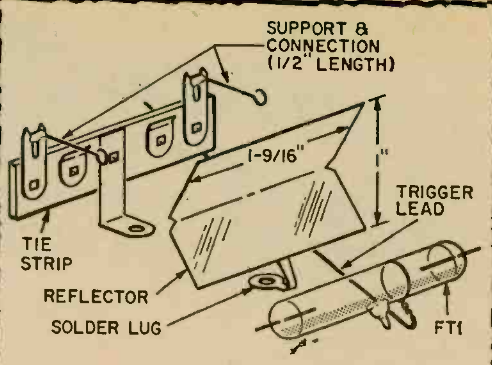
Major components of slave flash are depicted in this pix. Make certain you mount FT-1 so wires cannot short to metal case. Mount I1 to case's side so you can see it.

LI'L BLITZER

able swivel joint for this purpose is the pen holder swivel used for holding a pen on a desk set. You can salvage one from a desk set base or you'll find them in many shops selling handicraft supplies.

Speaking of swivel joints, a larger one, as used on photoflood or trouble lamp clamps, along with the clamp, makes an excellent holder for Li'l Blitzer. It'll stay put in any position you point it and if SC1 is also swiveled you are free to position the unit so that the flashtube and reflector will spot the light exactly where you want it and still be able to point the SC1 towards the master flash.

First step in perfboard assembly is to mount Q1 and then transformer T1. We used an aluminum channel ⅜ x ⅞ x 2⅜ in. (HWL), formed from a scrap of metal, to support T1 (see photo). If you prefer, T1 can be fastened directly to the perfboard. Next mount diodes D1 and D2 and established power supply buses. The neon lamps can be mounted against the perfboard except for I1; leave its leads fairly long so it can be positioned for easy viewing. Trigger coil T2 can be held in place with cement (RTV or Duco, etc.). The high voltage output trigger lead to the flashtube should be roughly 5-in. long and should be insulated with a length of spaghetti tubing. Once FT1

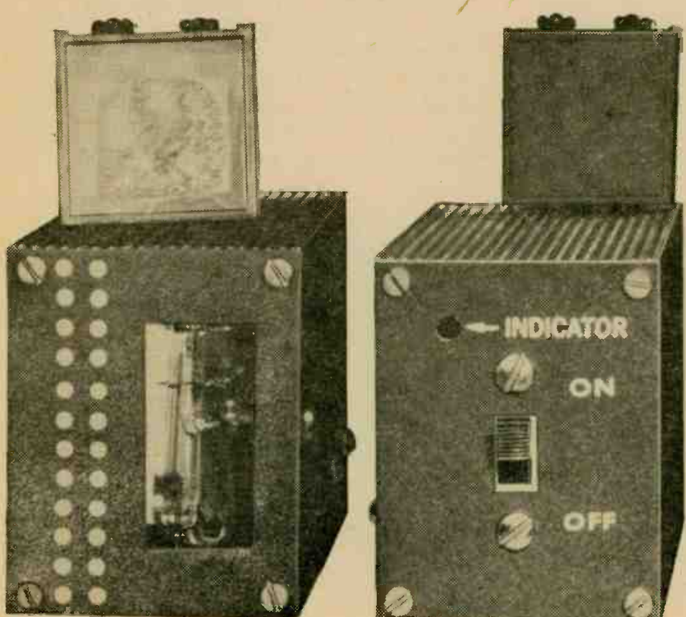


Trigger lead's routed directly to transformer T2 on perfboard. Don't skimp on wire quality; high voltages're present.

is in position the end of this lead should be formed into a single loop slipped over the tube near its center.

Flashtube and Reflector. Once you've mounted and wired all the components on the perfboard you can mount the board assembly in Li'l Blitzer's housing and then you're ready to tackle mounting FT1 and its reflector. A 4-point tie strip that has a mounting foot centered between the end points is used to hold the flashtube. Clip off the two inner lugs leaving those on the extremities for connecting to and supporting the flashtube. Use stiff wire (at least 16 gauge) to act both as a connection and a support. Make a small loop at the tube end

(Continued on page 113)



Li'l Blitzer's fore, aft views displayed. Left pic of unit shows flash tube vertically mounted; horizontal mounting, use is also permissable. Photo on right shows where lamp I1 lives in unit. Before you take Li'l Blitzer on assignment, shoot at least one roll of black 'n white film with Li'l Blitzer working as fill light. Stop down your camera lens one f/stop per frame as you shoot test subject. Develop film in normal manner; pick frame giving you best contrast ratio.

TennaBoost

Wipe out the dead spots on your BCB dial with our easy-to-build signal booster

by George Hattlett

WOULD YOU BELIEVE IT? There really isn't a dead channel on the BC band. What's more, neither rain nor sleet nor much of anything else (our apologies to the Post Office) will stay the broadcast signals in the 540- to 1600-kHz range. Transmitted daily by more than 7600 stations in the Western Hemisphere alone, these signals can be yours—if you have a suitable antenna.

To log real BCB DX (the flea-power locals in the band), you'll need a long-wire antenna supported as high as possible above buildings and tree tops and free of obstructions. Catch is, what city dweller can find such a spot? Fortunately, you don't have to. For by connecting our *TennaBoost* in place of whatever makeshift antenna you've been putting up with to date, you should be able to snag plenty of these distant weaklings. What may have appeared to be dead spots on your dial before *TennaBoost*

TennaBoost

will now come alive with stations you never knew existed. And signals that were once puny to the point of being unreadable will now blast in like a herd of buffalo heading for Injun country.

What Is It? *TennaBoost* is an inexpensive, easy-to-build, indoor antenna/signal booster amplifier. Basically, it consists of a tuned loopstick (same as supplied in the majority of transistor radios) that feeds signals to a two-stage, transitorized, wide-band amplifier. As noted in our Parts List, the amplifier is available in kit form direct from the International Crystal Manufacturing Co. Included in the kit is a well-laid-out printed-circuit board, ready to accept the components making up the amplifier, with easy-to-read identifications of the locations for the various parts printed on the board.

Building TennaBoost. Because the overall gain of the combined amplifier and loopstick is extremely high—30 dB for the amplifier and 10 to 20 dB for the loopstick—the layout of the amplifier and the overall wiring are critical. Therefore, we suggest you buy the kit and follow the construction details furnished with it as well as our construction tips and layout, to lessen the likelihood of your amp being plagued with instability. The amplifier kit sells for less than $4.00, so you'll be ahead of the game to buy it, considering the cost of the parts plus the dividend of getting a properly laid out, finished printed-circuit board.

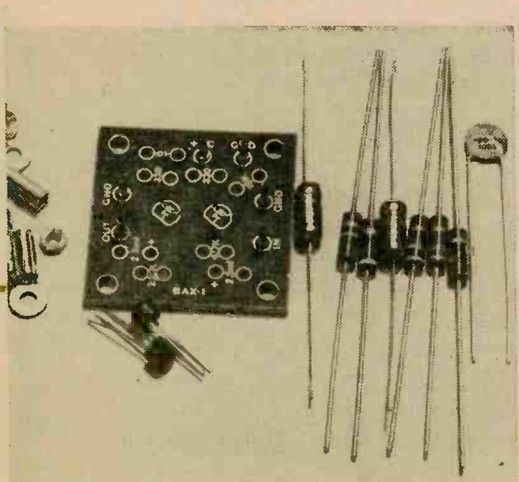
We made one change in the kit. Since it's intended to cover the 50 Hz to 150 kHz range, it comes with two 2.5-μF electrolytics. For optimum performance in the BC band we substituted two 0.001-μF subminiature ceramics. The two 2.5 μFs are the only electrolytics furnished in the kit, so you should have no trouble identifying them. Put them aside, as you'll no doubt find use for them in some future project.

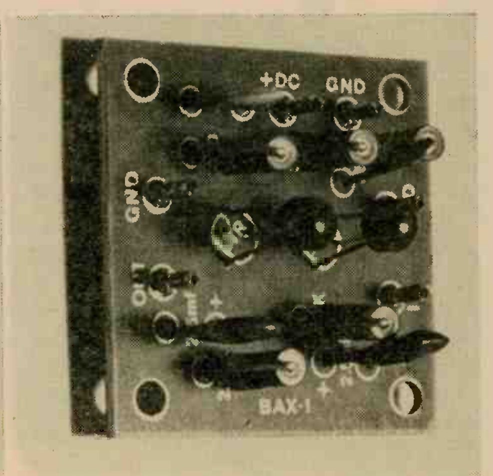
We recommend that you first assemble the kit and solder all components in place. Be very careful not to use excess heat on the transistors and other miniature components. In fact, you should use a small alligator clip as a heatsink while soldering them. A small pencil-type soldering iron rated at about 25 watts should work very nicely.

Just as the amplifier itself is critical as to layout, so is the completely assembled *TennaBoost*. Therefore, exercise the greatest care with your parts layout. Follow our construction details as closely as possible.

We mounted *TennaBoost*'s components in a 5¼ x 3 x 2⅛-in. minibox. All of the components are mounted in half the minibox; the other half closes up and shields the assembly. First step is to drill and deburr all mounting holes. Be sure to follow the dimensions for locating the holes, placing them exactly as shown in our drawing. This is necessary to reduce the possibility of instability for the complete assembly. Position the amplifier as shown, using two ¼-in. spacers to lift it from the metal of the cabinet so that there will be no possibility of shorts.

Place the amplifier so its input terminals





Pic on left is how you get 'em, pic on right is what you do with 'em to make a BAX-1.

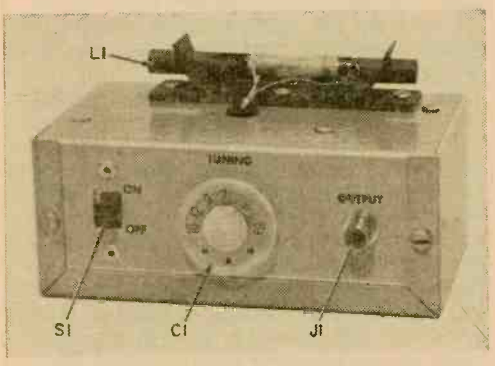
face the battery holder and its output terminals face the edge of the minibox. Mount switch S1, tuning capacitor C1, and output jack J1 on the front panel as dimensioned in our drawing. Jack J1 should line up with the center line of the amplifier board and S1 should be in line with one of the battery terminals of the battery holder. Both S1 and J1 are equidistant from the center of the box; capacitor C1 is centered to give the front panel a balanced look.

TennaBoost's Loop. Loopstick L1 is mounted outside on the top rear of the minibox. When mounted, the loop's tap, which is just a few turns from one end, should be in line with the grommet that is exactly centered in the top of the minibox. Since you will have to remove the loopstick from its fiber mounting bracket in order to mark the mounting holes, it's good to remember where the tap should be when reinstalling the loop in its mount.

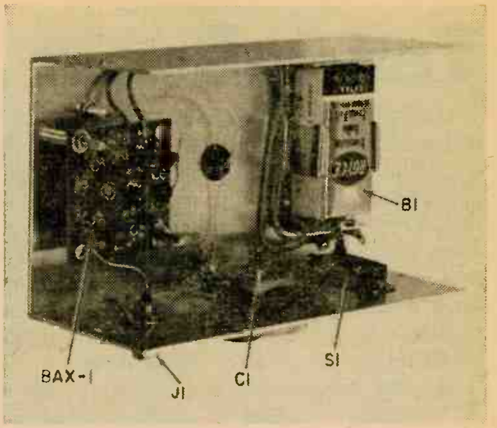
Be careful not to break the delicate leads of very fine wire from the loop. Also, install a ¼-in. rubber grommet in the hole for the leads to ensure that the loop leads will not be cut by the rough edge of the hole drilled in the minibox. Use the full length of the leads when connecting it to tuning capacitor and the amplifier.

The rotor plates of tuning capacitor C1 are grounded through the mounting of the capacitor; the stator plates are connected to L1 by the lead from the loop.

Amplifier output is connected directly to J1 with a short piece of unshielded hookup wire. Make this lead as short and direct as possible. Even though the input and output



TennaBoost's good looks are attributed to its balanced front control panel. However there's more than meets the eye here. Layout is important to ensure short, direct wiring for minimum coupling that can cause unwanted oscillation.



Here's how we put TennaBoost together. You'll be wise to follow this layout for a minimum of trouble with instability. TennaBoost's high gain requires careful parts placement.

connections of the amplifier are made to push-on clips, solder connections directly to them.

To avoid unstable operation care must be taken in proper dress of interconnecting leads. The leads from the loop should run through the rubber grommet directly to the amplifier, with the excess pulled towards the battery holder. Power leads from the battery should be run along the side of the battery to the rear of the cabinet and thence across to the power terminals on the amplifier.

The output cable to connect *TennaBoost* to the BC receiver should be a short piece of low-loss coaxial cable (it should be no longer than 40 in. maximum). We used RG-174/U. You can also use RG-62/U with equal success; if these are not readily available RG-58/U or RG-59/U can be used if the length is limited to a maximum of 24 in.

Since there is no check-out or alignment needed before putting *TennaBoost* into service, close up the minibox, being sure to use all of the screws furnished. If the box you use should be one of those having a snap fit to keep it closed, you'll have to drill it and install sheet metal screws to be sure that the two halves are electrically connected to provide complete shielding. You can't check out *TennaBoost* with the cover off since it will break into oscillation from feedback between the amplifier output and loopstick L1. Use press-on lettering (Datak or equiv.) for a very professional look in identifying the controls on the front panel.

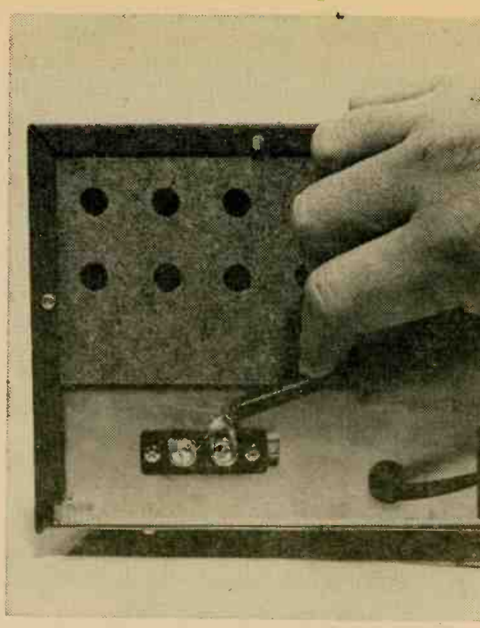
TennaBoost

Using TennaBoost. Connect the free end of the coax from *TennaBoost* to the antenna and ground terminals of your BC receiver. Be sure the shield of the coax cable is connected to the ground of the BC receiver. Turn *on* switch S1 of *TennaBoost* and the power switch of your BC receiver. If the set is a tube model, allow time for the tubes to warm up (because it's transistorized no warm-up is required for *TennaBoost*).

If your receiver uses a loopstick for a BCB antenna instead of having terminals for external antenna and ground, don't despair. Pare back about 2-in. of shield on coax cable to let you twist a turn or two of the center conductor around the set's loop. Best way to handle the shield is push it back, loosening the mesh. Gently make an enlarged opening in the mesh and draw the center conductor through the hole, leaving a pigtail of shield for grounding to the set's chassis. If, in this process, insulation on the center conductor is damaged, insulate the conductor with tape or sleeving. Once the twist has been tested in its initial position, move it back and forth over the set's loop for best signal.

Now tune the BC receiver to the approximate frequency of a station and adjust the dial of *TennaBoost* for maximum noise output. Once that has been done, tune in the station with the receiver's dial and peak the sensitivity of *TennaBoost* by adjusting its dial for maximum signal level. The dial furnished with capacitor C1 is calibrated in standard BCB frequencies so you can use these calibrations as an initial setting for

(Continued on page 109)



If your BCB set has terminals for external antenna and ground connections, here's how TennaBoost is connected.

THE RECEIVER WE USED

Hallicrafters' new Star Quest broadcast and shortwave receiver shown on page 25 incorporates many features normally found only in more complex and expensive general-purpose communications receivers.

It's a transistorized version of Hallicrafters' original most famous Model S-120 vacuum tube SW (shortwave) receiver. Many a freshman ham started his career by using the S-120 for his SWL activities. Model S-120A covers the AM-BCB and 76 shortwave services in four tuning ranges. Because of its special solid-state circuitry and BFO (beat frequency oscillator), standard SW as well as CW (code) and SSB (single sideband) reception is boosted considerably over conventional vacuum-tube sets.

The model S-120A is a transistorized receiver housed in a steel, communications-type cabinet. It has a large, illuminated slide-rule dial. This receiver covers the AM broadcast band as well as providing complete SW coverage from 2 to 30 MHz. Special features include electrical bandspread, a logging scale, and automatic gain control, in addition to the aforementioned BFO for SSB/CW reception. Its low-distortion audio power output of over 1000 mW drives a built-in, rugged, 4-in., communications type speaker. An universal impedance output jack for connecting various communications type headphones is mounted on the front panel.

Basically, the S-120A is a real winner that more than adequately fills the bill for the budding SWL-DXer, rather than being considered a commercial communications receiver.

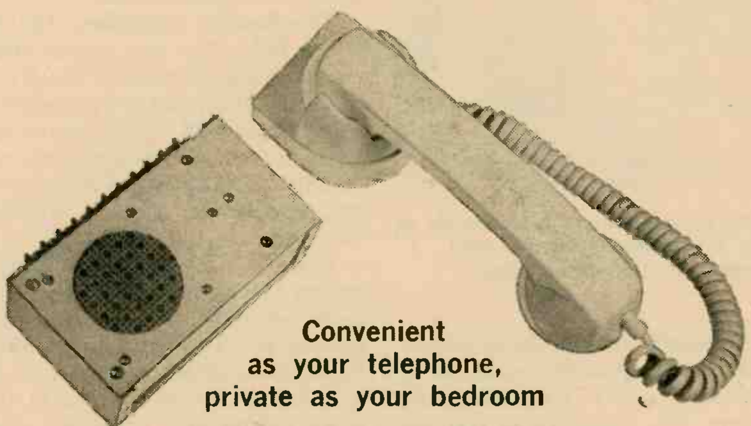
Hallicrafter's Model S-120A Receiver

PHONECOM

-The Hot Line Intercom

IF THE DECIBEL LEVEL in your home has been going up, and up, and up . . . and you're wondering where it will end so you won't have to become a stentorian to raise pop in his basement shop . . . take heart—here is a possible solution. Our PHONECOM is an inexpensive, easy-to-build, 2-station telephone intercom.

Now, with the aid of PHONECOM, when the little lady of the



Convenient as your telephone, private as your bedroom

by Edward A. Morris, WA2VLU

house calls out to hubby that din-din is ready, the entire neighborhood won't have to know about it. Seriously, though, if you are an average home owner, you'll readily see lots of advantages over the loud mouth method.

PHONECOM is easy to operate: you use it just like a direct-line telephone. There are no *on/off* or *talk/listen* switches to operate, since none are necessary. When the handset is picked up, a pleasant beeping tone signals one party that the other is waiting on the line. Upon answering the call, normal two-way conversation can take place. As with a standard telephone, the communicators can talk and listen at the same time, and the conversation is private.

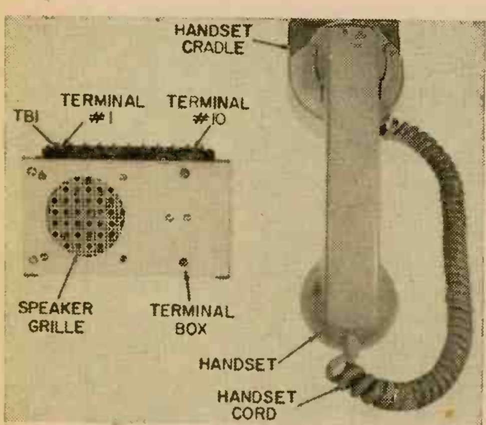
Unlike many loudspeaker-type intercom systems, with PHONECOM, unless both parties are on the line, neither station can listen in on room conversations taking place at the other station.

Total cash outlay to build the system (two stations) will run

PhoneCom

slightly under $50.00, with all parts purchased new. However, by a little judicious shopping for bargains, the complete system cost can be cut almost in half.

Maximum station separation, using the ordinary intercom cable specified in the Parts List, is about five miles. This is certainly more than enough for most applications.



Each complete PhoneCom station consists of a handset, a hookswitch assembly with handset hanger, and a terminal box.

Each station is indepedently powered by a single, inexpensive 9-V transistor radio battery. Battery life, especially if you use one of the new premium types, should be about a year under normal usage. The average hobbyist should be able to complete construction in six to eight hours.

How It Works. For simplicity, we'll break PhoneCom down into four separate sections: a) power supply, b) talk amplifier, c) receive amplifier, d) signalling section. The word *line* as it's used in this article refers to the interconnecting cable between the two stations.

The Power Supply. In the normal *on-hook* state, the handset is resting on the cradle switch. The cradle switch is then in the position shown in the interconnection diagram for Terminal Box 1. Positive 9V is present on the arm of switch S1B. When the handset is removed from the cradle, switch S1B closes and applies positive 9V to both the talk and receive amplifiers.

The Talk Amplifier. With power now applied to the talk amplifier, audio output from the dynamic microphone in the handset is fed to the base of transistor Q1 through coupling capacitor C1. Bias for the stage is set by the voltage divider formed by resistors R1 and R2. Emitter resistor R4 helps to stabilize the stage. It also helps to reduce variations in circuit performance due to the wide differences in current gain among individual transistors of the same type, which may be used for Q1.

Capacitor C2 bypasses the emitter resistor to prevent the undue loss of gain at audio frequencies. Resistor R3 serves as the collector load for Q1, and the amplifier output is developed across it. The amplified audio output is coupled to the XMIT line through capacitor C4. Note that the output (XMIT line) of one station should, of course, be connected to the input (REC line) of the other station.

The Receive Amplifier. The input REC line is fed to the arm of potentiometer R7, the receive level control. Pot R7 also serves to set the bias point for transistor Q2, along with resistor R6. The receive amplifier is basically similar in oprration to the talk amplifier. The amplified output is coupled to the receiver cartridge in the handset via coupling capacitor C7.

A small amount of talk amplifier audio output is also fed into the input of the receive amplifier, through capacitor C3 and resistor R5. The signal thus produced is referred to as sidetone. It permits the user to hear his or her own voice in the receiver when talking into a handset, thus creating the effect that the handset is working.

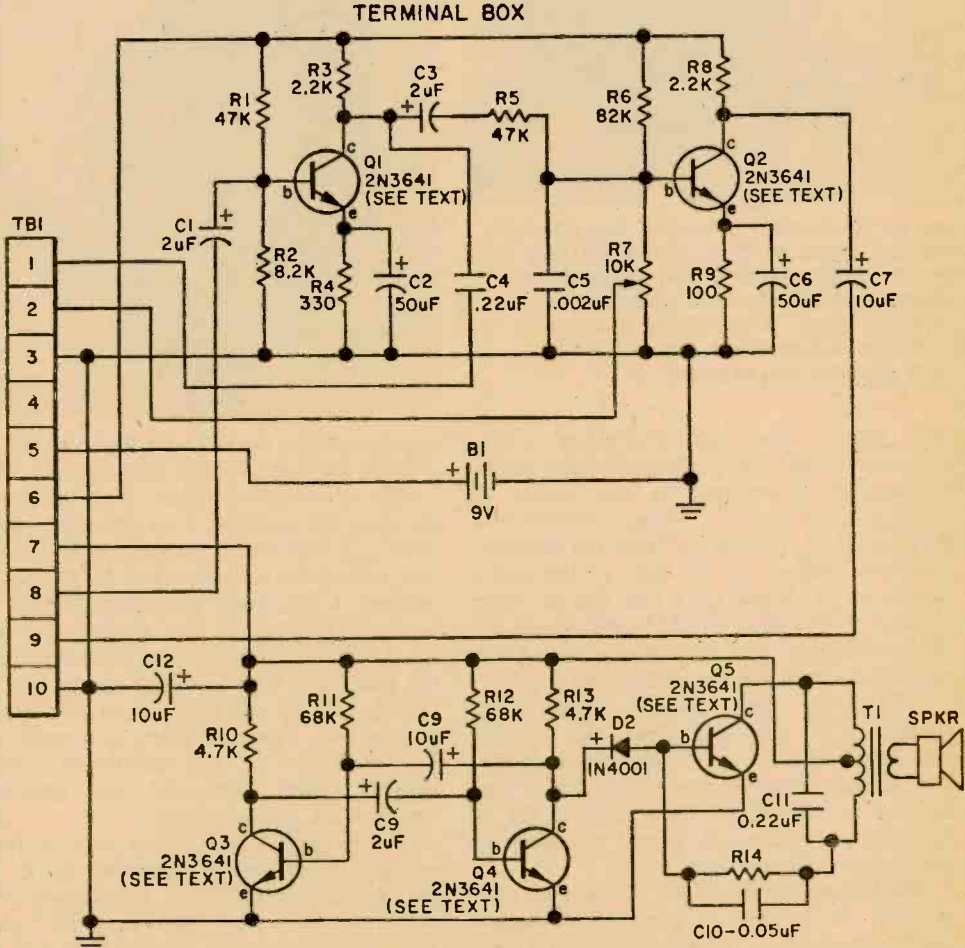
The Signalling Section. PhoneCom uses a form of DC signalling. Ringing, or signalling the other station is accomplished simbly by removing the handset from its cradle switch which causes the hook switch to operate. This applies +9V to the talk and receive amplifiers, as mentioned earlier, and in addition it also applies +9V to the Signal Line via terminal 4 on TB1, through diode D1. Diode D1 is forward biased by the positive voltage on its anode.

We must assume that the handset of the other station is in the *on-hook* condition (i.e., resting in its cradle against actuator lever of S1A and S1B). The positive ringing voltage is received from the other station via the Signal Line and is routed through switch S1A to terminal 7 of TB1, the input to the signaling circuit.

PARTS LIST FOR ONE PHONECOM TERMINAL BOX

B1—9-V transistor radio battery (type 2U6 or equiv.)
C1, C3—2-uF, 6-VDC miniature electrolytic capacitor
C2, C6—50-uF, 16-VDC electrolytic capacitor
C4, C11—0.22-uF, 12-VDC disc ceramic capacitor
C5—0.002-uF, 1000-VDC disc ceramic capacitor
C7, C9, C12—10-uF, 16-VDC electrolytic capacitor
C8—2-uF, 15-VDC electrolytic capacitor
C10—0.05-uF, 25-VDC ceramic capacitor
D2—50 PIV @ ½ A or better silicon diode (Motorola 1N4001)
Q1, Q2, Q3, Q4, Q5—2N3641, npn small signal silicon transistor (2N697, 2N3705, SK3020, GE-21, HEP 54 or equiv.—see text)
R1, R5—47,000-ohm, ½-watt resistor
R2—8200-ohm, ½-watt resistor
R3, R8—2200-ohm, ½-watt resistor
R4—330-ohm, ½-watt resistor
R6—82,000-ohm, ½-watt resistor
R7—10,000-ohm miniature potentiometer (Mallory type MTC-1 or equiv.)
R9—100-ohm, ½-watt resistor
R10, R13—4700-ohm, ½-watt resistor
R11, R12—68,000-ohm, ½-watt resistor
R14—18,000-ohm, ½-watt resistor
T1—Transistor output transformer: 500 ohm CT primary; 8-10 ohm secondary (Lafayette 99E61293 or equiv.)
TB1—10-terminal, screw, barrier type terminal strip (Lafayette 33E86109 or equiv.)
1—Aluminum minibox, 5¼ x 3 x 2⅛ in. (Lafayette 12E83738 or equiv.)
1—2½-in. speaker, 10-ohm voice coil (Lafayette 99E60972 or equiv.)
1—Keystone battery holder, type 203P
1—Battery connector for 9-V transistor batteries (Lafayette 99E62879 or equiv.)

TERMINAL BOX



PhoneCom

The positive voltage received on terminal 7 is filtered by the action of capacitor C12, and serves as the source of power for the signaling unit. The signaling unit comprises a multivibrator consisting of transistors Q3 and Q4, their associated components, and the audio oscillator composed of transistor Q5 and its associated components.

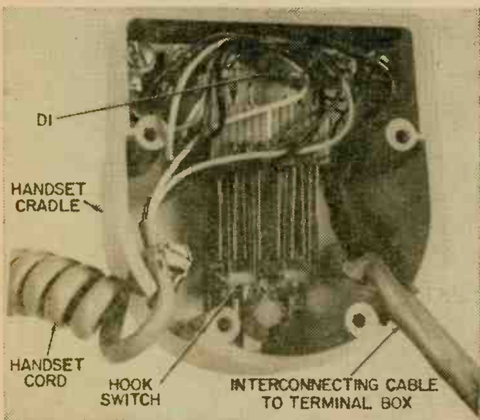
When DC power is applied, the multivibrator is activated. Its output is an asymetrical square wave, and it appears at the collector of Q4. The frequency of the multivibrator is determined by the values of capacitors C8 and C9, along with resistors R11 and R12. The output from the collector of Q4 is coupled to the base of the audio oscillator by diode D2. The square wave applied to the base of the audio oscillator transistor turns the oscillator *on* and *off*, thus producing sound in the speaker.

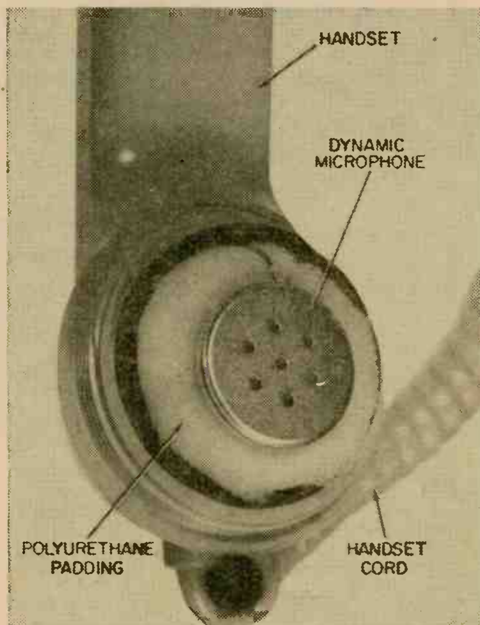
When the other station answers, its switches, S1A and S1B, close, and transfer the Signal Line to +9V through diode D1. The beeping stops because no current is now flowing on the Signal Line. Diodes D1 at both stations are reverse biased with positive voltage on their cathodes.

Mechnical Construction. Though we constructed the models in standard aluminum miniboxes, because the mechanical and electrical layout isn't critical, the electronics may be arranged to fit any suitably sized enclosure. For instance, in the interests of economy, the intercom stations could be built in discarded wooden cigar boxes. Suitably finished, these boxes present quite a good appearance.

The first step in construction is to lay out and spot the holes to be drilled in the case. A small T-square and sharp pointed scriber can be helpful here.

Center-punch the holes to be drilled to ensure that the holes will be accurately placed. The 2-in. dia. hole cutout for the speaker can be made easily with the aid of a nibbler. De-burr all holes and cutouts.





Above, hookswitch assembly and handset hanger. Diode D1 is mounted on hookswitch. Right, miniature dynamic microphone replaces standard carbon one normally used. Polyurethane cushion is forced into microphone well to hold dynamic unit in place.

The aluminum surface is prepared for painting by rubbing it down with a steel wool pad, and a slurry consisting of an abrasive household cleaner (Ajax or Comet and water). A fine grade of sandpaper can also be used. The case is then washed thoroughly. A slightly matte, roughened surface on the aluminum case to which spray paint can readily adhere will result from this type of preparation. This also helps to remove shallow scratches on the aluminum surface, which would otherwise be noticeable through the painted finish.

The prepared case, along with a 2½-in. section of perforated aluminum to be used as the speaker grille are now ready to be painted. We used spray paint which matched the color of the handsets and cradle switches used in the models. You may want to follow this color scheme or one of your own selection. It's immaterial to the functional qualities of the PhoneCom.

When applying the spray paint, remember not to over spray it. Several light coats are preferable to a single heavy coat. A good durable finish can be applied in as little as a half hour. The trick is to use three or four light coats which dry quickly, that can be applied about 10 minutes apart, or when the previous coat is dry. When the surface has been prepared as suggested, the resulting finish will adhere tightly, and will be more resistant to chipping, peeling, and abrasion.

Electrical Construction. The bulk of the components, except for the speaker, the hook switch (S1A and S1B), the terminal board (TB1), the battery (B1), and diode D1, are mounted on a 2¾ x 4¼ in. piece of perf board. As stated earlier, the exact physical layout isn't critical. However, care should be taken to avoid poor layout techniques. A good bet is to follow our layout as shown in the photos. Relatively exact component placement can be determined from them.

As can be seen in photos, all components are mounted via push-in terminals. The terminals anchor the components firmly to the board, and provide wiring points on the reverse side of the board. Wiring was carried out using small gauge, bare copper wire. Insulated plastic tubing was added at crossover points to prevent possible shorts.

A wide variety of substitutions for transistors Q1-Q5 are possible, only a few of

PARTS LIST FOR PHONECOM HANDSET ASSEMBLY

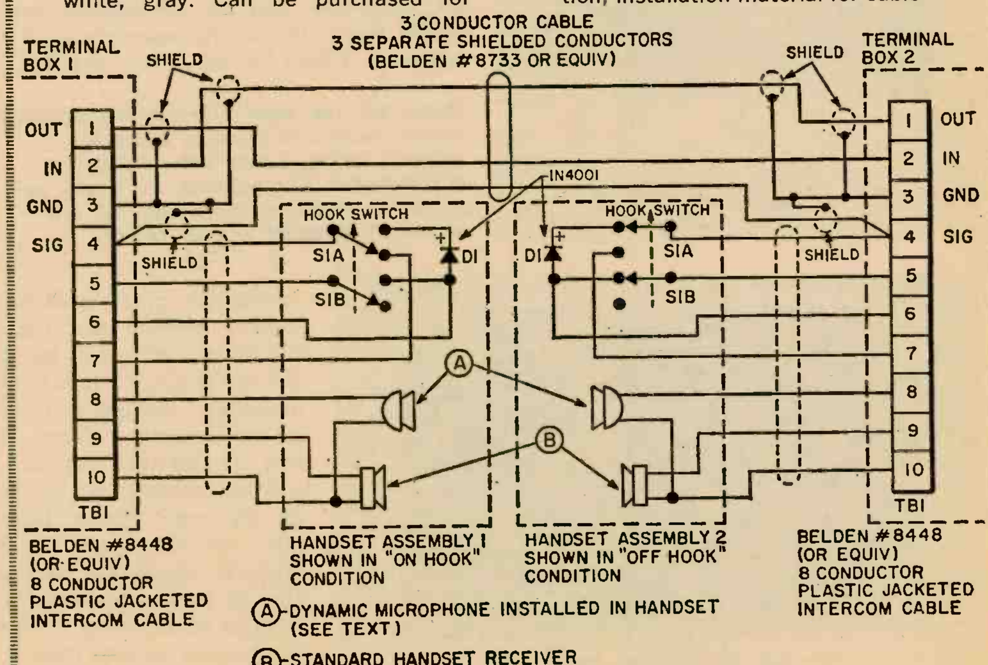
D1—1N4001 Motorola silicon diode (any silicon diode rated at 50 PIV, ½ A or better will do)

1—Handset cradle and hook switch assembly for S1A and S1B Switchcraft type 14412G, specify color of plastic—black, beige, white)

1—Miniature dynamic microphone cartridge, 600-ohm impedance (Lafayette 99-45270 or equiv.)

1—Telephone handset, less transmitter cartridge, complete with receiver cartridge and 4-wire coiled cord. Specify color when ordering: red, black, beige, white, gray. Can be purchased for $6.50 each plus postage from:
Grandcom Inc.
1152 Avenue of the Americas
New York, N.Y. 10036

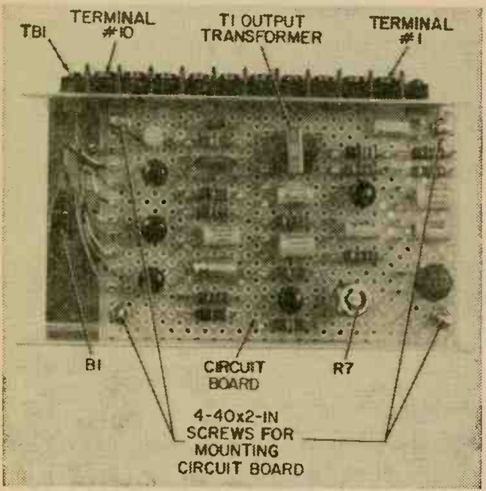
Misc.—Wire, solder, bolts, nuts, push-in clips, perfboard, spray paint, polyurethane foam sheeting, Belden #8733—3 separate shielded conductors in one jacket for interconnecting stations, 7 single conductors in one jacket for connecting cradle and hook switch assembly to terminal box (Belden #8448), lengths of cable for installation, installation material for cable



PhoneCom

which are tabulated in the Parts List. The model uses 2N3641s, obtained new at five for a dollar from Poly Paks. Fact is, just about any small signal, npn silicon transistor having a gain over 20 can be used with good results.

Assuming reasonable care is taken, the transistors may be soldered directly into the circuit. Modern silicon transistors are quite rugged and will not be damaged by the heat from soldering if just a bit of care is exercised. Simply use a low-to-medium power soldering iron (under 60 watts or so). Make sure it's well tinned, and leave more than ⅜ in. lead length between the soldered joint and the transistor case. Complete the soldering operation as quickly as possible. To be safe use a heat sink (an alligator clip on the lead being soldered).



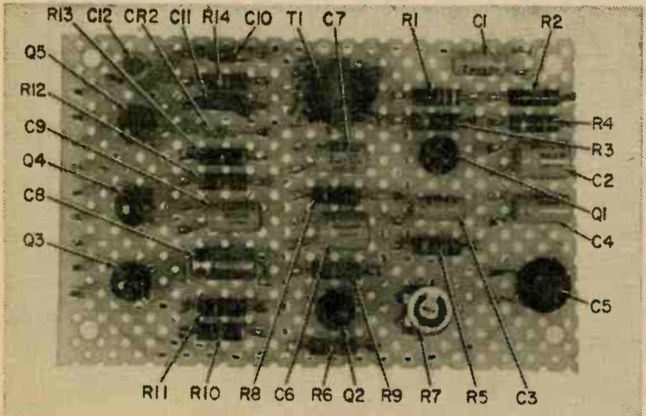
After the circuit card has been wired in accord with the schematic diagram, recheck your work for possible errors. Make sure all polarized components (electrolytics, diodes, etc.) are installed correctly. You should also check for accidental shorts and cold soldered joints.

Modifying the Handsets. In order to use a single inexpensive battery as the PhoneCom's power supply, the carbon microphone normally used in telephone handsets has been replaced with a miniature dynamic microphone element. Refer to the photos for mounting details. Note that the dynamic element is cushioned by a small piece of polyurethane foam placed in the microphone well of the handset. Connect the leads from the dynamic element to the red and black leads in the handset. If the handset is obtained from the vendor mentioned in the Parts List, it will be shipped less the carbon element.

The completed, checked, electronics circuit card is now ready to be mounted in the aluminum case. By referring to the photos, you can see how 4-40 x 2-in. machine screws and nuts were used to mount the card, and space it about 1⅜ in. above the aluminum panel. The various interconnecting wires between the circuit card, the speaker, and the terminal board should be installed now.

The Hook-Switch. Prior to wiring the handset cradle with hook-switch, the handset, diode D1, and the 7-conductor cable, decide where the cradle assembly is to be mounted. Check to see if it's possible to

Upper left, rear view of Terminal box showing circuit board and terminal board for external wiring. Lower left details circuit board. Components are neatly oriented to facilitate interwiring. All are identified to assist in your layout.



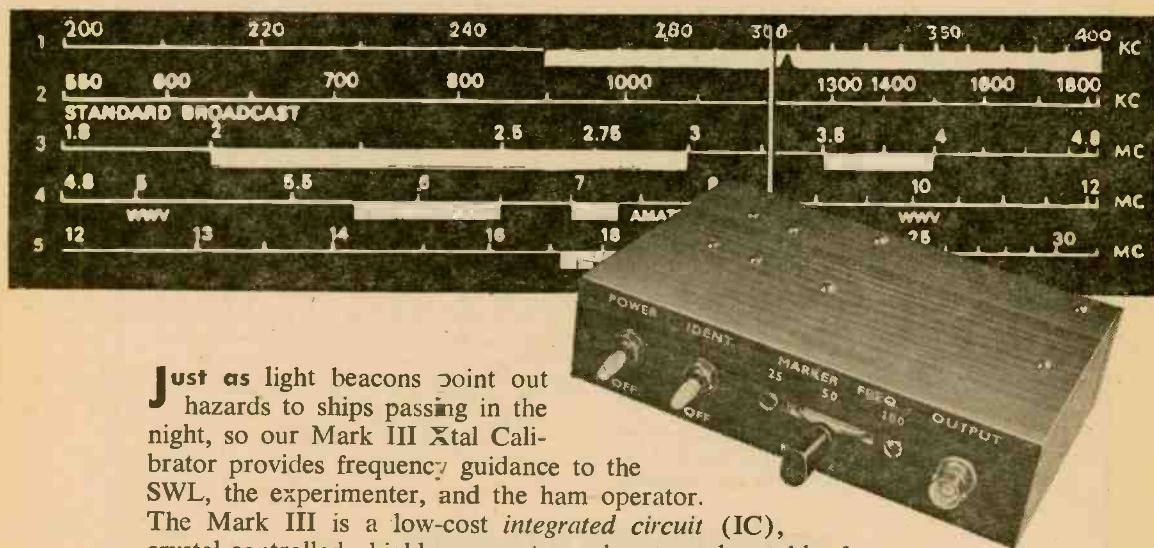
mount the cradle switch in such a position that the 7-conductor cable can be fed directly through a hole in the mounting surface to the cradle assembly from the rear. If this isn't possible, it will be necessary to use one of the semi-circular knockouts on the edge of the cradle's mounting surface. One of these knockouts will have to be removed to allow the handset cable to pass.

(Continued on page 111)

MARK III XTAL CALIBRATOR

You can be sure of the frequency when calibrating your receiver or locating new sub-band edges when transmitting. This compact, battery powered calibrator uses state-of-the-art ICs and crystal standard for accuracy, stability, and marker signals not found in commercially built units.

by Ed Morris, W2VLU



Just as light beacons point out hazards to ships passing in the night, so our Mark III Xtal Calibrator provides frequency guidance to the SWL, the experimenter, and the ham operator. The Mark III is a low-cost *integrated circuit* (IC), crystal-controlled, highly accurate and extremely stable frequency calibrator. It provides easily identified marker pulses at 25, 50, 100 kHz, and, in fact, all the way to 200 MHz and beyond.

It helps the SWL pinpoint the frequency of the signal he is tuned to and also makes it easier to spot and identify rare DX stations. Ham operators will appreciate the benefits of the 25- and 50-kHz markers in identifying the new sub-brand edges, which are not exact multiples of 100 kHz.

A feature not found in any of the commercial calibrators currently avail-

Mark III Calibrator

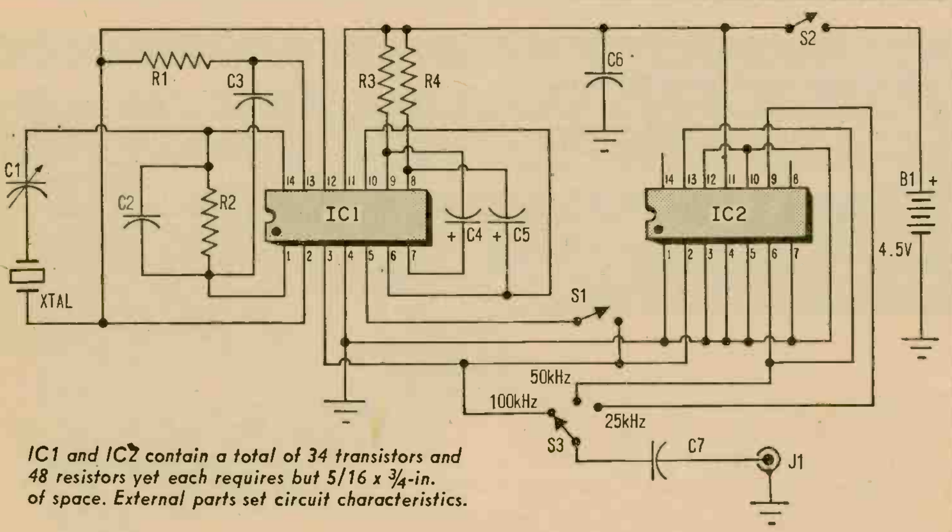
able is the unique type of identification produced by the Mark III. The output marker signals can be pulsed *on* and *off* twice a second. This is a great aid in separating the markers when the band is full of QRM and unmodulated carriers.

Ease of construction and wiring as well as low component cost are achieved by using two plastic ICs that can be bought for $3.35 the pair. These two ICs replace a total of 34 transistors and 48 resistors.

Entire cost to build this calibrator, using all new parts, should be less than $23.00. You can cut this figure almost in half if you happen to own or can borrow a crystal of the type used in our unit.

Construction time to build the calibrator is between 3 to 5 hours, depending on the adeptness of the constructor. Our unit is housed in a 6 x 4½ x 1½-in. aluminum cabinet attractively covered with vinyl plastic sheet which can be selected to blend with the decor of the room the calibrator will be used in. Even though this won't affect its operating characteristics it will improve family relations where the living room is also your base of operations.

It's The ICs. Mark III works in a straightforward manner. Circuit IC1 is a hex inverter. The inverters on this IC chip generate,

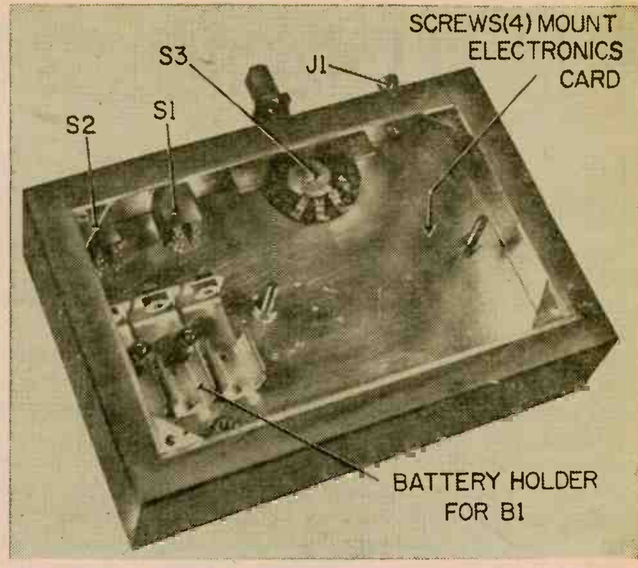


IC1 and IC2 contain a total of 34 transistors and 48 resistors yet each requires but 5/16 x ¾-in. of space. External parts set circuit characteristics.

PARTS LIST FOR MARK III CALIBRATOR

B1—4.5-V battery consisting of 3 AA mercury cells (Lafayette 32T4685 or equiv.)
C1—7-45 pF ceramic trimmer capacitor (Lafayette 32T2511 or equiv.)
C2—100-pF, 1000-VDC disc ceramic capacitor (Lafayette 33T2284 or equiv.)
C3—5000-pF, 1000-VDC disc ceramic capacitor (Lafayette 33T2331 or equiv.)
C4, C5—50uF, 12-VDC miniature electrolytic capacitor (Lafayette 99T6085 or equiv.)
C6, C7—0.01-uF, 75-VDC disc ceramic capacitor (Lafayette 33T6905 or equiv.)
IC1—Integrated circuit Hex Inverter (Motorola MC-789P)
IC2—Integrated circuit Dual JK Flip-Flop (Motorola MC-790P)
J1—BNC output connector, single hole mounting, type UG652 B/U (Lafayette 32T2121 or equiv.)
R1, R2—10,000-ohm, ½-watt resistor
R3, R4—6,800-ohm, ½-watt resistor
S1, S2—Dpdt toggle switch (Lafayette 99T6162 or equiv.) Note: only one pole used
S3—Miniature lever switch, 3 position, 2 circuit, non-shorting, positive action (Lafayette 30T4151 or equiv.)
Xtal 1—100-kHz parallel resonant crystal type S6P13 (available from Sentry Mfg. Co., Crystal Park, Chickasha, Okla. 73018 at $9.00, shipped prepaid air mail within continental United States within 24 hours after receipt of order)
1—Aluminum chassis, 6 x 4 x 1½-in. (Lafayette 12T8190 or equiv.)
1—Bottom plate for above chassis (Lafayette 12T8287 or equiv.)
1—Crystal socket Sentry type D40-152 (available from Sentry at 15¢ each—see address above)
1—2¼ x 3¼-in. piece epoxy glass sheet
Misc.—Vinyl covering (Contact or equiv.) miniature eyelets, wire, solder, nuts, bolts, etc.

Bottom view during initial assembly showing location for electronics card sub-assembly and battery holder, also controls on front panel. Keep circuit card away from chassis.



shape, and amplify a 100-kHz square wave and provide the marker pulses. Circuit IC2 is a dual J-K flip-flop, dividing the 100-kHz signal to 50 kHz, and that, in turn, to 25 kHz.

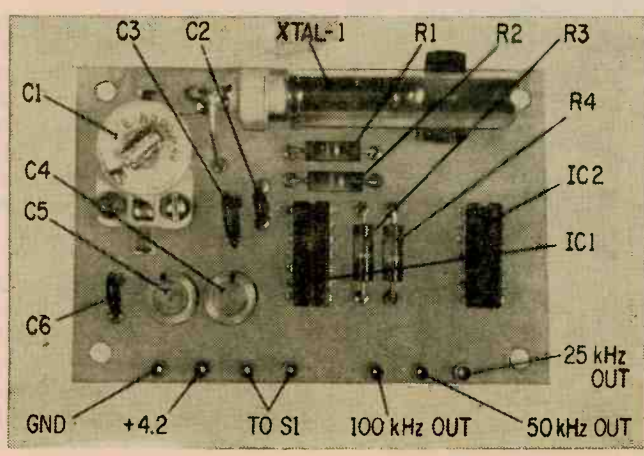
To be more explicit, IC1 contains six individual circuits, each of which is equivalent to a transistor amplifier that provides the simple inversion function. Two of these inverters are biased for class-A operation by R1 and R2. Capacitor C3 controls the output of the first one to the input of the second. Positive feedback is obtained by connecting the output of the second inverter to the input of the first through the crystal and trimmer capacitor C1. The output is a 100-kHz square wave. Because a parallel resonant crystal is sensitive to variations in load capacitance, the crystal can be trimmed to exactly 100 kHz by the trimmer capacitor.

A third inverter shapes the 100-kHz square wave and acts as a buffer to prevent variations in load from reflecting back into the oscillator, which would affect the oscillator frequency.

This buffered signal is fed to the first J-K flip-flop in IC2, which is connected as a divide-by-two counter, thus dividing the output to a 50-kHz square wave. This 50-kHz square wave, in turn, is divided in two by the second flip-flop in IC2 to produce the 25-kHz square wave markers. Switch S3 selects either the 100 kHz, the 50 kHz, or the 25 kHz output and couples the selected signal to jack J1 through capacitor C7. This capacitor also serves to block the DC component of the output signal.

The identification pulse function is achieved by connecting two of the remaining inverters in IC1 to form an astable multivibrator. The time constants of resistors R3 and R4 in conjunction with capacitors C4 and C5 establish the frequency of the multivibrators at 2 Hz. This very low frequency square wave is coupled to the input of the sixth inverter in IC1, which serves as a buffer. Switch S1 is used to couple the 2-Hz square wave pulse to the output of the 100-kHz generator, keying the output *on* and *off*. Since the 25- and 50-kHz outputs are derived by dividing the 100-kHz output, they too are keyed at the 2-Hz rate whenever S1 is closed.

Let's Make One. We used a 6 x 4½ x 1½-in. aluminum chassis and matching bottom plate to house our Mark III. You may prefer a different



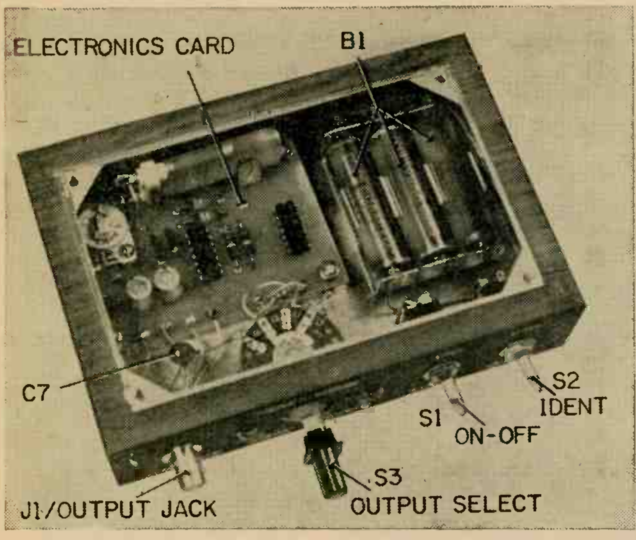
Electronics circuit card made from epoxy glass sheet holds all components except controls and battery. Note location of notch on ICs before soldering into place.

Mark III Calibrator

housing, or may want to combine it into an existing piece of test equipment, or build it into your receiver.

Scribe all the holes to be drilled in the housing and center punch them so that drilling will be accurate. A T-square will help in the layout work, particularly in laying out the slot for lever switch S3. After scribing the slot outline, drill a series of 3/32-in. holes within the outline as close together as possible. File the separations between holes with a needle file and dress the opening to the scribed outline. De-burr all of the holes and wash off the outer surfaces to ensure that all dirt and oil have been removed. Unless this is done the pressure-sensitive adhesive backing of the vinyl sheeting used to finish the housing may not stick tightly.

Front panel view of the Mark III details in-line arrangement for all controls. Use transfer or Datak letters for control identification to give your unit the professional appearance.



Bottom view of completed calibrator showing electronics card and batteries installed. Now use Mark III for numerous frequency checks

You'll need about one square foot of the vinyl material. When covering the chassis place the material on a smooth flat surface with the adhesive facing up. Center the chassis on the material and, after removing the protective cover from the adhesive, press the housing down firmly. Turn the housing over on its base and smooth out air pockets. Then fold the remaining material down over the sides, making slits at the corners for a neat, smooth finish all around. Some of the excess material may be folded over the edges and pressed down on the bottom. Use a razor blade or X-acto knife to remove vinyl from the holes and cutout in the housing.

To give the unit a professional look use dry transfer letters or decals to designate the function of the controls and output jack. Spray the finished lettered housing with several very light coats of clear acrylic to protect the lettering from abrasion.

Electronics Assembly. Except for the controls and the batteries, all of the components are mounted on a 2¼ x 3¼ x 1/16-in. piece of epoxy glass sheet. The layout isn't critical, though you may want to follow ours as shown in our photo. Be sure to keep all leads as short and direct as possible.

All holes for mounting and wiring components, except those for the two ICs, the trimmer capacitor, and the clip to hold the crystal, are eyeleted to anchor components and wiring. A 1/32-in. drill was used for the holes through which the pin connections from the ICs are passed. The pins are then folded back against the opposite side of the board. Pin numbers are read from the top of the IC. Starting from the identifying notch, with the notch to your left, and reading counterclockwise, pin 1 is the first pin of the bottom row.

Hooking It Up. We used #26 bare copper wire for all interconnections and formed it before soldering. This permits using a low-wattage soldering iron, keeping heat

(Continued on page 110)

NO-TICKET RIG

Here's 4 bucks worth of transmitter that says you can get on the air, now!

By Steve Daniels, WB2GIF

□ Are you just itching to key that rig? Most Novices are. Trouble is, most people who are dying to get on the air need a little bit more code practice before they can take the exam and grab their ticket.

The No-Ticket Rig is designed with precisely this in mind. And while you won't DX (legally) any further than your front porch, you will have an AM transmitter that can pop the *dihs* and *dahs* into your portable radio with no trouble at all. In fact, you will be amazed at how loud and clear the signals are. A more pleasant way to bone up on theory simply ain't to be found.

Circuit Operation. Transistor Q1, resistor R1, and audio transformer T1 comprise an oscillator circuit that produces a constant audio tone. The base of Q1 is forward biased through R1, while the emitter is forward biased through the secondary of T1; as a result, the transistor conducts heavily.

When the transformer's core is saturated, current flow stops, and the transistor is cut off when the magnetic field in the core reverses. This cycle repeats itself at a rate determined by T1, Q1, and R1.

The audio signal from T1 is injected into the RF stage through the emitter of Q2, and resistor R2 which also supplies the base bias for Q2. This RF oscillator is similar to the audio stage except that an autotransformer is used rather than a coil having two separate windings. The lower half of L1 augments the forward bias to Q2.

The modulated RF carrier appears at the collector of Q2 where it is coupled to a long-wire antenna. The signal can be picked up by any nearby AM radio.

Construction. A 1¾-in. square chip of perf board should provide enough space for all components. The adjustable antenna coil (loopstick) is mounted on one side of the case. You can use a larger board should things be too cramped, but all leads must be kept as *short* as possible.

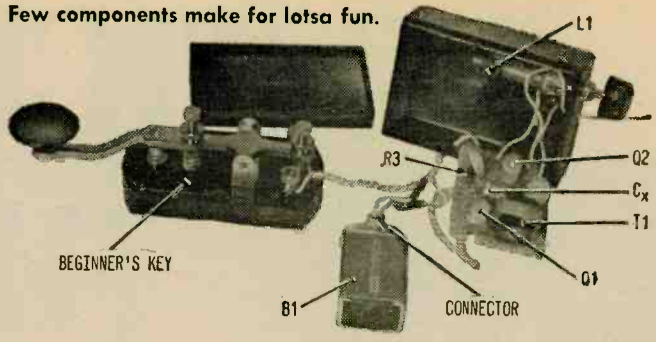
Wire the RF stage (Q2) first and bring out three leads for the loopstick. You will have to trim these to size later on. Then wire the audio oscillator, leaving an inch or so between L1's windings and T1. The core of the driver transformer may become over-saturated if these components are too close together.

Note that transistors Q1 and Q2 are not critical and that substitutes are available (see Parts List). Remember that the value of R2 (and perhaps R1) may require adjusting when a substitution is made.

When all the parts are mounted and wired, your key should be connected in series with the battery connector; it operates as a switch to bring power into the circuit. That nice twisted pair of leads in the author's model was obtained by securing two hookup wires in a vise and attaching the remaining leads to an electric drill. Turn on the drill for a few seconds and you have a cable.

To mount the antenna coil, start by drilling a ¼-in. hole and then ream it out until

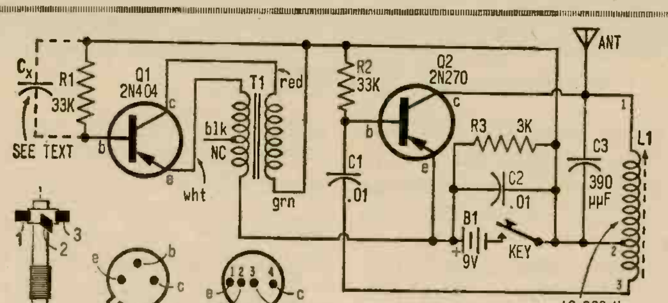
Few components make for lotsa fun.



the metal collar snaps snugly in place when the coil is pushed in. Make sure that the perf board, loopstick, and battery fit easily into the case. Connections should be as rugged as possible.

Adjustment. With the battery connected (for better voltage regulation and longer life, a mercury battery can be used), attach a long-wire antenna (between 3 to 6 ft) to terminal 1 of the loopstick and close the case. Screw your key shut (for a constant tone) and tune across the BC band until you pick up your rig's signal. Adjust the slug of L1 to get the tone on a quiet part of the band. There's no point in trying to copy through QRM.

If the audio tone is too low, add C_x to the circuit as shown. Any value between .01 to .02 *u*F should do the trick. ■

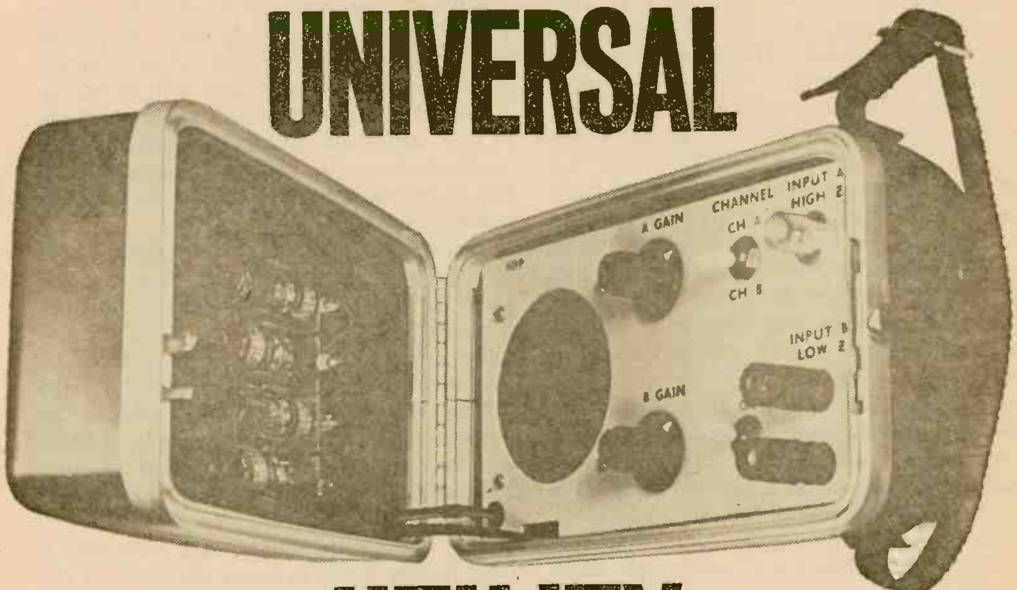


PARTS LIST FOR NO-TICKET RIG

B1—9-V battery (Burgess 2U6 or equiv.)—see text
C1, C2—.01-uF disc capacitor
C3—390-pF disc capacitor
Cx—See text
L1—40-300 uH, miniature BCB antenna coil (Lafayette 34T8749 or equiv.)
Q1—Pnp germanium transistor (RCA, GE 2N-404; HEP-739 or equiv.)
Q2—Pnp germanium transistor (RCA 2N270; HEP-632 or equiv.)
R1, R2—33,000-ohm, ½-watt 5% resistor
R3—3000-ohm, ¼-watt 5% resistor
T1—10,000-ohm pri., 2000-ohm (CT) sec., miniature audio transformer (Lafayette 99-T6126 or equiv.)
1—3¼x2⅛x1⅛-in. utility box (Lafayette 99T8077 or equiv.)

Misc.—Telegraph key (Lafayette 99T2554 or equiv.), battery connector (Cinch-Jones 5D, Allied 18C5184; Lafayette 99T6287 or equiv.), perf board, push-in terminals, knob, wire, hardware, solder, etc.

UNIVERSAL



UTILITY AMPLIFIER

Only one IC, but you can get up to better than a watt output

by Ed Morris, W2VLU

HOW MANY TIMES have you been frustrated because you had to make do with a compromise item in an experiment because you didn't have the one that was called for? You undoubtedly know what we mean. You saw an article describing an experiment you would like to try that depended on a small amplifier. So you had to improvise by borrowing (?) the youngster's phono or your wife's transistor radio. End result was that you wound up with Excedrin headache no. 279 and became an expert at defining frustration.

Seriously, most experienced servicemen and experimenters are well aware of the true value of a good universal utility amplifier for test purposes. Many, in fact, keep one on hand for just such applications. The neophyte, however, may not realize how handy, and at times absolutely necessary, such a unit can be. Therefore, for the relative newcomer in electronics, here

Universal Amplifier

are the details on how to build a top-notch utility amplifier for the embryo test bench. Also, building this up-to-date, solid-state Universal Utility Amplifier, should give any old pro excuse enough to retire his older, vacuum-tube versions.

Reasonable Power at Low Cost. Our utility amplifier can be built for just about $15.00, and that is based on having to buy all new components. When using the self-contained battery pack of four inexpensive AA cells, it delivers audio power in excess of 300 milliwatts. This same basic unit can be modified to provide a maximum power output of one watt, but more on that later.

The integrated circuit (IC) we used has fairly high sensitivity. When operated as a class B amplifier, with just 35 millivolts input, an output of about 150 milliwatts can be developed when using a 3-volt supply, or 400 milliwatts when using a 6-volt supply. If a CA3020A is substituted for the CA3020 we used, an output of slightly more than one watt is available when a 12-volt supply powers the unit.

The amplifier has both high- and low-impedance inputs that are switch-selectable from the front panel. The high input has an impedance of 55,000 ohms, while the low input impedance is 1000 ohms.

With just a few hand tools you can easily build our IC utility amplifier in three to five hours. Considering its small size and portability in contrast to its large performance, it's an extremely useful, versatile, and handy piece of equipment to have on the bench.

How It Works. An RCA integrated circuit is the basic component of the complete amplifier. Both the CA3020 and CA3020A are multifunction, low-cost, wide-band ICs that can be used as power amplifiers and drivers in portable and fixed communications equipment. They are designed to operate from a single supply voltage which may be as low as 3 volts. The maximum supply voltage is dependent on type of circuit operational requirements.

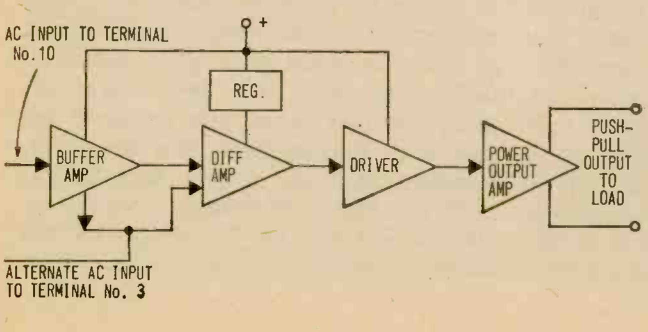
As used in the Utility Amplifier, the IC comprises the total complete amplifier assembly without requiring any other transistors or diodes. It serves as buffer, phase inverter, driver, power amplifier, and voltage regulator—and all in that little metal container. A few additional external components are required to couple audio signals and to set the operating conditions for the internal circuitry of the IC.

A functional block diagram (below) of the IC, indicates the relationship of its various sections. The voltage regulator is of basic importance in its operation. It provides accurately controlled voltages to the differential amplifier so that the proper idling current for the class-B operation is effected in the output stage. The differential amplifier operates in a class-A mode to provide required gain and phase inversion for the class-B driver and output stages.

The drivers are emitter followers which shift voltage levels between collectors of the differential amplifier transistors and the bases of the output transistors. They also provide the drive needed by the output transistors. The output-stage transistors are large, high-current devices and are able to deliver peak currents better than 250 mA. The emitters of the output transistors are brought out to pins 5 and 6 so that more complete stabilization of the idling current of the amplifier can be effected.

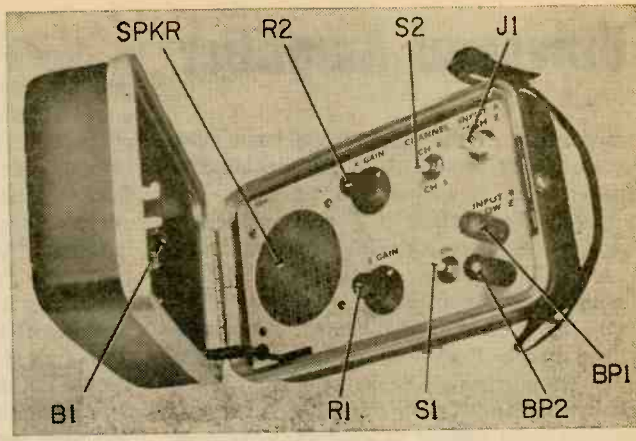
By adding resistors externally between pins 5 and 6 to ground, effectiveness of internal DC feedback supplied to the bases of the differential amplifier is enhanced.

To visualize the operation of this "mighty-mite" package, let's trace a signal from the input jack of our amplifier to the output through its self-contained speaker. Audio



Function block diagram for CA3020/CA3020A ICs shows relation of voltage regulator to differential amplifier and indicates signal flow through IC. CA3020 and CA3020A are identical except for power output; CA3020A accepts higher voltage and produces greater output.

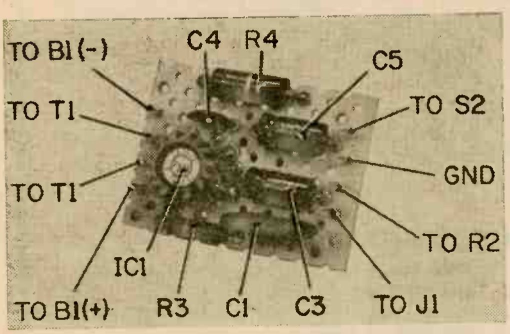
Carrying case opened, showing location of batteries. Three AA cells mount in clips in cover to clear controls.



signals, fed in through the high-impedance input (J1), are coupled via C1 to the input of the buffer amplifier. (C1 also blocks buffer-amplifier DC from the input of differential amplifier.) Output of this stage (pin 1) is coupled to the input of the differential amplifier (pin 3) through the gain control (R2) and capacitor C3. Resistor R3 establishes the operating conditions of this stage.

When input channel selector switch S2 is in *Chan A* position, the high-impedance input is selected. When S2 is placed in *Chan B* position, audio signals fed in through low-impedance input terminals BP1 and BP2 are coupled through R1, which serves as gain control for low-impedance input, to C3. They are then fed to pin 3, the input connection to the differential amplifier.

Because of the extended frequency range of the CA3020/CA3020A ICs, capacitor C4, a high-frequency AC bypass capacitor, is connected to pin 3 to prevent oscillation at



Amplifier circuit card detailing location of components. Wiring on underside of board can be hard wired or etched foil.

stray resonant frequencies of the external components, especially the output transformer. Pin 2, the other input to the differential amplifier, is placed at AC ground potential by capacitor C5.

Output of the differential amplifier is internally connected to the driver and from the driver to the output transistors in the output section of the IC. The output signal appears at pins 4 and 7, where it is coupled to the speaker through transformer T1, which matches collector-to-collector impedance of the output stage of the IC to the voice coil of the speaker. As previously discussed, R3 stabilizes the push-pull power stage.

Mechanical Construction. For greater versatility and applicability, we made our amplifier assembly portable. The Kodak M2/M4 camera case that we selected to mount our Utility Amplifier in serves very well as a housing for the unit. This lightweight, foam-padded interior, rigid body case makes an ideal housing for many small electronic instruments. We purchased ours from the photographic section of a local department store for less than $5.00.

Start the mechanical construction by mounting the battery holder in the upper half of the case, close to the hinge. It should be located so as not to interfere with switches and controls, etc., when the case is closed. A red paint marker (use some of your best girl's nail polish) on each of the battery clips near the positive end will ensure that the batteries are properly inserted.

Front Panel. The front panel is a 3½ x 6½-in. piece of G-10 grade, epoxy-glass printed circuit board. The copper-clad side is used as chassis ground. Epoxy glass sheet can be easily cut and drilled with simple hand tools.

Layout and drill all of the holes for the components that are mounted directly on the panel. The large hole for the speaker can be cut easily with a hand nibbler. An alternate method to make the speaker opening and grille would be to drill a series of closely spaced holes in a pattern similar to the perforated metal grille we used in our model.

Thoroughly clean the copper side of the

Universal Amplifier

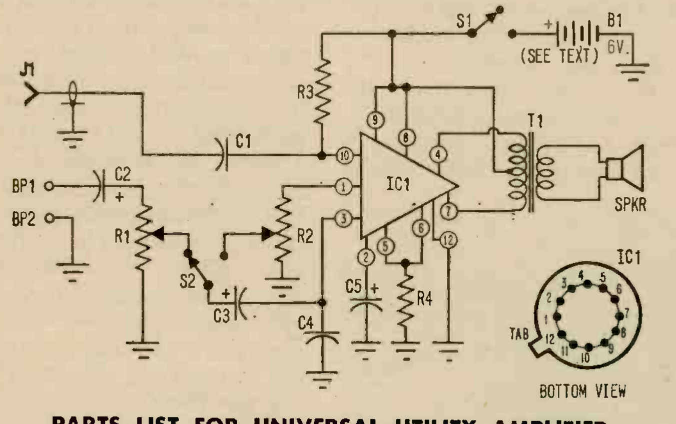
board after all the drilling has been completed. Either copper cleaner or an abrasive cleaner such as Comet can be used. This prepares the surface for easy soldering. Gently sand the epoxy side of the board with a medium-fine grade sandpaper to condition the surface for painting.

Wash the board and thoroughly dry it before painting. Follow manufacturer's directions for applying the spray paint. When spray-painting it's best to apply several light coats of paint instead of a single heavy coat. Be sure to allow each coat to dry completely before applying the next. For a really professional job, *"fog"* on the first few coats, and follow this up with an additional 3 to 5 light shiny coats. The results are well worth the extra work.

Add a finishing touch to the front panel by applying dry-transfer letters or decals. If you use dry-transfer letters allow the final coat to harden overnight before applying the characters. This will prevent the possibility of a slightly tacky finish from adhering to the letters on the transfer sheet. Apply a clear acrylic spray as a finish coat to protect the lettering from abrasion. Be sure the first coat of acrylic is very light, since excess solvent in a heavy coat could dissolve the transfer letters or decals.

Electrical Construction. Although the layout of the amplifier isn't critical, consideration should be given to the high gain and wide bandwidth of the IC. It will oscillate if there is sufficient coupling between the input and output circuits due to stray wiring capacitance. The newcomer would be wise to follow our layout. The more experienced experimenter may want to modify the layout

(Continued on page 105)



PARTS LIST FOR UNIVERSAL UTILITY AMPLIFIER

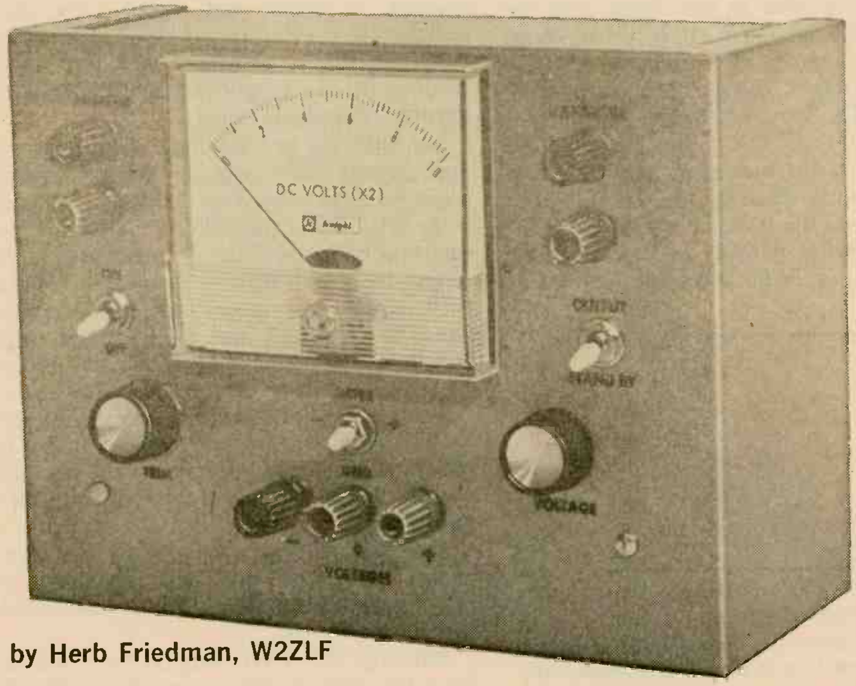
- B1—6 volt battery 4-AA 1.5-V alkaline cell batteries (Lafayette 99T6294 or equiv.) (see text)
- BP1—Red binding post (Lafayette 99T6121 or equiv.)
- BP2—Black binding post (Lafayette 99T6120 or equiv.)
- C1—0.1-uF, 75-V ceramic disc capacitor (Lafayette 99T6069 or equiv.)
- C2—15-uF, 25-V electrolytic capacitor (Lafayette 34T8459 or equiv.)
- C3, C5—6-uF, 25-V electrolytic capacitor (Lafayette 99T6054 or equiv.)
- C4—0.01-uF, 75-V ceramic disc capacitor (Lafayette 33T6905 or equiv.)
- IC1—RCA type CA3020 (see text)
- J1—BNC chassis mounting connector (Lafayette 32T2122 or equiv.)
- R1, R2—5000-ohm potentiometer, audio taper (Lafayette 33T1121 or equiv.)
- R3—510,000-ohm, ½-watt resistor
- R4—0.56-ohm, 2-watt resistor
- S1, S2—Dpdt miniature toggle switch (Lafayette 99T6162 or equiv.)
- Spkr—2½-in., 10-ohm speaker (Lafayette 99T6097 or equiv.)
- T1—Output transformer; 125-ohm CT pri., 8-ohm sec. (Lafayette 33T8571 or equiv.)
- 1—Battery holder for type AA cells (Lafayette 34T5009 or equiv.) (see text)
- 1—Carrying case (Kodak M2/M4 camera case or equiv.)
- 1—3½ x 6½-in. G-10 epoxy glass printed circuit board (cut from Lafayette 19T3704 sheet or equiv.)
- 1—1.3 x 1.9-in. piece perf board (cut from Lafayette 19T3606 or equiv.)
- 1—Heat sink for IC (Wakefield NF-209 or equiv.)

Misc.—Spray paint, sandpaper, bolts, nuts, wire, solder, hand tools, dry transfer letters or decals, push-in terminals, etc.

BI-POLAR POWER PACK

DUO-REG

Build this bipolar, adjustable, regulated power supply to power your IC and other solid-state circuits



by Herb Friedman, W2ZLF

A power source with positive and negative output voltage with reference to a common zero voltage point is required by many integrated circuit (IC) and some discreet component solid-state circuits. Such a supply, where the common zero voltage is centered between the positive and negative output, is called a bi-polar supply.

Commercial bi-polar power supplies aren't cheap. Fact is, they're darned expensive, so the hobbyist usually winds up connecting two batteries, or two power supplies, having the proper voltage output required for the circuit. But by taking a few short cuts, compromising a few features, and settling for a reasonable voltage range, you can build a fully adjustable, variable-voltage, regulated power supply.

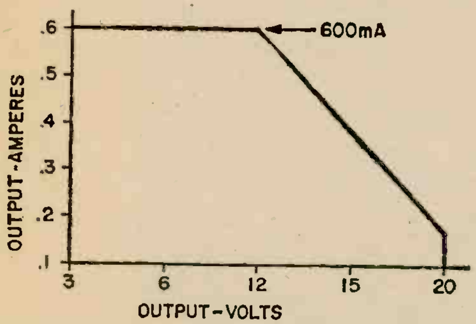
Actually, you customize the package to provide only as much power as your immediate needs require. In fact, the printed-

DUO-REG

circuit board has deliberately been made oversized to permit easy modification.

By changing to power transformers having higher current capacity than those specified for T1 and T2, this supply will be capable of producing up to 600-mA output current at ± 20 volts or ± 40 volts. The output voltage limitation is established by the peak input of the ICs used as regulators (these are specified in the Parts List for IC1 and IC2). If you want to invest about 15-20 dollars more, then purchase the ICs rated at a higher voltage that can handle up to 40 VDC input up to the full current rating of 600 mA. The output curve can be used to determine maximum current for a specific output voltage up to 20 VDC from each section of the bi-polar supply.

How It Works. A study of the schematic reveals that our *Bi-Polar Supply* consists of



Curve shows maximum output current vs voltage for each section of Duo-Reg bi-polar unit.

two almost identical single-voltage power supplies connected to a common zero voltage reference point, which is grounded. The half of the Bi-Polar Supply built around the circuit for IC1 is the basic unit. Except for the trimming potentiometer R7 and the fact that terminal #2 of the IC2 isn't connected to the common ground point, the supply built around IC2's circuit is identical to IC1's.

Let's first explain the function of the trim pot R7. Note that output voltage adjusting potentiometers R1 and R6 are dual, ganged units. Theoretically, when the common shaft is turned, both potentiometers should simultaneously adjust the outputs from both sections to the same voltage for each half. Unfortunately, because of normal R1/R6 tracking errors and variations in ICs and normal variations in resistor values used in the separate circuits, the two halves of the *Bi-Polar* unit may not produce exactly the same output voltage. Trim pot R7 will compensate for the difference in output voltage in the negative supply from that of the positive supply so that equal output voltage can be obtained from both supplies.

Meter M1 is used to measure output voltage of each supply separately and is also used when adjusting the equalization of output voltage. For example, M1 is switched first to the positive supply and a voltage reading is taken and noted. It's then switched to the negative supply's output and trim pot R7 is adjusted until the meter reading of the output voltage is equal to that of the positive supply.

Resistors R3 and R9 limit output current and thereby fully protect the ICs against damage caused by short circuits. Binding posts BP1/BP2 and BP6/BP7 permit the insertion of an ammeter in series with each output to read respective output current of each supply. A jumper must be connected from BP1 to BP2 and another one from BP6 and BP7 when meters are not in the circuits.

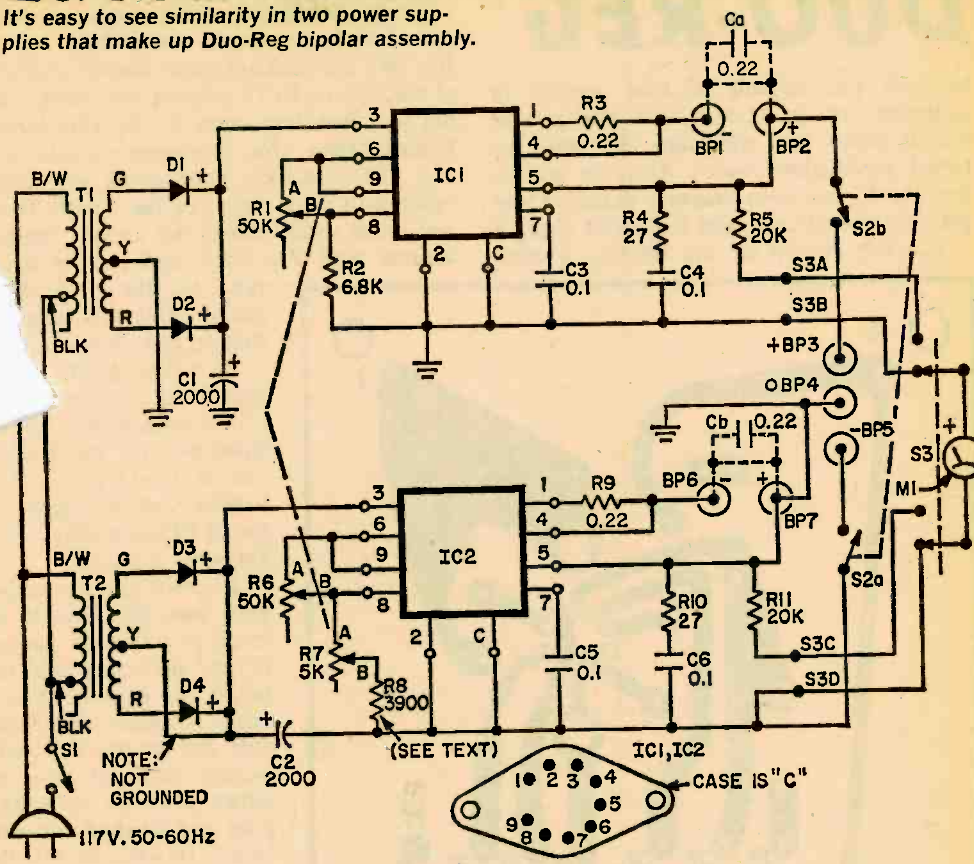
The sensing feedback through the regulator is via terminal #5 of each of the ICs, which automatically compensates for the normal voltage drop across the ammeter's impedance.

Switch S2 disconnects both supplies completely from the load circuits when in *standby* position and connects them when in *output* position.

Building the Dual Supply. In order to keep the cost as low as possible and still be able to use a small cabinet, the power transformers we specified are limited to 100 mA. However, if you have need for or desire the full 600-mA capacity previously mentioned, use the transformers having the higher current rating from the same group of transformers listed in the Allied Radio catalog. (Naturally, you'll need a larger cabinet.) No other circuit changes are required than to make certain that the rectifiers D1 through D4 can deliver 600 mA output.

First step in the construction is to make the printed circuit board. Extra precautions will have to be taken in making the board and later soldering circuit components on it, since the terminals for the ICs are very closely spaced and easily shorted. Remember that the ICs require reasonable care

It's easy to see similarity in two power supplies that make up Duo-Reg bipolar assembly.



PARTS LIST FOR BI-POLAR POWER SUPPLY

BP1 through BP7—5-way binding posts, kit of 10: 5 red, 5 black (Lafayette 99E62333 or equiv.)

C1, C2—2000-µF, 50-VDC electrolytic capacitor (Lafayette 34E58197 or equiv.)

C3, C4, C5, C6—0.1-µF, 75-VDC ceramic disc capacitor (Lafayette 33E69089 or equiv.)

Ca, Cb—0.2- or 0.22-µF, 75-VDC ceramic disc capacitor (Lafayette 33E69097 or equiv.)

D1, D2, D3, D4—750-mA, 50 or higher PIV silicon diode rectifier (Lafayette 19E42028 or equiv.)

IC1, IC2—Integrated circuit voltage regulator, Motorola MC1460R (MC1461R for high voltage—see text)

M1—0-1 mA DC milliammeter, 3½-in. sq. (Allied Radio 52A7209 or equiv.)

R1/R6—50,000-ohm linear taper dual potentiometer (Ohmite CCU-5031 or equiv.)

R2—6800-ohm, ½-watt, 5% carbon resistor

R3, R9—0.22-ohm, ½-watt, 5% carbon resistor

R4, R10—27-ohm, ½-watt, 5% carbon resistor

R5, R11—20,000-ohm, ½-watt, 5% carbon resistor

R7—5000-ohm linear potentiometer (Ohmite CU-5031 or equiv.—see text)

R8—3900-ohm, ½-watt, 5% carbon resistor (see text)

S1—Dpdt miniature toggle switch used as spst (Lafayette 99E61624 or equiv.)

S2—Dpdt miniature toggle switch used as dpst (Lafayette 99E61624 or equiv.)

S3—Dpdt miniature toggle switch (Lafayette 99E61624)

T1, T2—Power transformer: primary 115 V, 50-60 Hz; secondary 10-20-40 V at 100 mA (Allied Radio 54C4732 or equiv.)

1—8 x 6 x 3½-in. grey hammertone finish minibox (Lafayette 12E83936 or equiv.)

Misc.—Hardware, L-brackets, mounting feet, press-on letters (Datak or equiv.), wire, solder, etc.

Note: MC1460R available from Tridac Electronics Corp., Box 153, Malverne, N.Y. 11565 for $6.50 each, plus 75¢ for postage and handling (Canadian orders, $1.00 additional).

DUO-REG

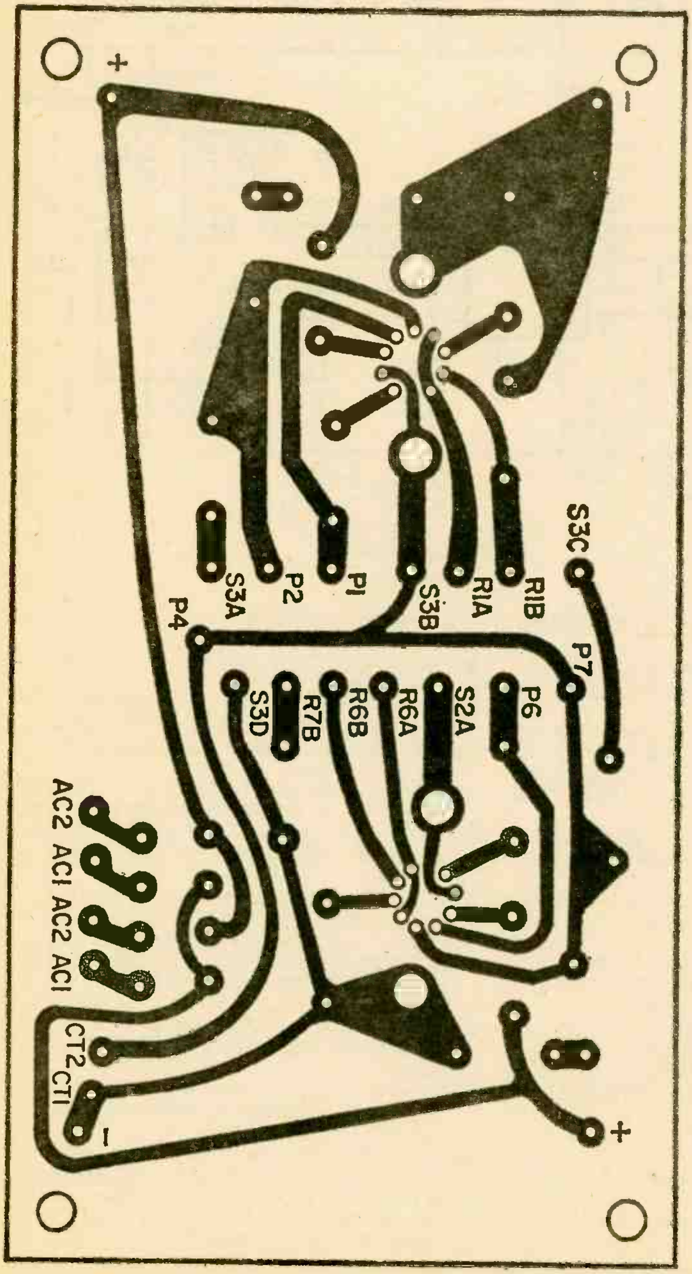
to limit the amount of heat applied in soldering, so be certain that the printed circuit board has maximum clearance between connection points. Also, be certain that the IC has been properly placed. (You get only one chance, and ICs aren't cheap.)

For this reason we are offering a commercially-made printed circuit board that is carefully etched to provide maximum clearance between base pin connections for the ICs. We are making these boards available at our cost of $4.75 prepaid, including mailing and handling costs in the Continental United States (for shipments outside U.S. add 50¢). Include your check or money order with your order for the board. To be sure your order shows the correct mailing address with Zip Code and can be easi[illegible] read by the post off[illegible] please print this info[illegible] tion on your order.

If you're game [illegible] your hand at etchi[illegible] own circuit board[illegible] structions on the[illegible] can be found in [illegible] tember/October [illegible] sue of ELEMENT[illegible] TRONICS, page 3[illegible]

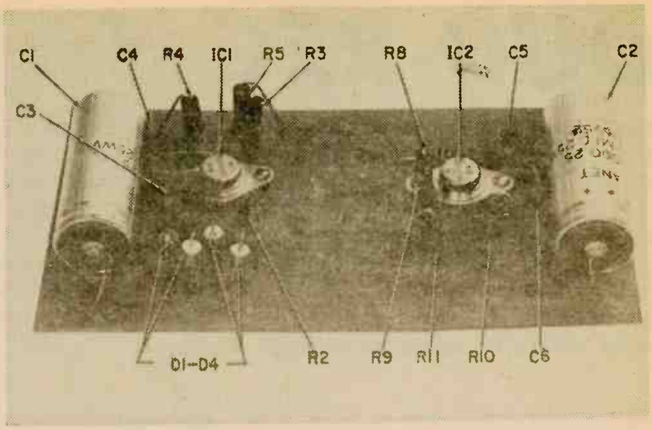
To assist you i[illegible] your own board [illegible] in-clude a full-scale pattern to use in laying out the board for etching. You'll need a piece of circuit with foil on one side only—base material can be either phenolic or epoxy glass and finished size will be 3 7/16 x 6½ in. Whether you buy the commercial board we're making available or you etch your own, you will need a #56 or 57 bit to drill holes to mount the components and a #26 or 27 drill for the four corner mounting holes for the ICs. Be very careful in drilling the holes to avoid damaging the foils left on the board after the etching.

Should you pull a foil loose from the board in



Full-scale pattern to be used if you decide to make your own printed circuit board. It's much easier of course to order the commercial one we are offering, but if you are a die hard we refer you to previous instructions in earlier issue.

Photo of printed-circuit board clearly shows dual complement for two separate supplies that make up complete Duo-Reg assembly. Interconnection leads terminate in center rows of holes in circuit board to facilitate hookup.



drilling, particularly around the base pin holes for the IC, in all probability you can still get by if you carefully flow solder from the IC's pin to the damaged foil. Use #4 screws to secure the ICs to the board even though you have drilled clearance holes for #6 screws. By using the smaller screws you'll have a little freedom to move the IC around to compensate for slight variations between the holes in the board and the pins on the ICs.

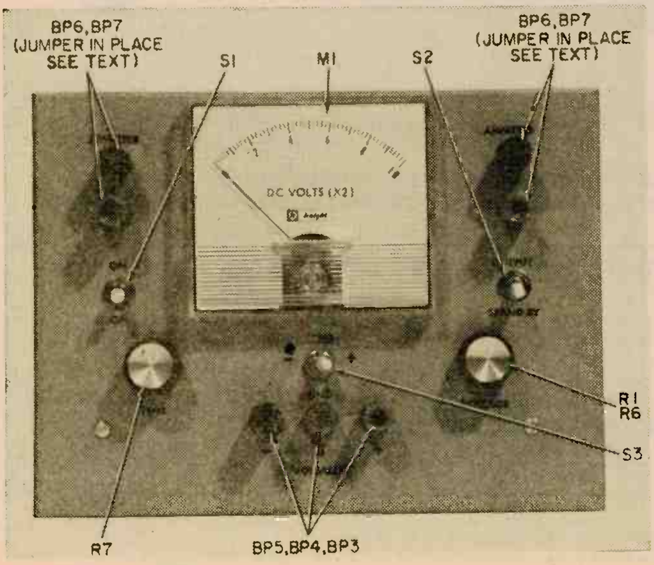
Don't force the ICs into the holes. If necessary, bend the pins with long-nosed pliers to line up with the holes. Should you still have trouble in positioning the IC, try making the base pin holes just a little larger, again taking care not to damage the foil.

When soldering components, use a lightweight low-wattage iron, not over 20 to 30 watts. Before soldering be sure you have diodes and electrolytic capacitors properly polarized.

Binding posts; meter M1; switches S1, S2, S3; and transformers T1 and T2 are mounted in one half the 8 x 6 x 3½-in. minibox. Drill and deburr all holes before mounting. The layout of parts is clearly shown in the photos. Though the circuit isn't critical as to layout, we suggest you follow our layout since it's been designed for easy construction and compact size.

The printed circuit board is held in place within the minibox by L-brackets fastened to the front panel. It should be mounted so that there is ample clearance between the bottom of the minibox and the circuit board to avoid possible shorts.

Transformer connections are critical, so doublecheck them for each transformer before soldering. Cut the transformer leads that aren't used as close as possible to the transformer and make certain that there are no strands (whiskers) that can short to the cabinet. The color codes for the various windings are the same as shown in the schematic for any size of transformer in this particular series of Allied's transformers. Therefore, it doesn't make any difference



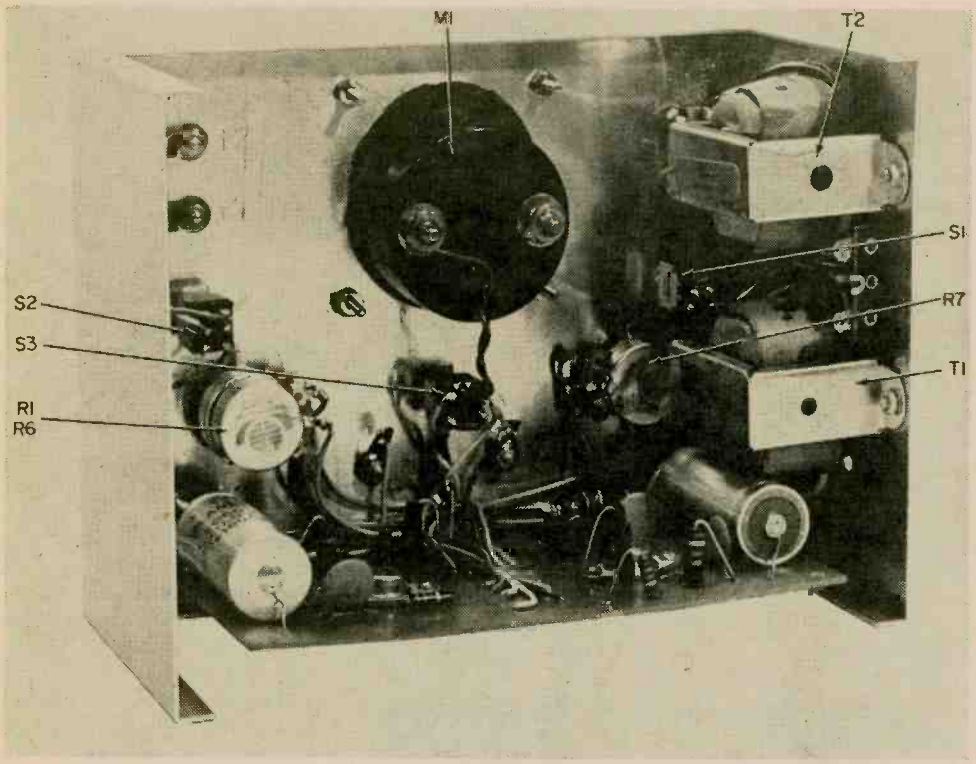
Here's how your Duo-Reg should look when you've finished project. All controls are front-panel mounted as are terminals for output voltages as well as terminals for adjusting voltage outputs. Switches check each output and apply load to supply.

whether you use the one limited to 100 mA or the higher capacity ones—the color coding will be the same.

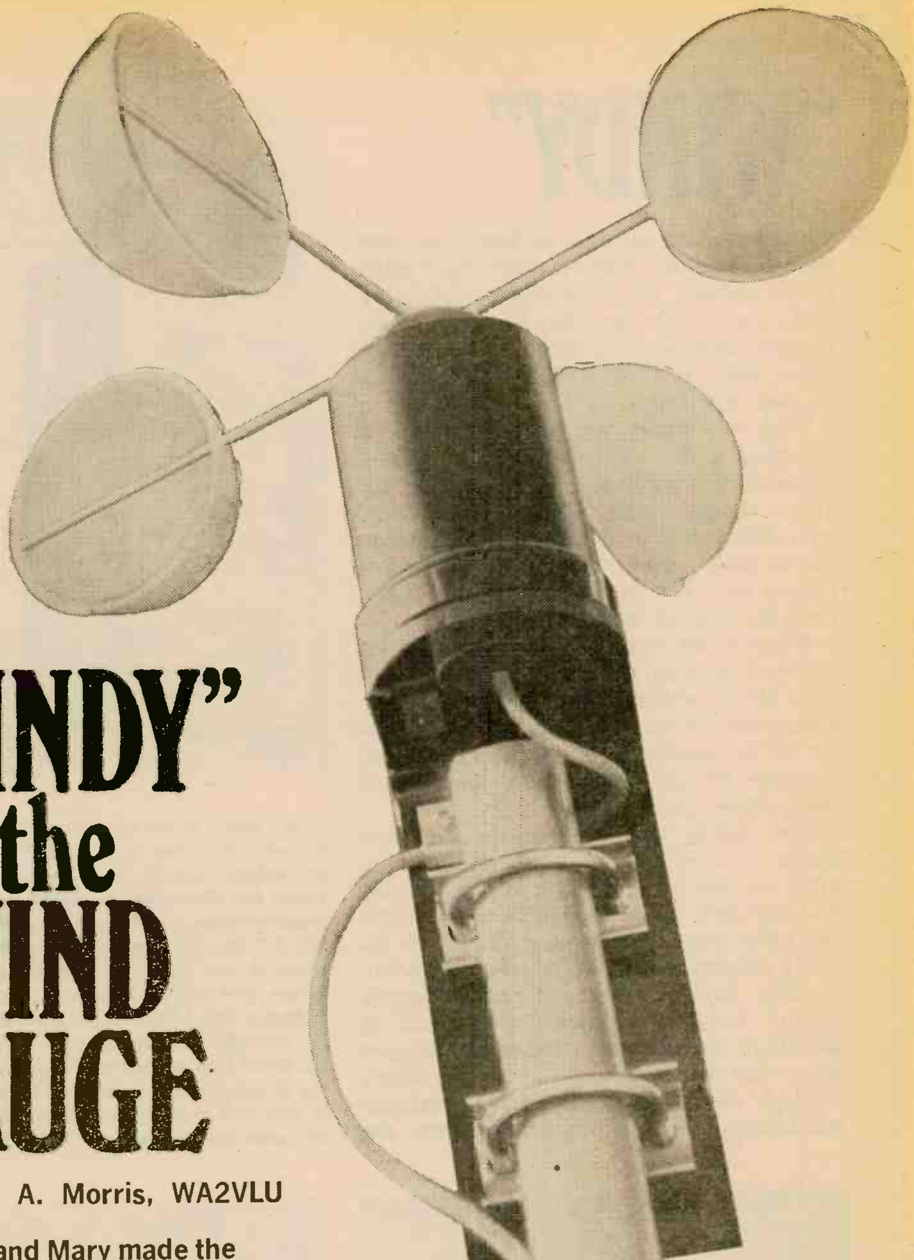
If by chance you use a transformer other than these specified in the Parts List, be sure that the AC secondary voltage it supplies to the rectifier will not produce more than 22 VDC out of the rectifier when using lower voltage IC regulators specified. If you build your supply using the higher voltage ICs, then the maximum output voltage from the rectifier should not exceed 40 VDC.

Keep the secondary leads from each transformer separated. Connect red and green leads from one to connections on circuit board marked AC1 and the center tap of this transformer's secondary winding to CT1. The corresponding leads from the second transformer should be connected on the circuit board to AC2 and CT2 respectively. Primary leads from both transformers

(Continued on page 113)



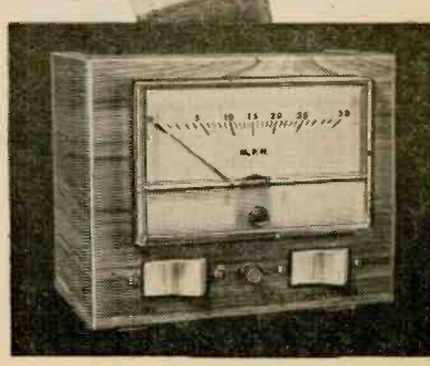
This interior view of Duo-Reg should help you to lay out your own project. When mounting printed-circuit board, be sure to leave clearance to prevent shorting to case when it's closed.



"WINDY" the WIND GAUGE

by Edward A. Morris, WA2VLU

Peter, Paul and Mary made the tune "Blowing in the Wind" popular. But if you hope to find out just how fast the winds are a-blowing, the song's lyric won't help much. You'll need an anemometer. Until now, if you'd had a need for an anemometer (wind gauge) or wanted one just because you were interested in keeping tabs on the prevailing winds,



"WINDY"

you'd have had but two choices. Toy ones, though the price may be right, leave much to be desired in performance, reliability, and accuracy. On the other hand, the better-quality instruments, available from specialty stores, start at about $125.00 and increase in cost very fast.

With our Windy you bridge the gap. Its accuracy is 5% or better, and its cost is reasonable, being in the $30.00 range. Dual meter ranges cover 0-30 mph and 0-90 mph. Readout is indicated on a large, clear, easy-to-read meter scale. And its remote pickup head can be located up to 150 feet from the readout indicator.

Windy's low cost and high accuracy are achieved through use of two integrated circuits (ICs), which together replace 12 transistors and 24 resistors. A novel optical sensor in the remote pickup head speeds construction by replacing a more complicated mechanical design.

How Windy Works. Whenever the wind blows, it revolves the windcups. The remote pickup head, built into the housing that supports the windcups, is a photoelectric pulse generator whose pulse rate is directly proportional to the speed of the wind. A disc, having holes punched uniformly around its edge, is fastened to the end of the shaft opposite the windcups. Mounted above this disc is a light source that shines through the perforations into a variable-resistance photocell positioned below the

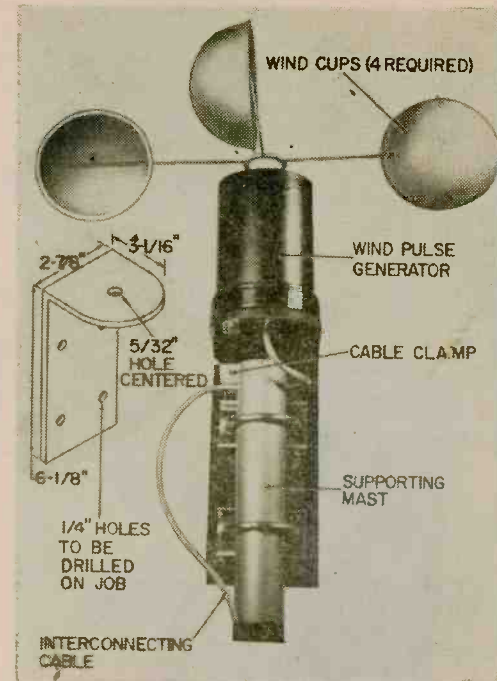
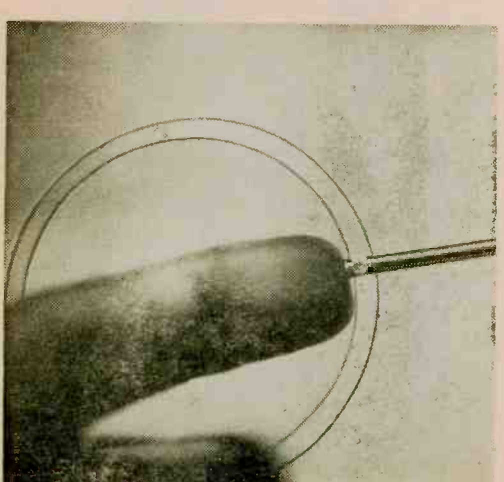
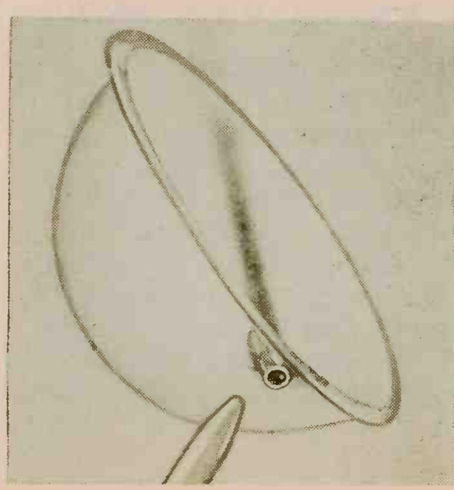
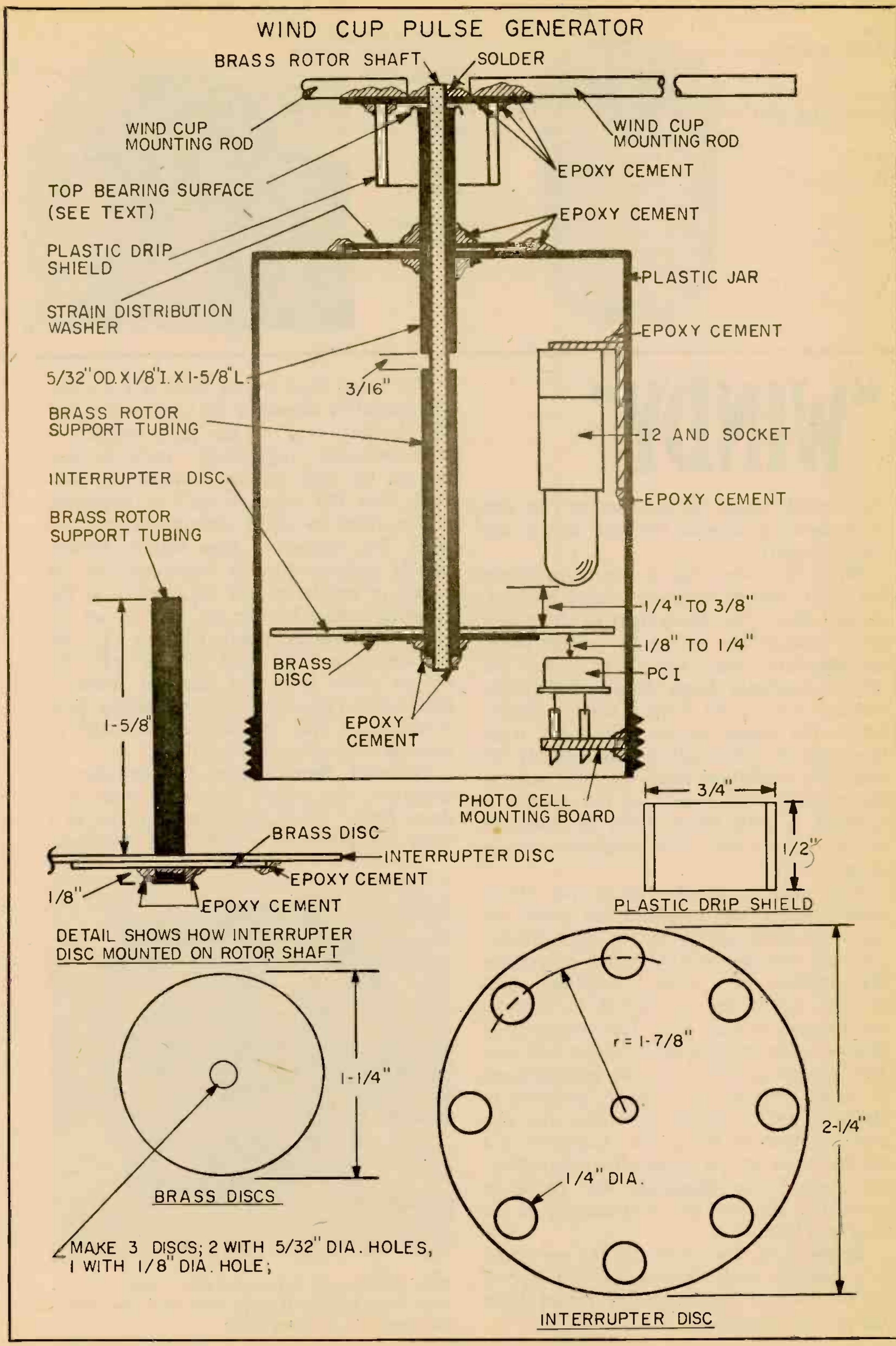
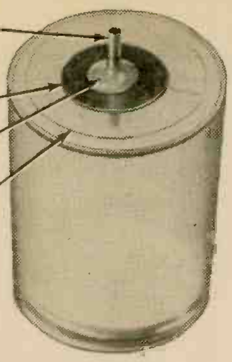


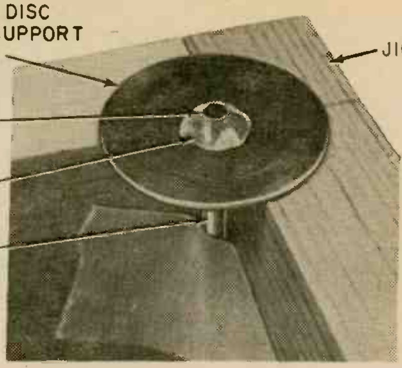
Photo above shows how Wind Cup generator is fastened to its mounting mast. Also, details on making the mounting bracket are shown. Photo below left illustrates how finger is used as a mandrel when punching holes in the polystyrene Wind Cups with a tool made by sharpening a piece of ⅛-in brass tubing. In the photo below right pointer shows where epoxy is placed to fasten Wind Cups to brass mounting rods. On the opposite page are construction details for the Wind Cup generator. Though not shown in the drawing, leads from lamp I2 must be tacked to side wall of jar to keep them away from the rotor disc, to prevent disc binding.






WIND CUP PULSE GENERATOR
BRASS ROTOR SHAFT
SOLDER
WIND CUP MOUNTING ROD
WIND CUP MOUNTING ROD
EPOXY CEMENT
TOP BEARING SURFACE (SEE TEXT)
EPOXY CEMENT
PLASTIC DRIP SHIELD
PLASTIC JAR
STRAIN DISTRIBUTION WASHER
EPOXY CEMENT
5/32" OD. X 1/8" I. X 1-5/8" L.
3/16"
BRASS ROTOR SUPPORT TUBING
I2 AND SOCKET
INTERRUPTER DISC
EPOXY CEMENT
BRASS ROTOR SUPPORT TUBING
1/4" TO 3/8"
1/8" TO 1/4"
BRASS DISC
PC1
1-5/8"
EPOXY CEMENT
PHOTO CELL MOUNTING BOARD
3/4"
BRASS DISC
INTERRUPTER DISC
1/2"
EPOXY CEMENT
1/8"
EPOXY CEMENT
PLASTIC DRIP SHIELD
DETAIL SHOWS HOW INTERRUPTER DISC MOUNTED ON ROTOR SHAFT
r = 1-7/8"
1-1/4"
2-1/4"
1/4" DIA.
BRASS DISCS
MAKE 3 DISCS; 2 WITH 5/32" DIA. HOLES, 1 WITH 1/8" DIA. HOLE;
INTERRUPTER DISC





"WINDY"

disc directly under the light source (the disc is sandwiched between the light source and the photocell).

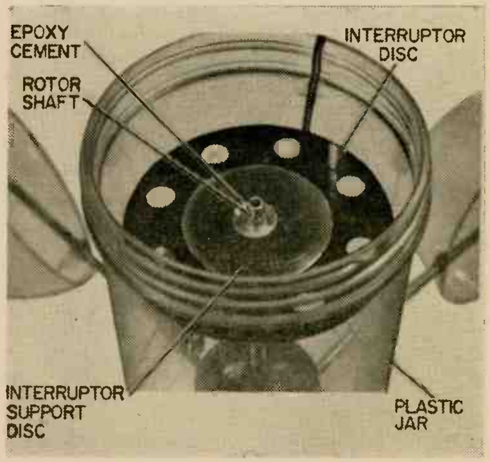
When the wind blows, the cups rotate the shaft, which, in turn, rotates the perforated disc. This allows light to alternately shine through to, and to be cut off from, the photocell. Each time light strikes the cell, its resistance drops sharply. The photocell and resistor R3 form a voltage divider across the power source. When the resistance of the photocell is momentarily reduced by excitation from the light source, the voltage in that part of the divider is reduced. A pulse results from the sharp increase in current and resultant voltage drop.

This pulse triggers the hex inverter (IC1) which shapes and amplifies the pulse signals appearing across the voltage divider. The first inverter of IC1, biased by resistor R4, operates as a class-A amplifier. Succeeding stages are connected in cascade and operate with no bias. This considerably improves the input pulse rise and fall time that is necessary for accurate performance. A small amount of positive feedback in stages 4 and 5 further improves the rise and fall time of the pulses. Capacitor C3 on the input acts as a high-frequency filter, eliminating false triggering that could be created by spurious signals picked up in the long lead line.

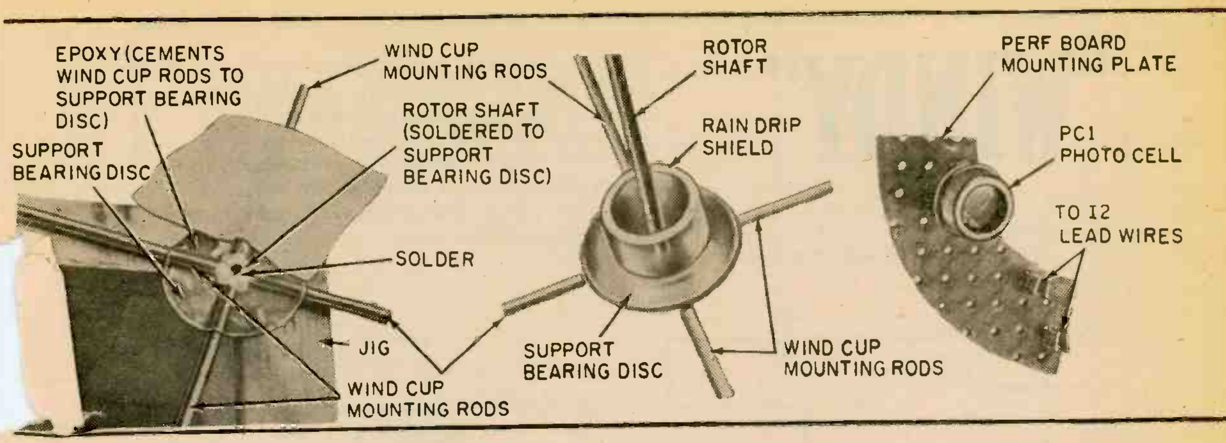
Stages 3, 4, and 5 of the IC are wired as a one-shot multivibrator that is triggered by the shaped and amplified pulses from the previous stages.

The sharp input pulses from IC1 are differentiated by capacitor C6 and resistor R5. The leading edge of the pulse triggers a constant-width, monostable multivibrator, formed by three of the inverters in IC2. Each time the one-shot multi is triggered, it flips from its stable state to an unstable state. The amount of time that it remains in this unstable state is determined by the values of resistance and capacitance in the coupling network. The *on* time is set by range selection capacitors C7 and C8, calibration control R6, and resistor R7. The output pulse from the one-shot multi is buffered and inverted by the remaining three inverters in IC2, which are connected in cascade (see schematic for ICs).

Protected Meter. When the one-shot is triggered, the output at pin 7 from IC2 drops from 3.6 V, the supply voltage, to a mere few tenths of a volt. This effectively



After installing I2, interrupter disc is held ⅛-in. from bottom of rotor shaft and cemented with epoxy to the rotor shaft.



gro_>ds the end of resistor R8 connected to the IC, and a pulse of current flows through meter M1. As the wind picks up speed, the one-shot is triggered more often, directly in proportion to the wind speed. The pulse rate increases, and meter M1 and capacitor C9 integrate the output pulses into a wind speed reading. Should the voltage across the meter exceed 0.6 volt, diode D6 conducts, shunting current around the meter and protecting it from overload.

A Zener-diode regulated power supply provides + 3.6 VDC power for the instrument. Output from the secondary of transformer T1 is rectified by a fullwave bridge rectifier comprised of diodes D1 through D4. Capacitor C1 brute-force filters the rectified output; Zener diode D6 holds the voltage on the base of transistor Q1 at 4.2 V. Since transistor Q1 is connected as an emitter follower, the filtered DC output appears on Q1's emitter. Low-voltage AC power to operate exciter lamp I2 is provided by the 6.3-V secondary winding of the power transformer.

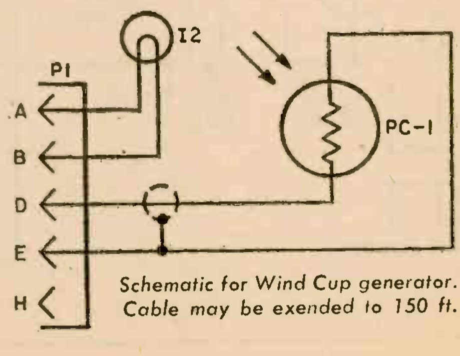
Construction Tips. Prior to starting the actual fabrication of the various units comprising Windy, we suggest you study our photos and illustrations to familiarize yourself with the basic units, how they were constructed, and their relationship to one another. Take into account the dimensions shown in relation to materials you have readily available. It may be necessary for you to compromise somewhat in order to use available sources.

Epoxy cement contributes a great deal to the building of Windy. In order to receive the most benefits from epoxy cements, the resin and the hardener must be thoroughly mixed as quickly as possible. Try to use the new 5-minute curing epoxies; they'll speed up the waiting time.

The remote pickup head, which actually

PARTS LIST FOR WINDY'S PULSE GENERATOR

- I2 #755 single contact, miniature boyonet base, 6.3 V-0.15 A lamp bulb (Lafayette 32E69032 or equiv.)
- P1 5-pin plug with hood and cable clamp (Amphenol 126-217 or equiv.)
- PC1 Photocell, Clairex C L-703L
- 1 Miniature bayonet base, pilot lamp holder (Lafayette 37E28079 or equiv.)
- 1 2⅝ x 3½-in. plastic jar with screw-on cover
- 1 2⅞ x 9³⁄₁₆ x ¼-in. plexiglas for mounting bracket (see text)
- 1 ¾-in. OD, ⅝-in. ID x ½-in. long plastic tubing for rain drip shield
- 4 3-in. dia. light plastic half-hemispheres
- 4 Pieces ⅛-in. OD x 6-in. long brass tubing
- 1 Piece ⁵⁄₃₂-in. OD, ⅛-in. ID x 1½-in. long brass tubing
- 1 Piece ⁵⁄₃₂-in. OD, ⅛-in. ID x 1¾-in. long brass tubing
- 3 ¹⁄₃₂-in. thick, half-hard brass discs, 1¼-in. OD (if discs not available cut from sheet brass)
- 1 Bakelite disc ¹⁄₃₂-in. thick x 2¼-in. dia.
- 1 2 x 1-in. piece perfboard
- Misc. Length os required (not to exceed 150 ft.) Belden #8734 3-conductor cable with vinyl insulation and overall vinyl jacket (one conductor shielded), black spray paint, antenna mast mounting hardwore (Lafayette 18E01950 or equiv.)



Schematic for Wind Cup generator. Cable may be exended to 150 ft.

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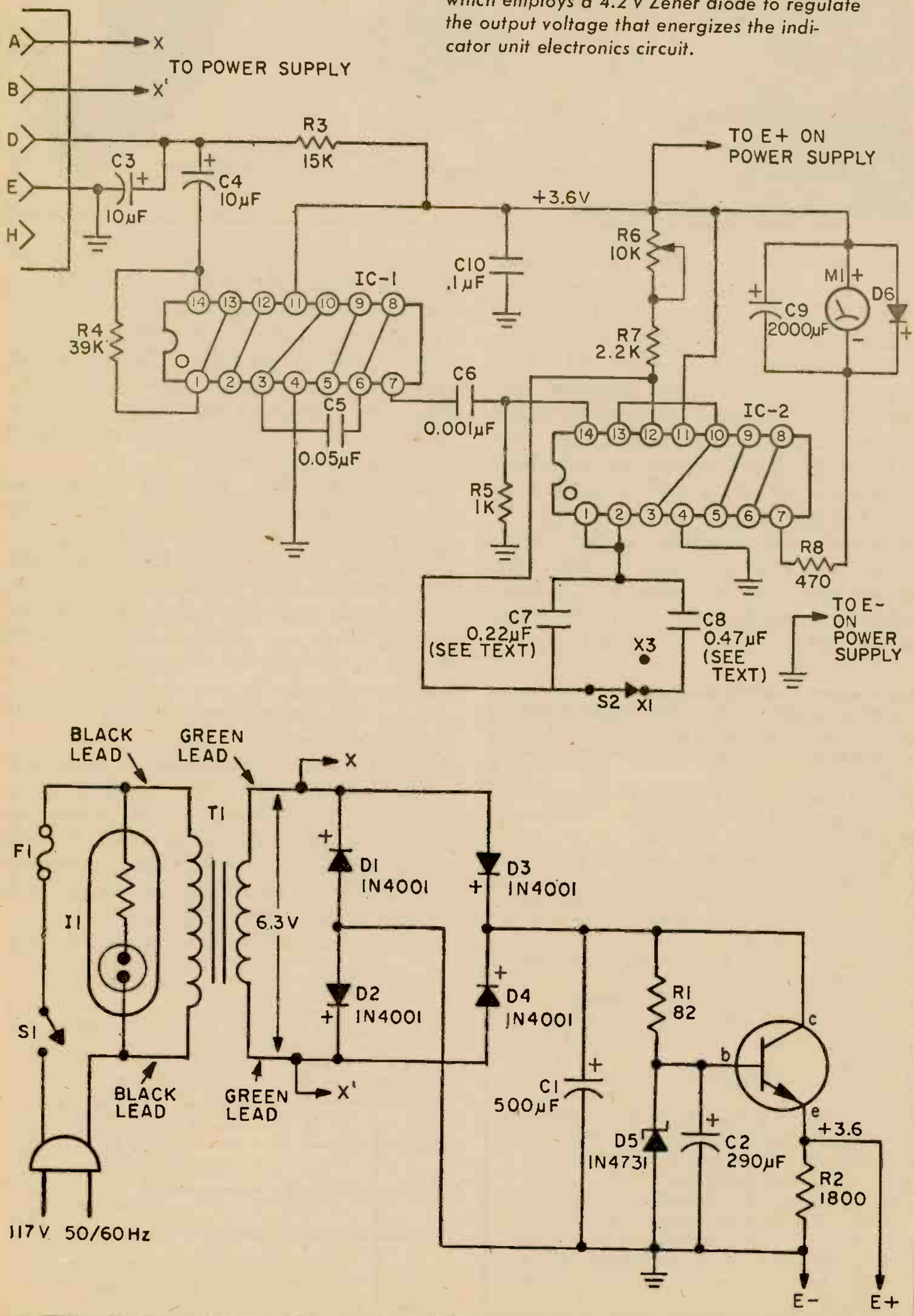
The schematic at the top details the circuit for the indicator unit of Windy, except for its power supply. The diagram shows proper orientation for the IC's, looking down on them. The lower diagram details the power supply, which employs a 4.2 v Zener diode to regulate the output voltage that energizes the indicator unit electronics circuit.



is a windcup pulse generator, is housed in a small plastic jar, preferably one with a screw-type cover. To ensure that no extraneous light reaches the photocell, we recommend that you spray the jar and its cover with several coats of flat black paint to completely opaque it. (We purposely did our painting after completion of construction in order that details in construction would show-up better in our photos.)

Drill a 5/32-in. hole in the lid of the jar to permit the lead cable to exit from the jar. Also drill the same size hole in the exact center of the bottom of the jar.

You'll need three discs made from 1/32-in. thick half-hard brass. The outside diameter of the discs is 1¼-in. Two should have a 5/32-in. hole drilled at the exact center; the remaining one should have a ⅛-in. diameter hole drilled in its center. One of the discs with a 5/32-in. hole serves as a strain distribution washer. The center holes in the strain washer and the bottom of the cup must be aligned to permit bearing support tubing to pass through both easily for free shaft rotation.

Prepare the bearing support tubing, made from a 1⅝-in. length of 5/32-in. OD, ⅛-in. ID brass tubing for mounting in the base of the cup. It's important that the inner and outer surface of one end of this piece of tubing be as smooth as possible, since these surfaces are top bearing surfaces. The tubing should be chucked in a slow-speed drill (400-600 rpm) and smoothed both on inner and outer surfaces with a fine needle file. Bring the file against the rotating tubing to create a smoothed radius on one end.

We cannot emphasize too strongly the importance of a smooth surface for the bearing support tubing. Rough spots at this point can create future trouble either by slowing down the rotor because whatever produced the rough spot gouged the surface of the support bearing disc or, perhaps, when the atmosphere is quite humid and the temperature drops suddenly, the moisture trapped between the gouge in the disc and the bearing support tubing freezes and stops the rotor completely.

Cement this bearing support tubing in position to the bottom of the plastic jar with a blob of epoxy spread uniformly around the tubing both inside and outside the plastic jar to give added support to the bearing. The end of the tubing with the smoothed

PARTS LIST FOR WINDY'S INDICATOR

C1 500-uF, 15-VDC electrolytic capacitor (Sprague TVA1162 or equiv.)
C2 290-uF, 12-VDC electrolytic capacitor Sprague TE1139 or equiv.)
C3, C4 10-uF, 15-VDC electrolytic capacitor (Sprague TE1155 or equiv.)
C5 0.05-uF, 12-VDC ceramic (Erie 5635-000 Y5FD-503M or equiv.)
C6 0.001-uF, 100-VDC ceramic capacitor (Erie 801-000X5FD102K or equiv.)
C7 0.22-uF, 12-VDC ceramic capacitor (Erie 5615-000Y5FD224M or equiv.)
C8 0.47-uF, 200-VDC capacitor (Aerovox V1462-134 or equiv.)
C9 2000-uF, 25-VDC electrolytic capacitor (Cornell Dubilier BR2000-25 or equiv.)
C10 0.1 uF, 12VDC ceramic capacitor (Erie 5655-000-Y5F0-104M)
D1, D2, D3, D4 1N40001 silicon diode, 50 PIV, 1 A
D5 1N4731 Zener diode, 4.2 volt, 1 watt, 10% tolerance
F1 Fuse, type 3AG, ¼ A
I1 Neon pilot lamp assembly, amber lens caps (Lafayette 34E52174 or equiv.)
IC1, IC2 Intergrated circuit, hex inverter (Motorola MC789P)
J1 5-pin chassis socket (Amphenol 126-218 or equiv.)
M1 0-1 mA meter (3 x 4½-in.) 100 ohms or less coil resistance (see text)
Q1 Npn silicon transistor, type 2N697
R1 82-ohm, ½-watt resistor
R2 1800-ohm, ½-watt resistor
R3 15,000-ohm, ½-watt resistor
R4 39,000-ohm, ½-watt resistor
R5 1000-ohm, ½-watt resistor
R6 10,000-ohm, PC board mounted miniature potentiometer (Mallory MTC1L41 or equiv.)
R7 2200-ohm, ½-watt resistor
R8 470-ohm, ½-watt resistor
S1, S2 Spst rocker type switch (Cutler Hammer 8144K21A1M52 or equiv.)
T1 Low voltage power transformer; primary 117 V, 50/60 Hz, secondary 6.3 VAC at 0.6 A (Stancor D6465 or equiv.)
1 Aluminum minibox 4 x 5 x 6-in. (Lafayette 12E83746 or equiv.—see text)
1 Dual fuse holder, 1 active, 1 spare (Lafayette 99E63372)
1 Piece perfboard (0.2 holes on 0.1-in. grid pattern) Lafayette 19E83584 or equiv.)
1 Heat sink for Q1 (Wakefield NF-209)
2 Sockets for ICs (Lafayette 47A2152 or equiv.—optional, see text)
Misc. Transfer letters (Datak or equiv.), bolts, nuts, hardware, push-in terminals and eyelets, pressure sensitive vinyl finishing material (Contac or equiv.), 5-minute curing epoxy, RTV Silicone Seal, rubber feet, AC line cord, wire, solder, etc.

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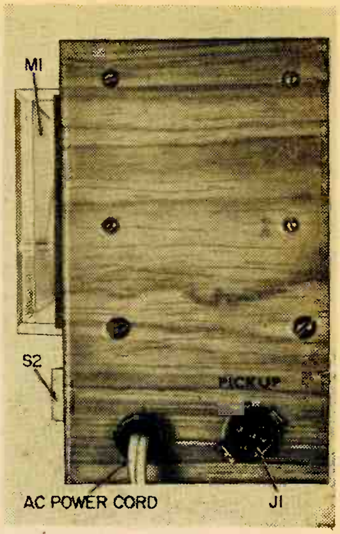
radius should protrude ⅝-in. beyond the strain distribution washer.

The Interrupter Disc. This disc is made from thin, rigid plastic sheet. If not opaque, spray it with flat black paint after cutting to size and punching holes in it. Punch eight ¼-in. diameter holes, in the disc, spaced uniformly around the circumference on a radius of 1⅞-in. Also drill a 5/32-in. hole in the exact center of the disc.

At this point make a jig from two pieces of wood, at least ¾-in. thick by 3½-in. wide, fastened at right angles. This jig is used to assure proper alignment of the interrupter disc on its bearing disc to the rotor shaft.

Insert a 1¾-in. long x 5/32-in. OD, ⅛-in. ID piece of brass tubing into the center hole of the plastic disc so that it protrudes ⅛-in. beyond the outer surface of the interrupter disc. Temporarily fasten the tubing with masking tape to the jig as shown in our photo. Next, epoxy one of the brass discs to the interrupter disc and cement both the perforated plastic interrupter and brass discs to the brass support tubing, spreading the epoxy uniformly around the tubing.

Rotor Shaft. A good time to prepare the rotor shaft is while the epoxy cement for the interrupter disc assembly is curing. It is made from a 3 9/16-in. length of brass tubing ⅛-in. OD. Check it for trueness and fit in the bearing support tubing previously epoxied in the plastic jar. The rotor must fit inside the bearing tubing snugly, but must still rotate freely in it.



Right side of Indicator unit shows location of J1, exit hole for power cord and mounting screws for T1 and fuse mounting board.

Four lengths of brass tubing ⅛-in. OD by 6-in. long serve as support arms for the four wind cups. These arms are epoxy cemented to the top of the bearing support disc at right angles to one another. One end of each of the rods should be 5/16-in. from the center line of the rotor shaft to leave a clear area so that rotor shaft can be soldered to the disc. For balance it's important that the arms are each separated by 90°. You should use a protractor to double-check this placement.

As soon as epoxy on the interrupter disc assembly has cured, the jig can be freed for proper alignment of the rotor when fastening the rotor shaft to the brass support bearing disc. Solder the brass rotor shaft to the brass disc, employing the jig to ensure ac-

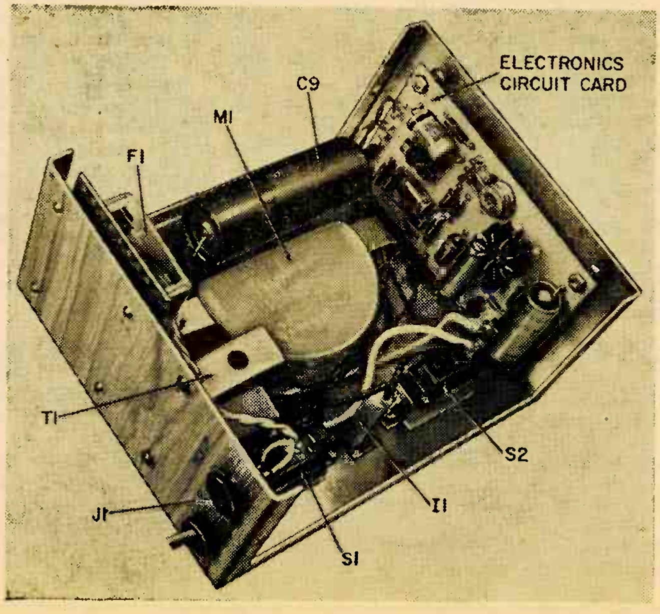
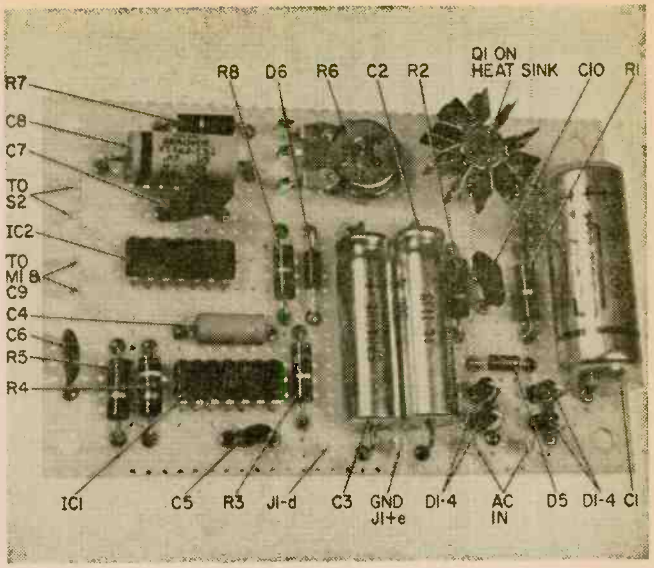


Photo shows the neat layout for the electronic components making up the Indicator unit. The power supply is located on the right (except for diodes and capacitors), the electronics card is on the left side and meter and controls on front.

The electronics circuit card is detailed here. Although the photo shows both C2 and C3 the same size, the author recommends C3 a 10 uF, 15v electrolytic.



curate alignment. Be careful not to bend wind cup mounting rods.

The rotor-shaft assembly and the interrupter-disc assembly are now ready to be mounted in the plastic jar. But first, a lamp holder, to which a pair of leads has been soldered, must be epoxied inside the plastic jar as shown in our illustration. At this stage you should also prepare a mounting board on which the photocell and terminals for the cable between the wind generator and the indicator are installed. The lead wires from the photocell and to the exciter lamp are contained in this cable.

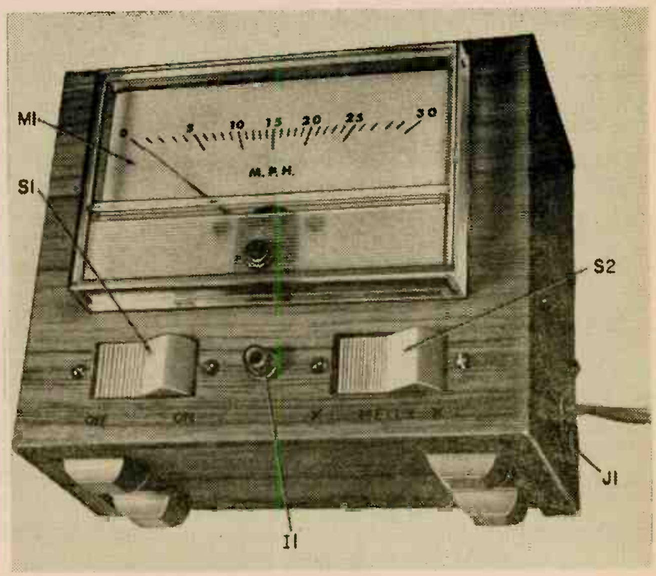
Make the photocell terminal mounting board from a piece of perfboard cut into a truncated pie section having an outside radius of 1¼-in. and an inside radius of ¾-in. Overall length of the board should be 1½-in. and it should be ½-in. wide. The photocell is mounted on push-in terminals. Terminal points between the lamp and photocell leads and the lead cable to the indicator are also push-in terminals.

Cement a rain shield, which is a ½-in. length of plastic tubing having a ⅜-in. OD x ⅝-in. ID, to the bottom of the brass-support bearing disc. It should be positioned concentric to the disc, as shown in photo.

Assembly of Pulse Generator. Before final assembly it's best to insert the lamp in its socket and test it to be sure it's working. Once the assembly has been completed it will be difficult to reach the bulb. For this reason we've specified the 50,000-hour long life bulb instead of an electrically interchangeable #47 pilot lamp, which doesn't claim anywhere near that length of life before burnout.

At this stage opaque the housing with dark spray paint if your plastic jar requires it.

Silicone grease, the type used in heat-sinking power transistors, will prevent



Note the clean long scale of the meter used to make it easy to read calibrations. Also note rubber feet on bottom (not mentioned in Parts List). Rocker type switches used for ranging and on/off control are easy to operate.

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freeze-up when the temperature drops and will also provide lubrication to allow the rotor to turn with little resistance. Place a pea-sized dab on the bearing surface of the support bearing disc. This lubricant should be applied each year before the start of cold weather.

Final Assembly. Insert the rotor assembly into the support bearing tube in generator housing. Now invert the housing and slip the interrupter disc assembly, with its support tubing, over the rotor so that the end of the support tube rides ⅛-in. below the end of the rotor shaft. Use a single drop of epoxy to cement the support tube to the rotor shaft. If you located the lamp socket correctly within the generator housing, the lamp bulb should clear the interrupter disc by ¼- to ⅜-in. when the housing is positioned so that the interrupter disc faces down. In this position you should note about 3/16-in. up-and-down play in the rotor shaft.

With the photocell mounted in position (see illustration) on its circuit board, cement this assembly inside the generator housing directly below the lamp so that the space between the bottom of the housing and the circuit board is 3/16-in. The lead cable will be connected and the cover of the jar fastened in position after the wind cups have been epoxied in position. The reason for this is that the jar can rest on the bench during this assembly if the wire is not in position at this time.

Wind Cups. We made our wind cups from thin, styrene plastic, half spheres, 3 in. in diameter. You may use smaller ones, but no smaller than 2½-in. in diameter. Regardless of the diameter of the wind cups, the center-to-center spacing should not be changed, since this would affect overall calibration of the instrument.

Make a punch by sharpening one end of a scrap of ⅛-in. diameter brass tubing, for punching the holes in the plastic hemispheres, as shown in our photo. The cups should be epoxied to their respective lengths of ⅛-in. OD tubing, positioned as shown in the photos.

Mounting Bracket. The mounting bracket for the completed wind cup pulse generator unit can be made from plastic (which we used), or from metal (iron or aluminum), or from wood.

If you use plastic, make the 90° bend by gently heating the plastic with a small butane torch, being careful not to touch it with the flame. When the plastic softens and becomes pliable, form it over a right-angled block. Keep the material in position over the block until it has cooled down, at which time it will be rigid. If wood is used the bracket is formed by nailing two pieces of wood together at right angles in the shape of the bracket shown in our photos. Metal is formed either in a brake or a bench vise.

Epoxy cement the plastic jar cap to the bracket so that the jar containing the pulse generator and wind cups can be screwed into the jar cap, thus holding it in position. Drill a hole in the bracket to permit the lead wires from the generator assembly to feed out of the jar.

Now The Indicator. The major mechanical construction is complete now and the only remaining assembly work is the indicator unit, which contains the electronics.

We started by trimming a standard 6 x 5 x 4-in. minibox to a 6 x 5 x 3-in. dimension. Since we used aluminum it was easy to pare 1 in. off the depth.

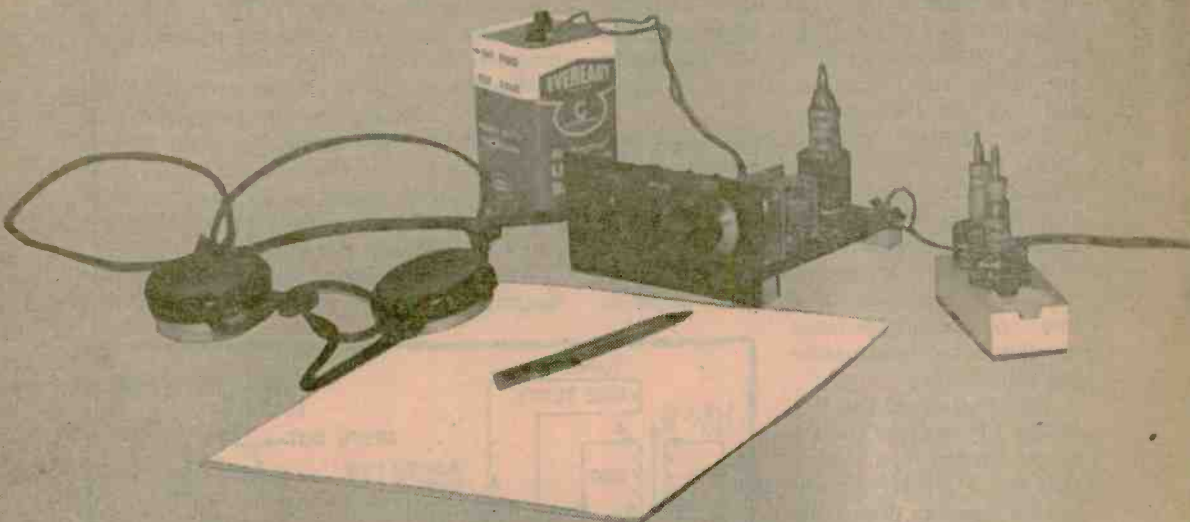
First step is to cut out the large round hole for the meter, and the rectangular holes for the rocker switches, and drill the hole for the pilot lamp, all on the front panel of the major half of the minibox. Also drill mounting holes for the power transformer, fuse holder, input jack, and AC cord on the right-hand side of the box and mounting holes for the circuit board on the left side.

To cut the meter hole and the rectangular switch holes, use a hand nibbler, or, if one isn't available, drill a series of small holes very close together around the peripheral of the main holes. Then knock out the large pieces of metal and file the edges smooth to the exact sizes and shapes required. Deburr all holes before assembly. We used a rectangular 0-1 mA meter we happened to have in the spare-parts box. However, any 0-1 mA having a coil resistance of 100 ohms or less will work. Be sure you have enough room in the cabinet for the size meter you use.

Mount the fuse holder on a 2 x 2½-in. piece of perfboard. The mounting screws for this board should be 4-40s at least ½-in. long so that the board can be held away

(Continued on page 108)

All-Solid-state IC LOW BANDER



Dip all the way down to a low, low 80 kHz with a regen receiver that's as mod as its IC innards!

by Charles Green W6FFQ

FROM the earliest days of radio the long wave band of the spectrum has been used for weather forecasts, naval and commercial CW communications, and aircraft beacons. Since many CW transmissions in the LF band are hand-keyed, listening to them is an ideal way to improve your ability to copy CW. SWLs can find a new interest in logging aircraft beacons and other LF stations.

Our easy-to-build, integrated circuit (IC), low frequency (LF), regen receiver tunes from 80 kHz to 420 kHz covering the most active portion of the long-wave band. Two plug-in coils cover the span of LF frequencies; a third plug-in coil covers the standard BCB to provide a dual-purpose receiver.

The output of this all-solid-state receiver is of sufficient level to drive either high- or low-impedance headphones or a small speaker. Construction has been simplified and the 6-volt lantern-type battery provides power for a long period of operating time before requiring replacement.

How It Works. Signals gathered by the antenna are fed to the receiver via input jack J1 to the primary winding of L1, the plug-in coil. The secondary of this coil is tuned by C2 and coupled to the input of one half of IC1 via C3. The signal is detected and fed to the input on the second half of IC1 via C6. Regeneration is effected through the tickler winding via C4 by feeding a portion of the signal being amplified in the first half of IC1, taken off at interstage pin 4. Potentiometer R1 is shunted across the tickler and limits the amount of signal fed back into the tickler.

The resulting signals from the first half of the IC are coupled as audio signals to the second half of the IC via C6 and gain control R3, where they are amplified further to drive output power transistor Q1. Output of Q1, which is a low-impedance transistor, will match speakers of 8 to 45 ohms or low- or high-impedance headphones without matching transformer.

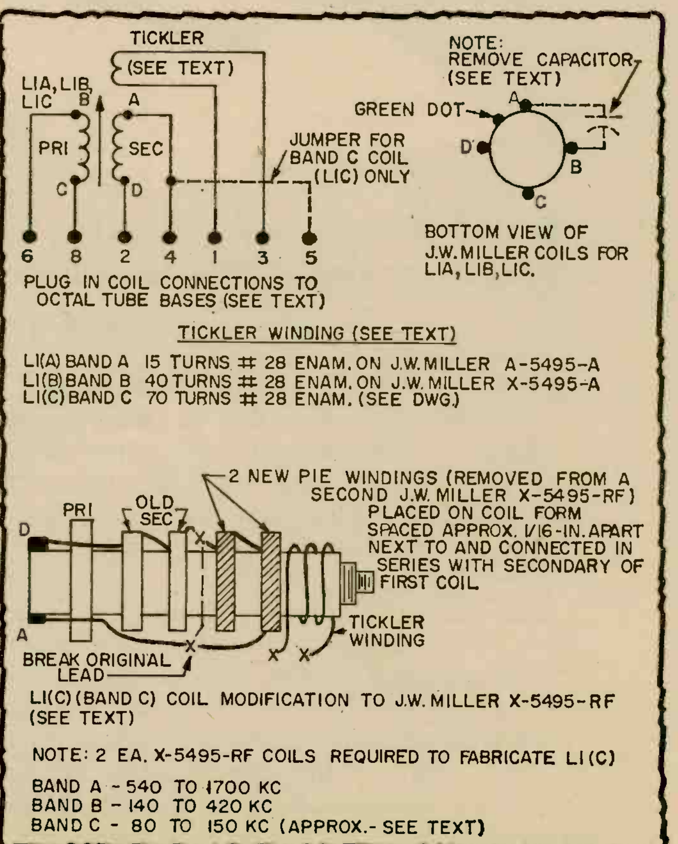
We've powered the IC/Vamp LF receiver from a 6-volt lantern type battery that has a greater current output capacity than D or A cells, and therefore will operate the receiver for longer periods of time before having to be replaced. Diode D1 has been included to protect the IC and transistor Q1 from damage that could occur if battery polarity should accidentally be reversed. If by chance you have an AC-operated power supply that will deliver 6 volts regulated output, it can be used in place of the battery specified.

Building It. Since LF circuits are notably unsusceptible to stray capacitance and leakage that may be created by interconnecting leads, our IC/Vamp LF receiver isn't critical to physical layout. You should, however, employ normal good wiring practices in building it. We suggest you follow our layout as shown in the photos to simplify construction.

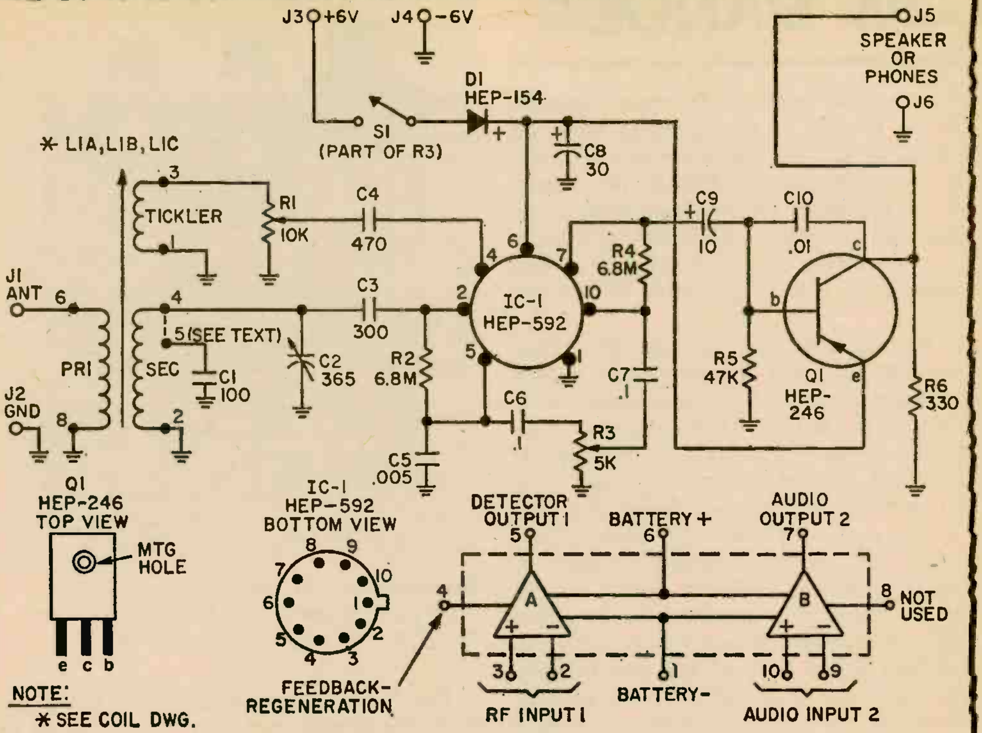
All components, except for tuning capacitor C2, audio level control R3, regeneration control R1, and the socket for plug-in coil L1, are mounted on a 2⅛ x 2¾-in. piece of perfboard. We used push pins to provide easy soldering of connections as well as for better mounting support plus a means to allow easy replacement of a part should it become necessary. The chassis base and front panel are made from ⅛-in. thick tempered hardboard (Masonite).

Wooden blocks, ½-in. square running full width, are cemented to the front and rear edges on the bottom of the main chassis hardboard sheet. These serve as feet to raise the entire assembly. Exact dimensions for the hardboard chassis base and front panel are given in the Parts List.

After drilling the front-panel holes for mounting R1, R3, and the tuning dial,



In making coils detailed here, remember all windings run in same direction.



IC/VAMP LF RECEIVER PARTS LIST

B1—6-V lantern battery (Eveready 510 S or equiv.)
C1—100-pF, 75-V ceramic capacitor (Lafayette 33E69022 or equiv.)
C2—365-pF variable capacitor (J.W. Miller 2111 or equiv.)
C3—300-pF, 150-V ceramic capacitor (Lafayette 33E21791 or equiv.)
C4—470-pF, 1000-V ceramic capacitor (Lafayette 32E01779 or equiv.)
C5—0.005-uF, 75-V ceramic capacitor (Lafayette 33E69048 or equiv.)
C6 C7—0.1-uF, 75-V ceramic capacitor (Lafayette 33E69089 or equiv.)
C8—30-uF, 16-V electrolytic capacitor (Lafayette 34E85505 or equiv.)
C9—10-uF, 16-V electrolytic capacitor (Lafayette 34E85463 or equiv.)
C10—0.01-uF, 75-V ceramic capacitor (Lafayette 33E69055 or equiv.)
D1—50-PIV, 1-A silicon diode (Motorola HEP-154)
IC1—Dual integrated circuit (Motorola HEP-592)
J1, J2, J3, J4, J5, J6—Fahenstock clips (Lafayette 33E71028 or equiv.)
L1A—540-1700 kHz coil (J.W. Miller A-5495-A antenna coil)
L1B—140-420 kHz coil (J.W. Miller X-5495-A antenna coil)
L1C—80-150 kHz coil (fabricated from 2 coils, J.W. Miller X-5495-RF—see text)
Q1—Pnp silicon transistor (Motorola HEP-246)
R1—10,000-ohm, linear taper potentiometer (Lafayette 33E12626 or equiv.)
R2, R4—6.8 megohm, ½-watt resistor
R3—5000-ohm, audio taper potentiometer AF gain control with spst switch S1 (Lafayette 32E22510 or equiv.)
R5—47,000-ohm, ½-watt resistor
R6—330-ohm, ½-watt resistor
S1—Spst switch (part of R3)
S01—Octal saddle socket for plug-in coils (Lafayette 32E20951 or equiv.)
1—1½-in. dia. vernier dial (Lafayette 99E60311 or equiv.)
1—5 x 5 x ⅛-in. piece tempered hardboard (Masonite or equiv.)
1—5 x 2½ x ⅛-in. piece tempered hardboard (Masonite or equiv.)
1—1½ x 2 x 1/16-in. sheet aluminum for bracket
1—2¾ x 2 3/16-in. piece perfboard for circuit board (Lafayette 19E83139 or equiv.)

Misc.—Knobs, perfboard and push-in terminals, ¼-in. spacers, ½-in. square wood strips, solder lugs, plastic sleeving, hookup wire, hardware, octal tube bases for plug-in coils, rub-on letters (Datak or equiv.) etc.

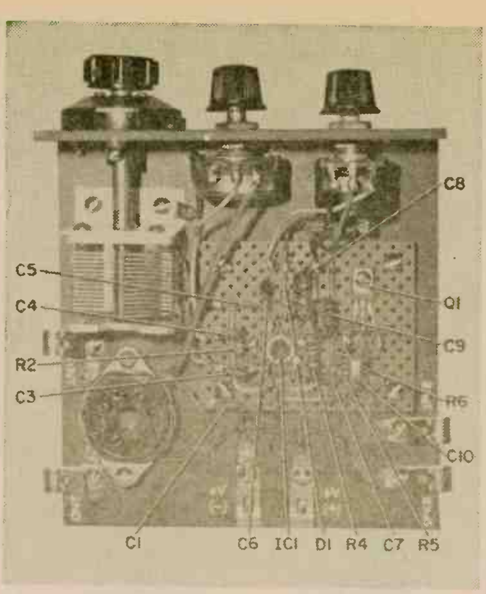
mount the dial on it. Next drill holes in the chassis base for mounting the plug-in socket for L1, the perfboard and antenna, battery wooden blocks to the bottom of the chassis and speaker terminals. Then cement the and cement the front panel to the wooden block on the front edge.

Put this aside to allow the cement to dry and make a 1½ x 1½-in. mounting bracket from scrap aluminum with a ½-in. foot, bent at a right angle to the main support. Drill the bracket to fix mounting holes on the front of C2 and the holes in the ½-in. foot, to match those drilled in the chassis base for mounting the bracket. Make holes in the foot oversized to allow slight alignment adjustments to ensure freedom of dial rotation when tuning capacitor is fastened to dial.

When cement has thoroughly dried, mount the capacitor loosely to the chassis and tighten set screw locking capacitor shaft to dial drive. Rotate dial through its complete excursion to check for binding. If satisfactory, tighten bracket to chassis.

If cement requires more drying time, go on to the perfboard assembly before adjusting dial and tuning capacitor positioning. Insert push pins as shown in photos, mount parts on them, and solder them in place. Great care should be taken not to apply too much heat to the leads of IC1 and Q1. We suggest you use an alligator clip on each of the leads of the solid-state units to act as a heat sink while soldering these units onto the perfboard. The IC is sunk into a hole in the perfboard, bottom-side up, with its leads fanned out to surrounding push pins.

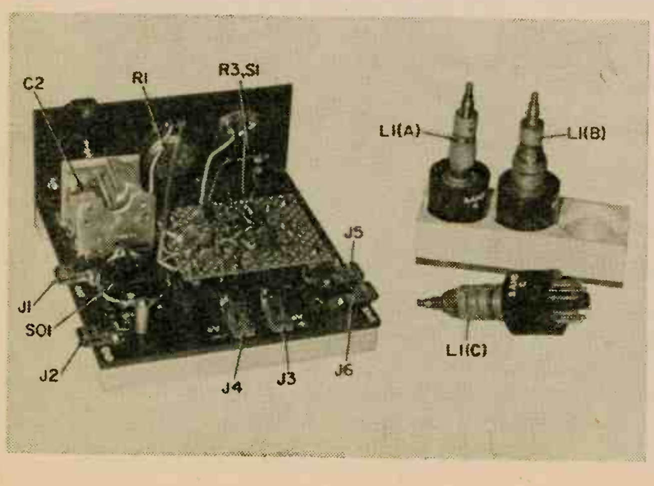
Except for Q1, which is fastened top-side down with a short bolt and nut that also acts as a heat sink, all parts are self-supporting on their leads. Interconnecting leads should be as short and direct as possible. You may want to place them on the bottom of the perfboard and solder to tabs of the push pins. This makes a neat subassembly.



This bird's eye view shows where all parts are located on perfboard. Base connections for IC1 and Q1 are shown in schematic.

Use ¼-in. spacers to raise the perfboard from the chassis base and ½-in. spacers to raise the socket for L1. You may have to bend or cut off some part of the socket lugs to keep socket clearance within the ½-in. spacing afforded by its mounting spacers.

Be a Coil Maker. The only construction work left is the making of the plug-in coil L1 [there are actually three—L1 (A), L1 (B), and L1 (C)]. Coils are fabricated from standard commercially-wound coils to which tickler windings are added by slipping them over the top of the coil form. Tickler for coil L1 (A) covering the BCB (540 to 1700 kHz) is 15 turns of #28 enameled



In addition to showing neat coil rack described in text, we've located all other parts not mounted on perfboard. Though layout isn't critical this one conserves space and makes for an efficient low-band receiver, so why not use it? You'll be pleasantly surprized at how well it works.

wire wound in the same direction as the other windings of the coil. Coil L1 (B) (140 to 420 kHz) tickler is 40 turns of #28 enameled wire, added with same precautions on direction of winding mentioned above.

Coil L1 (C) has other modifications in addition to the tickler, which, in this case, is 70 turns of #28 enameled wire. You'll need two of the Miller X-5495A RF coils specified in the Parts List. The second one is your source of supply for the two additional pi-windings needed to modify the coil you must fabricate for L1 (C). Be sure the additional windings are added so that the direction of the turns is the same for the additional windings as are the windings of the coil being modified. This same caution should be heeded for the tickler coils you'll wind for these coils.

One other modification is required: remove the capacitor installed by the manufacturer between connections A and B on each of the coils. Also, on L1 (C) *only*, add a jumper from pin 4 to pin 5 on the octal tube base in which the coil is mounted. Adjust all coil alignment screws so that they extend about ¼-in. above the top of the coil form.

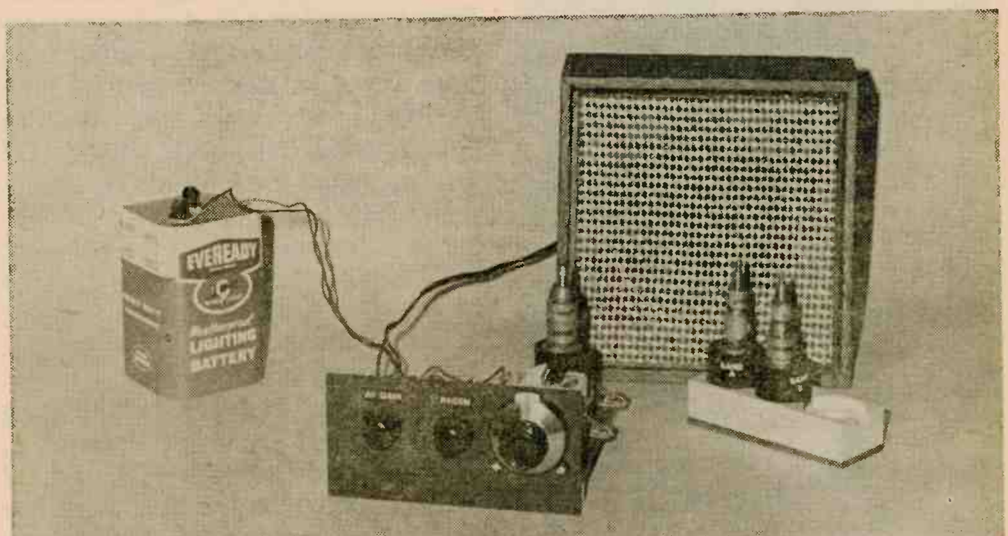
All three coils are each mounted in a separate octal tube base to facilitate plugging them into the receiver. Solder heavy bare copper wire to each of the coil's connectors, leaving the wires long enough to extend through relevant tube base pins. After soldering them to the coil, insert these wires in their respective pins in the base and push this coil assembly as far down into the base as possible to ensure a rugged coil mount.

Clean out all old cement and pieces of glass from the tube base, and clear all of the pins of solder. When a coil has been properly placed in its tube base, solder the lead wires to the tube pins and cut off excess lead wire and solder so that the completed assembly can be easily inserted in an octal socket. See details on the coil modifications in the accompanying drawing.

You may want to make the attractive, useful stand shown in the photo to hold the plug-in coils when not in use. It's easy to make. Drill three holes, ¾-in. in diameter, in a 1½ x 3⅞ x ¾-in. wood block and countersink them to a depth of ¼-in. with a 1⅛-in. diameter hole. Cement a piece of ⅛-in. hardboard over side not countersunk and you have your coil stand. You may have to ream the holes slightly if the coils fit too snugly.

Checkout and Operation. Before connecting the battery, check all wiring and double check for correct polarity of diode and electrolytic capacitors. One thing to bear in mind is that for best LF reception you need a long antenna mounted as high as possible. The exact length isn't nearly as critical for LF reception as for uhf and vhf reception. Also, for best reception you need a good

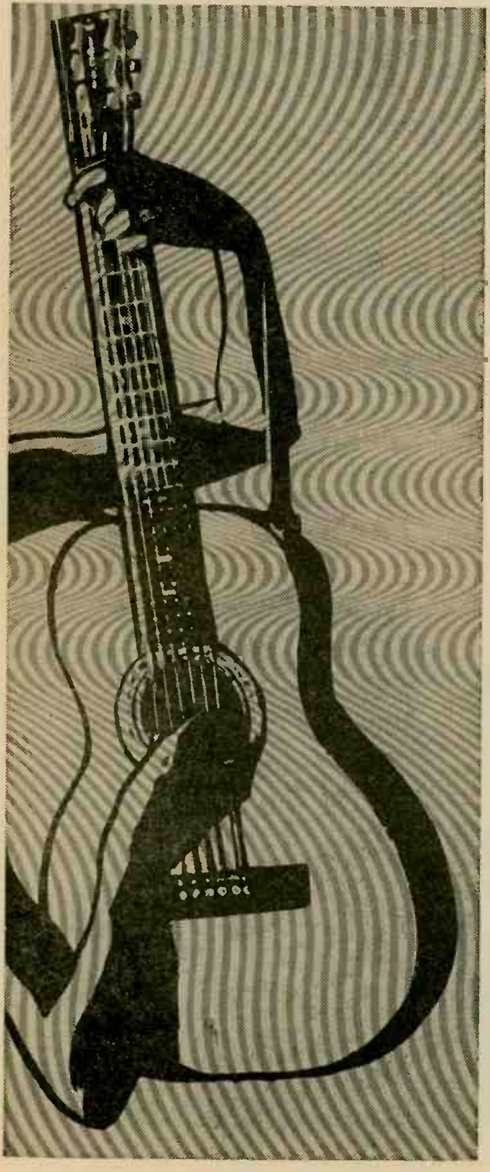
(Continued on page 107)



From opening photo and a quick glance at schematic you might guess the Low Bander will only operate phones. Actually we drove speaker at a fair audio level

UNIJUNCTION tremolo

Adds Rock Beat to Your Guitar



by Steve Daniels, WB2GIF

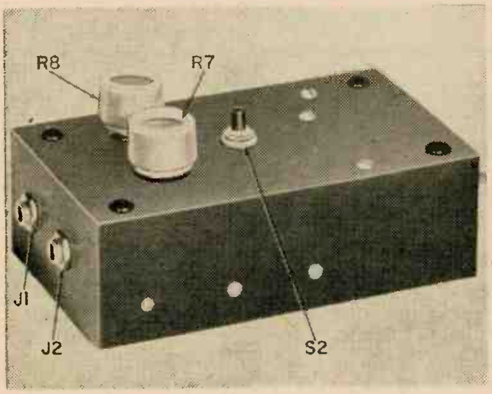
THE mournful throbbing and fast go-go effects that can be produced by an electronic tremolo make it a favorite instrument of rock groups to add interest to the sound of a guitar or organ. Unfortunately, many of these devices now commercially available produce a thumpy or choppy effect because the sound is modulated by heavy or sharp pulses. Most amps, especially bass amps, don't have a built-in tremolo circuit: therefore, our Unijunction Tremolo adds this refinement to help make your group an outstanding one.

How It Works. The basic unit of our Tremolo is a low-speed relaxation oscillator built around Q1, a unijunction transistor. Resistors R1 and R2 limit the fast and slow rates. Positive pulses, appearing on b1 of the UJT are coupled to the base of Q2, a common emitter amplifier, via C2 and R7. Lamp I1 is connected to the collector of Q2, which is slightly forward biased by R5. The lamp flashes on and off, following the pulses created by Q1. The thermal lag, inherent in incandescent lamps, reduces the thumping effect. Lamp I1 excites photocell PC1, charging capacitor C3. PC1 and C3 are connected to the output of the musical instrument (guitar, organ, etc.) and the input of the amplifier. As C3 is discharged across the input

UNIJUNCTION tremolo

to the amplifier it momentarily bypasses the musical instrument output to ground. Each flash of the lamp recharges the capacitor, thus producing the smooth tremolo effect.

Although total current drain of the *Tremolo* is quite small (it actually could be operated from a 9-volt transistor radio battery with relatively long battery life) we have included a self-contained power supply to permit operation directly from the AC



Here's operating panel of our Unijunction Tremolo. Switch S2 lets you turn off tremolo effect anytime you want just plain old music without benefit of trembling tremolo.

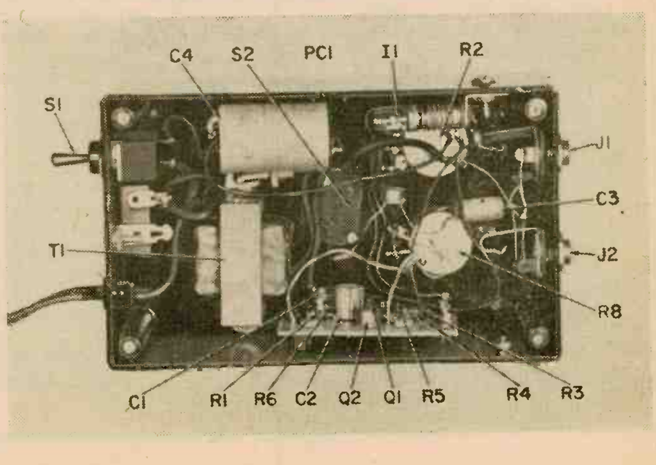
power line. In the schematic we show where the battery is connected in the event you may prefer operating your *Tremolo* from a battery. Initial cost for the battery-operated version is less than for the power line operated one.

Let's Make It. In spite of the fact that we built a 117-V, 50-60 Hz power supply into the unit, we were able to house the *Tremolo* in a small (3¾ x 6¼ x 2-in.) plastic instrument case. The power supply is assembled in one third of the pastic box, leaving the balance of the space available for the electronic portion. Transistors, coupling capactiors, and resistors are mounted on a 1¼ x 2½-in. piece of perfboard, which is fastened to one of the side walls inside the case. Flea clips or push pins are used to mount these components and make connections to them.

Exciter lamp I1 is fastened to the opposite side wall and jacks J1 and J2 are mounted on one end. Photocell PC1 is self-supporting on its pigtails and is positioned about an inch or inch-and-a-half away from its exciter lamp I1. For best results, you may have to push it around and/or vary the distance from the lamp by bending the leads. Mount power switch S1 on the end opposite to that holding the jacks and also drill a hole in this end for the power cord.

Potentiometers R2 and R7, as well as switch S2, are mounted on the base (which thereby converts it to be the front panel) of the plastic box, conveniently grouped nearer the end of the box holding the jacks. Power transformer T1 is mounted on the base of the plastic box as far as possible away from the input jacks, as are tie strips for holding rectifier diode D1, R9, C4, and power cord.

Preliminary check. Before tightening down the perfboard you will want to check out the flashing rate of exciter lamp I1. As stated earlier, the upper and lower limits of speed of oscillation (frequency) of the relaxation oscillator can be changed by varying the value of R1 for high rate, and R6



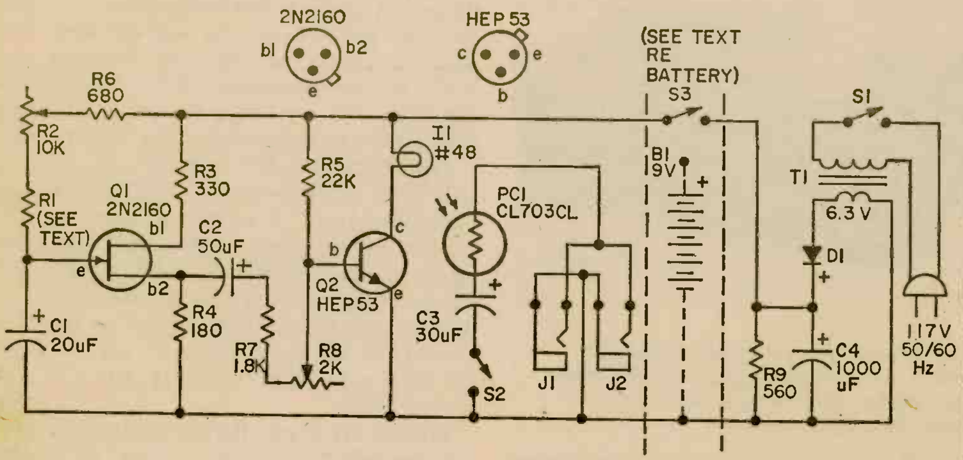
You must admit there's lots of parts crammed inside our box. After all, we do need a power supply as well as the UJT circuitry and photocell control unit. Photocell is suspended in space about an inch from lamp I1. Connection leads of photocell are stiff enough to hold it in position.

for low rate. As a preliminary adjustment, start initially with a 2700-ohm resistance value for R1 and substitute both higher and lower values until you have a maximum speed to meet your requirements. Of course, potentiometer R2 is set for maximum speed before making any substitutions. One you've adjusted the pulse rate to your satisfaction, fasten down the perfboard and you are ready to try your hand at tremolo-ing.

Let's Use It. The *Tremolo* is very easy to use. Just plug your guitar, or other musical instrument, pickup into J1, and plug into J2 the input to your amplifier. Connect the UJT Tremolo to the power line and turn *on* power switch S1. Initially set both controls to midpoint. Make certain that push switch S2 is turned *on* by observing that lamp I1 is flashing. You adjust the rate of flash by rotating the left hand knob (R2) and the intensity by rotating the right hand knob (R5).

You may want to calibrate the pulse rate knob. This can be done easily by counting the number of pulses in a given time period (e.g., one minute) and marking the position of the knob on the face of the plastic case. You can use transfer letters (Datak or equiv.) to indicate calibration count.

If you want certain passages to be amplified without tremolo, just push switch S2 to the *off* position. When you give it a second push the Unijunction Tremolo is back in business again. ■



PARTS LIST FOR UNIJUNCTION TREMOLO

C1—20-uF, 15-VDC electrolytic capacitor (Lafayette 34E85489 or equiv.)
C2—50-uF, 15-VDC electrolytic capacitor (Lafayette 34E85521 or equiv.)
C3—30-uF, 15-VDC electrolytic capacitor (Lafayette 34E85505 or equiv.)
C4—1000-uF, 15-VDC electrolytic capacitor (Lafayette 34E55177 or equiv.)
D1—50-PIV, 750-mA silicon rectifier (Lafayette 19E50070 or equiv.)
I1—#48 pilot lamp, 2-V, 0.06-A (Lafayette 32E66202 or equiv.)
J1, J2—Open circuit phone jack (Lafayette 99E62135 or equiv.)
PC1—Photoelectric cell, Clairex CL703L (note: do not use any other type or number as circuit is designed around resistance of this cell)
R1—2700-, 3900-, or 4700-ohm, ½-watt resistor (see text regarding choice of values)
R2—10,000-ohm, linear potentiometer (Lafayette 33E11255 or equiv.)
R3—330-ohm, ½-watt resistor
R4—180-ohm, ½-watt resistor
R5—3300-ohm, ½-watt resistor
R6—680-ohm, ½-watt resistor
R7—1800-ohm, ½-watt resistor
R8—2000-ohm, linear potentiometer (Lafayette 33E11172 or equiv.)
R9—560-ohm, ½-watt resistor
S1—Spst toggle switch (Lafayette 34E33026 or equiv.)
S2—Spst push-for-on, push-for-off switch (as in table lamps, available from hardware store)
T1—Power transformer: 117-V, 50-60-Hz pri.; 6.3-V, 0.6-A sec. (Lafayette 33E80490 or equiv.)
1—Pilot lamp socket, miniature screw base with mounting bracket (Lafayette 32E28038 or equiv.)
1—6¼ x 3¾x2-in. plastic instrument case with blank cover (Lafayette 19E20016 case, 19E37010 blank panel or equiv.)
1—Power cord and plug

Misc.—Perfboard, push pins or flea clips, wire, solder, tie strips, screws, nuts, ¼-in. spacers, etc.

Confessions of a solid-state circuit sleuth

by John McNarney

Most recently designed VOMs need to have built-in electronic movement protection. It's meant to guard the fragile, taut-band meter movement from the aftermath of accidentally trying to measure volts when the meter's selector knob tells you to read current. But what about those day-to-day thumps, thuds, and jars accumulated while your VOM tries living in a tool box? Or, how 'bout your VOM taking an occasional pendulum-like swing from the ends of your test leads. Followed, of course, by a fast trip to the floor when both leads jerk from their sockets.

Meter fatalities may not always be so spectacular, but it's another matter to an ever-famished wallet. And when a VOM finds itself hung across everything, from the switching circuit of the attic fan to the field coil on the sump pump, accidents are sure to occur a lot more frequently. For those around-the-house jobs where you've only got to check the circuit's continuity, we introduce you to *CON-TEST*, our faceless, scaleless continuity tester.

Our *CON-TEST* won't give you a voltage, current, or resistance *reading*. But it can surely check vacuum-tube filaments, auto fuses, power supply transformers and chokes, and heating elements from electric broilers or hotplates. Fact is, it's sensitive enough to handle most point-to-point testing where element continuity, rather than an exact resistance reading, is your unknown variable.

Since *CON-TEST* has no meter movement to damage, it's rugged enough to survive in a handyman's tool box. And with this beeper in your pocket, you avoid the need to juggle a delicate meter and two probes on your knee while crouching behind the kitchen range or balanced on a stepladder.

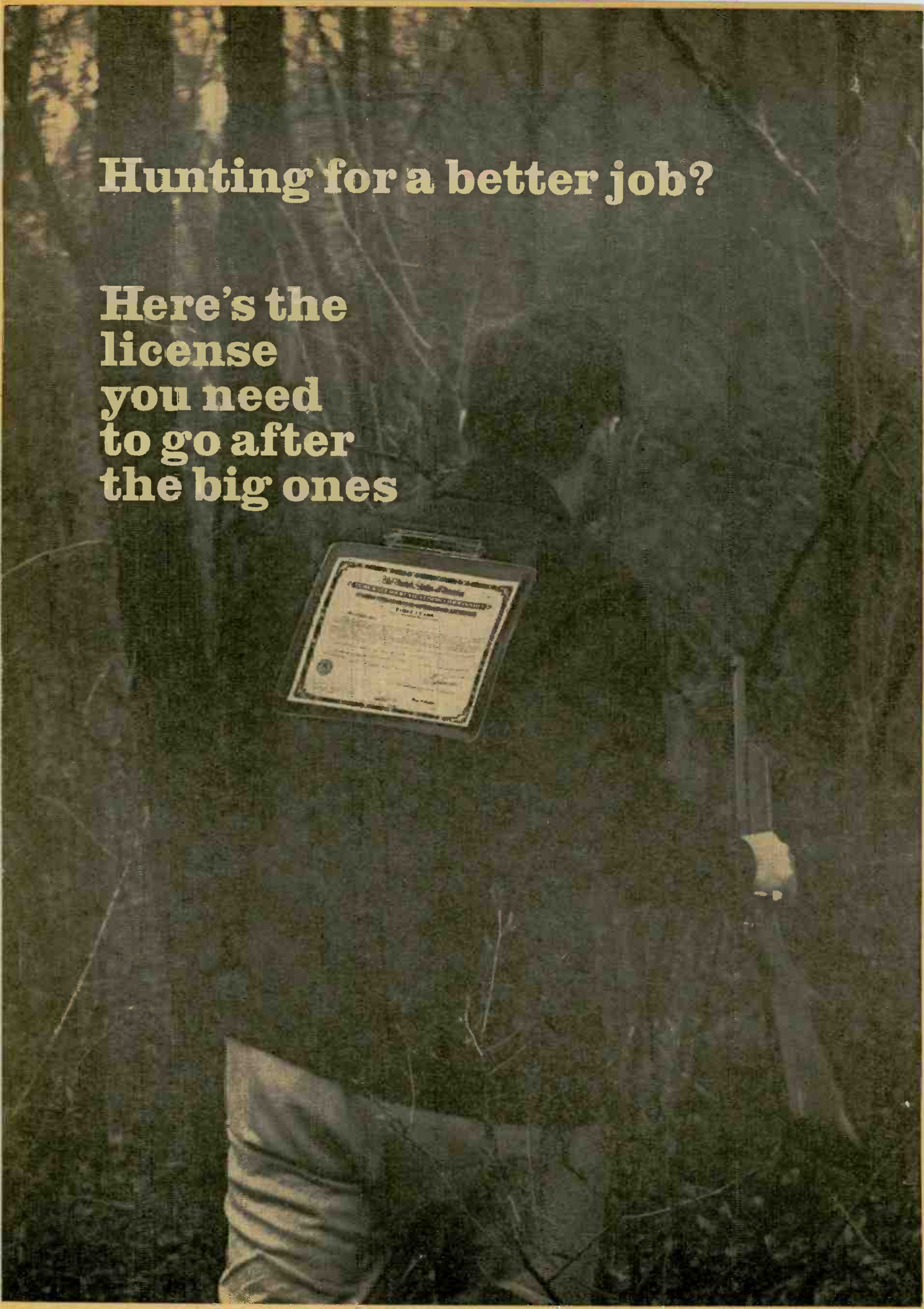
Budding radio amateurs also take to our tester, and for good reason. By connecting a key in place of the test leads, our ham has a very realistic practice oscillator for learning code! Between wrist-twister sessions, and after he's earned his ticket, our novice happily finds that his tester leads a double life as it earns its keep on a variety of household maintainence chores.

Total cost is less than $4.00, and it can be assembled in an evening with no danger of missing the late show.

Cheapy Beepy. *CON-TEST* (for Continuity Tester, see?) keeps costs to a minimum by having its panel serve as a chassis. Starting with the speaker, all parts except both transistors, and the capacitor, can be assembled directly on the front panel. The speaker opening was cut for a 2-in. speaker; it's about 1-in. high by 1½-in. wide.

The author home-brewed his battery holder from light aluminum stock and shaped to enclose a Burgess 2U6, or equivalent, 9-V transistor battery. No attempt was made to search the spare parts collection for subminiature parts. An alternate subminiature potentiometer with *on/off* switch is in-

(Continued on page 70)


Hunting for a better job?
Here's the license you need to go after the big ones

A Government FCC License can help you bring home up to $10,000, $12,000, and more a year. Read how you can prepare for the license exam at home in your spare time—with a passing grade assured or your money back.

IF YOU'RE OUT TO BAG A BETTER JOB in Electronics, you'd better have a Government FCC License. For you'll need it to track down the choicest, best-paying jobs that this booming field has to offer.

Right now there are 80,000 new openings every year for electronics specialists—jobs paying up to $5, $6, even $7 an hour...$200, $225, $250, a week... $10,000, $12,000, and up a year! You don't need a college education to make this kind of money in Electronics, or even a high school diploma.

But you *do* need knowledge, knowledge of electronics fundamentals. And there is only one nationally accepted method of measuring this knowledge...the licensing program of the FCC (Federal Communications Commission).

Why a license is important

An FCC License is a legal requirement if you want to become a Broadcast Engineer, or get into servicing any other kind of transmitting equipment—two-way mobile radios, microwave relay links, radar, etc. And even when it's not legally required, a license proves to the world that you understand the principles involved in *any* electronic device. Thus, an FCC "ticket" can open the doors to thousands of exciting, high-paying jobs in communications, radio and broadcasting, the aerospace program, industrial automation, and many other areas.

So why doesn't everyone who wants a good job in Electronics get an FCC License and start cleaning up?

The answer: it's not that simple. The government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. And that is to take one of the FCC home study courses offered by Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of 10 CIE graduates who take the exam pass it. That's why we can back our courses with this iron-clad Warranty: Upon completing one of our FCC courses, you must be able to pass the FCC exam and get your license—or you'll get your money back!

They got their licenses and went on to better jobs

The value of CIE training has been demonstrated time and again by the achievements of our thousands of successful students and graduates.

Ed Dulaney, Scottsbluff, Nebraska, for example, passed his 1st Class FCC License exam soon after completing his CIE training...and today is the proud owner of his own mobile radio sales and service business. "Now I manufacture my own two-way equipment," he writes, "with dealers who sell it in seven different states, and have seven full-time employees on my payroll."

Daniel J. Smithwick started his CIE training while in the service, and passed his 2nd Class exam soon after his discharge. Four months later, he reports, "I was promoted to manager of Bell Telephone at La Moure, N.D. This was a very fast promotion and a great deal of the credit goes to CIE."

Eugene Frost, Columbus, Ohio, was stuck in low-paying TV repair work before enrolling with CIE and earning his FCC License. Today, he's an inspector of major electronics systems for North American Aviation. "I'm working 8 hours a week less," says Mr. Frost, "and earning $228 a month more."

Send for FREE book

If you'd like to succeed like these men, send for our FREE 24-page book "How To Get A Commercial FCC License." It tells you all about the FCC License ...requirements for getting one...types of licenses available...how the exams are organized and what kinds of questions are asked...where and when the exams are held, and more.

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Confessions

(Continued from page 65)

cluded in the Parts List. This pot eliminates cutting 'n' filing chores for the slide switch.

Both transistors and the 0.02-uF capacitor are mounted on a board approximately 1¾ x 1¼ in. cut from ⅛-in. masonite or hardboard stock. This assembly is supported on two speaker bolts. If you don't have masonite or hardboard in your workshop, old reliable perfboard makes our construction scene just as well.

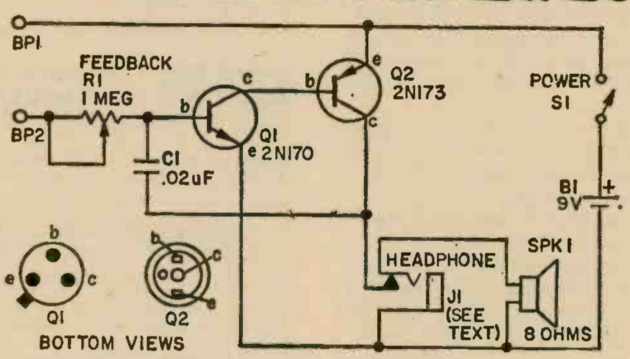
Your choice of transistors is not critical. For transistor Q1, the author found a bargain-basement 2N170 to his liking. And after thumbing through an electronics parts catalog, he tried several universal npn replacements jobs from those 20-for-a-buck assortment bags, with equally good results. Transistor Q2 can be any pnp power pusher, so long as it's happy with a 9- or 12-volt supply. In spite of the awkward size of Q2's TO-36 case, we found the 2N173 equivalent shown worked AOK in this circuit. The alternates given in the Parts List for Q2 would be just as satisfactory; any transistor enclosed in a TO-3 package would be smaller and easier to fit.

CON-TEST will earn its keep in your ham shack. Just connect a key to the binding posts and pound away—best little CPO you can make.

Log Taper Turn On. Resistor R1's a you-seen-'em-once-you've-seen-them-all ½-watt carbon potentiometer. Controlling circuit feedback, this 1-megger helps produce a low audio tone from the speaker, with minimum drain on the battery. Obviously you'll need less resistance as the battery ages, or if you're testing a high-resistance circuit. While your family's ham cures his code by using our *CON-TEST* as a practice oscillator, potentiometer R1 serves as pitch control. Don't be too surprised if his speed sweetens considerably, for a very realistic effect can be produced by our baby beeper!

It was found that small binding posts work better in place of the usual jacks, as they lock solidly on the test leads. They're also more convenient for inserting connecting wires from a Morse Code key.

(Continued on page 70)



PARTS LIST FOR CON-TEST

B1—9-V Battery (Burgess 2U6 or equiv.)
BP1, 2—Binding posts, one red, one black (Lafayette 99E62333 or equiv.)
C1—.02 µF, 50 VDC disc capacitor (Lafayette 32E09491 or equiv.)
J1—Phone jack, closed-circuit (Lafayette 34E60668 or equiv.)
Q1—Transistor, npn replacement type (Lafayette 19E27029 or equiv.)
Q2—Transistor, pnp power replacement type (Lafayette 19E15032 or equiv.)
R1—1,000,000-ohm, carbon potentiometer (Lafayette 99E63521 or equiv.)
S1—Slide switch, spst (Lafayette 34E37035 or equiv.)
SPK1—8-ohm, 2-in. speaker (Lafayette 99E60630 or equiv.)
1—Case, 5⅛ x 2⅝ x 1⅝-in. (Lafayette 99E80756 or equiv.)
Misc.—Hardware, solder, wire grille, solder lugs, wire, etc.

Color Organs

You haven't seen 'em all!

by Mel Serisky

SO YOU think when you've seen one color organ you've just about seen 'em all? Sure, it's true that some might have permanently engraved free-form screen patterns, but even they get boring to the eye after a few minutes. Then there're other mini light shows-in-a-box, grinding out the same ho-hum colors hour after hour. Worse yet, some just hang up on any input voltage signal, producing the same color intensity regardless of the program source sound level. It's enough to make you wonder why you built it in the first place.

Uptight light-show buffs, take heart, for we've run into a supergear color organ kit that's sure to keep any blue-sky audience up in the air for hours. By building your own color organ—partially from a kit offered by Science Workshop, Box 393, Bethpage, N.Y. 11714, and partly from the local lumber yard—you wind up with a real crowd attracter costing less than 25 very little ones. But here's the real hooker: this CO's got performance that can be modified to suit your taste or mood in a matter of minutes! Need a for instance? Your girl becomes tired of the same old red, green, and blue—and she's giving you that do-something look. The boys'll change the band, but a man switches his color. A smear of paint and you've got purples, yellows, or whatever you want. If she starts checking her manicure,

Color Organs

crinkle up some aluminum foil and tuck it behind the front plastic panel. The colors now seem to move from corner to corner!

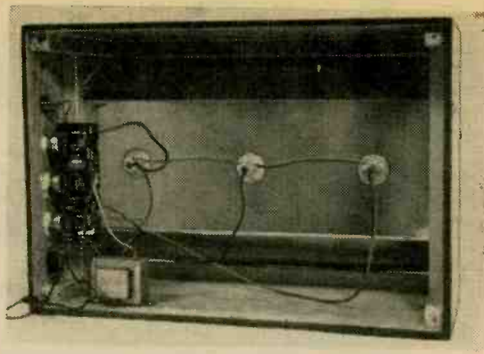
For those deep reds simply crank up the red gain control, or reduce the gain on the remaining two lamps. In a blue mood? Crank up the blue and kill the red. It's not hard to tailor color and triggering to your own preferences, or for those fortunate souls you're entertaining.

Heart of the budget color organ is Science Workshop's basic color organ kit, number LO-103, priced at $14.95. This is a complete low-voltage printed-circuit kit holding all the electronics.

What's with this low voltage bit, you ask? A special 11-Volt power transformer made for the kit powers three #93 automobile lamps, giving just the right amount of light for home use. The power transformer (Science Workshop's type 43P46) sells for a paltry $2.95 and three auto lamps (also available from Science Workshop) will set you back $1.77. Think you can afford it?

Throw in a few dollars for lumber, some sheet aluminum, a front screen, and lamp-dye and coloring, and the price works its way up to $25.00, or half the amount of a ready-to-build kit. If you want to go deluxe with a power-supply switch, input jack, and cabinet stain, figure on spending a total of $30.00.

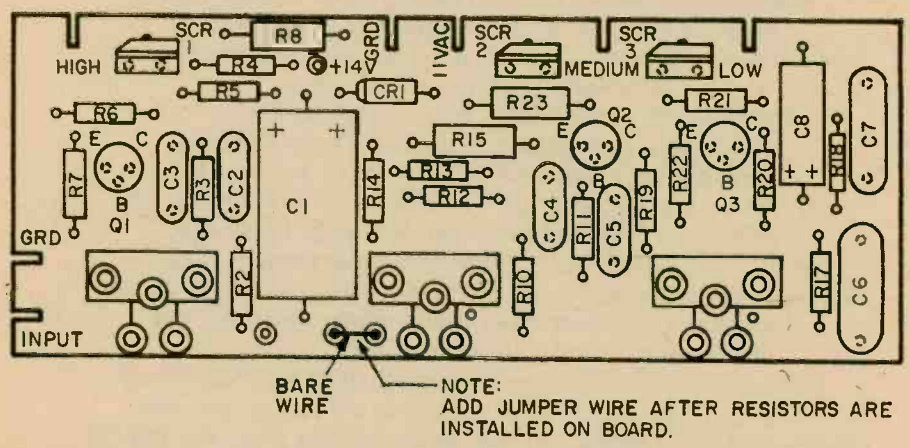
Green Lumber's a Drag. First step is to assemble the PC board. Following the supplied instructions, this should take about an hour. Then set the board aside until the cabinet and reflector are prepaired.



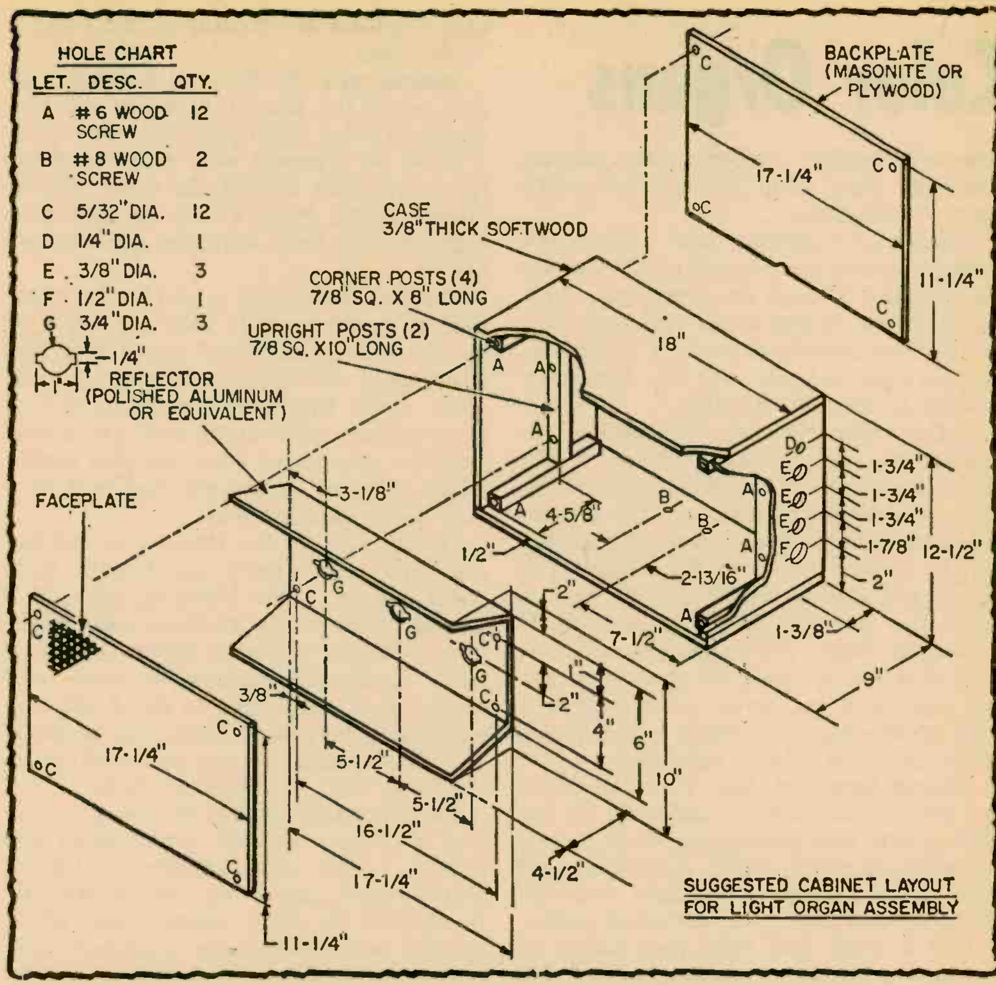
Color Organ's approaching completion as we're only minus rear panel for Organ. Try several light setups for best effect.

You can either salvage an existing cabinet, such as an empty compartment in your hi-fi cabinet, or you can unlimber your electric drill and saber saw and build the suggested cabinet. You'll need three hours to knock the cabinet together. And as a bonus, Science Workshop throws in a complete set of plans with their electronics kit. If you follow the home-brew saw 'n' sand route, then buy ¼-in. plywood because it's sturdy enough for rigidity, yet it's relatively lightweight and inexpensive.

Maximum light transmitted to the front panel means the lamps must be mounted with auto sockets to a polished aluminum reflector. You'll need single-terminal sockets; a local junk yard let the author remove



Here's what Science Workshop's printed-circuit board kit looks like. Kit builder's delight, PC board gives you lots of elbow room while soldering components into place or checking your handiwork for shorts, cold joints, etc. Note three rectangular shapes at board's bottom edge. They're for three color-intensity potentiometers.



Follow author's dimensional data when you construct cabinet. Those hobbyists who aren't keen on woodworking can still build suitable cabinet made out of heavy-duty cardboard. Cut cardboard to size with serrated knife, then glue pieces together.

three sockets from scrapped autos for a buck. If scrounging around moldy autos doesn't light your fire, new sockets are available from some of the larger auto-supply stores.

No matter how you breathe life into a cabinet, you'll still need the reflector size proportions specified in the cabinet plans. Custom builders employing existing cabinets scale the same general reflector layout down or up to their requirements.

Mount the lamp sockets in a straight line across the reflector's imaginary horizontal center line. Don't crowd the sockets against the ends of the reflector for this can cause a sharp loss of brilliance. A good arrangement divides the center line into thirds so the lamps will be equidistant from each other and the ends of the reflector. Those of you who want to exercise your imagination might try a triangular pattern. A test-triangle arrangement gave a very tight but

Goop being squished around color intensity pots is called Silastic Bathtub Caulk. Buy in any hardware store; it's easy to apply. holds PC board in place after curing.

Color Organs

unusually brilliant multiple color pattern; than's an ideal setup for compact multi-screen installations.

After you've finished your cabinet and reflector, install the printed-circuit electronics assembly. Though the instructions show the PC board secured to the cabinet by nuts on the three color-level controls, it was discovered these controls were too short for a cabinet at least ¼-in. thick.

Rather than butcher the cabinet to countersink the mounting holes, simply squirt a blob of silicon rubber adhesive between the control bushings and the cabinet. When the adhesive dries, the board assembly will be secured firmly to the cabinet. The phono jack shown installed in the cabinet could also give you grief because its shaft is also too short. You've got two solutions here; find a long length of phono wire for the input lead, or, better yet, substitute a long frame phone jack which is specifically made for wood cabinet installation.

Nailing Down the Job. Your last chore is fastening the power transformer to the cabinet base with self-tapping wood screws. Complete as much wiring as possible and then fasten the reflector/sockets assembly to the upright posts with four wood screws.

Run a single lead from each socket to the appropriate *high*, *medium*, or *low* PC foil connection on the board. The word *high* means high frequency, and should correspond to a cool color such as blue. Now you know that *med* stands for medium frequency, while *low* can be a hot color, like red.

Solder a common wire to the socket frames, then connect all common leads to the transformer's common lead. All wires connected to the lamps should be at least #18 gauge; #20 or #22 gauge hookup wire won't deliver enough amperage to the lamps.

Finally we come to the fun part—coloring the lamps. Like we said before, transforming your color organ from the run-of-the-mill light box into something exciting in the go-go mode's sure to separate the lions from the pussycats. Using lamp dye, you should try painting one lamp predominantly red, one green, and one mostly blue. But don't take the same route the other color organ builders do by painting each lamp a single color.

Instead, paint the front of each lamp, an area about the size of a nickle, the predominant color. Then paint four dots about 3/16-in. in diameter with each remaining lamp dye color around the outer circumference of the lamp. Fill in the remaining space on the lamp with the predominant color.

Don't be too careful as you let the colors mix 'n' match together over the edges of the dots and predominant areas. Your finished organ will burst forth with a riot of color across the entire screen instead of three distinct colors at the ends and center. Rainbow splashes of color and that special friend snuggled beside you can lead to a very psychedelic evening.

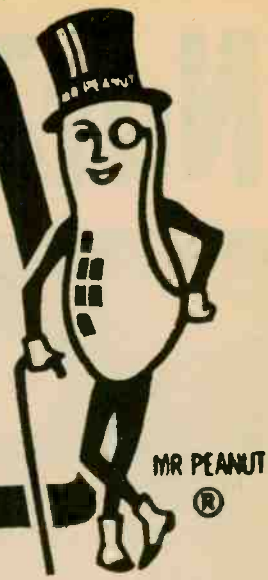
Getting back to the business of building our color organ, you'll see that the front panel can be either diffusing glass or a special plastic which produces soft colors. This prismatic plastic is called fluorescent light translucent paneling at your local lumber yard. Remember to install this material with the prisms facing the lamps; if they face toward you, the panel will act as a diffuser with no prismatic effect.

Listening and Lighting. By now you can't wait to connect the color organ's input lead directly across your amplifier or phonograph output. Stereo rig owners are sure to connect the organ across either set of speaker leads. Adjust the amplifier's gain control for proper lamp operation. Normal control settings make the associated lamp flash in step with the music, while each lamp's brilliance will be in proportion to the volume. If the lamps come up to full brilliance at all times, and fail to pulse with the sound, turn the organ controls down (or counterclockwise).

Keep in mind that if the musical passage hits a soft spot, the lamps will not light at all, as the dynamic range of the SCR controlling the lamps is nowhere near that of your ear. Classical music often produces many seconds (if not minutes) of zero light effect, but you can count on any good rock group to produce some really wild color effects, with rainbows of color spilling into your eye from first guitar note to last echo effect.

Remember to add a 50¢ shipping charge for each part you order from Science Workshop. And don't forget to include your Zip Code with your order. ■

NutZee
A taste treat for your ears!



by Capt. James E. Lockridge

NOW you can install speakers everywhere in your home for less than a buck each—providing that you can be talked into eating a certain brand of peanuts. NutZee, our super-cheap speaker, goes together in 10 to 15 minutes and provides outstanding fidelity and volume considering its size and cost. NutZees can be hooked into your stereo system or used as simple auxiliary speakers for your personal radio or transistor portable. The author happily uses his with a Roberts 770X tape recorder and also with a table radio.

What It Is. Heart of our NutZee is a 2½-in. dia. transistor radio replacement speaker. This is cleverly mounted inside a Planters peanut can, serving the dual role of an effective baffle and enclosure for the speaker. The entire assembly is fitted with a subminiature phone jack; NutZee goes anywhere in your home. And finally, it needs only a length of zip cord to your music system before you lean back and enjoy it.

How to Make It. First step is to solder a 10-in. length of zip cord to the speaker lugs. Then, place the speaker face down on the middle of the plastic cover top (supplied with every can of Planters) and trace the circumference of the speaker on the plastic with a ballpoint pen. Next, remove the speaker and carefully draw another circle ⅛-in. smaller inside the first one.

Using the point of a pair of scissors, punch a hole in the center of the plastic. Carefully cut your way to the inner circle; cut it out, and what you're left with is a ⅛-in. lip for mounting the speaker. Use a good brand of epoxy cement—the kind where you have to mix tubes A and B—and cement the speaker to the plastic top. Put the plastic top-speaker assembly aside to dry. While the epoxy compound is curing is a good time to mount the jack in the can.

(The plastic-top/speaker assembly will later be snapped into place on the peanut can so make sure that in mounting the speaker to the plastic you join them on the correct side. This is the one where the out-

Here's NutZee before finishing touches are applied. For effect, try painting plastic top matte black. Your friends will search high and low trying to find camouflaged NutZee!

NutZee

NutZee's major ingredients. Cloth covers speaker/plastic top assembly on author's NutZee; this pretties up NutZee and protects speaker cone from dust and prying fingers.

side flange of the plastic is facing towards the speaker.)

Drill a clearance hole ½-in. from the can bottom. Next, deburr the edge of the hole with a round file so the jack will mount cleanly. After the jack has been installed, you're ready to solder the speaker leads to it. Snap the plastic-top/speaker assembly into place and you're all set to finish NutZee.

NutZee can either be spray painted or covered with vinyl contact paper. Whichever you use, there are many colors and patterns to choose from to suit the decor of your home.

PARTS LIST FOR NUTZEE

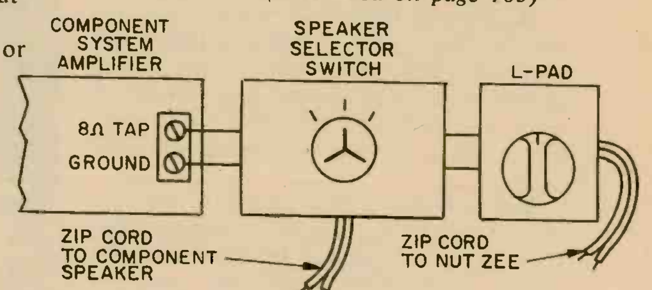
- 1—2½-in. dia., 8-ohm loudspeaker (Lafayette 99E60386 or equiv.)
- 1—6¾-oz. size Planters peanuts can with plastic snap top
- 1—Subminiature open circuit phone jack (Lafayette 99E62119 or equiv.)
- 1—Subminiature phone plug (Lafayette 99E62101 as required, or equiv.)
- 1—8-ohm L-pad (Lafayette 99T6134 or equiv.)
- 1—Remote speaker switch (see text)
- Misc.—Zip cord, paint or vinyl, epoxy, solder, etc.

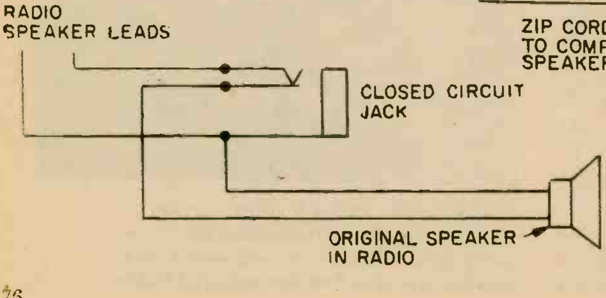
Broadening Your Music. You'll want to use your NutZees as auxiliary speakers for your table radios, or your stereo system. But first a word of caution. Do *not* use your NutZees with an AC/DC radio; a shock hazard may be present and could prove lethal. Some stereo systems have a couple of jacks marked *aux. speakers*. These jacks, when used with mating phone connectors, will disconnect the manufacturer's speakers from the set and give you the freedom to connect other external speakers.

After you've found a good place to put NutZee, solder the appropriate phone plugs to suitable lengths of zip cord. Make sure that the power is *off* when plugging or unplugging any speaker, since the transients caused may damage the output tubes or transistors in the set.

To use your NutZees with a personal radio (*not* an AC/DC set) or a portable, follow the same procedure and again make sure that the radio is turned off when NutZee is plugged in or out. If your radio has no jack for an external or auxiliary speaker connection, then you'll have to wire

(Continued on page 105)





Two ways to hook up NutZee. Above, those with component systems need two-way speaker selector switch and L-pad. Left, playing NutZee through personal radio requires closed circuit jack. Wire as shown.

let CASSIE give you the sweetest sound in CASSETTES

by Thomas R. Sear
WA6HOR

SIX years ago no self-respecting audiophile seriously considered slipping the Beatles into his hip pocket. And no stereophile envisioned cramming all those Monkees into, say, a tote bag. But all you Beautiful People know how time eventually changes fiction into fact. Today it's easy to hold the Boston Symphony in your hand. Spouting off at the tonsils aside, you've got a lot to like with a new-as-tomorrow tape cassette.

Since its introduction in the mid-1960s, the tape cassette has achieved immense popularity among novice and experienced audiophiles. The ease of loading this ½-in. wide, self-contained marvel into its record/playback unit consistently earns hurrahs from anyone who has ever fumbled with a conventional, reel-to-reel tape recorder. But it turns out all's not perfect in cassette country.

Like a small battery-operated transistor radio, a cheapie cassette player's playback sound oftentimes leaves a little something to be desired. Seems the commemorative-stamp sized speaker found in the majority of cassette players stumble and fall way down in the bass-reproduction department. One solution might have us tack on a larger speaker having better frequency response. But did you ever try driving that hi-fi speaker of yours with a cassette player? It's all show and no go as the flea-powered player struggles against your mighty inefficient speaker.

Room-filling sound for little expense is surely the password for our

gives you the sweetest sound...

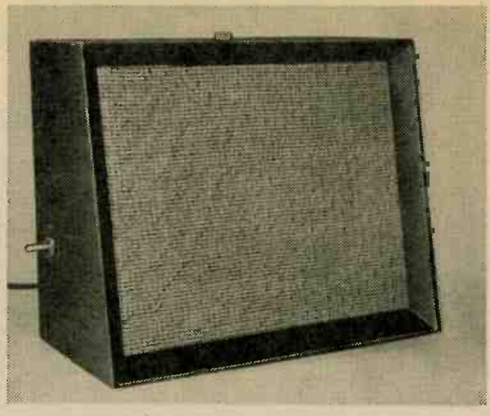
Cassie. She gives you the sweetest sound you've ever coaxed out of your cassettes! You won't have to sell your kazoo to build *Cassie*, either. Handily lifting Bacharach or Bach from soupy to silvery, *Cassie* tootles to a 20-buck tune. We think you'll be glad you found a couple of constructive hours and a finger for your solder gun trigger, after you've heard *Cassie* perform.

Our photos show *Cassie* in all its glory. You can easily see how speaker and internal amplifier fit into the cabinet, with neither cramped for breathing room. We did a bit of catalog page twisting and found a full-range 8-in. speaker tucked within a deluxe baffle for an unheard-of $6.95. And another six dollars and 95c later, we fished up an amplifier whose internals can easily drive the speaker.

Cassie can find happiness indoors with its own internal power supply, or outdoors by connecting a 12-volt battery to the terminals provided for this purpose. Making our *Cassie* even more electrically attractive are two inputs: one for high-level signals ordinarily cranked out by cassette players, another for low-level signals such as you'll find from phono cartridge, guitar pickup, or even a microphone.

These features make *Cassie* ideal for all those indoor or outdoor gatherings where you want your vocal cords or rock vibrations to carry a lot more zonk.

Prancing Through Cassie. The electrical body of *Cassie* consists of two major organs.



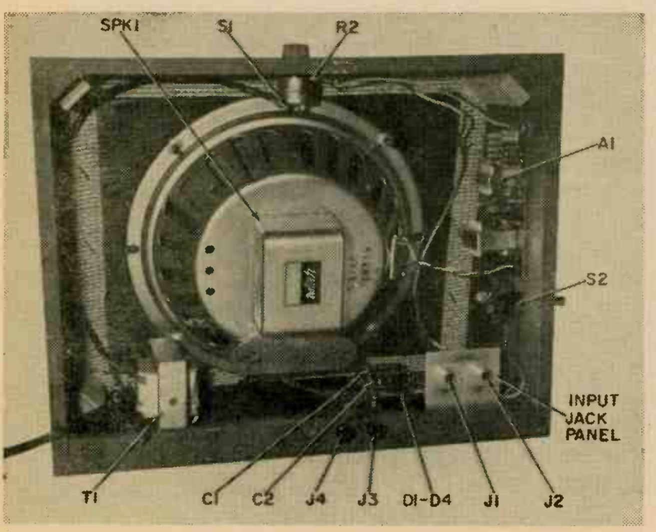
Cassie is a handsome addition to any system. Not only does it add tone quality to your cassette player, it's good to look at too.

One's a solid-state, store-bought, 1-watt power amplifier; the other's a home-brew 12-VDC power supply.

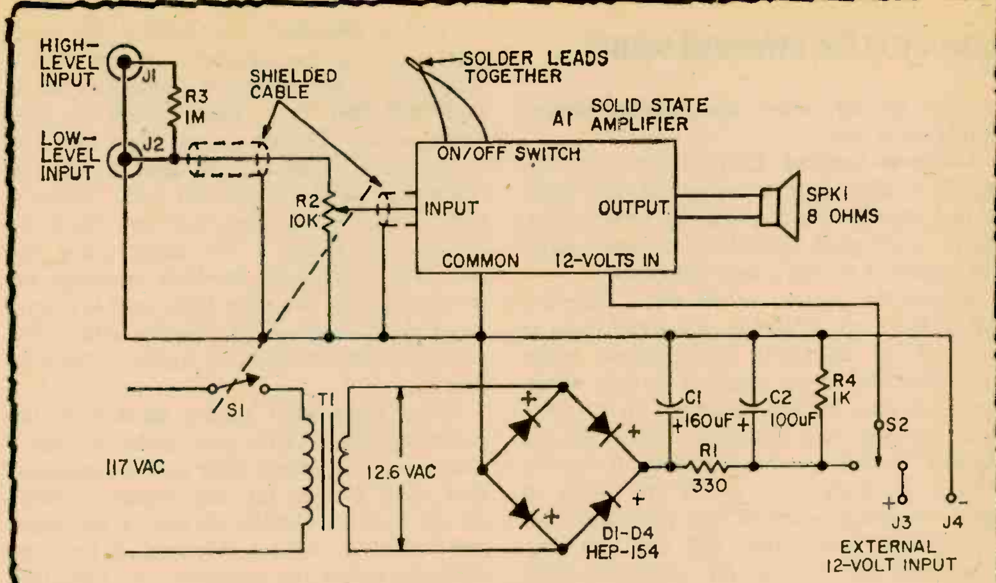
The power amplifier has a frequency response running out to 15 kHz. What's more, when presented with 4.5 millivolts at the head end, it'll zap its output into an 8-ohm speaker without busting a gut. And all this razzmatazz is yours with only 150 mils squeezed out of the power supply!

The 8-ohm speaker and enclosure were found hiding together in McGee Radio Co.'s catalog. You'll find it lurking as no. SLDC8S. The speaker's a no-nonsense coaxial job with a frequency-response curve considerably wider and flatter than the squawker found in most cassette players.

From Full Wave to No Wave. Taking a peek at *Cassie*'s schematic, you'll see that



Guts of Cassie layed bare here for all good constructors to see how easy it is to place all the units for easy accessibility without affecting speaker. Circuit board construction of amplifier and power supply lends itself to placement that fits spaces available. Controls are placed within easy reach from exterior.



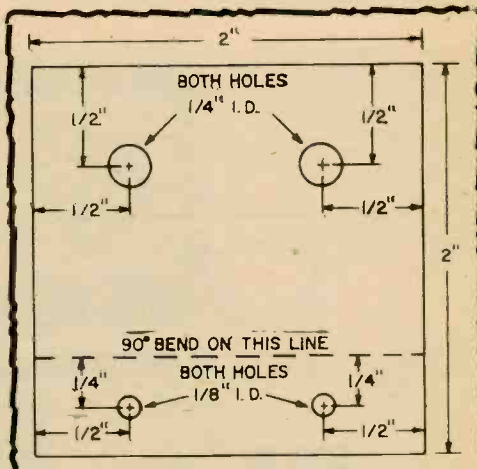
PARTS LIST FOR CASSIE

A1—1-watt, solid-state amplifier (Lafayette 99E90383 or equiv.)
C1—160-µF, 25 VDC electrolytic capacitor (Lafayette 34E85687 or equiv.)
C2—100-µF, 16 VDC electrolytic capacitor (Lafayette 34E85547 or equiv.)
D1-D4—50-IV, 1-A silicon rectifier (Motorola HEP-154 or equiv.)
J1, J2—RCA phono jacks (Lafayette 99E62341 or equiv.)
J3, J4—Insulated banana jacks; red (Lafayette 32E64942 or equiv.), black (Lafayette 32E64959 or equiv.)
R1—330-ohm, ½-watt carbon resistor
R2—10,000-ohm, ½-watt carbon potentiometer (Lafayette 32E22528 or equiv.)
R3—1,000,000-ohm, ½-watt carbon resistor
R4—1,000-ohm, ½-watt carbon resistor
S1—Spst on/off switch (part of R2)
S2—Spdt toggle switch, center off (Lafayette 99E61558 or equiv.)
*SPK1—8-in., 8-ohm coaxial speaker with wall baffle
T1—Power transformer: primary, 117 V 50-60 Hz; secondary, 12.6 V @ 2 A (Stancor P-8130 or equiv.)
1—2-ft. length shielded wire (Belden 8431 or equiv.)
Misc.—knob, 6-ft. line cord with plug, wood screws, solder, wire, etc.

*SPK1 available from McGee Radio Co., 1901 McGee St., Kansas City, Mo. 64108 for $6.95 plus postage. Specify stock no. SLDC8S.

switch S1 is the power *on/off* switch socking 117 volts to transformer T1's primary winding. Transformer T1's secondary is connected to the power supply, which is four silicon diodes, two capacitors, and two resistors. Diodes D1 through D4 are connected as a bridge rectifier; the output from this bridge is smoothed by capacitor C1 to provide a relatively hum-free DC output of approximately 20 volts. Resistor R1 drops the DC output voltage down to the 12 volts required to breathe life into our power amp. Capacitor C2 provides additional filtering.

There's nothing spectacular about switch S2. A prune-juice-regular, three-position toggle switch, it selects either the output from the internal power supply, or an external 12-volt supply connected 'twixt jacks J3 and J4. The *center-off* position of S2 also provides you with a means of turning *Cas-*



Don't say we haven't told you all—here's how to make input jack panel.

sie on or *off* when an external source springs it to life.

Longnose Looping. Okay, it's time to dig out your dikes. But before you'll read more of our sage construction advice to the shop-worn, you'll need to perform a minor surgical operation on the power amplifier.

Solder the power *on/off* wires (coming out of the amp) together, and wrap them in a piece of electrical tape. These wires normally run to an external switch which performs the *on/off* function. In *Cassie's* case, however, we halt those jolts with our volume control-mounted switch. If you're still in the dark over which two wires to solder together, consult the directions accompanying your amp; it'll call out two leads marked "to on/off switch." After you've taped up the patient, place it aside.

Don't let that bright 'n' shiny speaker talk you into mounting it into the baffle while you're still in the early construction phases. Few speakers improve their tone when they're subjected to holey indignities like screwdriver blades, drill bits, and solder gun tips.

Prior to mounting the electronics within the speaker cabinet, drill a 7/16-in. hole on the left-hand side of it. This hole is for switch S2, and it's positioned about 3¼-in. up from the bottom and 1½-in. from the back of the speaker baffle. Also drill two ¼-in. holes spaced ¾-in. apart on the side of the speaker cabinet. That's where you'll mount jacks J3 and J4.

Cutting, bending, and drilling the input jack panel is the toughest job on *Cassie*. Take a 2 x 2-in. piece of aluminum stock, and drill two ¼-n. holes about an inch apart, as our diagram shows. Then drill two ⅛-in. holes about an inch apart at the opposite end of the aluminum plate. Scribe a line ½-in. in from this side and bend the metal so it forms a 90° angle along the line. This aluminum mashery becomes the mounting plate for your high- and low-level input phono connectors. Finally, attach this assembly with round-head screws to the cabinet base.

Screw both RCA phono jacks onto the mounting plate. After you solder a 1-meg-ohm resistor between both center conductor pins, drill a hole for the volume control *on/off* switch assembly on top of the baffle and mount it in the newly-created hole. Be sure you orient the potentiometer terminals so they face the amplifier.

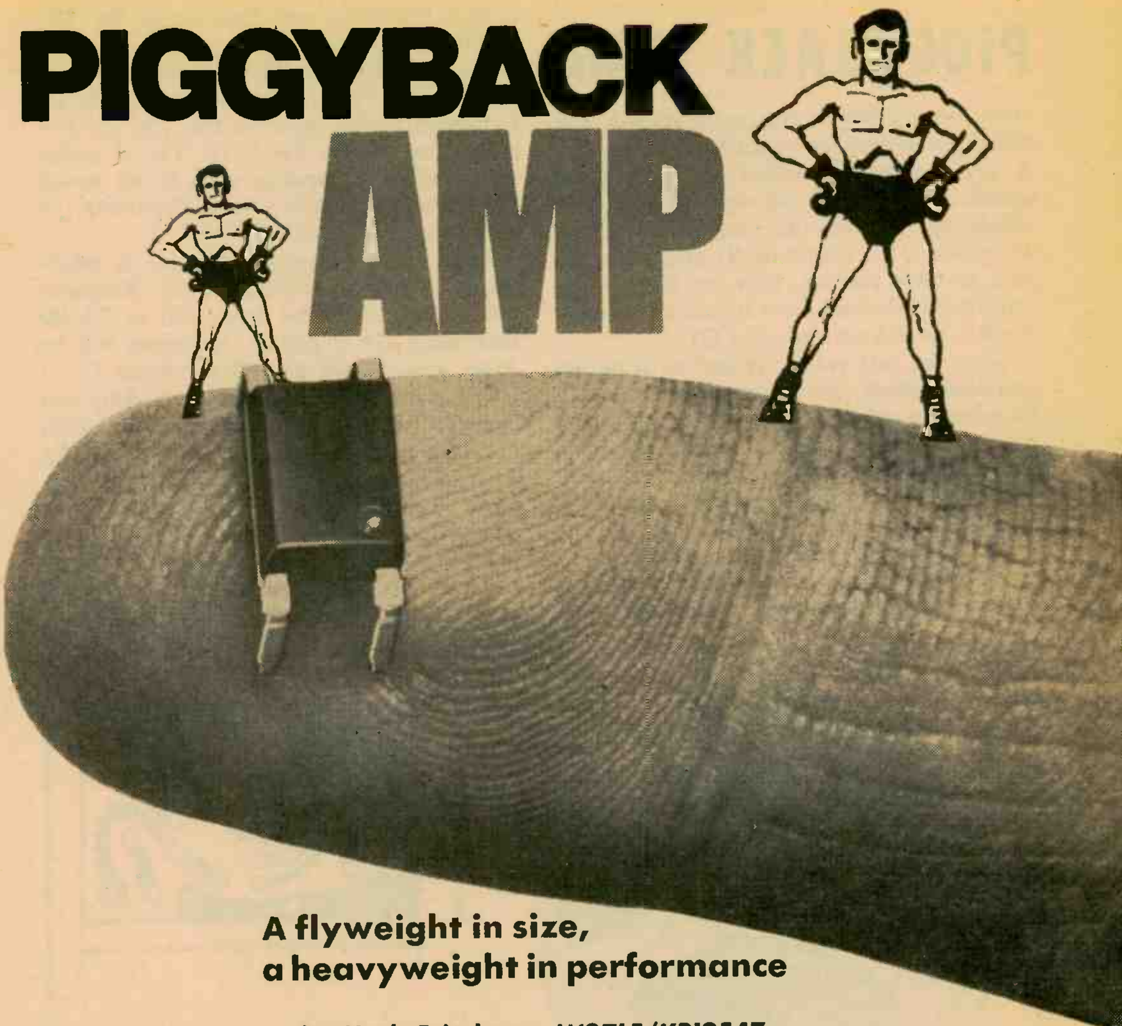
The power supply assembly can be tackled by any soldering iron wielder. The author built his volt smoother on a small piece of Bakelite, but we suggest you delve into your spare parts collection for a 3 x 2-in. hunk of perfboard. Before you loose your wonder-watter upon the components, remember that diodes and electrolytic capacitors are like polar bears. They lose their cool if jabbed too often with a hot iron.

Once you've wired the power supply, mount it to the speaker baffle's bottom with spacers between perfboard and mounting screws. Only four connections are made to one power supply—transformer T1's second-

(Continued on page 105)

Cassie's with it for other than cassette players. You can use it to sweeten up your tuner or build two of 'em for stereo. Too, it makes an OK phono amplifier when you feed it from a record changer. Need a small PA? That's right, just add a mic and you've got one rarin' to boost that weak voiced politico. In fact it fills the bill for just about any audio application where there's need to faithfully raise the signal level with low distortion and good frequency response.

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 1⅛ x 1½-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 x 0.21 x 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

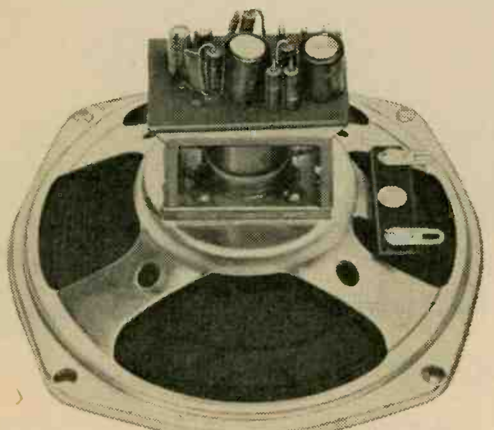
PIGGYBACK AMP

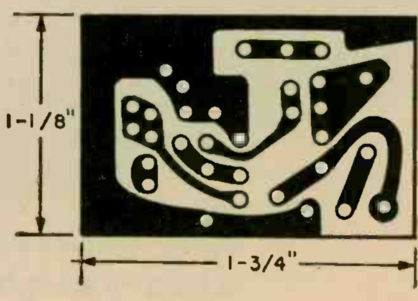
(rms) input drive for full power output. The IC's input impedance appears as 1000 ohms. A preamplifier is needed to increase its sensitivity for universal applications. Our schematic includes the preamplifier stage. Transistor Q1 is biased by R1 and R2 to act as a variable resistor. Bias for IC1's input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

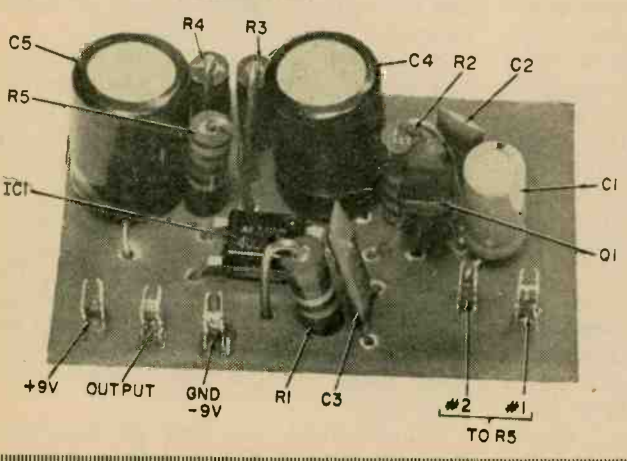
Since the bias voltage is derived from the amplifier output, the circuit is automatically temperature stabilized. Reason for this is that heating effects on the IC, which result in a change in DC, raise the amplifier's output. Thus the output signal, in turn, controls the amplifier's gain by being fed 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.

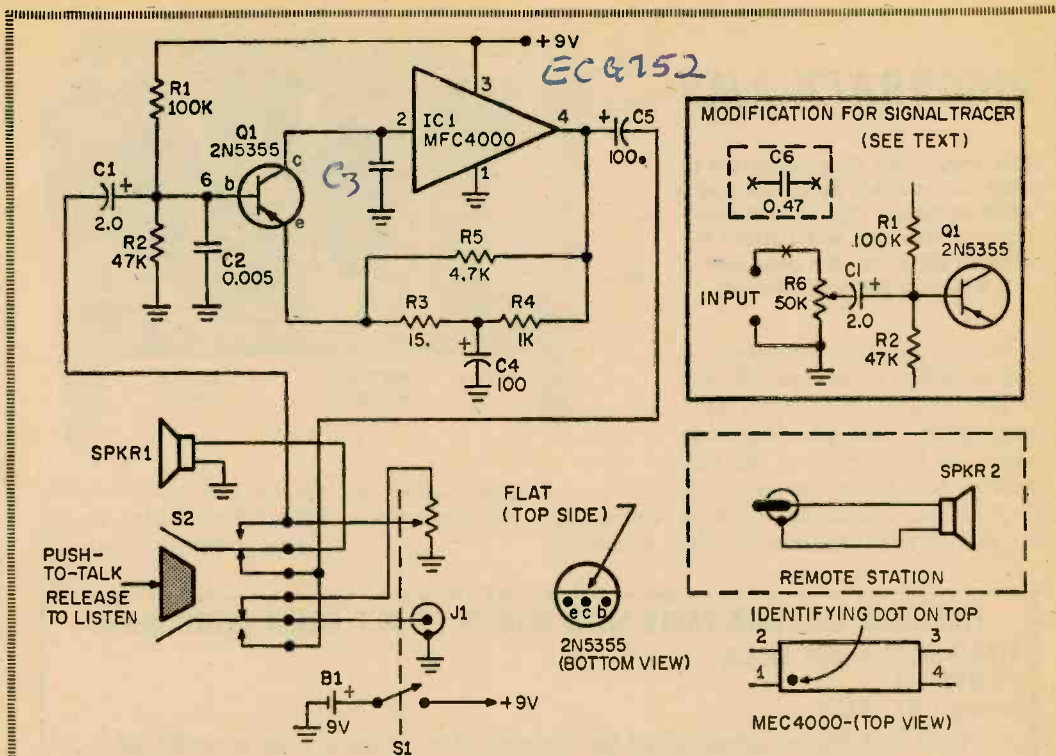
The overall frequency response is established by the capacitance of C5. Response will be essentially flat from 100 to 20,000 kHz when C5 is 500μF. Response will be down about 6 dB at 100 Hz when C5 is 100μF. However, since Piggyback Amp was intended for use with small speakers which can't reproduce lows, anyway, there's really no need for an oversize and expensive capacitor. Further, if C5's capacity will be greater than 100 μF, 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.

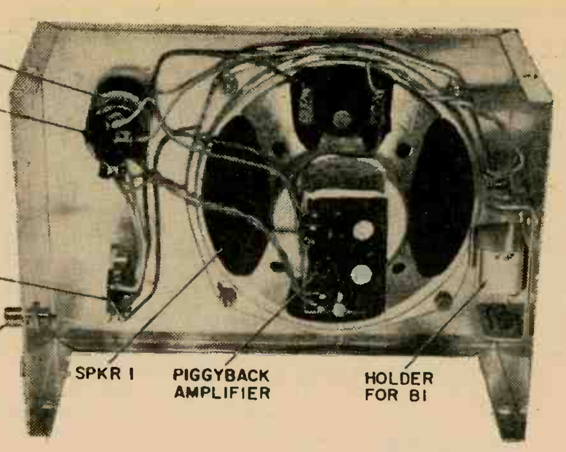
Mount all components, saving the IC for the last. All resistors are end mounted in a position perpendicular to the board; the capacitors are the printed circuit type with both leads on one end. Transistor Q1 is mounted using the full length of its leads. After the T-28 terminals or flea clips are soldered, 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 105)

PARTS LIST FOR PIGGYBACK AMP

Amplifier Parts Kit (parts mounted on PC Board)

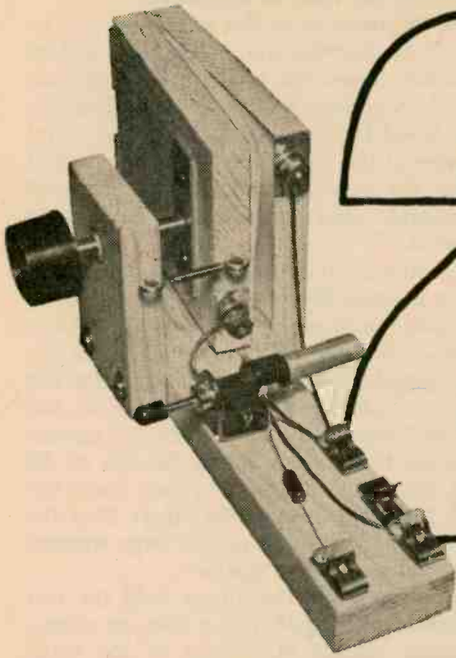
C1—2-µF, 3 to 50-VDC electrolytic capacitor for PC board (Aerovox BCD-5002 or equiv.)
C2, C3—0.005-µF, 75-VDC subminiature square ceramic capacitor (Lafayette 33E69048 or equiv.)
C4, C5—100-µF, 12 to 15-VDC electrolytic capacitor for PC board (Aerovox BCD-15100 or equiv.)
C6—0.47-µF, 100-VDC dipped mylar capacitor—see text (Lafayette 34E67248 or equiv.)
IC1—Silicon monolithic integrated circuit (Motorola MFC4000)
Q1—Pnp silicon transistor (GE 2N5355)
R1—100,000-ohm, ½-watt resistor
R2—47,000-ohm, ½-watt resistor
R3—15-ohm, ½-watt resistor
R4—1000-ohm, ½-watt resistor
R5—4700-ohm, ½-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.

RADIO FROM THE ROARING 20's



by Art Trauffer

Build an authentic Book Condenser Crystal Set

HERE'S a radio construction project that's just the reverse of what you'd expect. In this one, instead of making the coil and buying the variable tuning capacitor, we'll show you how to make a variable capacitor for use with a commercially made coil. You've got to admit that this is a project with a twist!

The variable capacitor we're going to show you how to build is called a book condenser. Its plates are hinged like the pages in a book, and capacitance is varied by increasing or decreasing pressure on the supports of the plates, which, in turn, increase or decrease spacing between the insulated plates—thus varying the capacity. Though this is a unique approach to varying capacity of a tuning capacitor, unfortunately we can't claim to be its innovator. Way back in the early 1920s, Crosley Radio Corporation (now a division of AVCO Corp. and renamed AVCO Electronics Div.) patented a design for and manufactured book condensers. These were used in the then famous Crosley Model 50, better known as the *Crosley Pup,* a one-tube broadcast band radio receiver.

Our *Book Condenser* is quite similar in basic design to the Crosley condenser. It's also easy to build, since it uses hardwood blocks, aluminum foil, tissue paper, etc., all materials normally found around the house.

The coil, a major component of the radio you'll wind up building upon completion of the condenser, is a standard ferrite cored variable loopstick used in many commercial radio sets, and therefore easily procured as a replacement part.

The How of It. Either the coil or the tuning capacitor shunted across it must be capable of having its parameters varied in order to tune across the band for which the combination has been designed. In this project the capacitance of the tuning condenser is varied by moving the plates closer together without shorting them, for maximum and moving them further apart for minimum capacitance. As the plates are brought closer together capacitance increases; as they are separated it decreases. That's all there is to it. The mechanical construction we've adopted is quite simple and therefore it's easy to make our variable book capacitor.

Making the Book Condenser. Two plates, one fixed in position and the other hinged so that it can be moved closer or farther

RADIO FROM THE ROARING 20's

away from the fixed one, is how we achieve variation in capacity. The plates for the condenser are made by carefully cementing aluminum foil to one side of each of two wooden blocks. The two blocks are mounted so that the foil sides face one another. A piece of unused airmail stationery, placed between the foil, insulates them.

The thickness of the paper determines maximum capacity—the thinner the paper the higher the capacity. That's why we've specified airmail stationery. This is just about the correct thickness for the plate sizes used to give our *Book Condenser* the capacity required to tune the loopstick coil over the broadcast band. The sizes of the blocks and mechanical details are shown in our photo and in the materials list.

Plate Connections. Be sure to leave a tab of aluminum that can be folded over the edge of the wooden block to make connections to the plates. After the cement has dried, fasten a soldering lug to the tab with a wood screw, making certain that the eyelet of the solder lug is held tightly against the foil by the head of the screw.

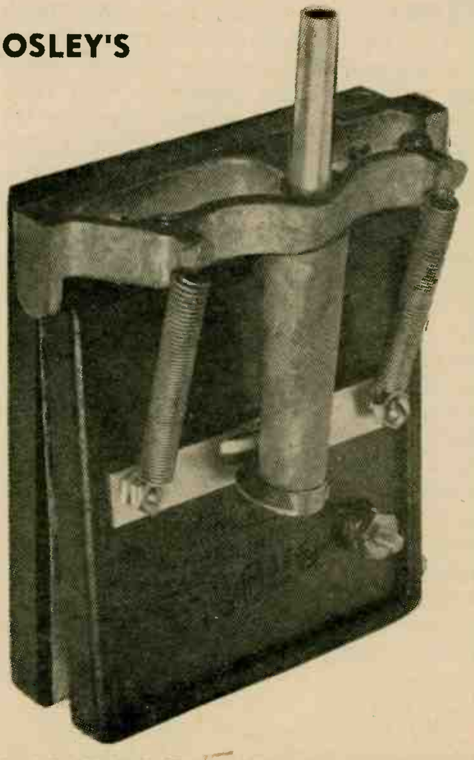
The foil must be as flat as possible, so be sure all air bubbles are pressed out before the cement dries and be careful not to tear the foil. A good cement to use is Pliobond. Since wood is more porous than the metal foil, spread the cement on the foil first and then on the wood. Press the foil to the wood immediately after spreading the cement on the wood.

A good way to ensure that the foil will be cemented smoothly is to first place the foil on a table top or other hard, smooth surface, facing *up* the side on which the cement has been spread, and then pressing down the cemented side of the wood block to the cemented side of the foil. After the cement has dried, trim excess foil to the size of the wood blocks. Cement the paper insulator, which has been cut slightly larger than the foil, to the hinged end of the large wooden block that is fixed in position.

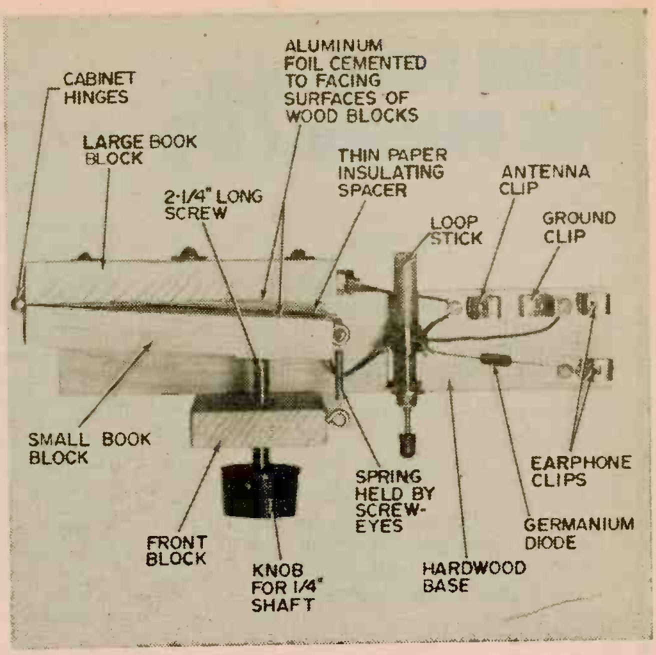
When mounting the hinges hold the two wooden blocks together in a vise, or clamp, to ensure correct movement of the small wooden block.

IN THE BEGINNING WAS CROSLEY'S BOOK CONDENSER

The Crosley book-type variable condenser consists of two molded insulating plates coated with metallic foil and hinged together at one edge so that they can be swung toward or away from each other like the leaves of a book. A cam, mounted on a shaft passing through a bearing in the condenser frame, and provided with a knob and dial, offers the mechanical means of adjusting this condenser. A thin sheet of mica is mounted between the plates in order that the capacity may be sufficiently high without making the plates excessively large, and so there will be no danger of short-circuiting no matter how close together the plates are pressed.
—Crosley Radio Corp., 1923



In this case innovation is the mother of invention. On the previous page we showed how one manufacturer, Crosley, made their commercial Book Condenser from metal and molded insulation. We've duplicated it with wood and aluminum foil. This top view of a complete radio shows its construction as well as location of all major components.



A screw or threaded rod, approximately 2¼ in. long and having fairly heavy threads, is threaded through the Front Block to exert pressure on the metal strip fastened to the small wooden block. Turning the knob clockwise causes the screw to change the length of the screw that projects beyond this Front Block. This in turn moves the Small Book Block closer to the Large Book Block.

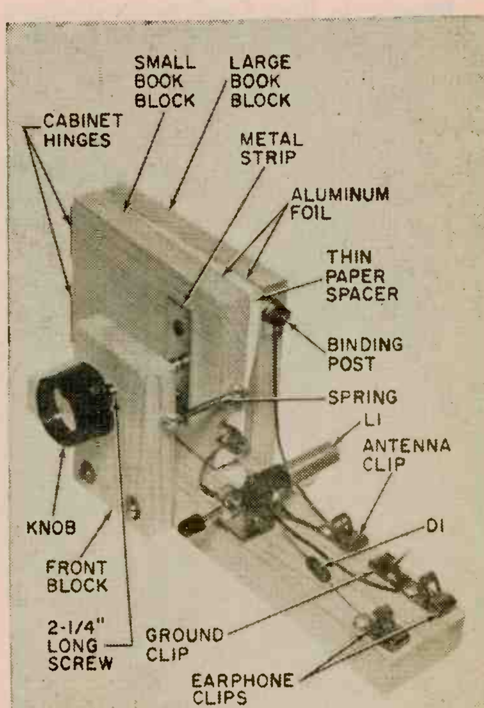
When the screw is turned counterclockwise, the part of the screw that moves the Small Book Block is shortened. The Small Book Block is pulled away from the Large Book Block by the spring stretched between the Front Block and the Small Book Block. Small screw eyes, one in the free end of the Small Book Block and one in the end of the Front Block that is adiacent to the free end of the Small Book Block, hold this spring in position.

Now the Coil. Remove all but 80 turns of wire from the loopstick coil to adjust its inductance to permit tuning the broadcast band with the capacitance of our Book Condenser. Mount this coil assembly on a 1 x 1 x ½-in. metal bracket with the ferrite core adjusting screw facing the front of the radio and fasten a small knob on the adjusting screw. You may find slight changes in the position of the core will improve the performance of the receiver.

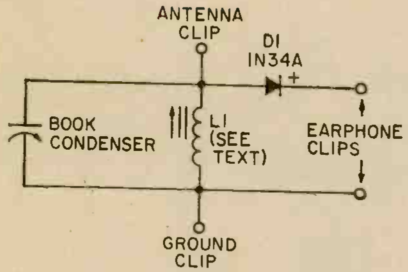
Connect the Book Condenser, coil, and crystal diode as shown in the schematic.

Enjoying Book Condenser Radio. Since there are no amplifier stages in this radio,

Just in case top view may not reveal all intimate details of construction of our Book Condenser we've included this oblique view. It's really a very crude approach by comparison with commercially produced ones even though they were made way back when radio was in its infancy.



RADIO FROM THE ROARING 20's



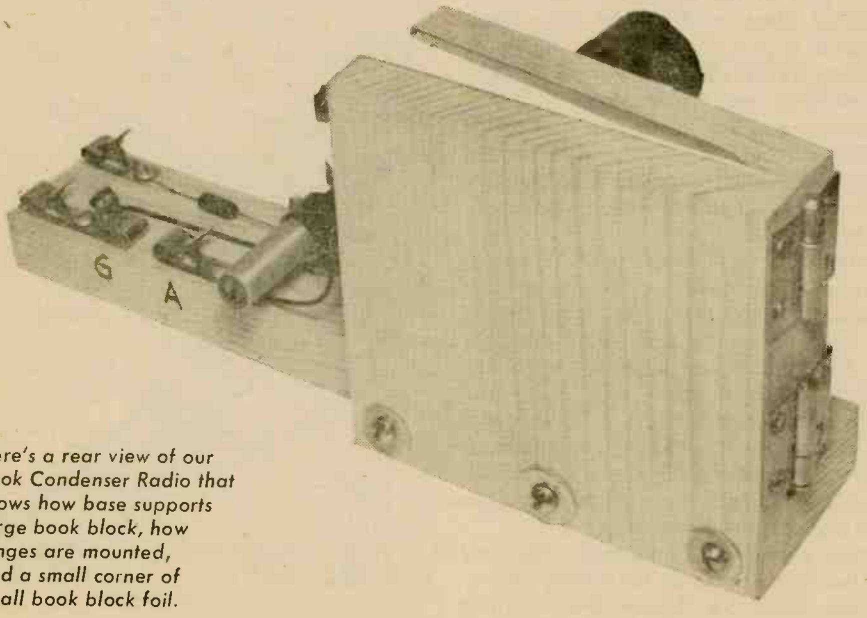
Back in the beginning we had solid-state radios but then they were called crystal sets. Note simplicity of circuitry.

BILL OF MATERIALS FOR BOOK CONDENSER RADIO

D1—Germanium diode, type IN34AS, IN60, IN82A, or IN295
L1—Variable loopstick (Lafayette 32E41064 or equiv.)
4—Fahnestock clips, medium size (Lafayette 32E71028 or equiv.)
1—Base, hardwood, 8½ x 1½ x ¾ in.
1—Block, hardwood, 3 x 2 x ½ in.
1—Small book block, plywood or hardwood, 4 x 3 x ½ in.
1—Large book block, plywood or hardwood, 4 x 3¾ x ½ in.
2—Brass cabinet hinges, 1 x 1 in. (usually available with required brass flathead screws)
1—Long screw, ¼-28NF x 2¼ or equiv.
1—Brass or polished steel metal strip, 2 x ½ in.
1—Spring, 1 in. long x 3/16 in. diameter
1—Knob for ¼-in. shaft
2—Screw eyes, ½-in.
Misc.—Aluminum foil, paper spacer, ½-in. round head brass wood screws, 1¼-in. round head brass wood screws, washers, wire, glue, solder etc.

it's important to use a long antenna and good water-pipe ground in order to collect as much signal as possible for the set. Since the output is high impedance, you must use either high-impedance magnetic or crystal headphones on the output.

Because the Book Condenser Radio has a simple single tuned circuit, it will not tune sharply, and therefore will receive only those stations whose signal strength is high and that are widely separated from other nearby stations. Strong local signals will be received best. If you are located near several powerful stations, this simple, broad-tuning receiver will make an ideal AM tuner for your hi-fi system. ■



Here's a rear view of our Book Condenser Radio that shows how base supports large book block, how hinges are mounted, and a small corner of small book block foil.

the MOVING COIL METER

SCIENCE FAIR PROJECT

Here's a real winner for a Science Fair project. It gives you the opportunity to show off your knowledge and understanding of basic measuring instruments as well as your dexterity with tools.

In previous issues of ELECTRONICS HOBBYIST we included articles on how to build more primitive meters such as a hot-wire ammeter and a moving-vane type meter (SnFe Moving Vane Ammeter). Now we consider you as graduate students ready to build the more sophisticated moving-coil type meter.

Moving-coil meters are used universally to measure DC current in all types of test instruments because they are highly sensitive, rugged and reliable, and relatively *(turn page)*

Build our accurate model of a moving coil meter and learn exactly how they work

by Charles Green, W6FFQ

MOVING COIL METER

inexpensive. They can also be used to measure AC current by first rectifying the AC with a small meter rectifier. Meters to measure AC directly without using a rectifier may look very similar to DC moving-coil meters. However, they are moving-vane instruments.

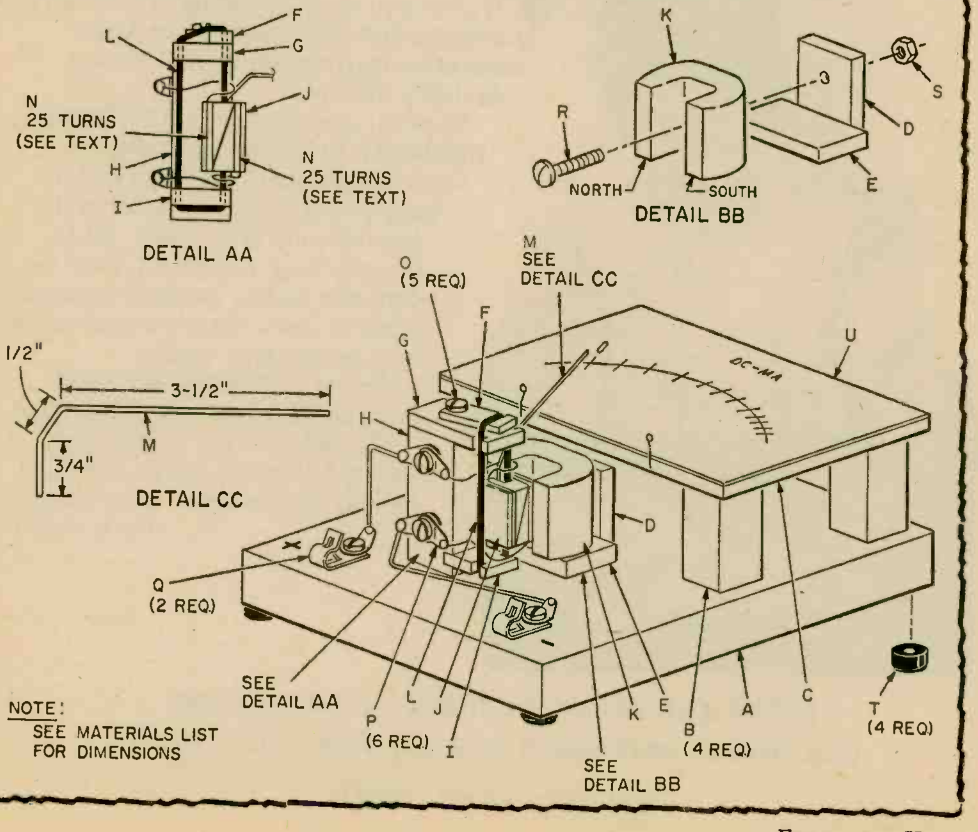
How Meters Read. The name moving-coil meter implies that a coil of wire will move whenever current flows through it. All DC moving coil meters employ a coil of fine wire suspended in a strong stationary magnetic field. The coil is pivoted so that interaction between the magnetic field of the fixed permanent magnet and the magnetic field created by the coil carrying the DC current being measured, rotates the moving coil assembly.

A pointer, attached to the moving coil,

BILL OF MATERIALS FOR MOVING COIL METER

A—6 x 7 x ¾-in. white pine
B—¾-in. sq. x 1½-in. white pine (4-Required)
C—4 x 5 x ¼-in. plywood
D—1¼ x 1 x ¼-in. plywood (see text)
E—1¾ x 1 x ⅜-in. plywood
F—⅜ x 1 x 3/16-in. white pine with end notch
G—¾ x 1½ x ¼-in. plywood with end notches
H—¾-in. sq. x 2-in. white pine (see text)
I—¾ x ⅞ x ¼-in. plywood with end notches
J—½-in. sq. x ¾-in. balsa wood with slot
K—Alnico magnet (Lafayette 14E33028 or equiv.)
L—Rubberband (see text)
M—Meter pointer (#18 copper buss wire—see text)
*N—50 turns 38 enameled magnet wire (see text)
O—Five #4 x ½-in. wood or sheet metal screws (Lafayette 13E43748 or equiv.)
P—Solder lugs (Lafayette 13E43433 or equiv.) (6-Required)
Q—Fahnestock clips (Lafayette 33E71028 or equiv.) (2-Required)
R, S—8-32 x 1 or 1¼-in. machine screw and nut
T—4 rubber bumpers
U—4 x 5½-in. heavy white paper for meter scale
Misc.—Hookup wire, 200-ohm rheostat (Lafayette 33E16064 or equiv. 1½-V. battery, VOM or DC milliammeter

* ¼ lb. #38 enameled magnet wire (Lafayette 32E30802 or equiv.) • If #38 not available use wire from an audio transformer or the secondary of an old power transformer. You may have to add or subtract turns because of differences in wire gauge to have meter as sensitive as the model.

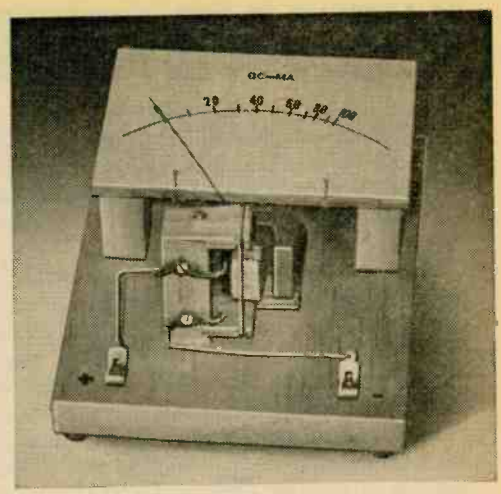


is deflected across an arced line calibrated in units to provide a relative value for the measurement. A hairspring formed in a helix is fastened to the coil at one end and to the basic structure of the meter at its opposite end.

As the coil is rotated by current flow, it exerts force against the spring. When the resistance of the spring becomes equivalent to the rotating force, the pointer stops and we read the value on the scale at the point directly under the pointer. An adjusting screw is provided to set the pointer on the scale's zero when no current is flowing.

In order to ensure greater accuracy means are taken to reduce friction and drag of the moving coil to a minimum. The coil is usually wound on a very lightweight, non-magnetic metal form which is pivoted in jeweled bearings. Within the last few years a new method of suspension called taut-band suspension has been developed. Instead of using jeweled pivots with their inherently small friction to suspend the moving coil the coil assembly is suspended on a thin metal strip that is stretched tight to hold the coil accurately in position. The helical hairspring is dispensed with by twisting the thin metal strip. This method of suspension provides an even more friction-free meter movement which results in a more sensitive instrument.

Be An Instrument Maker. As you can see from our photos and drawing, our model of a moving-coil meter has been made in a very simplified form to facilitate construction. It's a taut-band moving-coil instrument by virtue of the rubber band suspension of the moving-coil assembly. We used wood for the various supporting structures because it's easier to work with and most ev-



Here's how your finished MCM will look. Its innards are very similar to a bought meter.

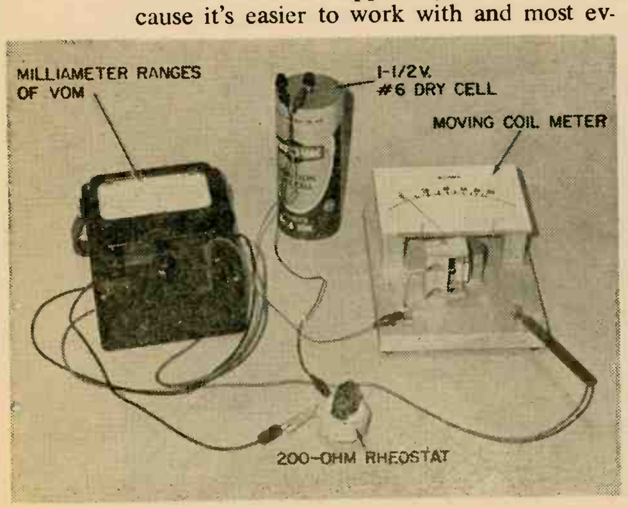
eryone has the very few hand tools required.

Size is relatively unimportant. However, we suggest you follow the dimensions and construction details given in the drawing and Parts List. In this way you should have no difficulty in making the meter and you won't have to fiddle with changing the number of turns of wire for the moving coil to compensate for a change in physical size.

You should cut out all of the various pieces of wood and sand them smooth before actually starting to assemble the meter. Mount rubber feet on the bottom four corners of the base (A) and then glue the 4 supports (B) to A, as shown in the drawing. Next cement the scale platform (C) to these supports. We used our electric glue gun, but epoxy cement, Elmer's glue, Pliobond, etc., can be used with equal success.

Now you're ready to cement the magnet and moving-coil assembly supports to base A. Pieces D, E, G, and I are made from ¼-in. plywood. First step is to cement D and E in their respective locations and fasten the magnet in place. If the magnet you use isn't drilled at the bottom center of the U to allow a bolt to go through it to hold the magnet in place, it too can be cemented to D and E.

At this point the main support block H should be readied for cemeting. But first you must notch it out so that piece I can be properly fastened to it. Hold H on the base (A) adjacent to piece E and mark H



A VOM is very helpful in calibrating the Moving Coil Meter. If no VOM is handy try a 0-100 mA milliameter in same circuit.

MOVING COIL METER

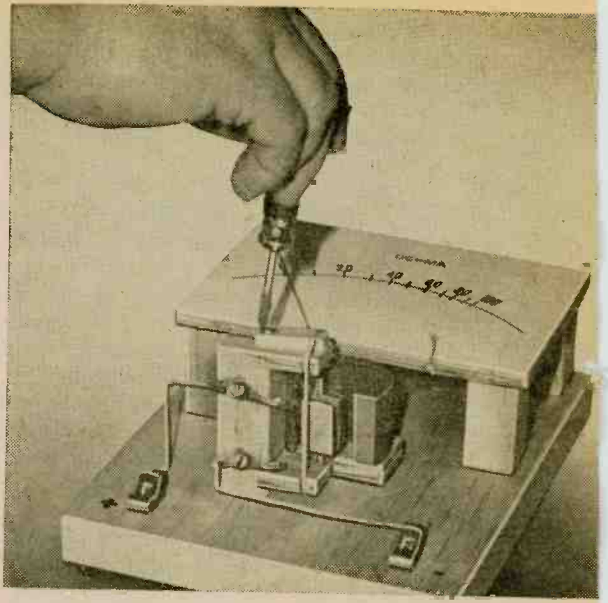
so that the top of the notch will be even with the top of piece E. The notch should be about ¼-in. deep. Best way to determine its depth is to hold piece G in position at the top of H and place piece I so that its notched end is even with the notched end of G.

Mark the depth of the notch in block H based on the position of the end of piece I that will be inserted in the notch when its free end is matched with piece G as mentioned above. Be sure that the notch in block H is cut square so that the surface of piece I will be square with the surface of block H when I is cemented in place. The notches in the free ends of I and G are required only to hold the rubber band in position. Cement block H in position, and also piece G to block H as shown in our drawing.

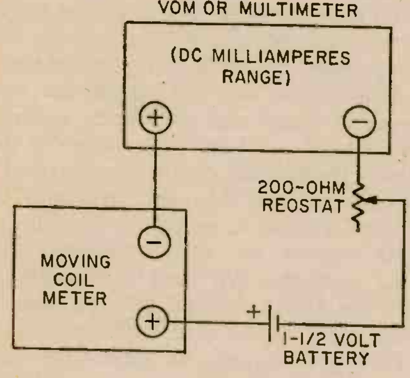
The form block for the moving coil (J) is made from balsa wood, which is lighter in weight than any other wood and therefore contributes to the sensitivity of the instrument. Cut a slot in the center of J as shown in our drawing. The rubber band (L) is cemented in this slot. We used a rubber band approximately 1¾ x ⅜ x 1/16 in.

The moving coil is made in two sections by winding 25 turns of #38 enameled magnet wire on each half of J. After completing the first 25 turns, without cutting the wire, continue to wind another 25 turns on the other half of J in the same direction. Put a touch of cement to the ends of each coil to hold the wire in place and leave 6-in. lengths of the start and finish of the two-section coil for future connection to it.

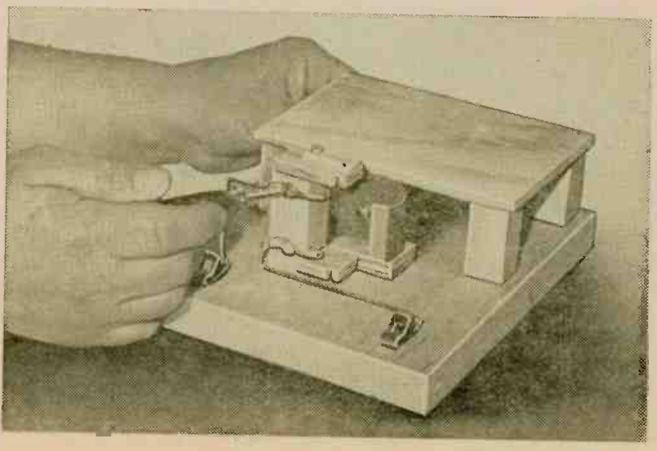
(Continued on page 103)



To zero pointer, simply loosen screw and move wood block, thus repositioning coil assembly.



You don't have to use a VOM or multimeter for calibrating your Moving Coil Meter. Any 0-100 mA or higher milliameter will do the job just as well, provided that its accuracy is fairly good.



By this stage you've almost completed the project. Except for cementing the scale on its platform, mounting the moving coil, and calibrating it, you're ready to make measurements or enter the Fair.

COLD-FLASH

By the flashing lamp in that window they shall find you

by James G. Busse

BLINKING a light is no great electronic feat (there are dozens of circuits around for that purpose). But how about a blinking light that can be seen for several miles in the dark of night and that won't burn out unexpectedly? How about one that will run for more than a year from sunrise to sunset on a single lantern battery? And get this, what about one that will continue to operate in low temperatures till battery voltage drops considerably because of temperature and then will start up again when battery voltage is restored by rising temperature, without affecting loss of power or life? Believe it or not, you can build one for just a few dollars.

Cold-Flash is based on a high-performance, high-reliability blinker beacon originally developed in Canada for navigation and rescue applications. In its present form *Cold-Flash* makes an ideal camp, trail, and dock marker. Put one on your boat or camp trailer. Mount *Cold-Flash* on a buoy to mark the location of underwater obstructions or a favorite nighttime fishing spot. Two units will permanently mark the entrance to your driveway at home in any kind of weather. And these are but a few of the countless uses for *Cold-Flash*.

How It Works. Basically, *Cold-Flash* employs a spiked pulse generator coupled to a stepup transformer to produce a high-voltage pulse that fires a fluorescent lamp bulb, much in the manner of a strobe. There are only nine components in its all-solid-state circuit. Silicon transistors for Q1 and Q2 are mandatory for maximum efficiency, for resistance to temperature extremes, and for the ability to handle hefty pulses of millisecond duration that may reach half an amp or more when the unit fires.

A cadmium sulfide photocell (PC1) is used to turn on *Cold-Flash*

COLD-FLASH

at dusk and to extinguish it at dawn. When the cell is exposed to normal daytime light levels, its resistance drops to less than a few hundred ohms, thus dissipating the charge on electrolytic capacitor C1. Its flash rate of approximately one flash per second, obtained with the capacitor and lantern battery specified in the Parts List, is established by the value of C1 and the impedance of the 6V battery (B1). Light levels to turn *Cold-Flash off* and *on* will vary somewhat, depending on the characteristics of PC1.

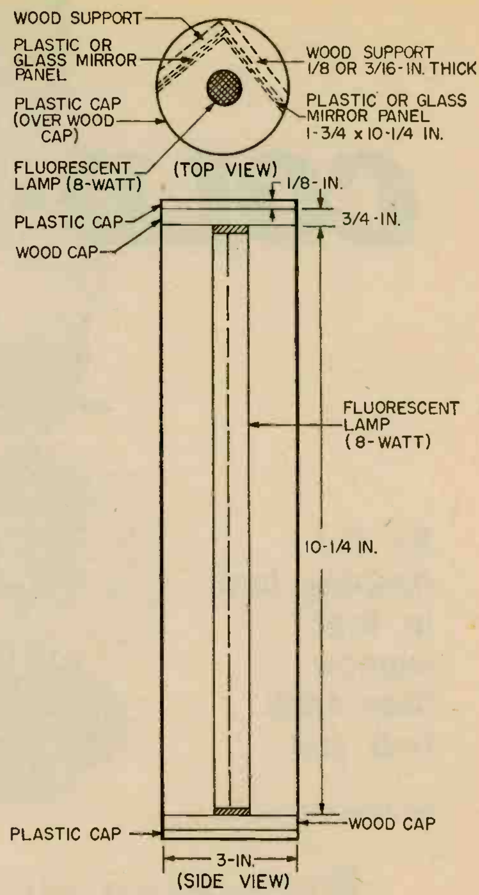
Long Battery Life. In the *off* state, current drain is less than 140 μA, which accounts, in part, for the exceptionally long battery life afforded by the unit. Equally important is the use of a fluorescent lamp bulb, operating like a giant neon bulb, in place of the usual incandescent lamp with its current-wasting hot filament.

Another obvious advantage offered by the fluorescent lamp is that it will last for years in *Cold-Flash* since the starter filament in the lamp isn't used to initiate fluorescence that produces illumination. Also, for all intents and purposes, the fluorescent lamp is almost a foot-long source of illumination. In addition, its blue-white light can be seen at much greater distances than the yellow-white light from incandescent-type blinkers.

If cold weather should affect the battery's output voltage, causing it to eventually drop below 2 volts, *Cold-Flash* will stop in the *off* state, thus minimizing power drain. It will start blinking again when the battery begins to recuperate as the temperature rises and the voltage reaches a couple of volts, provided, of course, that the light level outside is low enough to affect the photocell (PC1).

A right angled, dual panel, mirror-reflector, shown in our illustrations, was used to increase the unidirectional light output of *Cold-Flash*. The author used the model unit as a directional navigational aid. Actually, the fluorescent lamp assembly can be mounted permanently in any position to suit its particular application. It can even be used as an underwater beacon provided the lamp electrodes are properly insulated.

Construction. With the exception of the fluorescent lamp and the battery, all components are mounted inside a sturdy molded plastic box, 3¾ x 6¼ x 2-in., to protect them from the weather. Clear or black silicone rubber sealant, available from most



You can convert unidirectional Cold-Flash lamp assembly to omnidirectional one simply by omitting right angled mirrors. Make supports for top and base from rods.

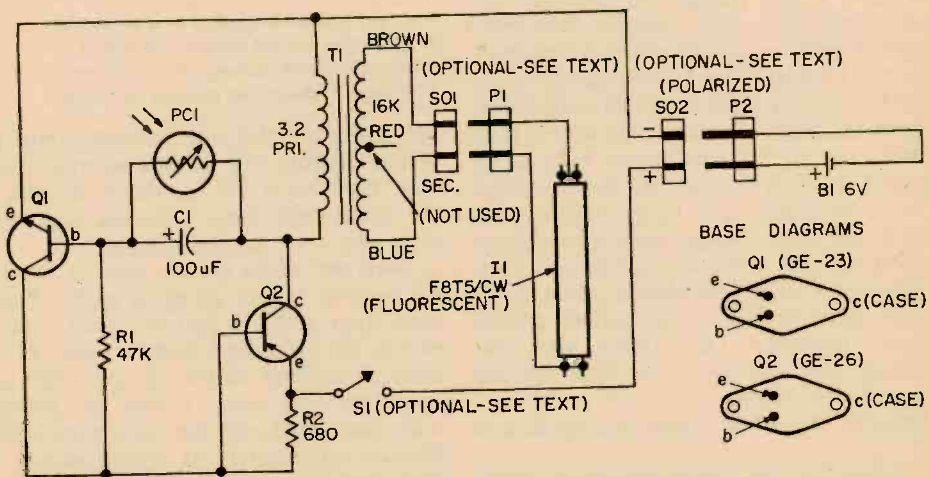
hardware or auto parts stores, is used to seal the cover and the holes around P1 and P2, S1 and PC1. Don't forget to also seal the bolts holding transformer T1 and the perfboard subassembly in place in the cabinet.

Circuit components Q1, Q2, C1, R1, and R2 are mounted on a small piece of perfboard, cut to fit the contour of the inside of the plastic box. Interconnected by point-to-point wiring, they form a subassembly. Parts layout isn't critical, but keep in mind that the power transistors' cases are their collectors. Therefore, insulate them from one another and from the other components. Use two small bolts to secure each of the transistors to the perfboard.

Drill two small holes through the top of the plastic box for the leads from PC1. The photocell is held in place on the outside top

PARTS LIST FOR COLD-FLASH

B1—6-V lantern battery (Eveready #731 or equiv.)—see text
C1—100 uF, 15 V electrolytic capacitor (Lafayette 34E5144 or equiv.)
I1—8 W. miniature fluorescent lamp bulb F8T5/CW)
P1—2 contact plug (may be any type available) —optional, see text
P2—2 contact polarized plug (Lafayette 34E20015 or equiv.) optional, see text
PC1—Cadmium sulfide photocell (Lafayette 99E63216 or equiv.)
Q1—Npn silicon transistor, AF power type, GE-23
Q2—Pnp silicon transistor, AF power type, GE-26
R1—47,000 ohm, ½ watt resistor
R2—680 ohm, ½ watt resistor
S1—Spst subminiature toggle switch (Lafayette 99E61624 or equiv.)
S01—2 contact socket to match P1
S02—2 contact polarized socket to match P2 (Lafayette 34E20460 or equiv.)
T1—5 to 8 watt tube type output transformer: primary, 16K to 25K ohms; secondary, 3.2 ohms (Lafayette 33E81415 or equiv.)
1—6¼ X 3¾ X 2-in. plastic box (Lafayette 19E20016 or equiv.)
1—Blank cover for above box (Lafayette 19E37010 or equiv.)
Misc.—Bolts, nuts, silicone rubber sealant, press-on letters (Datak or equiv.), zip cord, two plastic or glass mirror panels/and scrap wood for mounting them (for the corner reflector of the fluorescent lamb bulb), wire, solder, hot melt glue (optional), etc.



surface of the box with the silicone rubber sealant. For maximum sensitivity, PC1 must look straight up into the sky. Power switch S1 is optional—you can turn *Cold-Flash on* simply by plugging in the battery leads, thus not needing a switch to turn the unit *on* or *off*. Aside from saving the cost of the switch, it's one less component that has to be sealed.

If your *Cold-Flash* will be permanently installed, you can eliminate both plugs and sockets. Drill two holes to pass the battery and fluorescent lamp leads through the side of the plastic box. Use grommets to protect the wires and help in sealing the openings. On the other hand, the plugs and sockets are worthwhile accessories if you make your *Cold-Flash* portable so you can take it with you when you go boating or camping. The fluorescent lamp bulbs are relatively inexpensive, selling for under $2.00; therefore, you may prefer to mount several of them permanently on your boat, your trailer, your home, etc., and move just the control and power source with you wherever you may roam. In that way you get the benefits of owning several *Cold-Flash* units with an investment just a little more than the cost of one or two.

Power transformer T1 is a speaker output transformer used as a step-up transformer. Thus, as we have applied it, the voltage of the pulses fed its 3.2-ohm primary (normally the secondary when used as a speaker transformer), will be raised by a factor of more than 50. The output of its 16,000- to 25,000-ohm secondary (actually the primary in its original circuit application) is fed directly across the fluorescent lamp to fire it to produce a burst of light. Since the fluorescent lamp is really a self-rectifying tube, no

COLD-FLASH

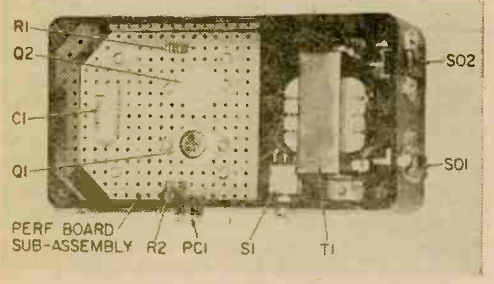
external rectification is required.

Though you would certainly save space and weight by using a transistor-type output transformer, the 5- to 8-watt capacity of the larger tube-type transformer reduces the possibility of momentary overload and subsequent insulation breakdown. Some output transformers, including the one specified in the Parts List, have an additional tap in their secondaries, which should be ignored for this application.

A word of caution. Though approximately 300 volts are developed with each short-lived pulse that emerges across the high-voltage output of T1, physical contact with this *hot* line isn't particularly dangerous. It does have a *bite* though, so take care in handling this line. Also, persons who may be susceptible to epileptic seizures shouldn't stare at a flashing *Cold-Flash* at close range.

Do *not* operate the *Cold-Flash* control unit without the lamp connected, or with a load greater than the 8-W fluorescent bulb we've specified. Though the unit will fire a smaller 4- or 6-W fluorescent lamp, loading the control unit with a larger lamp or a regular strobe tube will damage either one or both of the transistors. Accidental reversal of battery polarity input will almost always damage transistor Q2. That's why the polarized plug and socket is used for the battery supply leads.

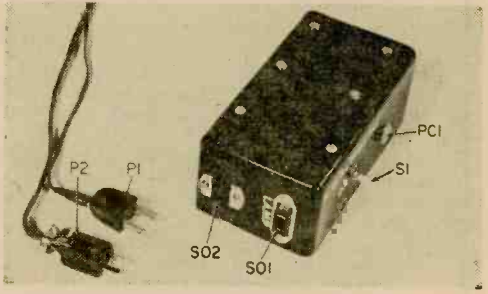
Reflector Assembly. Solder the leads that



By mounting all parts except T1, S1, PC1, SO1, and SO2 on perfboard and keeping battery and lamp separate, there's ample room inside plastic box for complete unit.

connect the lamp to the control unit directly to the pin contacts at each end of the fluorescent lamp as shown in our drawing, making sure that there is good contact on both pins. Mount the lamp in whatever manner that best suits your particular application. It can be mounted inside a clear or colored plastic tube sealed at both ends for safe marine installations.

Or, if you're looking for maximum light output in a specific direction, build a reflector assembly similar to the one shown in the photos and drawings. This reflector was fabricated from two plastic mirrors mounted on pieces of scrap wood cut to fit the mir-



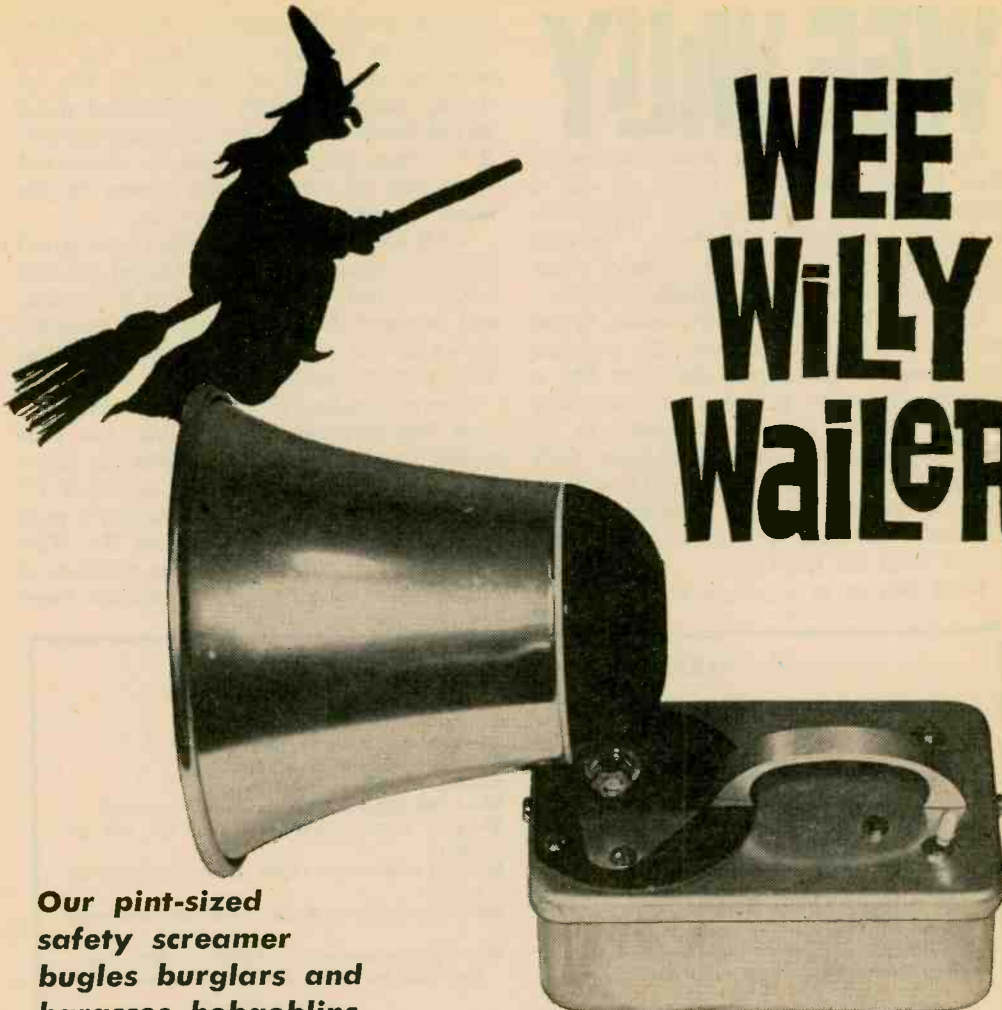
We used a polarized plug and socket for B1 to ensure correct polarity to unit at all times to avoid damage to transistors. PC1 should always be pointed skyward.

rors and assembled with an electric glue gun. (Glass mirrors will do just as well, though they may be a bit heavier.) Sockets for the fluorescent lamp bulb are superfluous since you won't be replacing it.

Checkout. Make certain that S1 is in the *off* position before plugging in the fluorescent lamp and the battery. Then flick the switch *on*. If enough light reaches PC1 to keep *Cold-Flash* in the *off* state, the lamp will flash only once. Cover the photocell with your hand and the lamp should begin flashing immediately at approximately one flash per second. Remove the cover over the photocell and it will stop flashing.

Now move *Cold-Flash* outside the shop. With PC1 *looking* up to the sky the lamp should stop flashing and start again as daylight diminishes or PC1 is shielded from outside light. There are no critical adjustments to be made. However, you may want to try a photocell having a different light response. The more sensitive the cell, the earlier Cold-Flash will come *on* in the evening and go *off* in the morning.

Troubleshooting. If construction details were carefully followed there should be no troubleshooting required. If the unit doesn't flash, turn *off* the power immediately and carefully doublecheck your wiring, particularly the polarity of the battery connections and the connections soldered to the fluorescent lamp. If the unit still doesn't flash, replace Q2 and, if necessary, Q1 in that order. ■



WEE WILLY WAILER

Our pint-sized safety screamer bugles burglars and harasses hobgoblins

by Charles D. Rakes

HALLOWEEN will soon be creeping up behind us, pointing its bony hand toward Jack o' Lanterns, hobgoblins, and pumpkin pies. If a member of your family gleefully participates in this great annual Trick-or-Treat Rite, you can add to his Hallowed Eve's tomfoolery with our Wee *Willy Wailer*. As Wee Willy's name implies, it's an electronic siren small enough to tuck under a gypsy, or ghoul, or giant costume—and big enough in the sound department to scare the shoes off your neighbors or the pants off a burglar. W.W. Wailer's no ordinary screamer, either; it can imitate a police siren's rising and falling pitch down to the last detail. And you won't need to grovel for funds City-Hall style to build Wee Willy, as fifteen leaves of Washington lettuce pay our screamer's way onto your workbench.

turn page

WEE WiLLY

Satanic Sounds. Muscle your orbs toward Wee Willy's schematic. You'll see it's a three-stage affair consisting of a unijunction transistor sawtooth oscillator, speaker power-amplifier stage, and a field effect transistor hooked up as a variable resistor.

Let's see how Wee Willy wails. When power's first applied via switch S1, unijunction transistor Q2 merely sits there like a three-legged lump. It doesn't do anything because it's not biased sufficiently in its forward-conducting state. Transistor Q3's direct-coupled to Q2's base 1; if Q2 doesn't generate pulses, Q3 has nothing to do. Naturally the end result is earnumbing silence from the speaker.

We'd like to give you a few words of wisdom about that speaker. Any miniature speaker of 8-ohm impedance you can scrounge up works in this circuit. For instance, you've probably cannibalized many an All-American Five for its 4-ohm speaker. If this rings your brain's bell, go ahead and bring two of those golden toners to life again by wiring them in series.

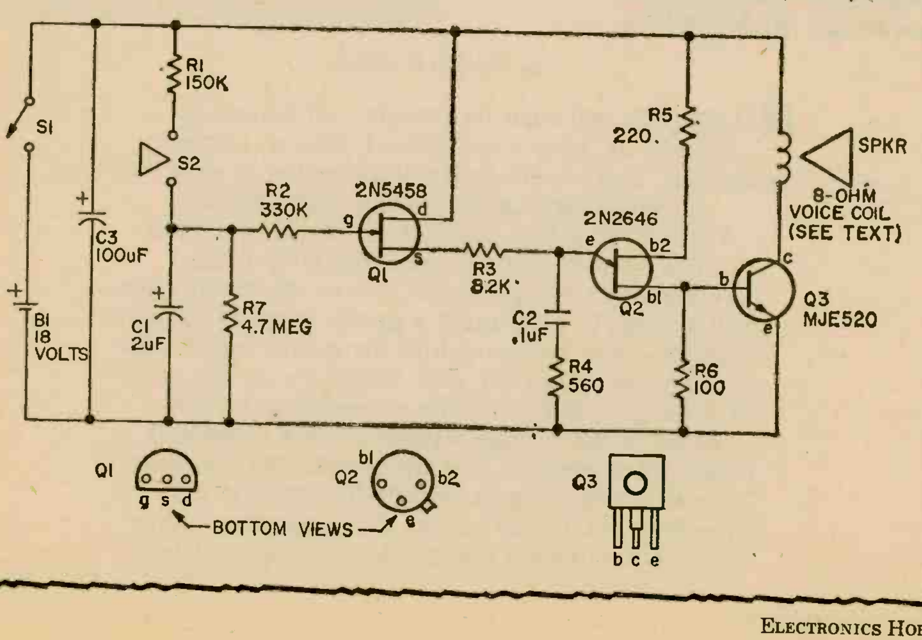
Want more sound power from your siren? Find *two* speakers having identical 16-ohm voice-coil resistance. Wire them in parallel, and connect the pair where one speaker's shown in the schematic. But back to Wee Willy's modus operandi.

You're standing in a neighbor's doorway, treat bag in hand, and it's time for your wailer to give with its gangbusters introduction. Press switch S2, and capacitor C1 begins to charge toward the battery's peak positive voltage through resistor R1. This action, in turn, drives Q1's gate positive; in effect, we're causing Q1 to conduct more

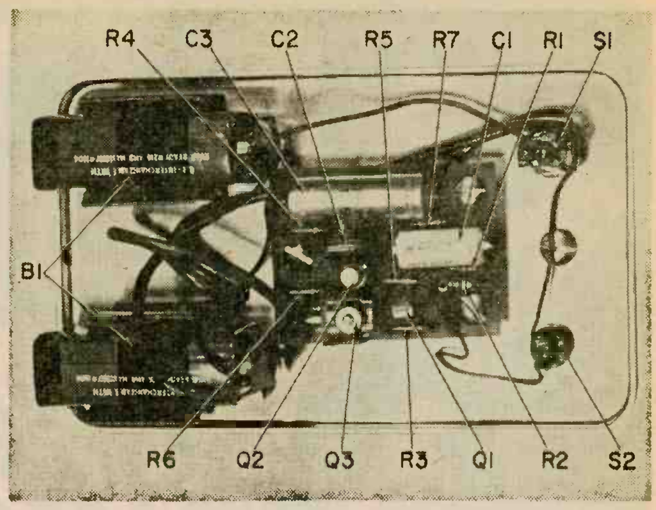
PARTS LIST FOR WEE WILLY WAILER

B1—18-Volt battery (2 Burgess 2U6 or equiv. in series)
C1—2-uF, 50 VDC electrolytic capacitor (Sprague TE-1301 or equiv.)
C2—0.1-uF, 100 VDC mylar capacitor (see text) (Sprague 10491 or equiv.)
C3—100-uF, 25 VDC electrolytic capacitor (Sprague TE-1211 or equiv.)
Q1—2N5458 transistor (Motorola)
Q2—2N2646 transistor (Motorola)
Q3—MJE520 transistor (Motorola)
R1—150,000-ohm, ½-watt resistor (see text)
R2—330,000-ohm, ½-watt resistor
R3—8,200-ohm, ½-watt resistor
R4—560-ohm, ½-watt resistor (see text)
R5—220-ohm, ½-watt resistor
R6—100-ohm, ½-watt resistor
R7—4,700,000-ohm, ½-watt resistor (see text)
S1—Spst switch (Continental-Wirt GF 323 or equiv.)
S2—Spst momentary switch (Switchcraft 101 or equiv.)
Spkr—Speaker with 8-ohm voice coil (see text)

Misc—Battery connectors, battery holder, case, flea clips, hardware, perf board, solder, wire.



Turning Willy into burglar bugler entails few changes. First situate speaker so it will make itself heard in area being protected. Then substitute trip wires for switch S2. Arrange wires at devices to be protected so they make contact when they're touched. You can protect any number of your valuables by connecting all trip-wire sets in parallel with switch S2.



heavily by increasing the FET's gate bias.

As Q1 is driven harder and harder, more current's drawn through resistor R3. This resistor is in series with Q1 *and* Q2. As more current flows through R3, transistor Q2's emitter voltage also rises. At some point Q2 will start to behave like a sawtooth oscillator and, *voila,* Wee Willy lets loose. But hold on—you're not finished yet!

Capacitor C2, you'll remember, is charging up toward B1's 18-volt level. Yes, we're driving Q1 harder, and drawing more juice through R3. Wee Willy's voice steadily rises from baritone to soprano, all the while serenading you and your hapless neighbor in fortissimo. Now take your finger off S2; the wailer will slowly shift its vocal range downhill. Capacitor C1's discharging through resistor R7, eventually bringing us back where we started from—pianoforte, and then silence.

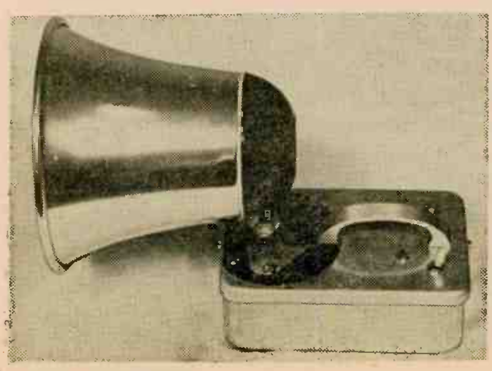
Workshopping Wee Willy. Our siren falls into the "anything goes" construction category. The author built his siren into a 5 x 3 x 1¾-in. metal box. He even whipped up a printed circuit board for his prototype version. But we like to get more yocks using Wee Willy, so to save time it's the perfboard route for us. Note B1's two 9-volt batteries connected in series. They can be secured to the perfboard in any manner you can think of. The easiest and cheapest battery holder consists of a rubber band looped over the ends of each battery.

End loops of the rubber band are inserted through the perfboard, and connected together on the perfboard underside with a short length of wire inserted through these loops and twisted together.

We needn't say too much about electrolytic capacitor polarity. And do exercise caution while you're soldering home the transistors. These little devils could never appreciate heat applied to their leads.

You might try building Wee Willy into your treat bag or costume. If you've got a large head mask for the occasion, wire two speakers as described and glue them into your mask's cheeks. Other Frankensteins will find the treat holder's their bag. These poltergeists will glue S2 to the bag handle, so it's easy to activate.

If you want to fiddle with Willy's wail, then experiment with resistors R1 and R7. Varying these components' ohmic values changes capacitor C1's charge and discharge rate. Resistor R4 can serve as a volume control if you substitute a 1000-ohm potentiometer for it. And finally, varying capacitor C2 changes Willy's basic frequency range. ■



Funnel-shaped thing shown on top of prototype version is author's speaker. Lafayette Radio sells it as stock no. 99 E 45080.

Our ever-so-simple construction project's guaranteed to keep 'em guessing

by Roy E. Pafenberg

Here's a one-evening Science Fair project, guaranteed to mystify those household electronics experts-in-residence, and knock the socks off the novice who knows it all (or thought he did)! Even your kid sister is no doubt aware that when you take a pair of ordinary lamps and toggle switches, wire them all in series and connect them to the power line, nothing happens 'til both switches are closed. When they are, both lamps glow at reduced brilliance.

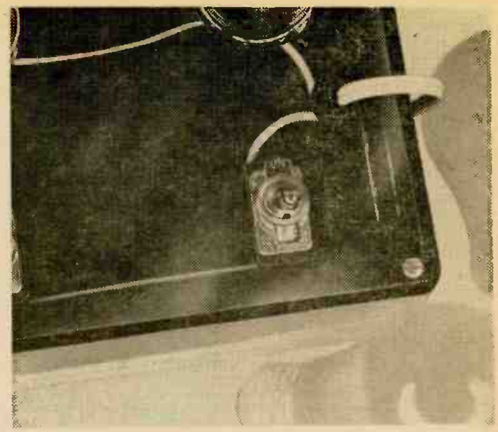
Not so with our *Magic Lamp*! Turn *off* both switches and hang our wonder box across the AC juice. The lamps remain *off*—whatdja expect, dancing girls? Throw one switch *on* and its corresponding lamp does a solo performance; throw the second switch *on* and both lamps glow. Reverse the sequence, and you'll see the same puzzling performance. Want to baffle your class Einstein? Remove one lamp from its socket and the other lamp's operation is unaffected. (They'll think you're onto some new and brain-boggling theory!)

What really stumps the experts is that *Magic Lamp's* method of construction makes all wiring clearly visible and a circuit diagram is provided to further confuse the issue. Given a really effective demonstration on your part, our *Magic Lamp* should turn you into a science project show-stopper *par excellence*.

Unraveling the Puzzle. A little basic theory of Magic Lamp's workings serves as a fascinating introduction to diode switching circuitry. Follow the action with our schematic diagram.

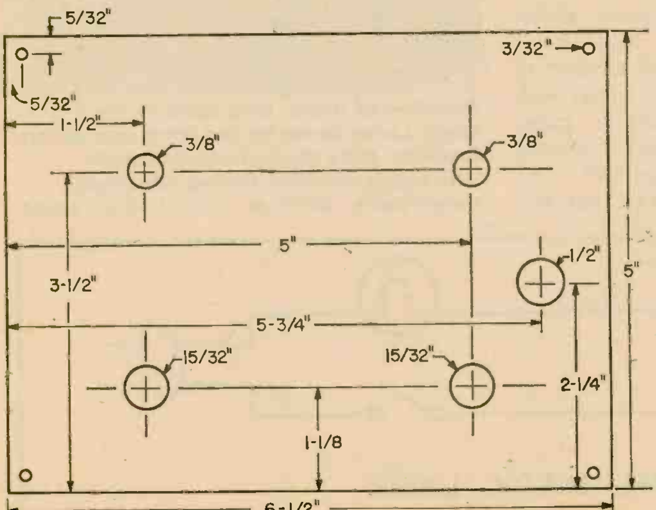
With both switches S1 and S2 open, silicon diodes D3 and D4 are connected back-to-back. This setup effectively blocks both the positive and negative half-cycles of the applied AC voltage, so no current ever reaches the lamp circuit. With switch S1 closed, diode D4 passes the positive half-cycles of the applied AC voltage to the series-connected lamps I1 and I2. Diode D1 thinks it's reverse-biased, so it doesn't conduct and current flows through lamp I1 to parallel-connected lamp I2 and diode D2.

Diode D2, on the other hand, conducts and completes the circuit to the other side of the AC line. Now you're beginning to see the light. Since the voltage drop across diode D2 is quite low (approximately 0.7 volt), current flows through D2 and lamp I2 remains extinguished. Lamp I1, however, glows at reduce brilliance 'cause we're feeding it with less than half its rated voltage.



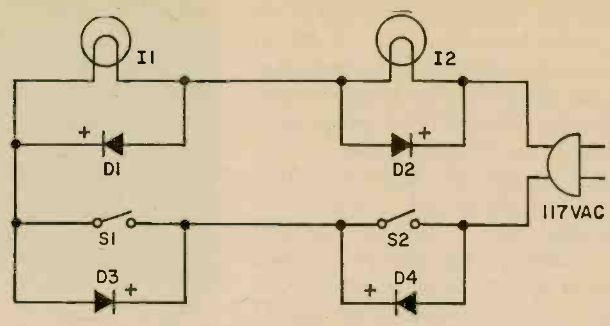
Part of Magic Lamp's secret lies under base of toggle switch, hidden from viewer.

Close switch S2 and, with switch S1 open, the reverse condition occurs. Lamp I2 glows while lamp I1 remains extinguished. With both switches S1 and S2 closed, full AC voltage hits both lamps. All this togetherness causes quite a family row, so diode D1 passes the negative half-cycle of the applied voltage and the positive half-cycle flows through the filament of I1. Not to be outdone by his sibling rival, diode D2 passes the positive half-cycle of the applied voltage and the negative half-cycle flows through the filament of I2. Both lamps are glowing at reduced brilliance. And if you've got our *Magic Lamp* at a science fair, a lot of guys



Clear plastic top covers' dimensions, hole drilling data. Except for smallest holes, we suggest you start drill operations with smaller size bit, eventually working your way to specified hole diameter.

MAGIC LAMP



PARTS LIST FOR MAGIC LAMP

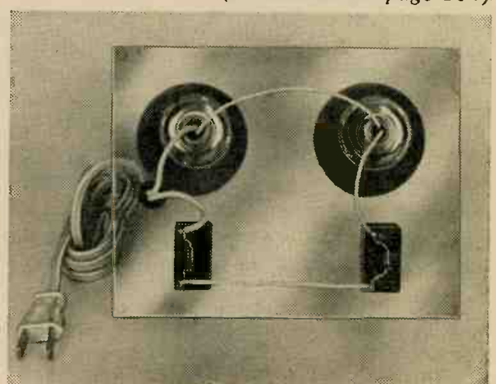
- D1-D4—Silicon diode (1N2070 or equiv.)
- I1, I2—Lamp, 25-watt, 115 Volt standard screw base, red frosted
- S1, S2—Spst toggle switch (Lafayette 99T 6150 or equiv.)
- 2—Lamp socket, medium screw base, keyless, brass shell
- 1—AC line cord, no. 18 zipcord, 6 ft. long
- 1—Instrument case, black plastic (Allied Radio no. 42 A 7886 or equiv.)
- 2—Threaded nipple, brass, ⅜ x ½-in. long with lock nut
- Misc—Acrylic plastic panel, linecord strain relief, hookup wire, solder, etc.

are sure to be cracking a bunch of half-smart remarks like "Only ML's constructor knows for sure!"

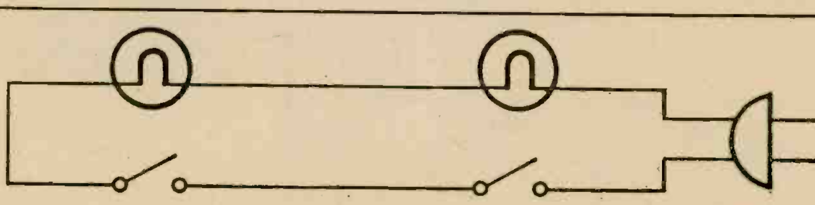
Construction. *Magic Lamp* may take any desired form just so long as there's no exposed wiring to provide a shock hazard. The method of construction we've shown in our photo is considered ideal because it provides a safe, shock-proof enclosure, permitting visual examination of the circuit wiring. It also allows silicon diodes D3 and D4 to be completely concealed behind the toggle switches while D1 and D2 hide in the bases of the lamp sockets.

Magic Lamp's housing is a black plastic instrument case measuring 6 13/16 x 5 9/32 x 2 5/32 in. Instead of employing the black plastic cover normally found with such cases, substitute a 5 x 6½-in. panel fabricated from ⅛-in. clear acrylic plastic stock. If you use the same case and components specified in the Parts List, cut and drill the panel as shown. Your spare-parts box might yield different components; if

(Continued on page 104)



Aladdin had easier time building his Magic Lamp 'cause he had fewer connections to solder. Note diodes lurking beneath both toggle switches. Cut out schematic shown below, paste on side of Magic Lamp.



THE MAGIC LAMP

Moving Coil Meter

Continued from page 92

Mount the coil assembly in place by stretching the rubber band over pieces G and I, centering it vertically within the height of the pole pieces of the magnet.

Now For The Pointer. Straighten out a 4¾-in. length of #18 gauge bare copper wire and then form it as shown in our drawing. The pointer is cemented in the slot in block J so that it rests near the zero end (left side) of the scale platform with the moving coil at rest with no current flowing. Piece F is used to make final zero rest position adjustments after a scale has been cemented into position.

Fasten two double solder lugs to block H; these are intermediary connecting points for the two wires from the moving coil. Form a helix like a hairspring with each of these leads so they will wind up as the coil assembly moves clockwise. Solder the end of the wire from the top helix to one of the top lugs and the bottom helix to one of the bottom lugs. Mount two Fahnestock clips or binding posts along the front edge of the meter baseboard and connect them to the solder lugs on H, using #18 solid, bare wire. Since meter polarity is determined by magnet polarity and the direction of current flow, depending on how the coil is wound, the correct polarity markings of the meter should be established at the time you calibrate the instrument.

Calibration. In order to calibrate this instrument, you'll need a potentiometer having roughly 200 ohms resistance, a 1½-volt battery, and a DC milliammeter, preferably a multi-range one available as part of a VOM.

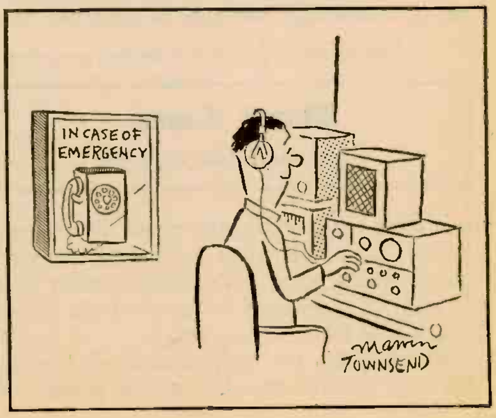
Now you are ready for the calibration scale that's mounted on the platform C made during the framework construction. The scale is drawn on a piece of heavy white paper (U) which will be cemented to the platform after the calibration marks have been drawn. (Rub on numerals, such as Datak, make a neat scale.) Temporarily fasten this white paper (U) to platform C, draw an arc as shown in the photo, and place a mark on the left-hand side for a zero reference point.

Connect a 1½-volt battery, a 200-ohm potentiometer (used as a rheostat), a VOM set on DC milliamp ranges (or a milliammeter), and the moving coil meter you have just built, as shown in the calibration diagram.

Set the potentiometer for maximum resistance and at the start use the highest milliamp range of the VOM. If the pointer on your moving coil meter deflects to the left (below the established 0 point), reverse connections to it and then mark the binding posts + and −. Use the connection diagram to determine their polarity markings after connecting the meter so that the pointer moves to the right.

Slowly turn potentiometer to reduce resistance in the circuit and note the readings of the VOM milliamp range selected. Mark your moving coil meter with the same readings shown on the milliammeter. We divided the 0-100 scale into 10 mA divisions. In commercial manufacture of DC moving coil meters, spring tensions, spacing, and coil weight are carefully controlled so that these meters are linear. For this reason commercial milliammeters have uniform spacing between divisions. Our moving coil meter doesn't have such uniformity because of the variations in the rubber band used for suspension and tension, and because it's difficult to maintain accuracy of positioning the various pieces and to be assured of the strength of magnetic field developed by the magnet. Once you have established the calibration points they will be accurate.

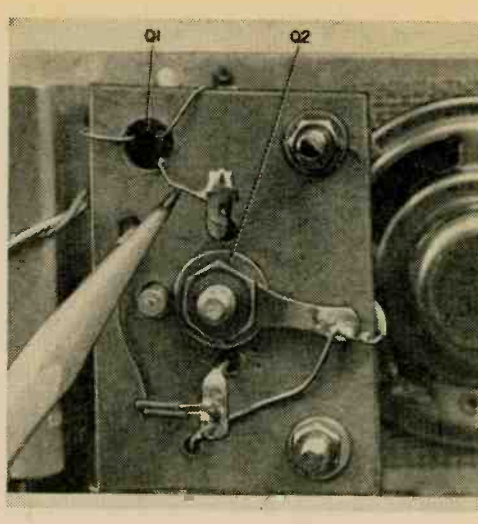
Now that you have marked the scale in pencil you can remove it from the platform and apply the permanent markings. Then permanently fasten the scale in position and stand back to admire your work. If you used reasonable care in following the instructions, you'll have good reason to be proud of your handiwork and should expect a good grade and/or congratulations from your friends and teachers. ■



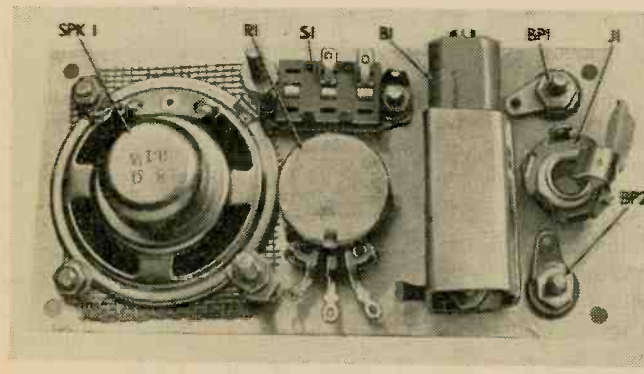
Confessions

(Continued from page 70)

Wire Rapping. Needless to say, the wiring is straightforward. You can get a detailed picture from our schematic. The battery's negative side, a speaker terminal, one side of the optional jack, and the emitter of Q1 are all connected to the front panel. If your ear lobes don't take kindly to headphones,



With careful lead placement, transistor Q1 can be mounted to masonite panel with single ¼-in. hole. Pencil's pointing to Q1's collector lead; it is soldered directly to base pin of transistor Q2. Transistor Q2 is bolted to board. Solder lug underneath bolt is Q2's collector lead.



Almost all parts are mounted to front panel. Only transistors Q1-2, capacitor C1 sit on masonite board. Board's attached to front panel with 1½-in. screws which also hold speaker, grille to front panel. Exercise caution when mounting binding posts BP1-2 to panel; take care not to crack plastic insulators as you tighten down mounting nuts with hex wrench.

the phone jack can be omitted.

The remaining speaker terminal's connected directly to Q2's collector terminal. Power transistor Q2, and the capacitor, can be wedded to your choice of board before uniting this assembly with the panel. Metal-to-metal contact between Q2's case and the panel or potentiometer should be avoided.

As you can see from our photo, all connections excepting one capacitor lead are easily accessible, and can be soldered with the circuit board in place. Transistor Q1 and the battery snap were installed last because their leads are the most fragile.

The current you induce through a component being tested will run between .02 mA and .06 mA. You should be able to wring at least 30 hours of life from the battery as drain will average about 7 mA throughout its life. If you can bear to lose a little audio, your *CON-TEST* will operate with as little as 5 volts from Battery B1. ■

Magic Lamp

Continued from page 102

that's the case modify the panel dimensions, layout, and hole sizes according to your needs. Only point we're emphasizing here is that it's important to keep *Magic Lamp* shock-free from prying hands.

Disassemble the lamp sockets and secure the base shells to the clear plastic panel with ½-in. long by ⅜-in. diameter threaded brass nipples and mounting nuts. You can find these items in a plumbing supply, or an electrical parts supply house. Drill holes for and mount toggle switches and *on/off* indicator plates using the supplied hardware. Next, install the line cord, making sure it passes through a strain relief bushing; leave approximately four inches of wire projecting through the panel.

The toggle switches specified in the Parts

(Continued on page 112)

Universal Amplifier

(Continued from page 40)

to best suit his needs. In any event, good practices for high-frequency wiring should be followed. 'Nough said?

Mount the potentiometers, switches, and input terminals and jack on the front panel which is detailed in our photo. The speaker is mounted with machine screws. A 2½-in. square piece of perforated aluminum is mounted between the speaker and the front panel to serve as a grille, unless you drill your own grille directly in the epoxy glass board as mentioned earlier.

Transformer T1 is mounted as shown in our photo by soldering its mounting tabs to the copper side of the board. Clean the tabs so that the solder will flow evenly on them.

Perform the soldering quickly, using a medium-powered soldering iron (50-100 watts). Remember, too much heat will blister the paint on the reverse side of the board.

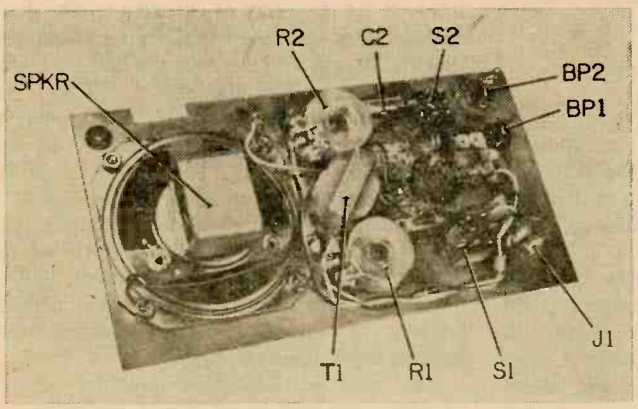
Next, mount the balance of the components on a 1.3 x 1.9-in. piece of perf board as shown in our photo on page 65. All of the remaining components with the exception of C2 are mounted on this card. Capacitor C2 is self-supported between gain control R1 and BP1 by its leads.

Though we built the amplifier on a perf board, an interesting variation would be to construct it using a printed circuit technique. The September/October '69 issue of ELEMENTARY ELECTRONICS contains an article that details construction of a printed circuit board which can be used as a guide to technique for making this one. Push-in clips are used to mount components to the board and as terminal points.

Use a battery clip as a heat sink when soldering the IC circuit leads. A well-tipped, low-powered soldering iron (20-50 watts) should be used for this operation. Complete the soldering as quickly as possible to avoid too much heat—this could damage the IC.

After the various components have been positioned on the card and wiring links have been made between them, check for errors in circuitry before soldering connections. Also, check that electrolytic capacitors have been properly polarized, that there are no shorts, and that the wiring to the IC is correct, thus avoiding having to replace components. Once they're soldered it's hard to remove them, especially ICs.

The completed card is mounted on the rear of the front panel, as shown in Fig. 3. We used ¼-in. squares of plastic, cemented to the panel as stand-offs and then cemented the circuit card to them. We used this method, rather than screws, which would interfere with the lettering on the operating side of the front panel. Now connect the mounted circuit card to the controls and other components on the panel Capacitor C2 is wired in at this time. Use very flexible stranded test lead wire for leads from the battery holder to the amplifier.



Rear view of front panel locating controls, speaker, and circuit board on which IC and its components are mounted. Front panel is spray painted and marked with transfer letters.

Check the completed assembly for possible shorts, cold solder joints, etc. Insert the batteries in the holder, making certain that polarity of each of the cells is correct, and you are ready to test the unit. Connect the input to an audio oscillator (if none is available, a microphone will do, or the output from a tuner). Turn the amplifier *on*, and if all is well you should hear "beautiful music!" Be sure to check both high and low inputs.

If only one input works, check the input circuit for the channel that doesn't work. Make corrections to wiring or replace any defective parts. If neither of the inputs operate, first check for battery polarity, then for cold solder joints, or for possible short circuits that may have developed when the panel was inserted while mounting the assembly in the case.

This done, check the wiring once again. If all these tests reveal no errors, check all the external components connected to the IC with an ohmmeter to be sure of their correct value. If all checks prove OK and the circuit wiring is correct in every respect you will have to replace the IC.

Higher Output Power. As mentioned earlier, should you prefer more than the 300 milliwatts output power, the power of our basic amplifier, you can raise it to 550 milliwatts or even 1 watt very simply. To raise output to 550 milliwatts, all that's required is to increase the battery voltage from 6 to 9 volts. This can be done by substituting a standard 9-V transistor radio battery for the four AA cells.

It's possible to achive the 1-watt-or-better output by using a CA 3020A IC in place of the CA3020 and raising the battery voltage to 12 volts. Do this by doubling up on the AA cells, using 8 rather than 4 (you will need an additional battery holder to do this). The CA3020A has a higher voltage rating than the CA3020. This permits using 12-V supply instead of 9, the maximum for the CA3020 in push-pull class B operation. It's the higher voltage that provides the increase in output power. The CA3020A has the same pin connections as the CA3020 and can be placed in the circuit without having to change any of the wiring. But, always be careful with lead numbers.

A word of caution: if you elect to make your Utility Amplifier with the higher output be sure that the speaker and output transformer you use in the output circuit can handle this much power. We suggest that in the event you go to the higher output, you bring out the output leads through a suitable jack or binding posts on the front panel. The output leads are connected to pins 4 and 7 of the CA3020A.

Now that you've assembled this easy-to-build, simple, useful, and inexpensive portable Utility Amplifier, we're certain you have thought of its many potential applications. Some of the uses that come to mind immediately are the audio amplifier of a phonograph; a low-powered stereo amplifier (using two of the amplifier assemblies); the modulator section of a low-powered amateur transmitter; or, as an amplifier in intercom systems. No doubt you can dream up other applications. ■

Li'l Blitzer

(Continued from page 18)

of each lead that will slip over the connecting pins on the flashtube. Form the stiff wire to hold the tube about ½-in. in front of the tie strip and connect to the lugs on each end.

Form the reflector from a scrap of bright aluminum, stainless steel or a polished tin can. The reflector is 1⅝ x 1-in. before rolling it around a broomstick to form a concave reflector. Notch each end on the center line to clear the connecting leads. Solder or cement a solder lug midway along the bottom edge so that it can be placed over the mounting screw for the tie strip, thus holding the reflector in position behind the flashtube.

Solar Cell. The plastic box in which the solar cell (SC1) is shipped is ideal to use as a final housing for it in this application. Cement the cell to the clear plastic half of the container so that the active surface faces out when the container is closed. Use Duco or a similar clear cement for this.

The cathode tab of silicon-controlled rectifier SCR1 is soldered directly to the back of SC1. Cut the tabs of SCR1 to about half original length and connect the red (+) lead of the solar cell to the gate of SCR1. The black (−) lead of the solar cell connects to the ungrounded primary terminal of T1 and the cathode of SCR1. The anode of SCR1 connects to the juncture of R3 and R4. A red and a black wire twisted together runs from the solar cell/SCR assembly to the main assembly to interconnect them. A Vee notch cut with a hot soldering iron permits feeding the leads out of the enclosure when its back is snapped in position.

The solar cell assembly must be capable of being oriented in all directions to ensure that the flash from the master flashtube reaches it directly and with a reasonable amount of intensity. Though not shown in the photos of the model we suggest you use an universal joint used to mount a desk pen on the base of the desk set. If you can't find one in a handicraft shop you certainly can rob one from an inexpensive desk set.

The four AA cell plastic battery holder fits inside the housing for the basic unit. A conventional 9 V transistor battery connector should be used between the battery holder and the electronics sub-assembly to provide quick disconnect and reconnect.

Testing Li'l Blitzer. Insert four fresh AA cells in the battery holder, plug it into the flash unit and turn *on* S1. If your ears are sharp you may be able to hear a very slight humming from the T1 end of the assembly. In about 10 seconds the *ready lamp* should light, indicating that C1 is now charged again and Li'l Blitzer is ready to fire the flashtube. Fire your master flash lamp a few feet away from Li'l Blitzer and observe the flash of Blitzer's flashtube, that is, of course, assuming you did a good job of building Li'l Blitzer. If it doesn't fire check connections of various components for mistakes in wiring. Be sure diodes D1 and D2 and capacitor C1 are properly polarized and the batteries are correctly inserted and deliver a full 6 VDC output.

Using Li'l Blitzer. The unit can be hand-held and pointed where the additional light is wanted. Just be sure that SC1 is facing the master flash which triggers Li'l Blitzer.

You should mount a standard tripod socket on the bottom of Li'l Blitzer to assist in placing it exactly where it's needed. You might like to equip your Li'l Blitzer with a clamp and universal joint like those furnished with portable lamps.

We used an 80-μF capacitor at C1 which produces about 6 watt seconds of light. You may use up to 400 μF for this capacitor which will increase output accordingly. We've included a chart that gives approximate watt-seconds output for various sized capacitors, starting at 80 μF and increasing up to 400 μF (which produces 30-watt-seconds of light, the maximum output attainable from the MFF45S flashtube used).

Once you've checked out Li'l Blitzer and are assured it's working properly, close up its box and have some fun trying it out on a new batch of photos. ■

CAPACITY VS. WATT-SECONDS

C1 in μF	Watt-Seconds Output
80	6.0
100	7.5
150	10.3
200	15
250	18.8
300	22.5
350	26.3
* 400	30

* Maximum rating of FT1

IC Low-Bander

Continued from page 61

ground. Connect antenna and ground to clips J1 and J2, respectively, then a 6-volt battery to clips J3 and J4. Be sure polarity is correct and connect either a small PM speaker or headphones to clips J5 and J6.

Oh yes— plug in a coil L1 (A), covering the BCB, for initial checking because there are far more transmissions day and night in that band. Initially turn both volume and regeneration controls fully clockwise. As you tune through from one end of the dial to the other you should hear a chirp or squeal as you tune past each station. If no chirps or squeals are heard reverse connections to the tickler in the tube base.

Set the dial on a strong squeal and rotate regeneration control R1 counterclockwise until you reach a point where the squeal turns into either sweet music or sweet talk. At this point the volume control should be adjusted to suit your listening pleasure.

Duplicate the above operations for coils L1 (B) and L1 (C). You will gain experience as to where the controls should be set for best performance as you use the receiver. You'll be surprised and delighted at how well it works. ■

Sure it can be done

"WINDY"

Continued from page 56

from the metal box with extra locking nuts. The circuit board is mounted in the same way.

When all holes have been drilled cover the outer surface of the minibox with wood grained pressure-sensitive adhesive vinyl (Contact or equiv.) to make an attractive-looking instrument. A word of caution: when tightening mounting screws be sure to hold the heads of the screws rigid with a screwdriver and tighten mountings by using a socket wrench on the nuts; otherwise, the vinyl sheeting will be pulled and stretched by the bolt heads. Trim vinyl around the holes with a razor blade before mounting components.

To make your project really professional-looking, letter the controls with press-on letters (Datak or equiv.). Spray lettering with several coats of clear acrylic for protection.

Electrical Assembly. Most of the electronic circuit parts are mounted on the circuit board. We suggest you use G or P pattern perfboard as the hole spacing matches the pin spacing of the ICs we used. The components are mounted flat on the board and push-in clips and/or eyelets are used to facilitate mounting and connecting. The leads of the ICs are pushed through the perfboard and bent outward against the board. This holds the IC in place and provides a tab to which leads are soldered. Inter-component wiring is made with #26 bare copper wire. Where wires cross over they are insulated with plastic tubing.

Wire the circuit card in accord with the schematic. Be sure electrolytic capacitors and diodes are properly polarized before soldering to them. Also make certain that the ICs are correctly positioned before you solder them in.

Alternate IC Mounting. You may want to use a socket for the IC. As a matter of fact, the investment of less than a dollar for a socket is well worth it. You solder to the socket, rather than to the IC, thus reducing the possibility of damaging the IC with excess heating. You also have the advantage of being able to plug in the IC for proper orientation and or replacement should this be necessary.

Use an alligator clip temporarily clipped to a lead when soldering Q1 and the diodes. If you elect to solder in the ICs, you should use the heatsink on each of their leads, too.

The circuit card is mounted on the left side of the indicator housing with four 4-40 bolts and nuts so that the card is supported away from the metal of the housing, as mentioned earlier. Inter-connect the various components not part of the card except for the meter.

Meter Modification. Any 0-1 mA meter having a coil resistance of under 100 ohms can be used for M1; the one we used measures approximately 14 ohms. However, the meter scale will have to be changed from 0-1 mA calibrations to 0-30 mph. See the Sept./Oct. 69 ELEMENTARY ELECTRONICS "Meter Scales You Can Count On," for details on how to do this most effectively. You can just turn it over, spray it with flat white, and then follow the steps outlined in referenced article. To mark the scale, use press-on letters.

Checking It Out. Plug in the remote pulse generator, turn *on* the AC power, and give the rotor a spin. If all has gone well you should get an indication on the meter. Check both ranges (X1 and X3).

If nothing happens, start out by checking all wiring for possible glitches, cold soldered joints, shorts between pins of ICs and transistor Q1, etc. See if + 3.6 V is present on pin 11 of both ICs. Also check to see if the exciter lamp in the pulse generator is lit. Doublecheck the polarity of all electrolytics and diodes and also check to be sure the ICs are oriented correctly.

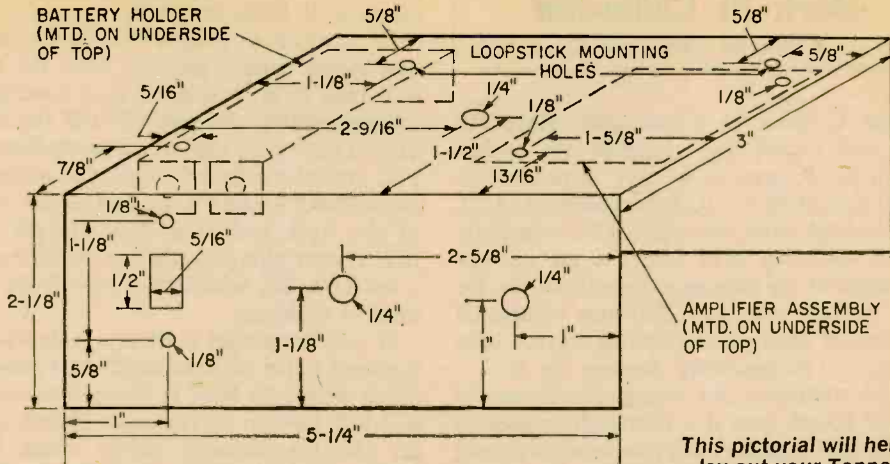
Calibration. When you get an indication on the meter by rotating the wind cups, the meter reading in the X1 position should be three times the reading in the X3 position for a given speed of the rotor. While maintaining rotor speed by hand, switch back and forth to check meter readings.

Tracking between these two ranges is dependent on the capacitances of C7 and C8. The capacitance of C7 should be exactly half that of C8. Since capacitors can vary as much as ± 20% or more from the nominal value indicated on them and still are considered commercially acceptable, you should check their capacitance on a bridge if at all possible. If not, you can trim them by adding small capacitors until the desired meter range is reached.

To do this turn the rotor by hand to produce a reading of 15 mph in the X1 range. If the reading drops below 5 mph in the X3

(Continued on page 112)

TennaBoost *(Continued from page 22)*

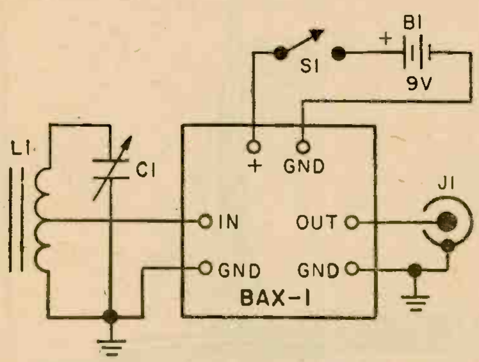


This pictorial will help you lay out your TennaBoost for maximum efficiency.

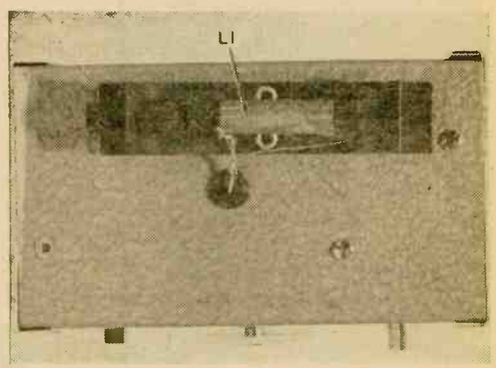
PARTS LIST FOR TENNABOOST

BAX-1—Broadband amplifier, International Crystal Mfg. Co. type BAX-1
B1—9-V transistor radio battery (Eveready 216 or equiv.)
C1—385-pF tiny tuning capacitor with dial (Lafayette 99E62176 or equiv.)
J1—RCA type phone jack, single-hole mount (Lafayette 99E62341 or equiv.)
L1—Miller type 2001 miniature loop antenna (Lafayette 34E87485 or equiv.)
S1—Miniature slide switch, spst (Lafayette 34E37035 or equiv.)
2—0.001-uF, 75-VDC subminiature ceramic capacitor (Lafayette 33E69022 or equiv.)
1—$5\frac{1}{4}$ x 3 x $2\frac{1}{8}$-in. minibox (Lafayette 12E83738 or equiv.)
1—Keystone type 203P battery holder for 9-V transistor batteries
Misc.—Wire, solder, coaxial cable and connector to fit J1, screws, nuts, press-on letters (Datak or equiv.), spray paint in colors of your choice, etc.

Note: BAX-1 broadband amplifier kit is available from International Crystal Manufacturing Co., Inc., 10 N. Lee, Oklahoma City, Okla. 73102. Kit costs $3.75 F.O.B. factory, add 25¢ for parcel post. International Crystal can ship from stock upon receipt of order accompanied by money order or check in the amount of $4.00.



Schematic shows how easy it is to hook up.



Bird's eye view giving correct L1 location.

TennaBoost. Since the loopstick on *TennaBoost* acts just the same as any loop antenna, try rotating *TennaBoost* for a possible improvement in signal strength.

If you find that adjusting capacitor C1 of *TennaBoost* tunes stations on the receiver, or the receiver blocks, chances are you have a feedback loop between the receiver and *TennaBoost* because of their proximity to one another. Should this occur, move *TennaBoost* further away from the receiver to bring back A OK condition. ■

Mark III Calibrator

Continued from page 32

on the IC pins, to a minimum. Keep the iron well tinned and complete the soldering to the IC pins as quickly as possible to avoid damaging the IC by excess heat. Also, doublecheck each wire against the schematic before soldering to be sure you are correct. It's difficult to change connections on the ICs. And the extra heat that may be applied because of changes required to correct your wiring can permanently damage the IC.

After mounting and wiring all components on the board, give it a thorough inspection to be sure there are no errors in wiring, cold solder joints, or shorts created by excess blobs of solder or clippings of wire. Mount all of the controls to the housing, taking care not to mar the lettering or the vinyl covering.

Mount the battery holder as shown in our photo and then the circuit card. Use several nuts as spacers to keep the wiring from shorting to the housing. Connect the switches, J1, and the battery to their respective points on the circuit card. You may want to put a dab of red to identify the positive contacts of the battery holder.

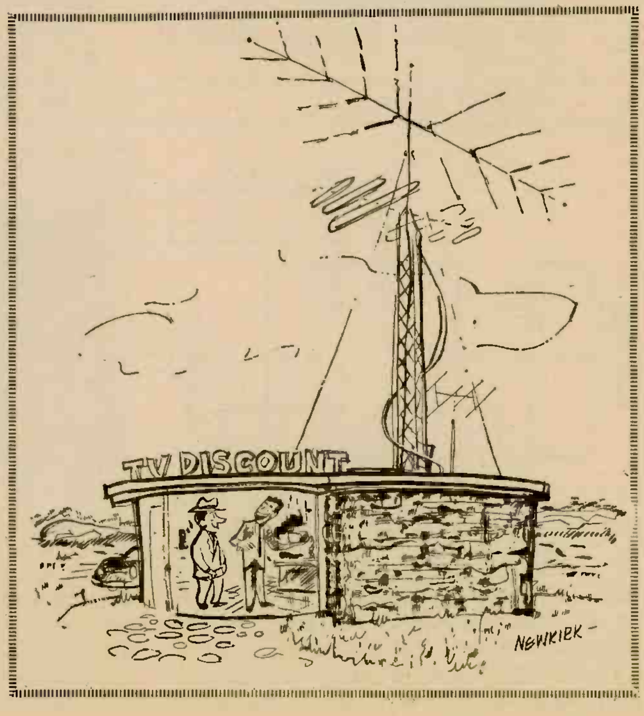
Testing and Aligning. Now we're ready to enjoy the benefits of our hard (?) work, but first let's check out and align our calibrator. Insert three AA cells in the battery holder, taking care to observe correct polarity. Before doing so, be sure power switch S2 is *off*.

Loosely couple the output of the calibrator through a 10-50 pF capacitor to the input of a receiver that has been warmed up and is operational. Place output selector switch S3 of the Mark III to the 100-kHz position and turn its power switch *on*. If the unit is working you should be able to pick up strong marker signals at 100-kHz intervals across the band. Next tune in one of the marker signals and turn Ident switch S1 *on*. The marker signal should pulse *on* and *off* about twice a second. Repeat these steps with S3 placed at the 50- and 25-kHz positions and observe markers at these intervals.

If you cannot receive the marker signals first check battery polarity, then for shorts that may have developed in mounting and interconnecting the controls and the circuit card. Then check the circuit around the 100-kHz crystal oscillator. Check the polarity of capacitors C4 and C5, as well as for voltage at pins 8, 9, and 11 of IC1 and pin 11 of IC2. If everything checks out you may have a defective IC, which may have been damaged in soldering.

If you cannot get marker signals when S3 is placed in the 50-kHz, or 25-kHz positions, check wiring to IC2. If this proves correct, IC2 will have to be replaced. If you cannot get the identification pulses when S1 is closed, check the switch and also for wiring errors in the 2-Hz multivibrator.

WWV Calibration. To be most useful, the Mark III must be accurately calibrated. Once this is done it should remain on frequency. Calibrating with WWV is very easy to do. Tune your receiver to the 5-, 10-, or 15-MHz WWV signals—whichever you receive best in your location. Set S3 on the calibrator to 100 kHz, loosely couple its output to the input of the receiver, and turn on the calibrator. Adjust C1 until the output of the Mark III zero beats against WWV.



PhoneCom

Continued from page 28

When wiring the switch, note that only two of the 4PDT switches are used. Be sure to observe the proper polarity when installing diode D1.

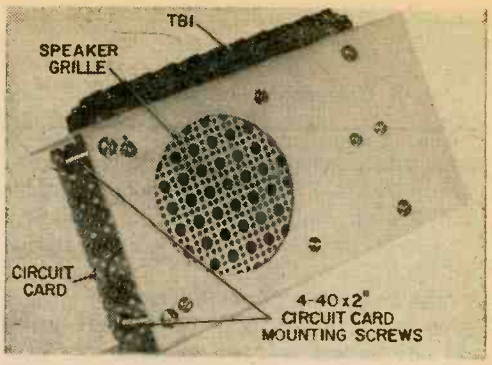
Check Out. Before interconnecting the two completed intercom stations as a system, several checks should be made on each unit to assure their proper operation. With the battery (B1) installed and the handset *on hook,* clip a jumper lead between terminals 5 and 7 of TB1. This applies +9V to the signaling section, and a beeping tone should be heard from the speaker. If not, first check the wiring associated with the multivibrator and the oscillator, then the individual components.

Lift the handset *off hook* and clip a jumper lead to terminals 4 and 7. This checks the polarity, of D1 and the switch wiring.

With the jumper removed, you should hear sidetone when speaking into the microphone. Good sidetone indicates both the transmit and receive amplifiers are functioning properly. If sidetone is not obtained, remove the handset receiver connection to terminal 2 and connect it to terminal 1. If sidetone is now heard, the trouble will be found in the receive amplifier. With the possible fault isolated either to the transmit or receive amplifier, check the wiring to the appropriate section.

Interconnecting the System. After the intercom units have been tested individually to assure proper operation, they may be wired together as shown on the Interconnection Diagram. The Xmit Line wires should be shielded. This helps to avoid problems arising from excess coupling between the Xmit and Rec lines. A suitable intercom cable is Belden 873 or its equivalent. This cable contains three shielded conductors. The shield is used as the Ground Line connection, the 4th conductor shown in the schematic connected to terminal #3.

The maximum line length between the two stations is limited only by the total resistance in the Signal Line/Ground Line loop. The greater the resistance, the greater the drop in signaling voltage on the line, and the lower the signaling tone level will be at the other station. The loop resistance may be as high as 300 ohms before the signaling level drops excessivly. This corresponds to a maximum line length of about five miles, using #18 wire. Substituting #22 wire cuts the distance to half.



Front view of Terminal Box assembly. Perforated metal makes attractive grille to protect speaker used to amplify calling signal that sounds automatically when handset is raised.

Sidetone level can be adjusted to compensate for individual preferences by increasing or decreasing the value of resistor R5. Likewise, if it is desired, the pitch of the beeper can be changed by altering the value of capacitor C10 or C11.

The level of the signaling tone may be reduced by inserting a small resistor, under 30 ohms, in one of the leads between the secondary of transformer T1 and the speaker.

The last step in setting up the system is to adjust the receive level control (potentiometer R7) at each station to a comfortable listening level. If the control is adjusted too low, it will lower the sidetone level at the distant station. This, however, should not be a problem, as the control is normally set above this level to produce an adequate listening level in the receiver. ■

Windy

Continued from page 108

range add capacitance in small increments until it reads 5 mph. If it indicates more than 5 mph add capacitance to C8. Add capacitance in steps of 0.01 μF or 0.02 μF to align the two ranges.

Adjusting Meter Reading. Once the proper range tracking has been established, probably the easiest way to complete the calibration is to do it in your car where you have a reasonably accurate speedometer to serve as a calibration standard. Unless you happen to have a car with a 6-V battery (very rare these days—most use 12-V batteries) you will need 6 VDC, either from 4-D cells connected in series, or a 6-V lantern battery.

Disconnect one side of T1 and bring out a pair of leads, one of which is connected to the indicator's ground and the other to the collector of Q1. The ground lead is connected to the negative and the collector lead to the positive of the 6-VDC source. Don't goof here!

Also remove the leads connected to X and X^1 on the secondary of T1. Connect a pair of leads between pins A and B of J1 and the external battery. This provides current to light exciter lamp when operating Windy from an external DC power source while calibrating in a car ride. Once the calibration has been completed remember to restore this modified wiring to its original condition as well as the modification to the battery wiring.

You'll need a friend, either to drive the car while you make adjustments or to make the adjustments for you while you drive. Calibration should be done on a calm, windless day if at all possible. Should there be a light breeze you'll have to average the calibration by checking readings obtained by driving in both directions.

With the car traveling at 30 mph (according to its speedometer) and Windy's indicator set on X1 range, adjust R6 until the meter reads 30 mph. This is the only calibration necessary as you have already corrected the ranging, as previously mentioned. (Of course you've temporarily mounted the wind cup pulse generator outside the car so as to be in the wind's stream.)

Installation. Now that Windy has been built and calibrated, where is the best location for the remote wind cup pulse generator to give a true indication of wind speed?

The pulse generator unit should be mounted 5 to 10 ft. above the building on which it's being used. It should not be mounted in the lee of a taller building and the arms of the rotor should remain perfectly level as they rotate.

We recommend that easily-available TV antenna mounting hardware (e.g., mast clamps, mast mounting base, etc.) be used to mount the remote unit above the roof of the building.

The lubrication recommended won't be affected by temperatures below 0 F. This is very important for year-round accuracy. ■

Magic Lamp

Continued from page 104

List permit silicon diodes D3 and D4 to be concealed against the back of their associated switch. Carefully observing diode polarity, solder the diode leads to the switch lugs, and dress the diodes flush against the back surfaces of the switches. Solder one lead of the line cord to the indicated lug of switch S2. You'll need a hank of stranded hookup wire (18 gauge will do). Solder a length of this wire between switches S1 and S2 and to lamp I1, feeding the wire through the lamp shell mounting bushing.

Diodes D1 and D2 are connected directly between the screw terminals of their lamp sockets. Carefully observe their polarity before you connect the diodes. Run another lead between the sockets of lamps I1 and I2. Connect your last-but-not-least-line-cord lead to the vacant terminal of lamp I2's socket. For safety's sake, keep this lead just long enough to permit connection to I2's terminal. Give your how-does-it-do-it a once-over, looking for short circuits and open solder joints. After all's said and done, replace the fiber insulators in the lamp socket shells.

After you've completed your *Magic Lamp's* wiring, give with an ol'hawkeye test to your new theory teaser. As a finishing touch, cut out our simplified diagram of *Magic Lamp's* schematic and cement it to the case. Now mount the panel with the screws supplied with the case, and your *Magic Lamp's* ready for action. Okay, go out and fool the experts. ■

Duo-Reg

Continued from page 46

are paralleled on the AC line by matching lead colors from each transformer.

Meter M1 is a 0-1 mA DC meter (100 ohms per volt). Multiplier resistors R5 and R11 convert M1 to read 20 VDC full scale. If you make the higher voltage supply, these resistors should be double the resistance shown for the lower voltage.

You can either recalibrate the meter scale or do it the easy way, as we did in the model (we simply put a dot of white paint over the decimal points on the scale furnished with the meter). With this calibration a reading of 5 on the meter scale will mean 10 volts output. In other words, whatever reading is indicated on the scale should be doubled to arrive at the correct voltage reading.

To get at the scale, break the four small adhesive seals on the back of the meter with a knife and then pry off the plastic cover. This takes a little pressure; however, the scale can be removed easily without causing damage. Take care not to damage the pointer. Reassemble in reverse steps taken to remove the scale; the plastic cover will snap into place and doesn't need to be resealed.

Using the Supply. You can use either the *bi-polar* output (both positive and negative output with a common ground), or you can use just the positive output or the negative output individually. Another way you can use this unit is to supply two different circuits simultaneously providing they share the same common ground. Remember, you'll have to run a jumper between BP1 and BP2 and another separate one between BP6 and BP7. The output load is connected to BP3, BP4, and BP5.

Switch S2 should be kept in *standby* position until the output voltage has been set to correct value. For bi-polar use set meter switch S3 to the *positive* position and adjust ganged R1/R6 for required output voltage. Then set switch S3 to the *negative* position and adjust trim pot R7 so that the negative output voltage is the same as the positive voltage. Now you can apply power output to the load by setting S2 to the *output* position.

A drop in output voltage when applying power to the load by closing switch S2 indicates either that the circuit being powered is drawing more current than the capacity of the transformers T1 and T2 you used in your supply, or that there is a short and the current protection for the regulator is functioning. Check carefully for shorts either in the power supply or in the circuit being powered by it.

If trim pot R7 cannot adjust the output voltage to match, don't look for trouble in the regulator—check the meter circuit first. Use a VOM connected to the outputs. If it reads the same voltage for both positive and negative output, then suspect the meter multiplier resistors R5 and R11 (they probably aren't matched or sufficiently close in tolerance). We have provided two multiplier resistors in the event you would prefer to use separate meters for each supply. You can use a single resistor in series with the meter, in which case eliminate R5 and R11 and mount just one 20,000-ohm resistor in series with one of the meter terminals.

If you want to use R5 and R11 as shown, then match them up in resistance. In the event the VOM used externally indicates the M1 readings are correct, and you can't match the output voltages with the trim pot, then change the value of R8 approximately 20% (higher or lower) to obtain matched voltages.

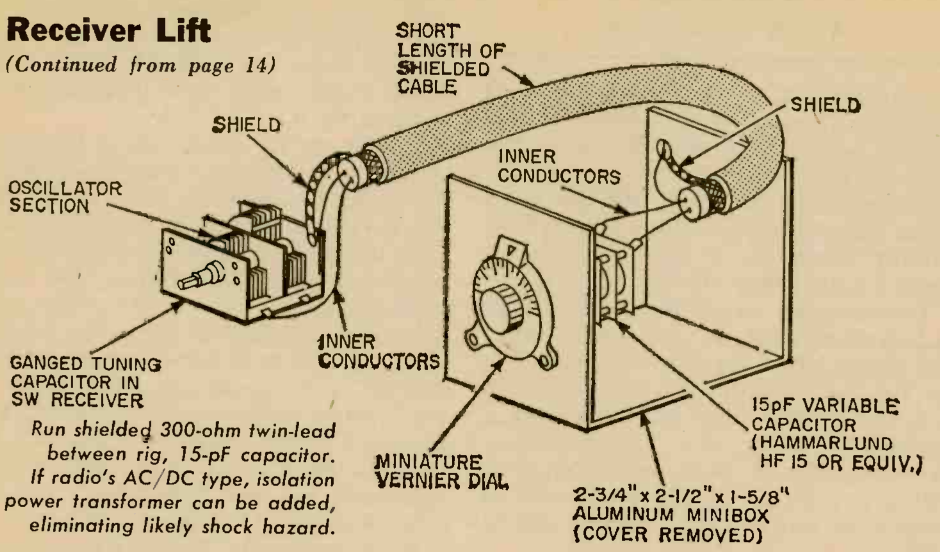
This supply has been designed to provide a minimum output voltage of 3 VDC in order to save the cost of some twenty additional components that would be required to effect complete adjustment from 0 VDC output to full output. The supply is working properly if minimum voltage is 3 VDC. If the minimum voltage is either lower or higher than 3 DC there is an error in wiring in the supply.

Should you find that an ammeter connected to BP1-BP2 or BP6-BP7 in place of the jumpers will not read more than ¼ to ½ the maximum output, connect an 0.2 or 0.22-μF 75-V (or higher) capacitor across each pair of binding posts. These are indicated in the schematic as Ca and Cb.

Because of transformer losses, it's possible that maximum voltage output will be only 18 VDC if the load circuit draws more than 100 mA. If full voltage is a must at the higher current, use the red-black and green-black transformer primary leads in place of the black and black-white. This will provide an additional 2 VAC to the rectifiers. If, however, you don't expect to use this supply on loads higher than the 100 mA capacity of the supply, then use the original primary transformer connections. ■

Receiver Lift

(Continued from page 14)



Run shielded 300-ohm twin-lead between rig, 15-pF capacitor. If radio's AC/DC type, isolation power transformer can be added, eliminating likely shock hazard.

back and forth from their original position, for maximum signal level. Then tune in a weak SW signal, such as the weakest WWV transmission, and recheck these adjustments. If your set boasts an S meter, all the better; make your adjustments for maximum S reading on the meter.

If you really want to go all out for increased sensitivity, try building the *Station Blazer RF Preamp* detailed in the April/May 1969 issue of SCIENCE AND ELECTRONICS. For an investment of about $6 and a few hours in construction time it'll take any SW receiver out of the mediocre class. And, if your set lacks audio oomph to drive a speaker to your satisfaction, you might try adding a packaged transistor audio amplifier and separate speaker. How about building the *Universal Utility Amplifier* described in the November/December 1969 issue of ELEMENTARY ELECTRONICS? If you don't want to build, you can buy low cost, factory built, transistor amplifier from most parts suppliers.

Adding Bandspread. One other disadvantage of the lower priced SW receivers is a lack of bandspread tuning, a most useful assist in separating closely spaced stations at the higher frequencies. With a little patience, and a few parts and tools you can also add this feature to most economy model SW receivers. All you need in the way of parts is a 15-pF variable capacitor, an inexpensive vernier dial, a small aluminum box and a short length of low capacity, shielded two conductor cable. Once you've mounted the capacitor and dial in the aluminum box as shown in our drawing, you're ready to hook it up. Locate the oscillator section of the tuning condenser gang in your SW receiver and connect this externally mounted variable capacitor in parallel with this section of the set's tuning gang. Ground one end of the shield from the interconnecting cable to the common ground bus in your SW receiver and the other end of the cable shield to the box used to house the external 15-pF capacitor. Connect one end of the two conductors of this shielded cable to the two connections of the oscillator section of the ganged tuning capacitor in your receiver, and to the two connections of the 15-pF variable capacitor in the aluminum box. Keep this piece of cable as short as possible.

To use the bandspreading feature you've just added to your set start off by setting the new capacitor's dial to zero and tune the receiver in the normal way. Once you tune in a station (in all probability you'll get several stations interfering with one another in a congested portion of the band), you then use the bandspread dial to improve the signal by separating these stations near the same frequency. With a little practice you'll soon learn how best to use the band spread to your advantage.

Now that we have given you tips on how to get into the swing of things better with your economy model SW receiver—go to it, have more fun out of SWL. ■

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