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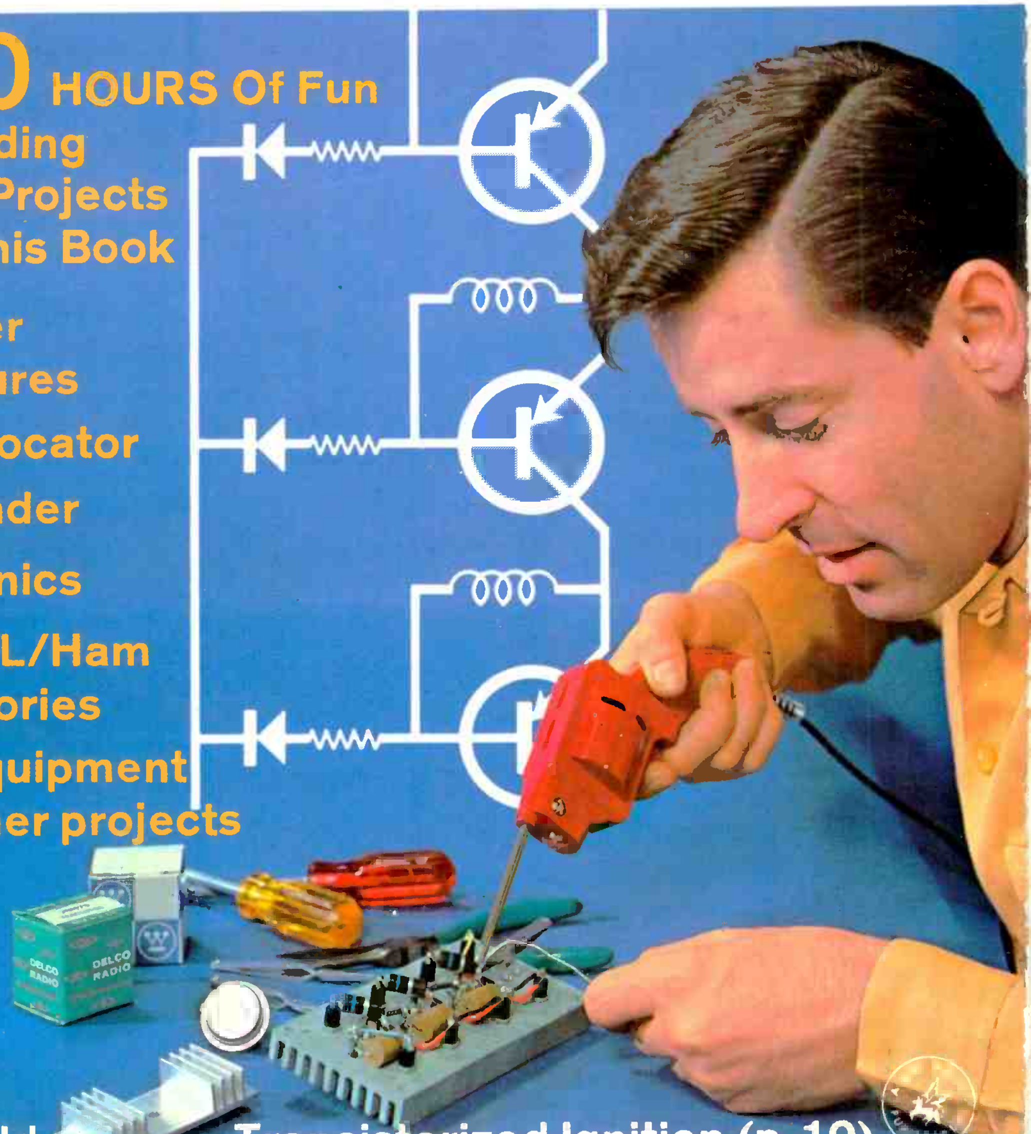

Build Transistorized Ignition (p. 10)

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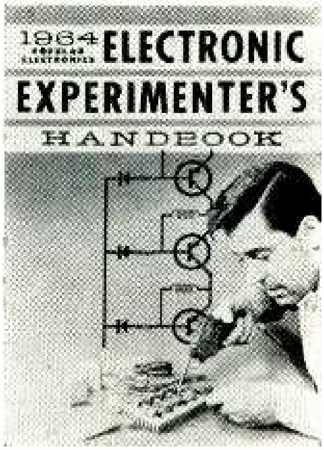

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JUST for the fun of it, the Editors of POPULAR ELECTRONICS figured out how many hours it would take to build every project in this HANDBOOK. The average figure turned out to be 250 hours, but all agree that this is strictly guesswork. Obviously, there is no time limit on the enjoyment of building one, two, three, five, or ten of the projects described on the next 160 pages.

As in our previous seven annual editions, every project and circuit has been carefully double-checked. Parts listings have been reverified so that all components are known to be available at this writing. The author of each article was asked to bring his project up to date where desirable. Known difficulties in building have been eliminated and, where required, substitutions carefully outlined. In short, we've put together a book we know you'll value and enjoy throughout 1964.

THE EDITORS

The "X" means it's built for experimenters

Here's a whole line of components for experimenters . . . with hundreds of schematics for building everything from HO gauge controls, remote controls, amplifiers, and transistorized citizens band receivers to ingenious alarm systems to scare away burglars.

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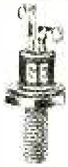

GE-X1 SILICON CONTROLLED RECTIFIER. 117-volt, solid state switch. Controls up to 4.7 amps.

Applications: Plug in speed control for hand tools, blenders, mixers, lamp dimmers, HO train controls, automotive alternator regulators.

GE-X2 LIGHT ACTIVATED POWER SWITCH. It will conduct up to ¼ ampere, up to 25 volts.

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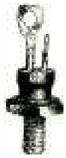
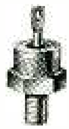


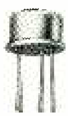
GE-X3 HIGH CURRENT SILICON CONTROLLED RECTIFIER. For high current (up to 13 amps) at lower voltage up to 50 PIV.

Applications: 12-volt regulated battery chargers, electroplating, relay replacement or low voltage controls operating from car or boat batteries.



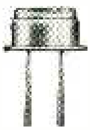
GE-X4 CONVENTIONAL HIGH CURRENT SILICON RECTIFIER. 20 amp rating. For voltages up to 200 PIV.

Applications: High-low-off controls for heaters, lamps and motors. For battery chargers, and in conjunction with the GE-X1, or GE-X3, full wave SCR light dimmers or DC power supplies.



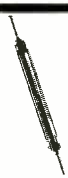
GE-X5 HIGH SENSITIVITY SILICON CONTROLLED RECTIFIER. For special circuits up to 1.6 amps and 50 volts. Activated by extremely low signal power (a momentary signal power of 200 micro watts or less).

Applications: Enlarger phototimers, simple remote controls, temperature controls, alarm systems.



GE-X6 PHOTO CONDUCTIVE CELL. Cadmium sulfide, end-illuminated type. Can be used up to 250 volts peak AC or DC.

Applications: Light target night lights with automatic on-off controls, punched card readouts, remote indicators, relay controls.

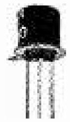


GE-X7 REED SWITCH. Carries loads ranging from 15 volt-amperes to micro-amperes. External magnetic actuation.

Applications: Night lights and burglar alarms, automatic on-off controls, liquid-level controls, weight measuring devices, multiple relays.

GE-X8 MED. SPEED, NPN TRANSISTOR. Germanium. Isolated case. For low level switching and amplification.

Applications: Oscillators, direct coupled amplifiers, light flashers, triggered light sources, bi-stable lamp driver circuits.



GE-X9 MED. SPEED, PNP TRANSISTOR. Germanium alloy. For medium power amplification and switching at low frequency.

Applications: Light flashers, light target, triggered light sources.

GE-X10 NEW UNIJUNCTION TRANSISTOR. Three-terminal semiconductor with properties not found in conventional transistors. Has low value of firing current, stable negative resistance, stable firing current, high pulse current capability.

Applications: Oscillators, tachometers, timing circuits, voltage sensing circuits, SCR firing circuits, bi-stable circuits.

GE-X11 ZENER DIODE. Silicon Zener diode rated 8.2 volts at 1 watt.

Applications: For low voltage transistor and silicon controlled rectifier applications requiring voltage regulation or protection against voltage transients.

2N107 AUDIO PNP TRANSISTOR. Alloy junction.

Applications: Audio amplifier, radio receiver, practice oscillator, radio receiver loudspeaker, one, two or three transistor broadcast radios.

2N170 AUDIO NPN TRANSISTOR. Low voltage, high frequency transistor.

Applications: Three transistor radio receivers, direct coupled "battery saver" amplifiers, pre-amplifiers.

2N2160 UNIJUNCTION TRANSISTOR.

Applications: Transistor metronome and code practice oscillators.

GE-M100 GERMANIUM MESA TRANSISTOR.

Applications: Citizens band receivers, and control units (27 MC).

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Chapter 1

Electronics Around the Home

AUTOMOTIVE ELECTRONICS holds a tremendous fascination for the hobbyist. It reached its peak in 1963 with the publication of "Operation PICKUP"—a three-transistor ignition system using the stock ignition coil that comes with the car. Totally unlike previously published transistorized ignition circuits, POPULAR ELECTRONICS' "PICKUP" became an overnight celebrity. Thousands upon thousands were built and are perking away throughout the world as you read these words. Because of the enormous interest in this ignition system, "Operation PICKUP" is the first article in this chapter. If you recall the original version, you will immediately realize that it has been rewritten and expanded. The circuit parameters, construction, weatherproofing, etc., incorporate many of the recommendations of hundreds of users.

The above should not detract from the remaining projects in this chapter, but if you don't read "Operation PICKUP" first, maybe it's time to trade in that horse and buggy.

Operation PICKUP

THE ADVANTAGES to be gained through the use of a transistorized ignition system in your automobile are many. Wear and tear on the distributor points will be drastically reduced, spark plug life greatly extended, fuel economy improved, and the automobile will give peak performance over many months. Few, if any, Detroit designers argue that a transistorized system, or some solid-state ignition switching system, is not going to be "standard" on every 1965 car. But what about those of us with cars made in the 1950's or early 1960's?

There are kits available to convert a conventional ignition system to a transistorized system; some are good, a few are marginal, and probably one or two won't work on every car. From the standpoint of the electronics experimenter with minimum automotive electrical experience, isn't there something just a little different, easy to build, and easy to install?

Yes, there is. Operation PICKUP. The transistorized PICKUP ignition system described in this article has been road-tested both by the author and the POPULAR ELECTRONICS staff. It was designed to be as foolproof as humanly possible, even to the extent of employing the ignition coil that comes with the car—something that nine out of ten other transistorized ignition systems cannot do. The cost has been kept to a minimum consistent with good performance and maximum reliability against ignition failure on the road.

On the author's 1958 Cadillac, the PICKUP improved gas mileage by not less than two miles a gallon! On a Pontiac station wagon with a low-horsepower (economy) engine, it also improved gas mileage while simultaneously permitting smoother idling, faster pickup, and greatly improved engine performance at high speeds.

If you are reasonably familiar with automotive electrical systems, you should be able to install the PICKUP in five to ten minutes. Should it ever fail on the road, even the most perfunctory gas station mechanic can put your original ignition system back into operation in the same amount of time.

Construction. There are two separate wiring diagrams shown for the PICKUP. One is to be used when the negative post of the car's battery is connected to the chassis (negative ground). The other diagram is for positive ground cars. Both diagrams and pertinent notes explain the modifications necessary to employ either system on 6- as well as 12-

COVER STORY

a transistorized PROJECT IGNITION CONVERTER KEEPING USEFUL PARTS

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By C. E. RUOFF

volt cars. Other permissible part substitutions are itemized in the combined Parts List.

The Delco 2N1970 power transistors at *Q1*, *Q2* and *Q3* were chosen for the PICKUP after considerable research into the requirements that should be met by an ignition switching system. In the PICKUP circuit they are simply expressed as *Ic* of 15 amps and *Vcbo* of 100 volts. Transistor substitution is possible, but the only recommended transistor at this time other than the 2N1970 is the 2N1100—a more expensive unit.

Diodes *D1*, *D2*, and *D3* must be silicon units with a rating equal to or better than 200 volts PIV (Peak Inverse Voltage) at 600 ma. There are many silicon diodes that fit these requirements. Recommended are either the Sarkes-Tarzian F-6 (1N2484) or the RCA 1N540. The use of low-cost second-grade silicon diodes sold at "distress" prices should not be given serious consideration because of the high leakage currents in many of these bargains.

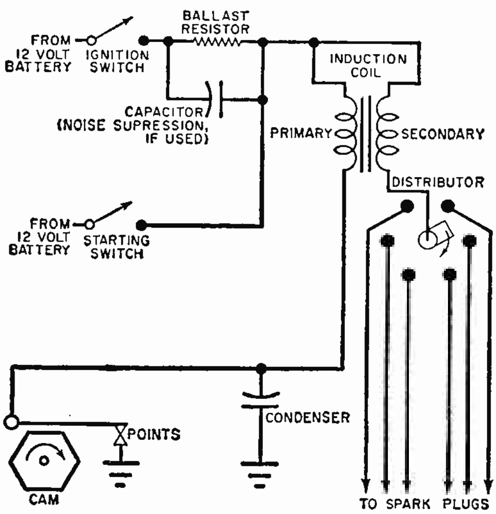
Fabricating your PICKUP is relatively easy. Illustrated in this article is a three transistor system using a Cesco HS-4 heat sink. This heat sink is pre-punched for four transistors and is thus readily adapted to a PICKUP system. The builder might also want to consider a "building-block" system involving the mounting of three separate Delco pre-punched heat sinks, type 7276040. A photo shows typical parts placement when using this latter arrangement.

If you have not previously mounted a *round* transistor, note that the square pre-punched mica sheet goes under the transistor between it and the heat sink. The round mica washer goes between the metal washer and the underside of the heat sink. Thread the nut down on the metal washer, but don't apply too much pressure when tightening this "sandwich" of transistor, mica, and heat sink. Be sure that the transistor case is centered and not shorted out to the fins of the heat sink.

Mounting the System. Reasonable care must be taken to protect the transistors and diodes in your PICKUP from overheating and from the elements. This means mounting the PICKUP in a spot under the hood where air can flow around the heat sink, where there is no conduction of heat from the engine block to the heat sink, and where there will not be an excessive accumulation of dirt, snow or rain water.

Fire-wall mounting will prove satisfactory with some cars, but in all cars installation on the metal panel extension

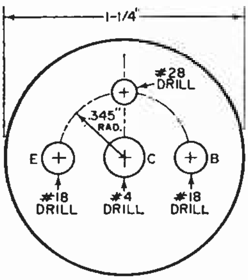
Circuit of the usual negative ground automotive ignition system. Note how ballast resistor (usually 1-2 ohms) is shorted out by starting switch.

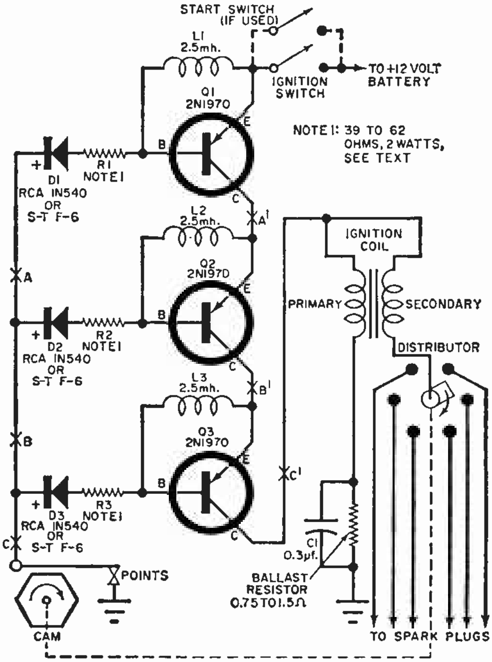


PARTS LIST

C1—0.33-µf., 100-w.v.d.c. Mylar capacitor
D1, D2, D3—Silicon diode, 200 volts PIV, 600 ma., or better (Sarkes-Tarzian F-6, RCA 1N540, or equivalent)
L1, L2, L3—2.5-mh. ferrite core choke (J. W. Miller 9350-38, Superex M-25, or equivalent)
Q1, Q2, Q3—Delco 2N1970 power transistor—see text
Q4—Westinghouse 151-04 power transistor (order from Schweber Electronics, Jericho Tpke., Westbury, L.I., N.Y., for $6.15)
R1, R2, R3—See note on schematic, and text
R4—68-ohm, 2-watt resistor
R5—See note on schematic, and text
R6—150-ohm, ½-watt resistor
Misc—Heat sink (see photos), insulated standoff terminals, wire, solder, etc.

Transistor template. Larger holes can be reamed with hand reamer if necessary.





Negative ground circuit ONLY. The connections to the induction coil now have the ballast resistor in what may be called the "cold" lead. Although six spark plugs are shown here, the circuit will obviously operate with four, six, or eight plugs.

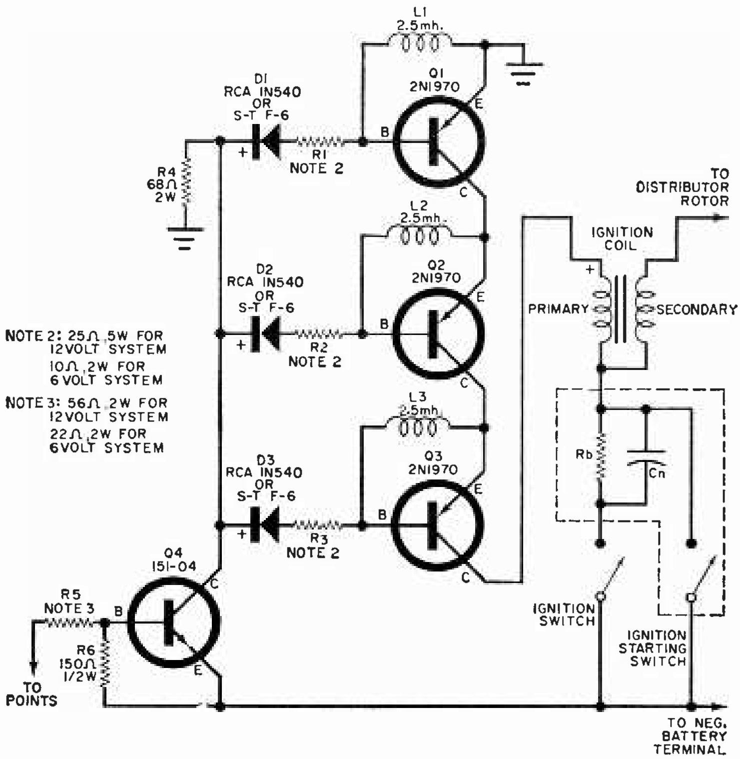
of the front radiator is to be preferred. Lead lengths from the PICKUP to the ignition coil, switch and points can be up to 8′ or 10′ without ill effects—however, use well-insulated stranded wire (#14).

Hard Starting. The initial values of base resistors *R1*, *R2* and *R3* should be 62 ohms if the *beta* of all three transistors is above average. However, to obtain a current drain through the transistors of 5 amps and keep breaker point current as low as possible, the base resistors may need to be reduced. Start with 62-ohm resistors at *R1*, *R2* and *R3*. If the car is difficult to start, check the current drain through the transistors (insert an ammeter between the ignition switch and the junction of *L1* at the emitter of *Q1*) to see if it is under 5 amps. A low current flow calls for dropping the value of *R1*, *R2* and *R3* to 47 ohms—or even 22-27 ohms in extreme cases where the *beta* is at the lower limits of the manufacturer's specifications.

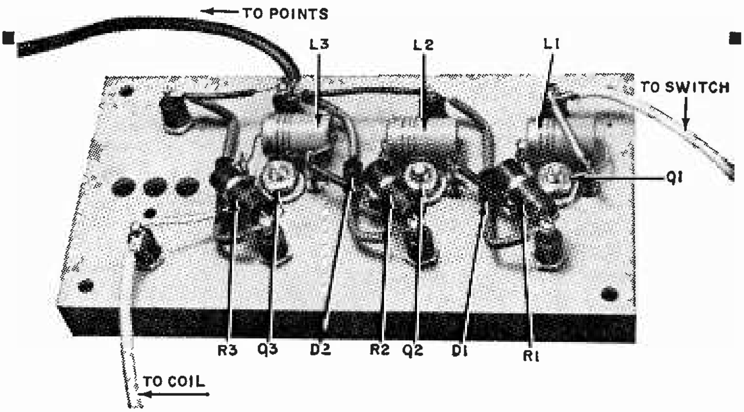
There is a second method to check for loss in the transistor circuit if you have trouble starting. Measure the voltage drop between the ignition switch and coil with the engine not running and the points closed. The drop should not exceed 1.5 volts. If it is greater, it's a sign that the base resistors must be reduced in value.

Another cause of hard starting is due to *L1*, *L2* or *L3* having a value under 2.5 mh. and 20 ohms or less d.c. resistance. The use of a choke is not absolutely necessary (units have been built without chokes, but do not operate as well), but the d.c. resistance is critical. Keep it above 22-25 ohms; use of a choke provides a short pulse (collapsing field) to turn the transistor "off."

Ballast Wiring. A large percentage of the automobiles now being manufactured do not have a ballast resistor, per se. In its place there appears "ballast wiring." Unfortunately, the characteristics of ballast wiring seem to vary from car



Positive ground circuit ONLY. The use of an npn transistor to "invert" the PICKUP circuit is mandatory. Adjust values of R1, R2, and R3, or R5 to eliminate any tendency toward hard starting. By careful drilling and reaming, transistor Q4 can be mounted in the spare hole in the heat sink below.

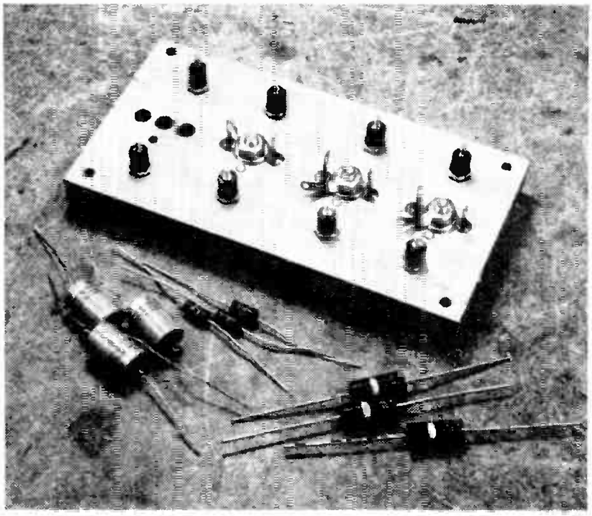


Placement of the parts for a negative ground system is straightforward.

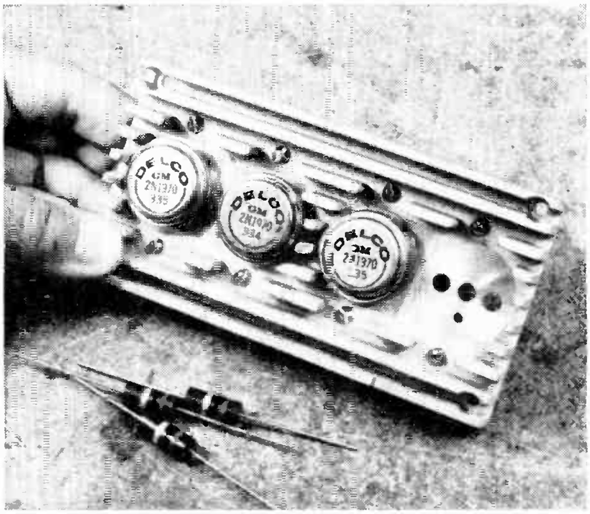
to car. To further complicate this problem, some cars will have a temperature-compensated ballast resistor instead of a fixed value, high-wattage resistor.

To properly install any transistorized ignition system, the ballast resistance must be taken into account. As mentioned above, the ideal current through a 100:1 turns ratio ignition coil is about 5 amps. Since the dropping resistor in series with the bases of all three transistors should not be less than 22-27 ohms, the ballast resistor must be adjusted (reduced) to obtain a 5-ampere flow. Increase the ballast resistor, or install one, if the current flow is too

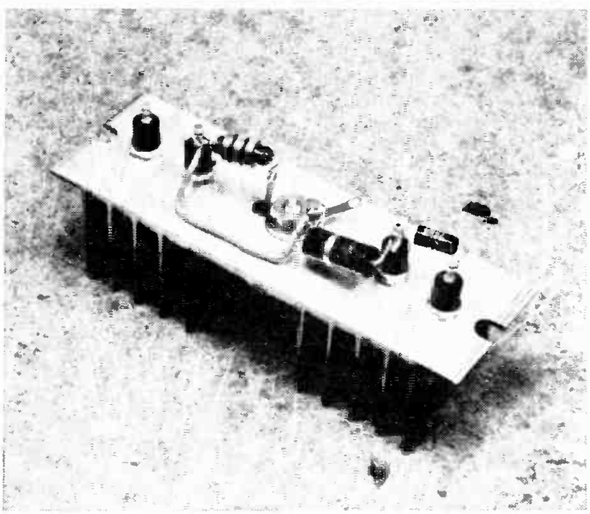
If use is made of a Cesco HS-4 heat sink, plan to attach 2"-long bolts to the four corner holes. Mount the heat sink to the radiator extension (see photo on page 10) using these bolts as mounting posts. Eight standoff terminals are spaced around the heat sink as shown in the photo at the right.



All of the transistors must be fully insulated from the heat sink. Delco provides the necessary mica hardware with each transistor. Clip the corners of the mica insulators to fit around the heat sink fins. Ream out the center hole to fit in the fiber insulating collar.



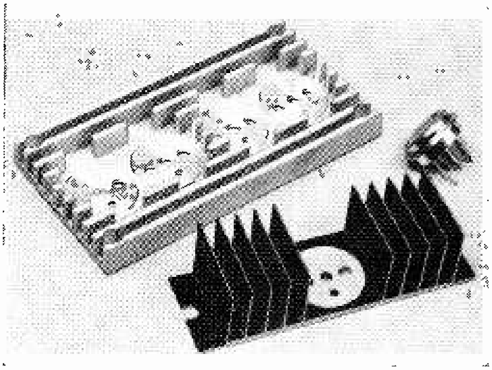
This is a test version of the PICKUP circuit on a Delco 7276040 heat sink. This sink is also pre-drilled for easy transistor mounting. The choke visible here is a Superex M-25. Initial tests indicate this simplified circuit can be used with 400:1 turns ratio ignition coils.



great—bearing in mind that 62 ohms at *R1*, *R2* and *R3* is the idealized value for top *beta* transistors.

Higher Ratio Coils. Either a 250:1 or 400:1 turns ratio ignition coil can be used with the PICKUP system. The substitution is not direct, but involves elimination of part of the circuit. This permits additional current to flow through the transistors by reducing areas of possible voltage drop.

If you want to use a 250:1 turns ratio coil, eliminate *D3*, *L3*, *Q3* and *R3* and connect B to C and B′ to C′. When using a 400:1 turns ratio coil also eliminate *D2*, *L2*, *Q2* and *R2*, connecting A to C and A′ to C′. In many cases, higher turns ratio coils will not make a noticeable difference in car operation.



A Cesco heat sink has the advantage of being able to mount four transistors—even though only three are required in the negative ground circuit. Delco heat sinks are capable of more heat radiation, but only mount a single transistor. A means must be provided to hold the three sinks, if they are used.

Weatherproofing. Proven in practice are a number of household plastic sprays that will water- and weatherproof your PICKUP ignition system. Even the readily-available Krylon clear spray is satisfactory if the system will not be directly exposed to harsh weather conditions.

A liberal painting with clear Lucite-type plastic will also work. A new spray manufactured by Columbia Technical Corp. (HumiSeal type 1A27) that is transparent, humidity-resistant and highly adhesive might be tried if available. Rubber potting can also be used.

We still like the General Electric silicon rubber adhesives in the RTV-series. Sold in tubes and applied like a toothpaste, RTV-108 is white and RTV-102 is crystal clear.

Spark Plugs. Many advertisements on transistorized ignition systems boldly proclaim that "any old" spark plug will work. Possibly this statement is true, but it's rather foolish economy to believe it. In setting up your car for top performance, check your plugs; if they have over 5000 miles on them, install a new set. Gap them to the manufacturer's specifications for your car. Occasionally an increased gap of 0.005″ will improve car performance with the PICKUP, but set the spark plugs according to specs, and experiment later on.

Distributor Points. To guarantee best possible results with the PICKUP, install a new mirror-bright set of distributor points. Simultaneously, disconnect the capacitor. Old points may be pitted or worn so that a good contact is not being made. This could easily destroy the usefulness of your PICKUP system. Where formerly the points had to make and break a current of about 5 - 6 amperes, the current from the PICKUP's transistor switching circuit will be on the order of 400 - 500 ma. In fact, it is our prediction that the fiber cam kicking the point open and shut will wear out before the points need replacing. A reasonable life estimate is on the order of 40,000 miles or greater for points when using the PICKUP.

Check Timing and Dwell. To insure premium performance from the PICKUP, you should have a reputable automobile service shop check the timing and dwell after you install the new system. Be sure that the timing is set to the car manufacturer's specifications. If it is not —if the car's timing is 2-4° late, rather than 5-6° early, for example—your car will probably not start with transistorized ignition.

Setting the dwell to the manufacturer's specs is frequently not as important as timing, but nevertheless it should be held to a tolerance of within ±2°.

If it is not possible to check timing and dwell before installation, be sure to have it done as soon as possible after the PICKUP is installed. -30-

THE LODESTAR

Transistorized metal locator pinpoints metals by a change in pitch

THERE'LL always be plenty of uses for metal locators in addition to the most "rewarding" one—prospecting for precious metals. During World War II and the Korean conflict, for example, metal locators used as mine detectors saved countless lives. Out West, weekend "prospectors" combing through "ghost" towns call on their trusty metal locators to uncover pistols, rifles, and dozens of similar "prizes." Still other "prospectors" are busily ferreting out pipes and other metallic objects buried in the

By CHARLES CARINGELLA, W6NJV

THE LODESTAR

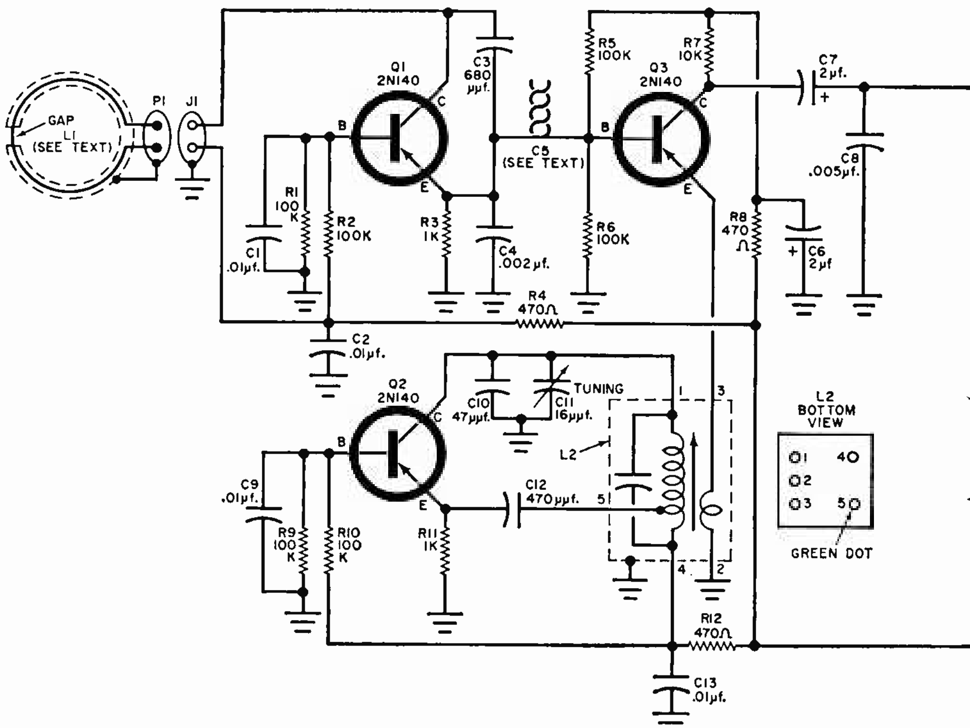
ground or hidden in walls of buildings.

The transistorized metal locator pictured here operates on the "beat frequency" principle. Though this mode of operation is hardly new, the fact that transistors are used does update the device. The result is a metal locator that is compact, rugged, and easy to handle. In addition, its power requirements are decidedly low when compared to those of an equivalent vacuum-tube unit.

About the Circuit. The "Lodestar"'s "front end" consists of two oscillators (*Q1* and *Q2*), each operating in the vicinity of 1000 kc. Each oscillator's output is fed to transistor *Q3*, which

PARTS LIST

B1—9-volt battery (Burgess 2U6 or equivalent)
C1, C2, C9, C13—0.01-μf. paper capacitor
C3—680-μμf. silver mica capacitor
C4—0.002-μf. paper capacitor
C5—Gimmick capacitor (optional—see text)
C6, C7—2-μf., 10-w.v.d.c. electrolytic capacitor
C8—0.005-μf. paper capacitor
C-10—47-μμf. silver mica capacitor
C-11—16-μμf. variable capacitor (Hammarlund HFA-15B or equivalent)
C12—470-μμf. ceramic or mica capacitor
J1—2-conductor shielded jack (Amphenol 80-PC2F or equivalent)
J2—Open-circuit phone jack
L1—Sensing coil—see text
L2—455-kc. transistor oscillator coil (J. W. Miller 2021)

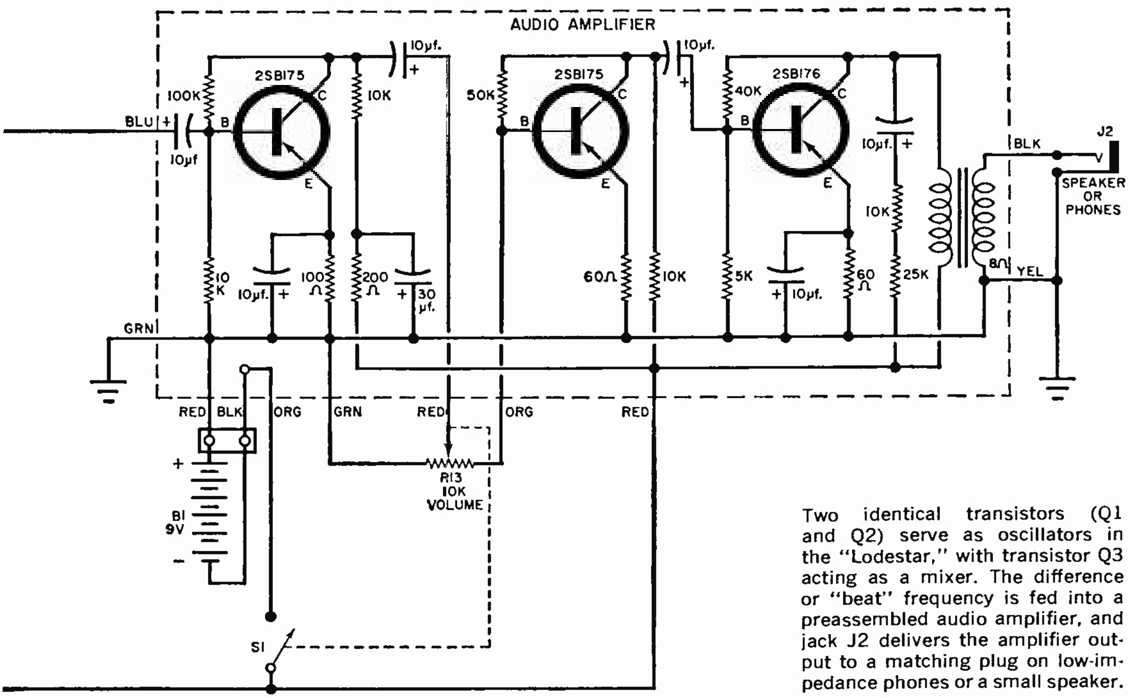


"mixes" the two signals in the same manner as a mixer in a superheterodyne receiver. The mixer output consists of both the sum and difference of the two signals fed into it, but the difference or "beat" frequency is the one of interest in this application. We'll see why in a moment.

If the two oscillators are oscillating at precisely the same frequency, the beat frequency will be "zero"—in other words, there won't be any "beat frequency!" However, if one of the oscillators is de-tuned slightly, the beat frequency will occur at an audible rate, and the beat note can be amplified and heard through a pair of phones or a speaker. This is accomplished in the unit shown by the three-stage audio amplifier following the mixer.

Now here's how the unit succeeds in detecting the presence of metal. Note that the sensing coil (*L1*) is part of the resonant circuit or "tank" of the first oscillator. If a metallic object enters the field of the sensing coil, eddy currents are induced which effectively decrease the inductance of the coil; as a result, the frequency of oscillation is increased. The second oscillator, however, shielded within the enclosure, remains at a fixed frequency. Since the first oscillator has changed frequency with respect to the

P1—2-conductor shielded plug (Amphenol 80-MC2M or equivalent)
Q1, Q2, Q3—2N140 transistor (RCA)
R1, R2, R5, R6, R9, R10—100,000 ohms
R3, R11—1000 ohms
R4, R8, R12—470 ohms
R7—10,000 ohms
(All resistors ¼ watt, 10%)
R13—10,000-ohm potentiometer with switch S1
S1—S.p.s.t. switch (part of R13)
1—Three-transistor subminiature audio amplifier (Lafayette PK-522—see text)
1—5¼" x 3" x 2⅛" aluminum utility box (Bud CU-2106-A or equivalent)
1—5' length of 2-conductor shielded microphone cable (Belden 8422 or equivalent)
1—6½' length of 5-conductor intercom cable (Belden 8445 or equivalent)
1—6½' length of ⅜"-diameter copper or aluminum tubing
Misc.—Phenolic board, Masonite board, wooden handle, transistor sockets, knobs, screws, hook-up wire, solder, etc.

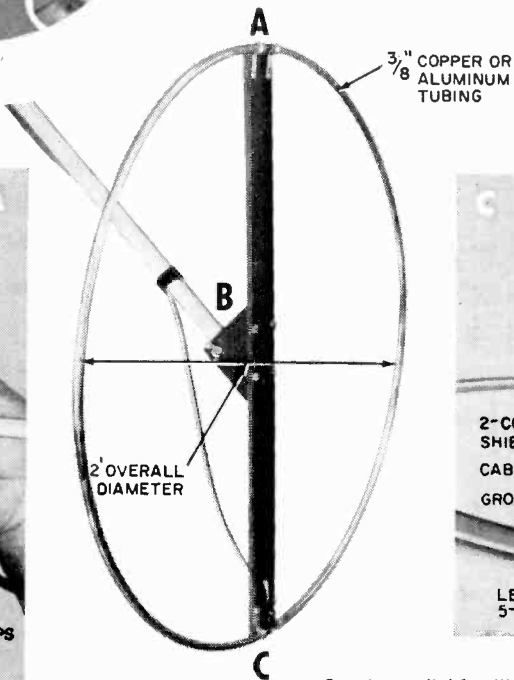


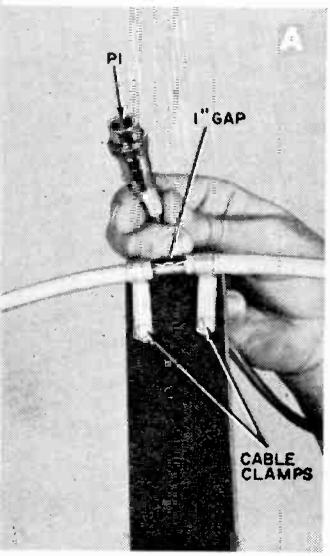
Two identical transistors (Q1 and Q2) serve as oscillators in the "Lodestar," with transistor Q3 acting as a mixer. The difference or "beat" frequency is fed into a preassembled audio amplifier, and jack J2 delivers the amplifier output to a matching plug on low-impedance phones or a small speaker.

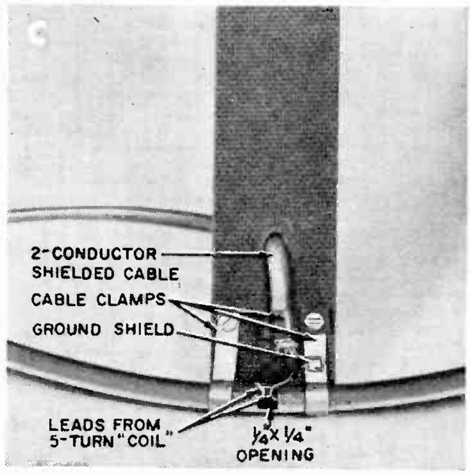
second, the presence of metal is then evident as a change in the audio pitch heard in the phones.

In actual operation, the second oscillator is initially tuned (by means of capacitor *C11*) to a frequency which beats with that of the first oscillator and produces a tone which is comfortable to your ear. (This adjustment, of course, must be made with the unit well away from metal objects). Then, as metal is approached, the pitch will go up or down, depending on whether the reference oscillator (*Q2*) is above or below the search oscillator (*Q1*) in frequency.

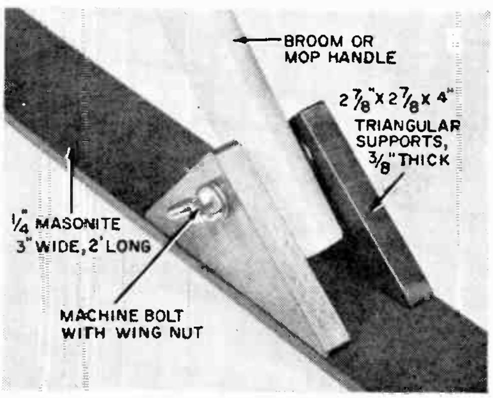
Since the d.c. biasing methods are

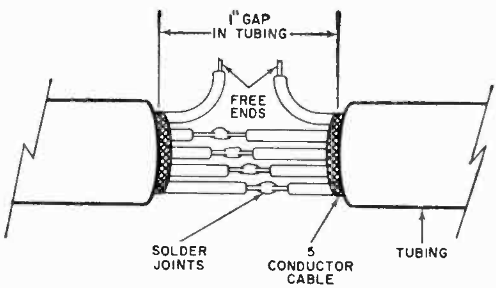


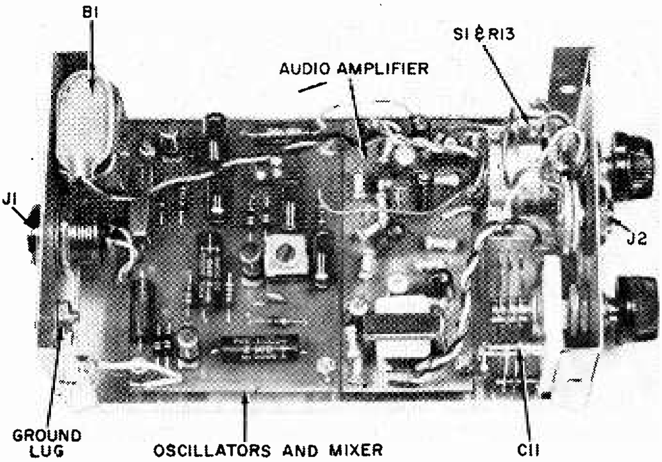


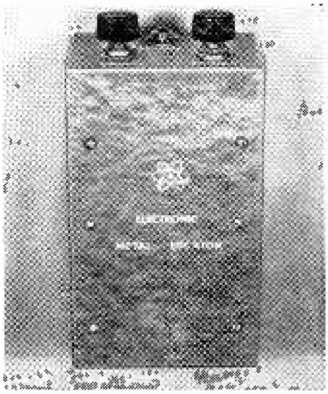


Sensing coil L1 will go together smoothly with aid of photos and drawing shown here. Details A, B, and C picture, respectively, 1″ gap, pivot for wooden handle, and method of connecting coil to shielded cable. "Alternate" leads in 5-conductor cable are soldered together to form 5-turn coil (below).









Completed Lodestar fits snugly in a $5\frac{1}{4}'' \times 3'' \times 2\frac{1}{8}''$ box. To operate it, simply plug the sensing coil into jack J1, headphones or speaker into jack J2.

identical and the temperature coefficients of the transistors are the same, frequency drift between the two oscillators is minimized. The frequency drift of the two circuits will be nearly the same, and in the same direction, resulting in no apparent change in the beat note.

The operating frequency of 1000 kc. is actually a compromise between two important effects. At higher frequencies, a smaller change in inductance brings about a larger change in frequency; therefore, the higher the frequency of operation, the more sensitive the unit will be. However, beginning at frequencies of several megacycles, the depth to which the signal will penetrate begins to drop; therefore, a "happy medium" is reached at about 1000 kc.

So far, we've discussed only the effects of inductance on the unit's operation. However, nonmetallic objects and the earth itself cause capacitive effects at these frequencies, and the audio beat note would change every time the search coil was brought near any object or near the ground if these effects weren't taken care of. Any capacitive effects are virtually eliminated with a shield which completely encloses the sensing coil except for a 1" "gap" which keeps the shield from acting as a shorted turn.

Putting It Together. The electronic portion of the Lodestar is housed in an aluminum utility box measuring $5\frac{1}{4}'' \times 3'' \times 2\frac{1}{8}''$. The tuning capacitor (*C11*), volume control (*R13*), and phone jack (*J2*) are mounted on one end, and the jack (*J1*) for the sensing coil on the other.

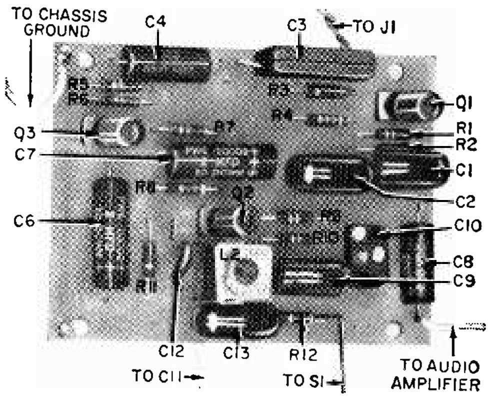
The "front end," which consists of both oscillators and the mixer, is assembled on a piece of phenolic board; the drawing shows how the components are secured to the board as well as how the board is mounted in the enclosure.

Direct, point-to-point wiring is used throughout, and the entire assembly should be rigid enough to be substantially free from mechanical vibrations. If it isn't, you'll find yourself troubled with frequency instability.

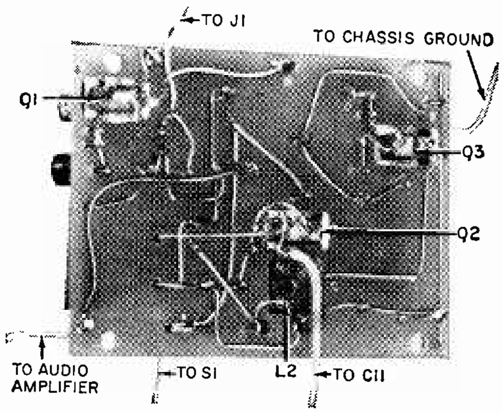
To make assembly that much simpler, a three-stage transistorized audio amplifier was purchased, factory-wired and ready-to-go. This amplifier* delivers enough power to drive a speaker directly, and phones can be used as well. (Unless you happen to have a pair of 8- or 10-ohm phones on hand, there will be some mismatch between the output transformer and the phones, but this won't be critical.) The audio section is mounted in the enclosure in the same manner as the board which holds the "front end."

The Sensing Coil. As in the balance of the unit, the leads to the "sensor" or

**Catalog number PK-522, the amplifier is available from Lafayette Radio Electronics Corp., 111 Jericho Turnpike, Syosset, L. I., N. Y., for $3.75, plus postage.*



"Front end" of Lodestar is mounted on a small phenolic sheet, about 2 1/16" wide and 2 13/16" deep. Top and bottom views show location of all components as well as details of interconnecting wiring.



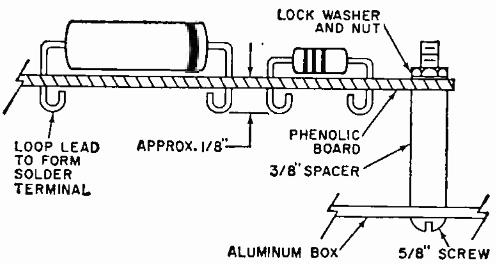
search coil must be as rigid as possible to prevent slight motions or jarring from pulling the oscillator off frequency. The ⅜" tubing, which can be either copper or aluminum, serves a dual purpose—it acts as a shield, and it also rigidly supports the coil.

A 5-turn coil is fabricated from one length of 5-conductor cable by connecting the ends in such a manner that they form a single coil. The outer jacket holds the five conductors together, so that they are not allowed to move with respect to one another. Any movement of these wires would change the inductance and stray capacitance of the coil, and, again, the oscillator would be unstable and pull off frequency whenever the coil was jarred.

The first step in fabricating the search coil assembly is to form the ⅜" tubing into a loop about 2' in diameter with a gap of about 1" between the ends (this will require a piece of tubing approximately 6' 3" in length).

Next, cut a ¼" square in the tubing directly opposite the 1" "gap." Connections to the coil will be made through this opening a little later in the construction process.

Now, feed the length of 5-conductor cable into the tubing and trim it so that



Attach components to board by drilling holes, then inserting and looping leads to form solder terminals.

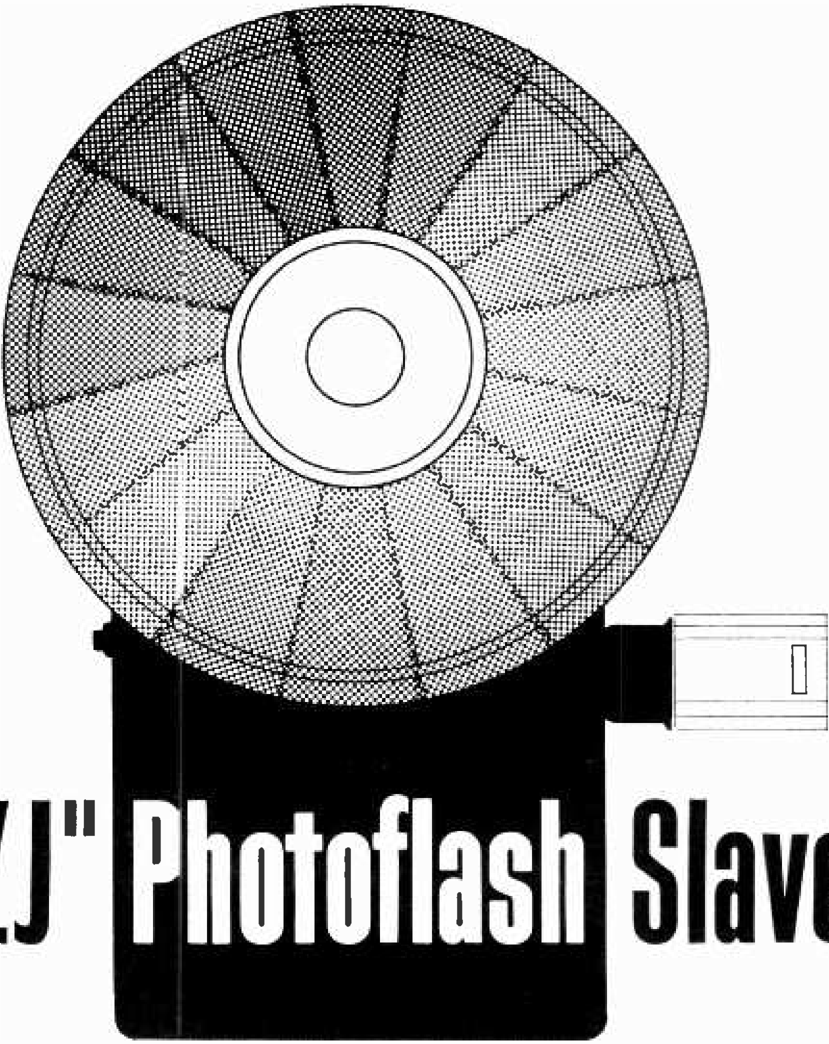
about 1" protrudes from each end of the tubing. Strip the outer plastic jacket from the ends of the cable, leaving the five wires, each 1" in length, exposed at each end of the tubing. Connect and solder the ends of alternate wires so that one continuous 5-turn coil is formed (there will be four solder joints and two free ends).

If you "stagger" the solder joints somewhat, you should be able to wrap one turn of plastic tape around each of the four wires and the respective solder joints to insulate them from each other and also from the metal tubing. Be sure to leave the two unsoldered wires free, since you'll need them to connect the coil into the circuit.

Once the cable has been taped, work it around inside the tubing so that the taped portion is located at the ¼" x ¼" opening. Next, "fish" the two free leads through this opening and connect them to the 2-conductor shielded cable. Keep the leads as short as possible so they won't vibrate, and ground the cable shield to the cable clamp near the opening in the tubing.

A piece of ¼" Masonite, about 3" wide

(*Continued on page* 162)



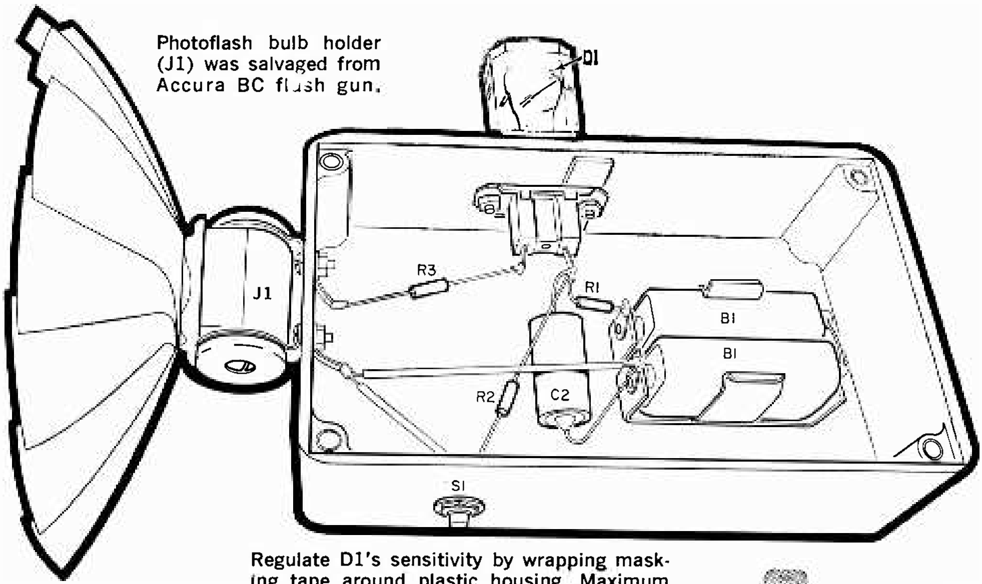
"ZJ" Photoflash Slave

By BRICE WARD

Introducing the light-activated switch—a startling new development in the field of semiconductors

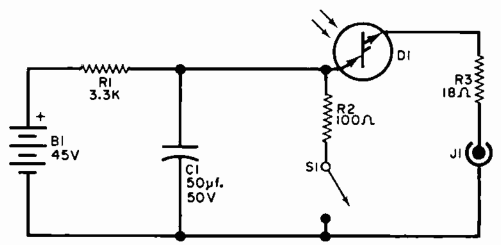
THE TERM "photoflash slave" is often inappropriate. Practically every advanced amateur or semi-professional photographer will tell you it's used to describe an exasperating piece of machinery that may or may not give light at the right (or wrong) time. Slaves can be triggered by a stray headlight passing the window, or, on the other hand, become so insensitive that they refuse to fire unless their photocells happen to be facing in exactly the right direction. Slaves that incorporate relays occasionally misfire due to dirty contacts, and the complexity of some circuits only adds up to component failures.

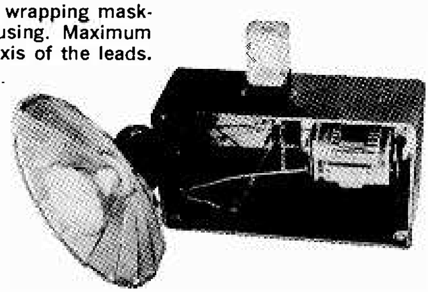
The "ZJ" photoflash slave has *no* relay contacts to get dirty, needs *no* sensitivity adjustments, and has *no* built-in delay—except the ordinary



Photoflash bulb holder (J1) was salvaged from Accura BC flash gun.

Regulate D1's sensitivity by wrapping masking tape around plastic housing. Maximum light pickup is 45° off the axis of the leads.





PARTS LIST

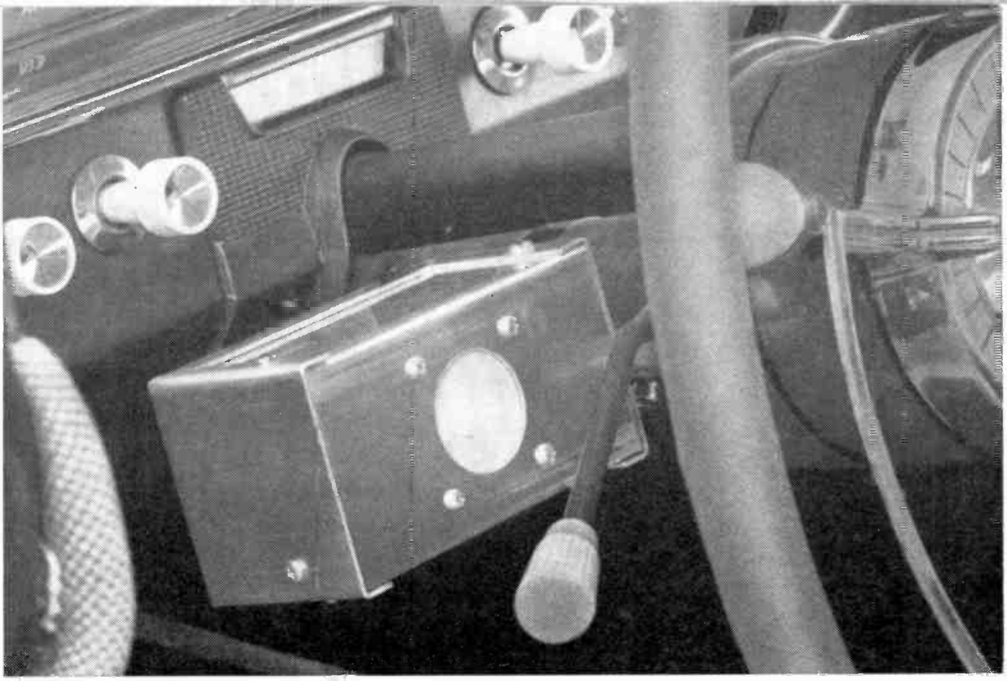
B1—22½-volt photoflash battery (two Burgess Type U-15 cells wired in series)
C1—50-µf., 50-volt capacitor
D1—Pnpn light-activated diode switch (General Electric ZJ235F)
J1—Photoflash bulb holder
R1—3300-ohm, ½-watt resistor
R2—100-ohm, ½-watt resistor
R3—18-ohm, ½-watt resistor
S1—Single-pole, push-button N.O. switch
Misc.—Mounting box, battery holder, a.c. chassis socket, a.c. plug, etc.

delay inherent in the bulb. The whole secret of the device is that, instead of an ordinary photocell, it uses a semiconductor equivalent of a vacuum-tube thyratron. Sold by General Electric as a *pnpn* light-activated switch, the ZJ235F is somewhat similar to a silicon-controlled rectifier operating in the microsecond range. Identified here as diode *D1*, the ZJ235F may be considered a silent, hermetically sealed switch that can be triggered millions of times by light impulses without wearing out.

The author's model uses a flash-bulb holder salvaged from a stripped-down Accura BC flash gun. Diode *D1* is soldered to the prongs of a dime store plastic a.c. cap. Since *D1* is a miniature glass-enclosed unit, it must be protected against breakage; a good way is to cement the end of a clear plastic toothbrush holder over it and to the a.c. cap.

To use the "ZJ," plug the diode assembly into the regular a.c. socket mounted in the side of the slave's cabinet. With this socket, you can also use the slave as a simple remote flash by removing *D1* and connecting a cord between the "ZJ" and your camera.

The circuit is extremely simple and can be duplicated by the most inexperienced builder. However, one word of caution is in order: when you replace the flash bulb, be sure to grip the case so that switch *S1* is closed, releasing the stored-up charge in capacitor *C1*. This will prevent the flash bulb from firing prematurely. -30-



THE BLINKER MINDER

Transistorized gadget emits an audible beep whenever your car's turn-signals are on

By FREDERICK J. HAINES*

HOW MANY TIMES have you observed the driver ahead "poke" along mile after mile, turn-signals blinking away, confusing everyone and making you hesitant to pass him? Now think back and ask yourself, "How many times have I done the same thing?"—inadvertently, of course!

The mechanical turn-signal canceling device in your auto *usually* takes care of the situation. But with the advent of limited-access superhighways and freeways, the 45° turn is now commonplace —on entering or leaving via a ramp, for example. And you've probably noticed that the "canceler" doesn't always cancel under these conditions.

True, the flasher unit in some cars emits an audible click to remind you that the lights are blinking, but other cars have these devices mounted in the engine compartment where they can't be heard. In addition, if the windows are open and your speed is high or traffic noise is great, you can't hear flasher clicks anyway.

"Well," you say, "all I need to do is glance at the green arrows that light up on the dashboard when the signals are on." This is a fine idea, but don't you find it difficult to see them on a bright day? And isn't it a safety hazard to take your eyes from the road? If you agree, then you'll want to build and use the "Blinker Minder."

The idea behind the Blinker Minder is simple enough—have a speaker mounted

*Closed Circuit Television Engineering
Technical Products Operation
General Electric Co., Syracuse, N.Y.

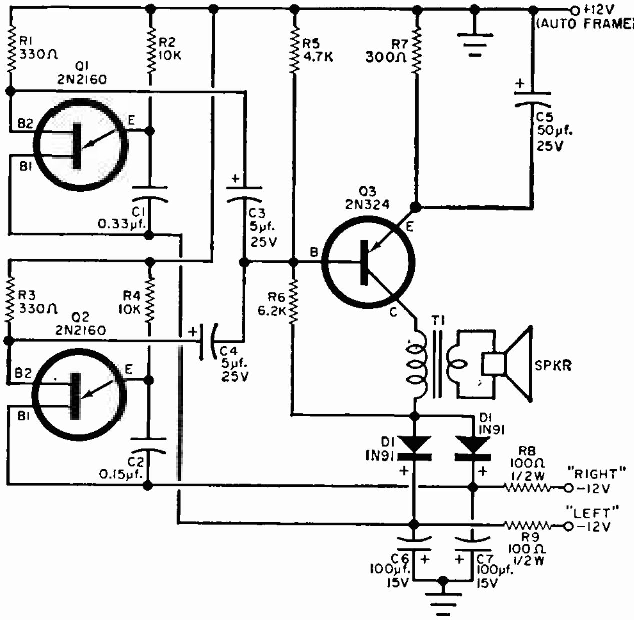


Fig. 1. Schematic diagram of "Blinker Minder" for autos having "positive" grounds. Transistors Q1 and Q2 are new "unijunction" types made by General Electric; "B1" and "B2" indicate "base 1" and "base 2," respectively.

near the driver to provide two different audio tones controlled by the left and right turn-signal circuits. A low-pitched tone for the left flasher and a high-pitched tone for the right let you know which way your signals are set without your even looking up from the road.

It's interesting to note that the device helps develop good driving habits, too—it's such fun to use that you never "forget" to signal. A "bonus" feature of the device is that the flasher usually slows down or stops if a signal bulb burns out, and this fact will be readily apparent to any driver using the Blinker Minder.

In a sense, there are really two Blinker Minders, and two schematic diagrams are provided here; Fig. 1 is for autos having an electrical system with a positive ground and Fig. 2 is for those with a negative ground. Unfortunately, six volts isn't enough to operate either Blinker Minder at full volume. However, this is of no great consequence, since the great majority of vehicles on the road today are equipped with 12-volt batteries.

Construction. A 2¼" x 4" x 2¼" miniature case houses the author's Blinker Minder. The speaker, a miniature type used in pocket radios, is mounted in one section of the case; the speaker opening is covered with a square of cloth, glued in from the rear, of a color to match or blend with the car's interior decor.

The transistor sockets and several tie-strips accommodate the components and are placed in the other "half" of the case. Wiring and layout can be varied to suit your preference or to allow for parts which deviate physically from those shown in the photos.

Take care to wire your Blinker Minder to suit the battery circuit used in your automobile. If the wrong polarity is applied to the Minder, it's likely that the three transistors will be retired from active duty, but permanently! As a precaution, it's a good idea to measure the voltage from the dashboard light circuit with a voltmeter, and note the polarity of the meter leads.

A stainless steel hose clamp is fitted to the side of the case with two *4-40* machine screws, lock washers, and nuts. (*Two* screws are used to prevent rotation of the unit after it's clamped on the left side of the steering column just under the turn-signal lever). As a matter of fact, it's extremely important to use lock washers throughout the unit to prevent "vibration failures."

After installation, check with an ohmmeter on the low-ohms scale to insure that the hose clamp mounting has provided a good contact to the auto frame. If not, scrape a bit of the paint off the

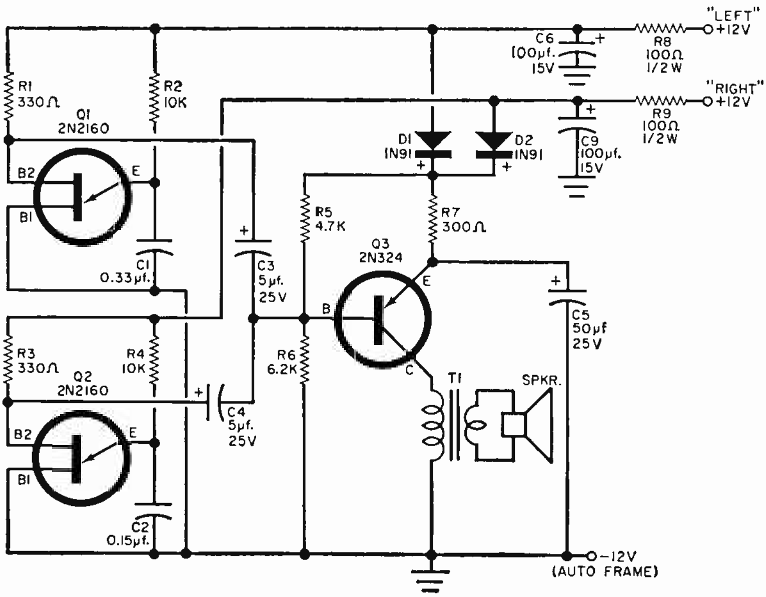


Fig. 2. Automobiles having "negative" grounds will require this version of the "Blinker Minder." Regardless of which version you build, you'll find that the circuit draws almost negligible current—the total power consumption is approximately 0.25 watt.

steering column under the clamp, or provide another wire from the Blinker Minder's case to a good ground point under the dash.

Actually, the most difficult part of the installation is tapping power from the dashboard light circuits. In most cars, the light sockets snap out from behind the dash and drop down to allow easy bulb replacement. In the author's case, the wire to the bulb was cut about 3" from the socket, both ends stripped back about ½", then spliced together along with the third wire needed to run to the Blinker Minder. The splice should be soldered and taped, and the "third" wire should be a tough, automotive-type to resist abrasion.

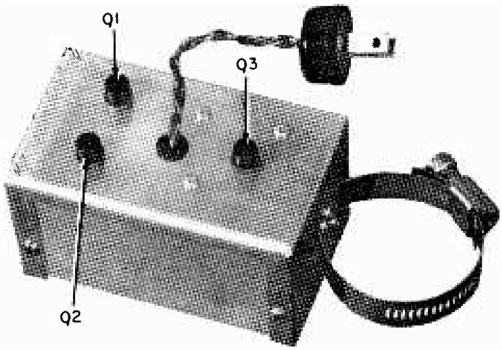
About the Circuit. Both Blinker Minders—the one for positive grounds shown in Fig. 1, and the one for negative grounds which appears in Fig. 2—are essentially the same in operation. Both use two 2N2160 unijunction transistors (*Q1* and *Q2*) as audio oscillators to provide the necessary signaling tones. (The unijunction transistor, incidentally, allows the utmost in circuit simplicity, with only two resistors and a capacitor required in each of the oscillators).

The time constants of *C1/R2* and *C2/R4* determine the frequency of oscillation for *Q1* and *Q2*, respectively. With the values indicated, the "left" oscillator operates at about 400 cycles, and the "right" at about 800 cycles, thus making it a simple matter to differentiate between a left and a right turn-signal being on.

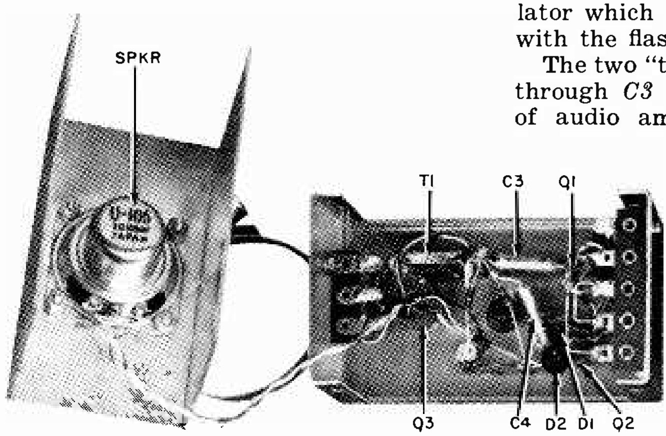
If the voltage between the emitter and base 1 of either transistor is less than the voltage between bases 1 and 2, only a very small leakage current will flow from the emitter to base 1. (In effect, the diode formed by the emitter and base 1 is cut off or reverse-biased). But if the emitter-to-base-1 voltage should be-

PARTS LIST

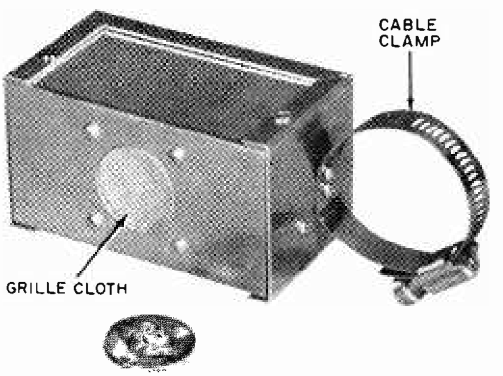
C1—0.33-µf., 200-volt miniature paper capacitor
C2—0.15-µf., 200-volt miniature paper capacitor
C3, C4—5-µf., 25-w.v.d.c. miniature electrolytic capacitor
C5—50-µf., 25-w.v.d.c. miniature electrolytic capacitor
C6, C7—100-µf., 15-w.v.d.c. miniature electrolytic, capacitor
D1, D2—1N91 diode (G.E.)
Q1, Q2—2N2160 transistor (G.E.)
Q3—2N324 transistor (G.E.)
R1, R3—330 ohms
R2, R4—10,000 ohms
R5—4700 ohms } *all resistors ½-watt*
R6—6200 ohms
R7—300 ohms
R8, R9—100 ohms
T1—Transistor output transformer: primary, 500 ohms (CT not used); secondary, 10 ohms (Lafayette TR-109 or equivalent)
SPKR—1½" PM speaker, 10-ohm voice coil
1—2¼" x 4" x 2¼" aluminum utility box (Premier AMC-1003 or equivalent)
Misc.—Wire, solder, transistor sockets, terminal strips, grille cloth, hardware, hose clamp, etc.



Neat and compact, Blinker Minder can be mounted on steering post or in any other convenient spot.



Hooking up your Blinker Minder should be easy—photo above shows location of all major components. Just be sure to select the correct circuit for your automobile and to observe all indicated polarities.



Grille cloth can be chosen to blend with auto color scheme; metal grille will give more protection.

come equal to or greater than the base-1 to base-2 voltage, current will flow from the emitter to base 1 and the emitter-to-base-1 resistance will suddenly decrease.

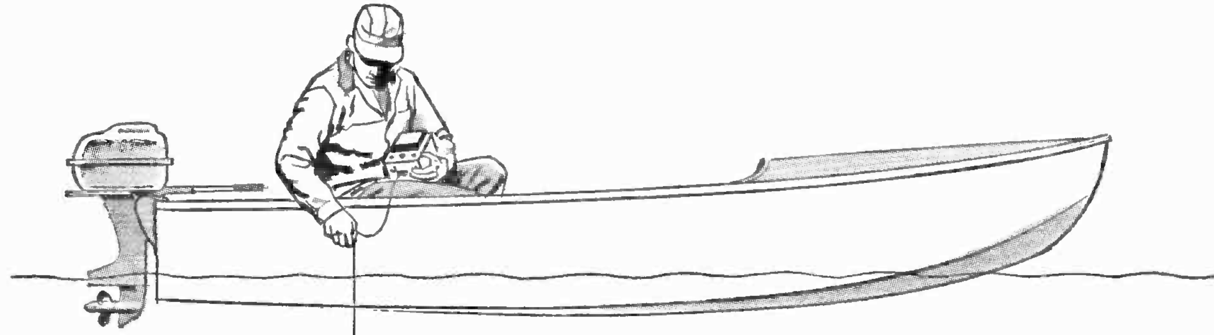
In other words, capacitor *C1* will charge toward +12 volts through *R2* until the voltage across *C1* becomes equal to the voltage between base 1 and base 2. At that instant, the emitter/base-1 diode conducts, shorting out *C1*, and the process begins all over again.

Power for the "left" oscillator is "stolen" from the dashboard "left" turn-signal indicator socket, and power for the "right" oscillator is obtained from the other turn-signal indicator lamp. This results in a tone from either oscillator which is turned on and off in step with the flashing indicator lamps.

The two "tones" are coupled in parallel through *C3* and *C4* to the base circuit of audio amplifier *Q3*. This stage, in turn, drives the speaker through output transformer *T1*. Bias stabilization of *Q3* is assured by the 300-ohm emitter resistor and the relatively low impedance of the base-bias voltage divider, *R5/R6*.

The two 1N91 germanium diodes, *D1* and *D2*, perform a most interesting function. Obviously, the amplifier stage, *Q3*, must be powered regardless of whether the "left" or "right" oscillator is on. However, the "left" and "right" power sources from the dash-indicator lights can't be shorted together. Although one solution would be to power the amplifier directly from the battery and leave it on all the time the ignition is on, a more "elegant" approach was deemed necessary.

In this circuit, *D1* is poled so that it "turns on" when voltage appears at the "left" power supply terminal, thus allowing current to flow to the amplifier stage. No current can reach the "right" +12-volt line at this time because *D2* is "turned off" by the positive potential at its cathode. Similar action takes place when voltage appears at the "right" power supply terminal, except this time *D2* is "turned on" and *D1* is "off." No current is drawn by the unit when the turn-signals are in neutral. -30-



THE FISH FINDER

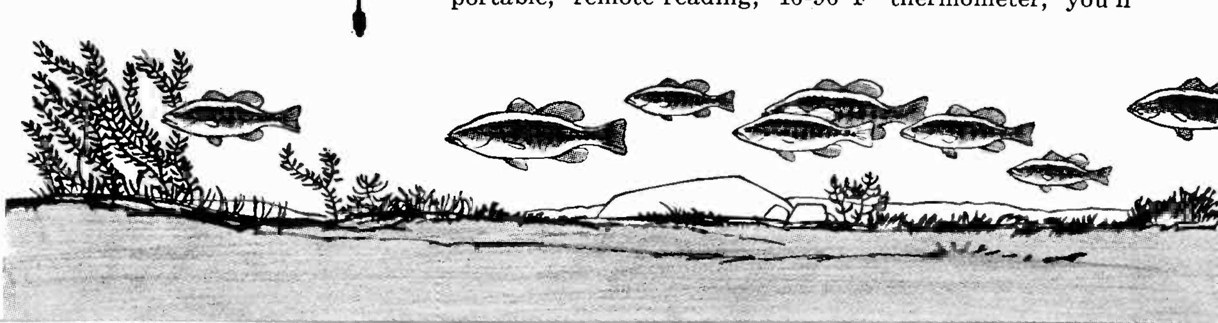
Pity the poor fish when anglers probe the depths with underwater thermometers

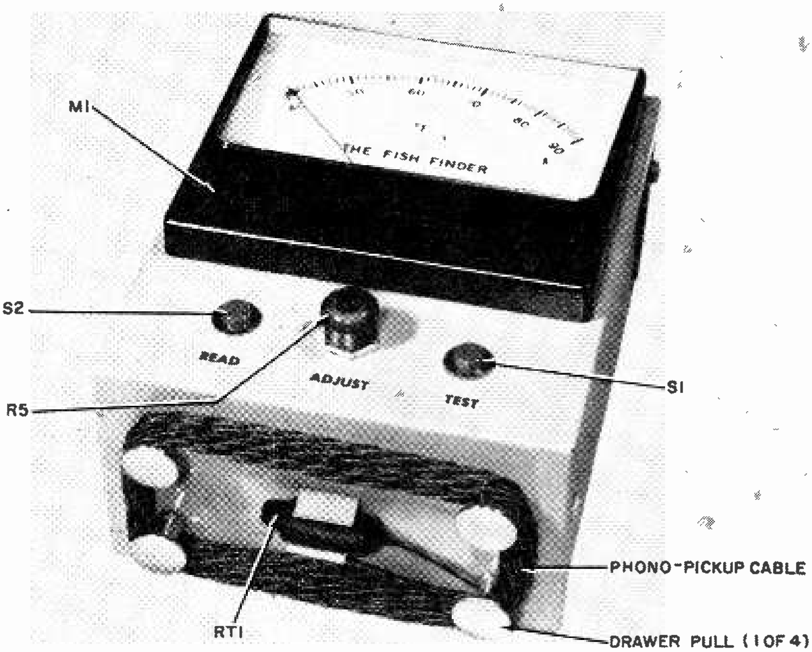
By R. L. WINKLEPLECK

NOT LONG ago, a "fishing nut" friend of mine dropped in with a problem. He needed an instrument, small enough to take on fishing trips, that would quickly and accurately read water temperature at various depths. When asked what he wanted with such a unit, he offered the following explanation.

Different kinds of fish, it seems, have different preferences for the temperature of the water in which they swim. And water temperature (especially the temperature of still or slowly flowing water) is apt to vary with depth. By measuring the temperature at the depth of each "catch," he hoped to work up charts showing the temperature preferences of various species of fish. With the charts, he could select his future catches by placing his hook at a depth having the proper temperature for the type of fish desired.

The author doesn't guarantee the soundness of this theory, but the unit he designed to do the measuring is described here. If you'd like to try your hand at "scientific" fishing, or if you have any other use for a portable, remote-reading, 40-90°F thermometer, you'll





Completed "Fish Finder" is neat, attractive, and professional-looking. For protection against corrosion, apply a couple of coats of paint to box before mounting components.

find it worth your while to take a few hours of your time and put together the "Fish Finder."

About the Circuit. Operation of the Fish Finder depends on a device called the "Thermistor," a resistor which varies inversely in value with the temperature. When the temperature goes up, the resistance of the Thermistor goes down—and vice-versa.

But for our purpose, the important thing about the change of the Thermistor's resistance with temperature is that it's large . . . large enough so that the resistances of switch contacts, long leads connecting the Thermistor to the indicating device, etc., can be ignored in comparison. And we can read the greatly changing resistance with relatively insensitive meters and without elaborate amplifying circuits.

The Thermistor used in the Fish Finder forms part of a Wheatstone bridge circuit (see schematic diagram). Two "arms" of the bridge are resistors *R3* and *R4*; the other two are the Thermistor (*RT1*) and potentiometer *R2*. Assuming that the "Test" push-button (*S1*) is in the position shown (not depressed), the voltage from the battery appears (via "Read" push-button *S2* and potentiometer *R5*) across the bridge between the junction of *RT1* and *R3* and that of *R2* and *R4*.

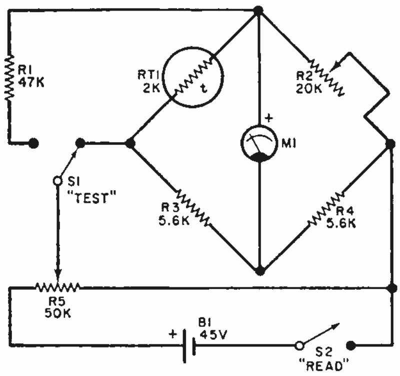
Notice, in this case, that *R3* and *R4* make up one voltage divider and *RT1* and *R2* make up another. Since *R3* and *R4* have the same value, the voltage appearing at their junction is one-half the voltage impressed across the bridge. And, when *R2* is adjusted to the same value as *RT1*, the voltage at their junction is also one-half the voltage across the bridge. Therefore meter *M1*, which is connected across the two junctions, sees no voltage difference between its terminals and reads "Zero."

But if the temperature of *RT1* should change, its resistance would change proportionally. This, of course, would alter the voltage at the junction of *RT1* and *R2*. And, since the voltage at the *R3*-*R4* junction remains the same, meter *M1* now sees a potential difference and shows a reading. The magnitude of the reading is proportional to the temperature change at *RT1*, so *M1* may be calibrated as a thermometer.

Potentiometer *R2* determines which resistance value of *RT1* will "balance" the bridge, giving a zero reading on *M1*. Hence, *R2* controls the lower temperature limit of *M1*'s calibration.

Potentiometer *R5* adjusts the voltage input to the bridge. It has no effect on the meter reading while the bridge is in a balanced condition because there will be no voltage difference between the junction of *RT1* and *R2* and that of *R3* and *R4* whatever the voltage input. However, potentiometer *R5* does determine how high the meter will read for a given degree of temperature change (or bridge imbalance). Therefore, it controls the upper temperature limit of *M1*'s calibration.

"Test" switch *S1* and resistor *R1* are used to maintain a check on the battery voltage. When *S1* is depressed, the arm of *R5* is switched from the junction of *R3* and *RT1* to the free end of *R1*. This provides a reference reading on *M1* which does not vary with temperature but is dependent only on the voltage of *B1*. (Though *RT1* remains in the circuit when *S1* is depressed, its effect on the

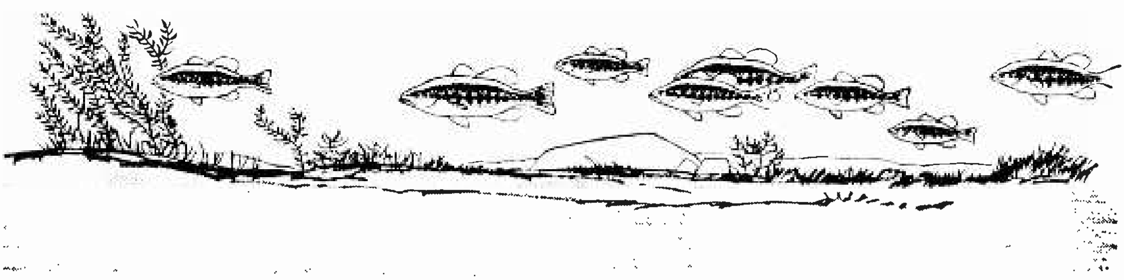


Thermistor (RT1 on schematic) is used as one leg of a Wheatstone bridge indicator.

PARTS LIST

B1—45-volt battery (Burgess XX30 or equivalent)
M1—0-1 ma. meter (Simpson Model 1329 or equivalent—see text)
R1—47,000-ohm, ½-watt resistor
R2—20,000-ohm potentiometer, linear taper
R3, R4—5600-ohm, ½-watt, 5% resistor
R5—50,000-ohm potentiometer, linear taper
RT1—2000-ohm Thermistor (Veco 32D14)*
S1—S.p.d.t. push-button switch
S2—S.p.s.t. push-button switch
1—7" x 5" x 3" aluminum utility box (Bud CU-3008-A or equivalent)
1—4½" x 3¾" section of perforated board
25'—Phono pickup arm cable, vinyl insulated (Belden Type 8430 or equivalent)
Misc.—Foam plastic or rubber, plastic tube, solder, tool dip, connector for B1, drawer pulls, grommet, plywood, etc.

*Write directly to Victory Engineering Corp., Springfield Ave., Springfield, N.J. for information on availability and distribution. At writing this type of thermistor is not being cataloged.



meter reading becomes negligible.) As the battery voltage decreases, the meter is brought back to the reference point by adjusting *R5*.

Construction. All of the components except Thermistor *RT1* are housed in an aluminum utility box. A 6" x 5" x 3" box was used by the author, but the more common 7" x 5" x 3" size specified in the Parts List will do as well.

Locate switches *S1* and *S2*, potentiometer *R5*, and meter *M1* on the box's front panel. Resistors *R1*, *R3*, and *R4*, and potentiometer *R2*, are mounted on a 4½" x 3¾" piece of perforated board.

Meter *M1*'s terminal posts are passed through two holes made in the board, and a solder lug, washer, and nut are installed on each post. The nuts and washers rigidly hold the board assembly in place, while the solder lugs provide a means of connecting the meter to the rest of the circuit.

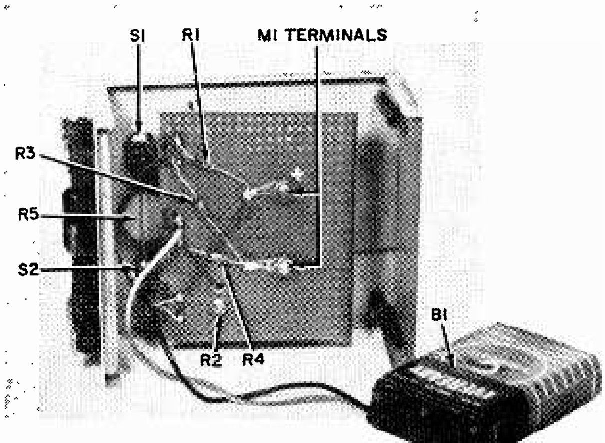
Battery *B1* is wedged in between the board and the top of the box. A scrap of foam plastic or rubber glued underneath the battery provides further support, and sideways movement is restricted by a pair of hollow dowels slipped over the upper meter mounting screws.

Four small drawer pulls mounted on the bottom of the box serve as a rack on which the 25' Thermistor cable can be coiled when it is not in use. Since the drawer pulls which the author had on hand were fitted with wood screws, a 4½" x 2¼" piece of plywood was placed in the box bottom for them to "bite into."

Waterproofing. Both the Thermistor and the Thermistor-cable junction must be suitably waterproofed. In the model described here, *RT1* was connected to the cable and slid into a plastic tube. The tube was then wrapped with wire solder (which acts both as a sinker and a heat-transfer surface).

Next, the whole assembly was dipped several times in encapsulating compound —allowing each layer to dry before redipping—until a solid, waterproof surface was built up. The net result was a short cylinder about the diameter of a penlight cell. It is held in place on the bottom of the box by means of a battery clip.

An alternative waterproofing method



Rear of "Fish Finder" with cover off. Battery B1 mounts in space behind perforated board.

might be simply to put several coats of encapsulating compound on the bare Thermistor, and its leads, after attachment to the cable. This might provide better heat-transfer characteristics, but the finished assembly would be awkwardly shaped and more susceptible to accidental damage. Another disadvantage is that a separate weight would then have to be attached to sink the Thermistor.

Regardless of how you carry out the waterproofing, a good preparation to use for encapsulating is "Insl-X Tool Dip." It's manufactured by the Insl-X Co., Inc., Ossining, N. Y., and is available by mail from Allied Radio, 100 N. Western Ave., Chicago 80, Ill. (Cat. No. 42 N 400 for the 6-oz. size.)

The free end of the Thermistor cable is fed into the box through a grommet-lined hole in the bottom. To prevent moisture from leaking in, seal the grommet with household cement.

Calibration. The instrument was designed to cover a 40-90°F range (the most useful for the majority of fishing situations), but the upper and/or lower limit of this range may be shifted several degrees to suit individual tastes.

Begin the calibration by preparing a jar of water whose temperature has been set at exactly 40°F (or at the lower limit of the temperature range you desire) with an accurate thermometer. Remember that the larger the volume of water you use, the more stable the temperature

(*Continued on page* 163)

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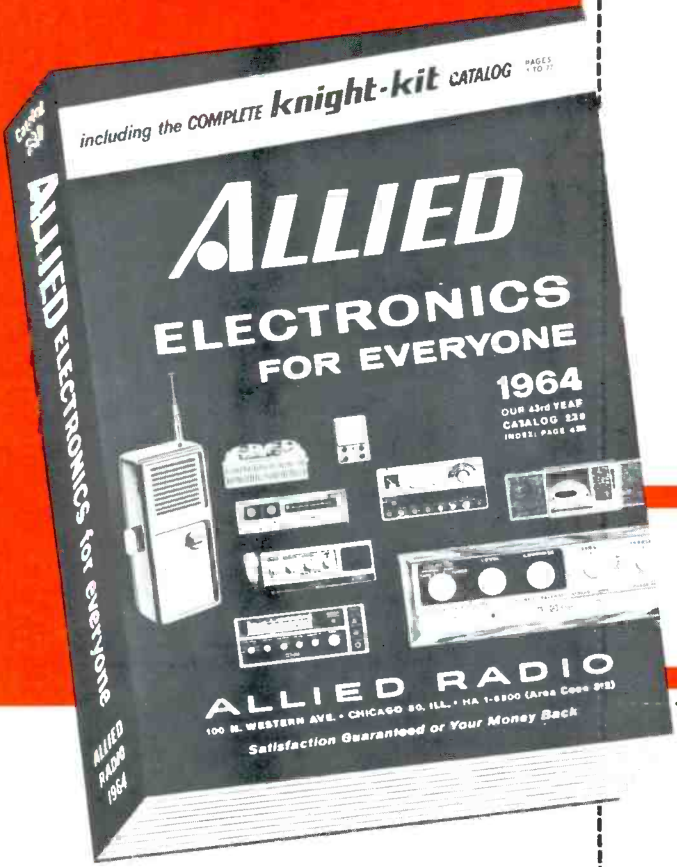

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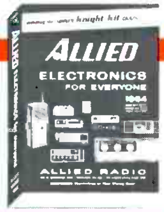

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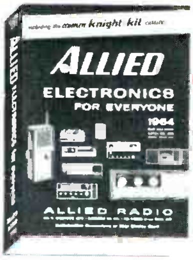

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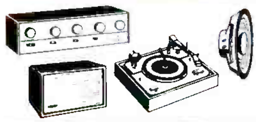

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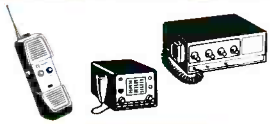

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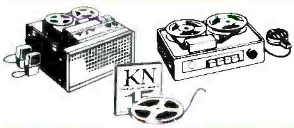

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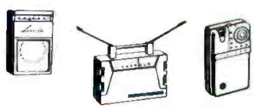

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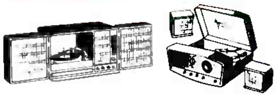

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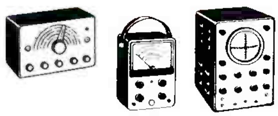

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EMERGENCY HOUSEHOLD LAMP

Don't be left in the dark— here's a gadget that will provide instant light when the power fails

By R. L. WINKLEPLECK

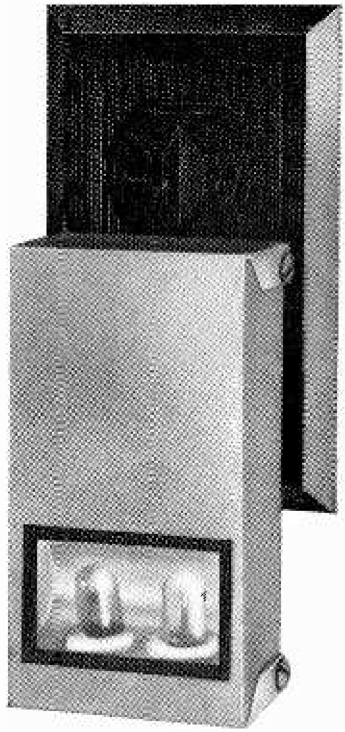
WHAT happens at your house when the power suddenly goes off at night? Do you stumble around trying to find a flashlight or a candle and some matches? If so, here's the answer to your problem. It's a modernized, scaled-down version of the emergency lights you've probably seen in public halls, railway stations, and other places where crowds gather. It goes on automatically when the power goes off, eliminating the possibility that you will be left in complete darkness.

This emergency light, unlike the big commercial types, is a convenient, miniature unit. It can be plugged into a home wall outlet and forgotten. An additional feature is a small neon night light which draws almost no current and remains on all the time. This was incorporated in the design because the location for an emergency light is often one where a night light is needed regularly. The small metal box has a male plug on the back to fit directly into any a.c. outlet. A plastic-covered window on the front protects the two small lamps in a reflector. One lamp is lit when the power is on—the other when the power is off.

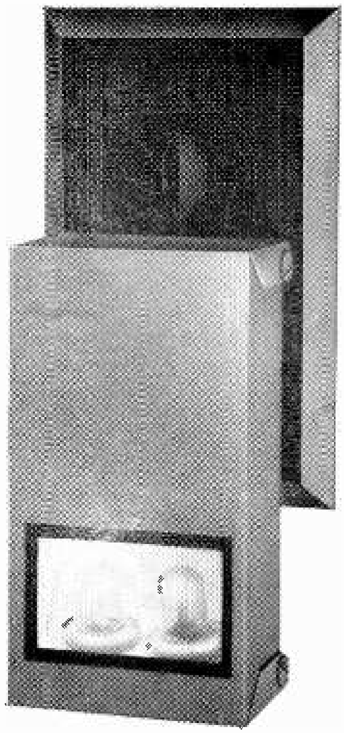
The schematic diagram on page 39 reveals the heart of the emergency light: a small 6-volt rechargeable nickel-cadmium battery which is trickle-charged as long as the power is on via rectifier *D2* and current limiting resistor *R3*. The charging rate, just over 3 ma., will maintain the battery at full charge indefinitely without harmful overcharging.

Transistor Relay. The emergency light connects to the battery via the emitter-collector circuit of the power transistor which acts as a never-failing relay. To keep the transistor cut off, voltage-dropping resistor *R2* and rectifier *D1* keep the capacitor charged to just over 6 volts. This makes the transistor base just slightly more positive than the emitter, and no current flows between the emitter and collector. Resistor *R4* is the load for the capacitor.

What happens when a power failure occurs? The capacitor discharges through *R4*, which then becomes a current limiting resistor in the base circuit of the transistor. When the base swings negative, the transistor conducts, lighting emergency lamp *I2*, and you're no longer in the dark.



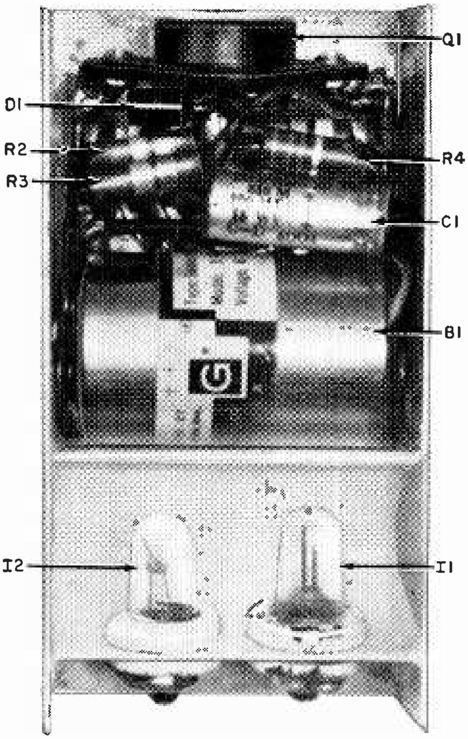
A combination night light and emergency light, this unit has both a low-current neon bulb which remains on all the time (at right, above), and a pilot lamp which flashes on when the power line fails (photo below).



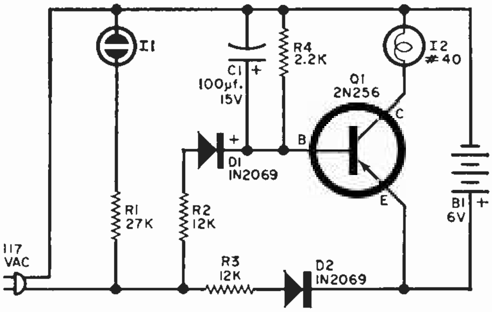
The rest of the circuit, the neon night light, is simple. Neon lamp *I1* and current-limiting resistor *R1* are connected across the a.c. line to provide a guiding glow when the other lights are turned off.

Components and Performance. Component values were chosen to combine small size with adequate performance. The battery used in the author's unit is rated at 180 ma./hour. The #40 pilot lamp, in this circuit, draws about 120 ma. Thus, the fully-charged battery will supply light during a power failure for well over an hour in addition to the small current required to keep the transistor conducting. This is usually adequate to last through most power failures. You can, of course, use a larger battery or two smaller ones in parallel for a longer-lasting emergency light.

Since this unit is designed for long life and trouble-free service, all compo-



The entire emergency night light is compactly built in a cut-down Minibox. A larger housing can be used if desired. The arrangement of components is not critical.



When charged, C1 keeps Q1 from conducting. If power fails, current flows, causing I2 to light.

PARTS LIST

B1—6-volt, 180-ma./hour nickel cadium rechargeable battery (Gulton Type 6VO—.180, or Burgess CD21 rated at 150-ma./hour)
C1—100-μf., 15-volt electrolytic capacitor
D1, D2—350-ma., 200-PIV silicon rectifier (Texas Instruments 1N2069 or General Electric 1N92)
I1—NE-51H neon lamp
I2—#40 pilot lamp, 6 volts, 150 ma.
Q1—Power transistor (2N256 or equivalent)
R1—27,000 ohms
R2, R3—12,000 ohms } *All resistors 1 watt*
R4—2200 ohms
1—4" x 2⅛" x 1⅝" Minibox—see text
Misc.—Tin can stock, epoxy cement, two rubber grommets to hold lamps (approx. ⅝" o.d.), a.c. plug for panel mounting (Amphenol 61-M1), terminal strips, hookup wire, hardware, etc.

nents are larger than absolutely necessary. Only a little over 3 ma. flows through the battery charging circuit, and about the same current is required to keep the capacitor charged. Obviously, half-watt resistors are adequate, but one-watters have a longer life potential. Likewise, the capacitor, transistor and rectifiers are all over-rated for the job. This is one way of building in dependability.

Construction. The model shown was built in a 4" x 2⅛" x 1⅝" Minibox cut down to just over an inch in thickness, so that it would not protrude from the wall more than necessary. Any housing of this size or larger can be used. The reflector is made of tin can stock glued in place with epoxy cement. Two holes are drilled in the bottom of the reflector to take grommets of a size that will securely hold the neon and pilot lamps. Before mounting the lamps, spray the reflector compartment glossy white.

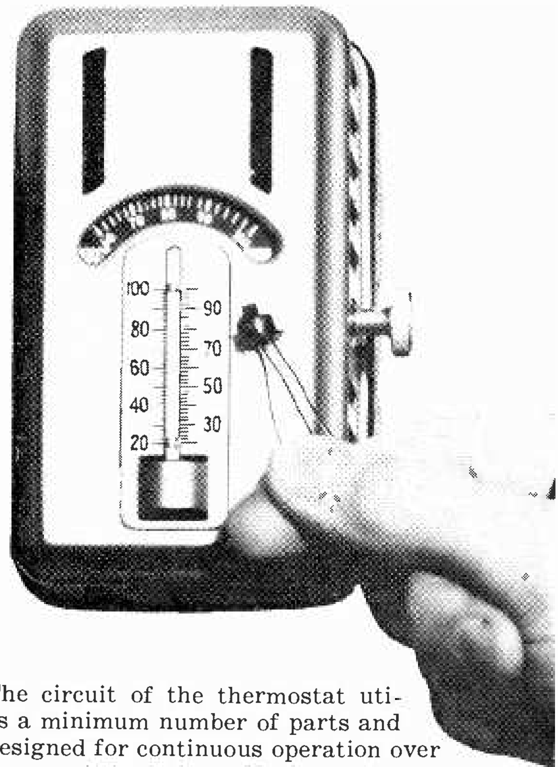
For mounting the other parts, use terminal strips on each side of the box to serve as anchors for the capacitor, resistors and transistor. The battery is wedged in place between them. There is no isolation transformer, and care must be taken to insure that all components, including the body of the transistor, are isolated from the metal box.

Charging. The battery used in the emergency household lamp will be completely discharged as the wiring is completed. Because the trickle charging rate is quite low, it will take several days to recharge it, but the unit can be checked to see if it's working with only a partial charge—the lamp will simply burn for a somewhat shorter time. —30—

TRANSISTOR CONTROLS TEMPERATURE

That's right—a transistor is the transducer in an intriguing home thermostat

By **FRED IPPOLITO, Jr.***



EVER CONSIDER that a transistor makes a fine temperature-sensing device? You've probably known for years that some transistors are highly sensitive to temperature changes—and, like almost everyone else, you've likely viewed this sensitivity *only* as an adverse characteristic. But hang on! You're going to learn about a little gadget that puts this "shortcoming" to practical use!

A transistor is the heart of the thermostat described here, and the unit boasts some specifications that are truly spectacular. In brief, this simple circuit will control temperatures within a 30° F range and with a sensitivity far better than that of most ordinary thermostats —at least ±0.5°.

Applications for this novel device are all but unlimited: in addition to its use as a thermostat for the home, it will control blower motors—those used to dissipate heat in electronic equipment racks, for instance. It can also be used to turn household cooling fans on and off during the summer months. And in still other installations, it will control the temperature of crystal ovens, photo-lab darkrooms, incubators, and just about every other enclosure where accurate temperature control is the goal.

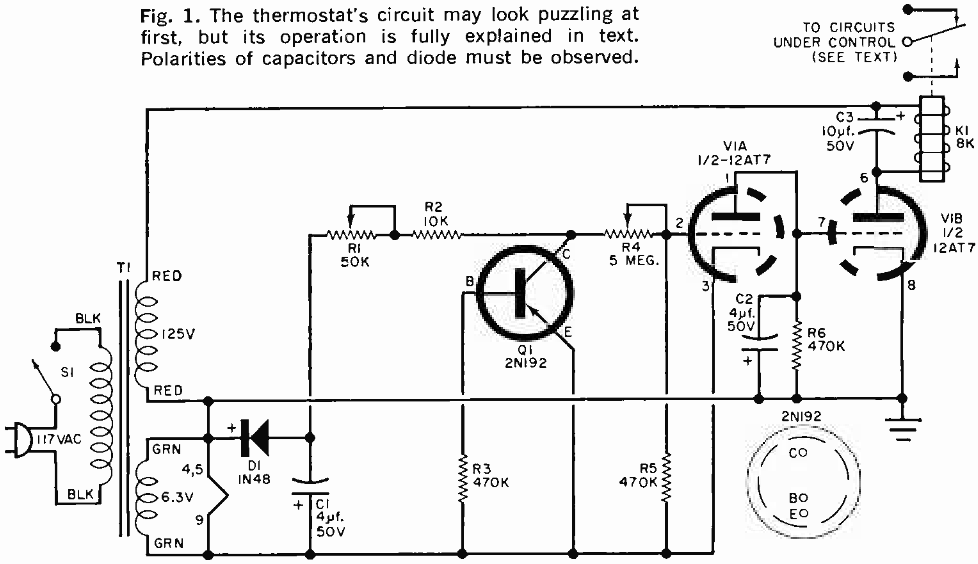
*Sylvania Electronics Systems
Wehrle Drive and Cayuga Road
Williamsville 21, N.Y.

The circuit of the thermostat utilizes a minimum number of parts and is designed for continuous operation over a long period of time. No batteries are required, and the entire unit can be assembled for less than $10.00—inexpensive indeed for such precise temperature control.

About the Circuit. As you can see from the schematic diagram in Fig. 1, transistor *Q1* is connected as a conventional common-emitter amplifier, although there is no signal applied to its base. The biasing arrangement, while undesirable for most transistors because of the change in bias with variations in ambient temperature, is ideal for this application.

Capacitor *C1* and diode *D1* develop approximately 8 volts d.c. from the 6.3-volt filament winding of transformer *T1*. Current flowing through resistors *R1* and *R2* in series with the parallel combination of transistor *Q1* and resistors *R4* and

Fig. 1. The thermostat's circuit may look puzzling at first, but its operation is fully explained in text. Polarities of capacitors and diode must be observed.



PARTS LIST

- C1, C2—4-µf., 50-w.v.d.c. electrolytic capacitor
- C3—10-µf., 50-w.v.d.c. electrolytic capacitor
- D1—1N48 diode
- K1—Plate relay; s.p.d.t. contacts; 8000-ohm coil (Sigma 4F-8000-S/SIL or equivalent)
- Q1—2N192 transistor (General Electric)
- R1—50,000-ohm potentiometer, linear taper
- R2—10,000-ohm, ½-watt resistor
- R3, R5, R6—470,000-ohm, ½-watt resistor
- R4—5-megohm potentiometer, linear taper
- S1—S.p.s.t. toggle switch
- T1—Power transformer; primary, 117 volts a.c.; secondaries, 125 volts @ 15 ma. and 6.3 volts @ 0.6 amp. (Stancor Type PS-8415 or equivalent)
- V1—12AT7 tube
- 1—2" x 7" x 5" aluminum chassis (Bud AC-402 or equivalent)
- 1—Line cord and plug
- Misc.—Hardware, wire, solder, terminal strips, transistor and tube sockets, components for calibration setup (see text), etc.

R5 produces a bias voltage at the grid of triode *V1a*. Under average room conditions, this voltage varies from —0.8 to —7 volts because the collector current through transistor *Q1* varies with changes in the transistor's ambient temperature.

Potentiometer *R1* controls the negative voltage at the collector of *Q1* and thus serves as the thermostat's "temperature" control. Potentiometer *R4*, in contrast, acts as a voltage divider in conjunction with grid resistor *R5*; it controls the bias voltage on tube *V1a* and thus acts as a sensitivity control in the circuit.

The 12AT7 dual triode is connected as a direct-coupled d.c. amplifier and serves both as an amplifier and as a relay control. Because of the amplification within triode *V1a*, changes in the grid voltage of *V1a* cause even more marked changes in the grid voltage of triode *V1b*. The voltage on the grid of *V1b*, in turn, controls the flow of current through this triode, which controls relay *K1*.

Since the plate of triode *V1a* is effectively grounded (through capacitor *C2* and resistor *R6*), this triode will conduct whenever *T1*'s 6.3-volt filament winding drives the cathode of *V1a* negative. A d.c. voltage is then developed across the *C2*/*R6* combination. The magnitude of this voltage is determined by the negative bias on the grid of *V1a*, and this bias in turn is controlled by the transistor/resistor network discussed above.

The d.c. voltage across *C2* and *R6* is the bias voltage on the grid of *V1b*. As previously mentioned, this bias voltage controls the current through *V1b* and thus the action of relay *K1*. When the high-voltage winding of transformer *T1* drives the plate of *V1b* positive, the triode conducts, and the amount of current flow is determined by the bias on the grid. If the bias is small enough, suffi-

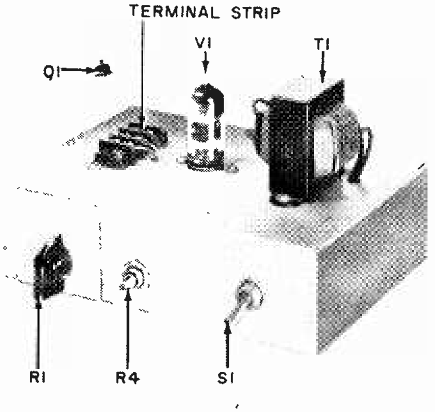


Fig. 2. Top view of thermostat. Transistor is connected to a barrier-type terminal strip.

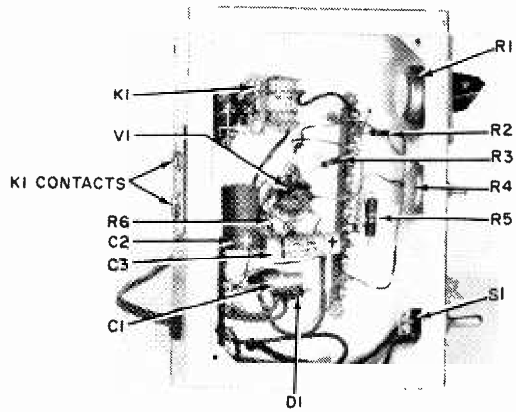


Fig. 3. Bottom view of the thermostat, showing placement of parts. Wiring is not critical.

cient current flows to close relay *K1*; if the bias is too large, relay *K1* remains open.

The circuit shown can be used to control temperatures in a 25°—30° F range, with the maximum and minimum temperatures dependent on the setting of sensitivity control *R4*. With *R4* at minimum resistance (maximum sensitivity), temperature control *R1* may be set for any temperature between 61° and 91° F.

Because of the nature of the circuit, there will necessarily be some interaction between *R1* and *R4*. Generally speaking, however, the setting of *R1* will determine the average or "mean" temperature, and the setting of *R4* will fix the upper and lower limits of control.

Construction. The unit is assembled on a 2″ x 7″ x 5″ chassis, with tube *V1*, transformer *T1*, and transistor *Q1* located above the chassis. (See Fig. 2.) Note that the transistor isn't actually mounted on the chassis proper, but is simply connected to a barrier-type terminal strip. This arrangement makes *Q1* less sensitive to heat radiation from the tube and transformer and makes it an easy matter to remove the transistor for use in remote locations.

Potentiometers *R1* and *R4* should be wired so that clockwise rotation decreases the amount of resistance in the circuit. The maximum clockwise position of the potentiometers will then be the highest temperature and maximum sensitivity settings, respectively. Figure 3 shows the underchassis components—try to duplicate the approximate locations.

Calibration. While it's possible to calibrate the thermostat in a variety of ways, building the calibration setup pictured in Figs. 4 and 5 will greatly simplify the problem. A small cardboard box, approximately 4″ x 5″ x 6″; an accurate, easily read thermometer; some hookup wire; and a Christmas-tree light set with standard, 117-volt a.c. bulbs are all the materials you'll need.

Begin by cutting two holes in the box just large enough to pass the bases of the light bulbs. Push the bases through from the inside of the box and screw them into their sockets; the remainder of the lights on the set can be removed.

Next, cut a small hole in the box and pass a three-wire cable (or simply three wires twisted together) through it, and connect the transistor leads to the three wire ends in the box. (Remember to use a heat sink between the transistor and the soldering gun if you solder the transistor in place.)

Run the other ends of the wires to the proper terminals on the control unit terminal strip, taking care to make the correct base, emitter, and collector connections. Plug the light set into an a.c.

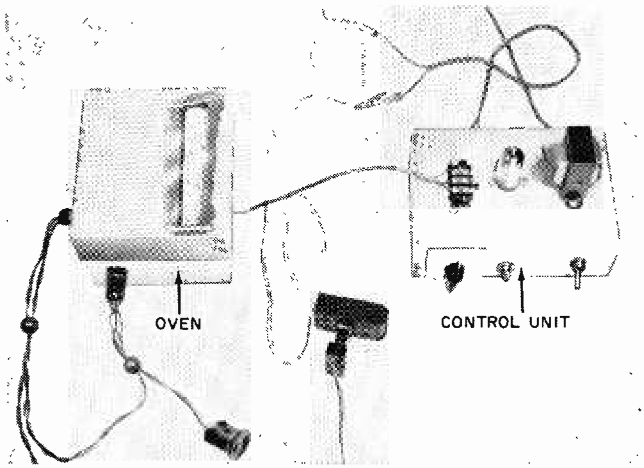


Fig. 4. A cardboard-box "oven" will be required to calibrate the thermostat. Christmas-tree bulbs serve as source of heat.

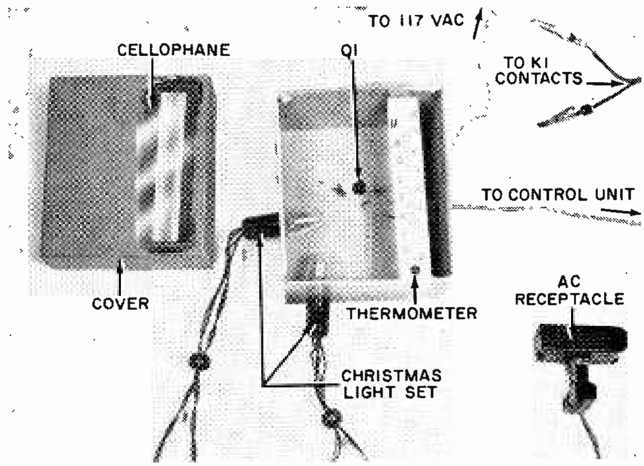


Fig. 5. Transistor is placed inside "oven" to calibrate R1. Cellophane over thermometer prevents undue heat loss from box.

outlet, using the contacts of relay *K1* as a power switch. Finally, cut an opening in the cover of the box to view the thermometer, and paste a piece of cellophane over the opening to minimize heat loss.

Although two light bulbs were used in the setup illustrated, you may find that one will do the trick, depending on the size and nature of the box you've selected and the quality of the thermometer used. Since the reaction time of the transistor to temperature changes is significantly faster than that of the thermometer, it will be difficult to read the temperature changes on the thermometer if the "oven" (the cardboard box) is heated and cooled too quickly. In any case, it's a simple matter to remove one bulb from its socket if necessary.

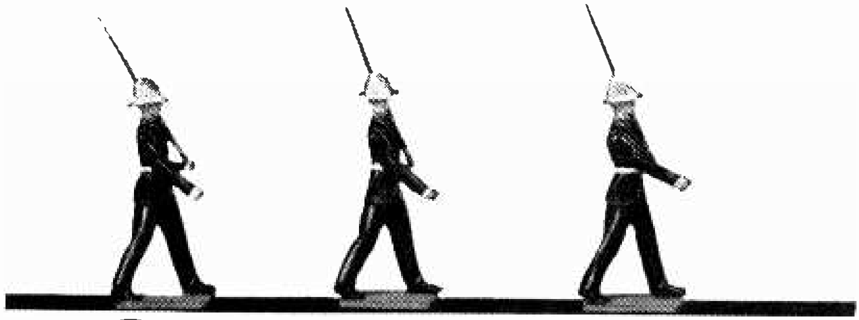
To use the calibration setup, turn temperature control *R1* and sensitivity control *R4* fully clockwise (highest temperature and maximum sensitivity settings, respectively). Apply power, and the oven lights will go on. Heat generated by the bulbs will raise the oven temperature and the transistor will sense the temperature changes.

Relay *K1* will remain closed (and the lights will stay on) until the temperature of the oven reaches the level for which temperature control *R1* is set. With *R1* turned fully clockwise, the oven temperature will rise to approximately 90° or 95° F before the lights go out. If you encounter trouble at this point, recheck your wiring, especially connections to potentiometers *R1* and *R4* and to the diode rectifier (*D1*).

(*Continued on page* 158)

1-2-3

Here's one electronic counter that's handy time and again—it responds to



TOTALIZER

YOU CAN probably think of umpteen uses for an electronic counter, and once you've studied the circuitry of the little unit shown here, you'll no doubt think up umpteen more. Because of its sensitivity and versatility, the counter about to be described will fill the bill for just about every application.

The cadmium sulphide photocell in the device is especially sensitive and is therefore effective even with relatively small amounts of incident light. Even more important, the unit can be set to count either "light" or "dark" pulses at the flip of a switch, and there is a jack which allows you to bypass its photocell and use a remote switch or relay whenever you wish.

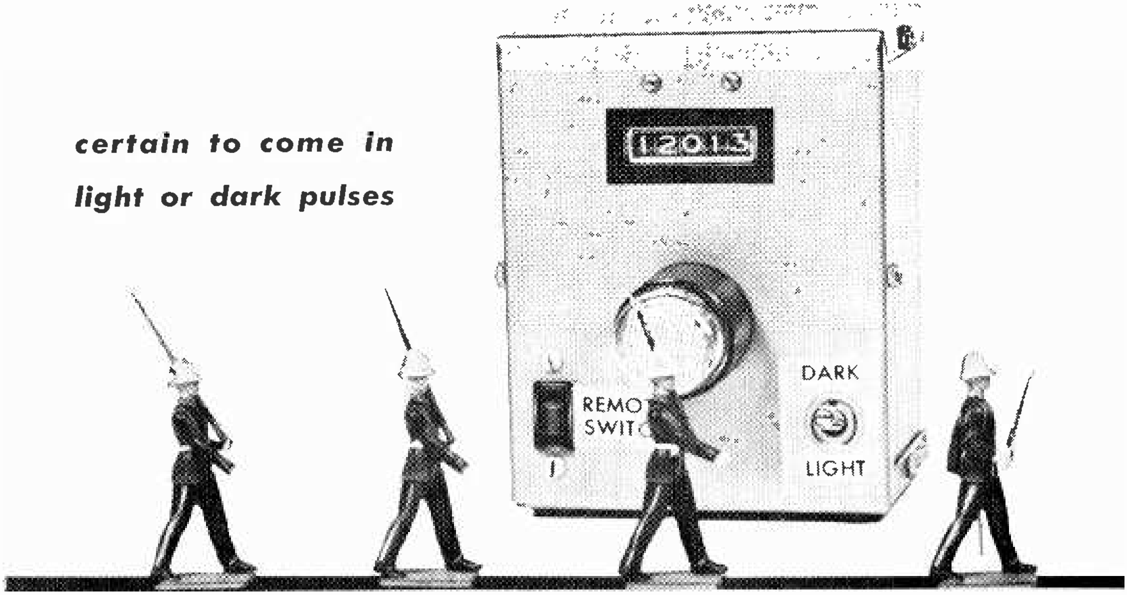
Construction. Building the electronic counter requires little more than mounting the components on the top cover of the utility box and wiring them up as shown in the schematic diagram.

Begin by attaching the counting mechanism to the upper part of the cover. Then center the octal socket for the photocell below the counting mechanism. The jack (*J1*) for connecting a switch, relay, or other triggering device should be mounted on the lower left-hand side of the cover; and the "dark/light" switch (*S1*) should be mounted on the lower right-hand side.

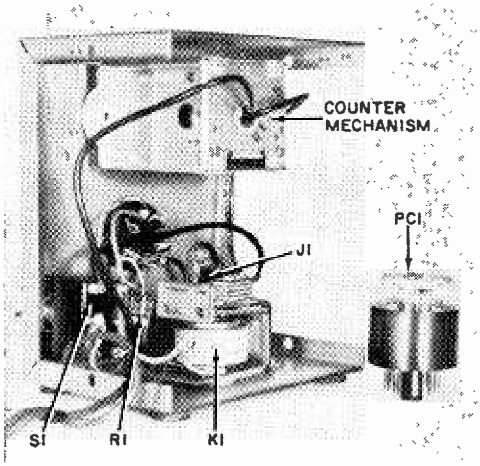
Photocell *PC1* comes installed in a tube base and can either be plugged directly into the socket on the front panel or into a similar socket on a "probe" cable. The author prepared a cable from a length of #16 rubber zip cord with an octal socket on one end (for mating with the tube base on the cell) and an octal plug on the other (for mating with the tube socket on the counter itself).

This arrangement makes the unit much more versatile than it would otherwise be, since the photocell can be conveniently moved about and placed almost anywhere. The probe cord can be any reasonable length. Since only two terminals are required, it's a simple matter to hook up the sockets and plugs so that they mate properly.

certain to come in light or dark pulses



By HAROLD REED

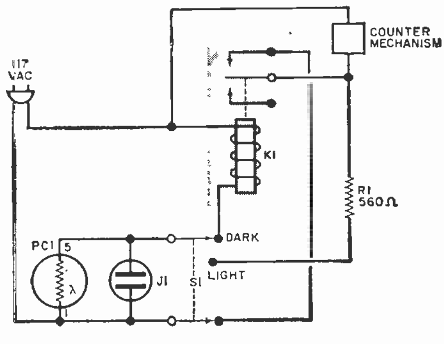


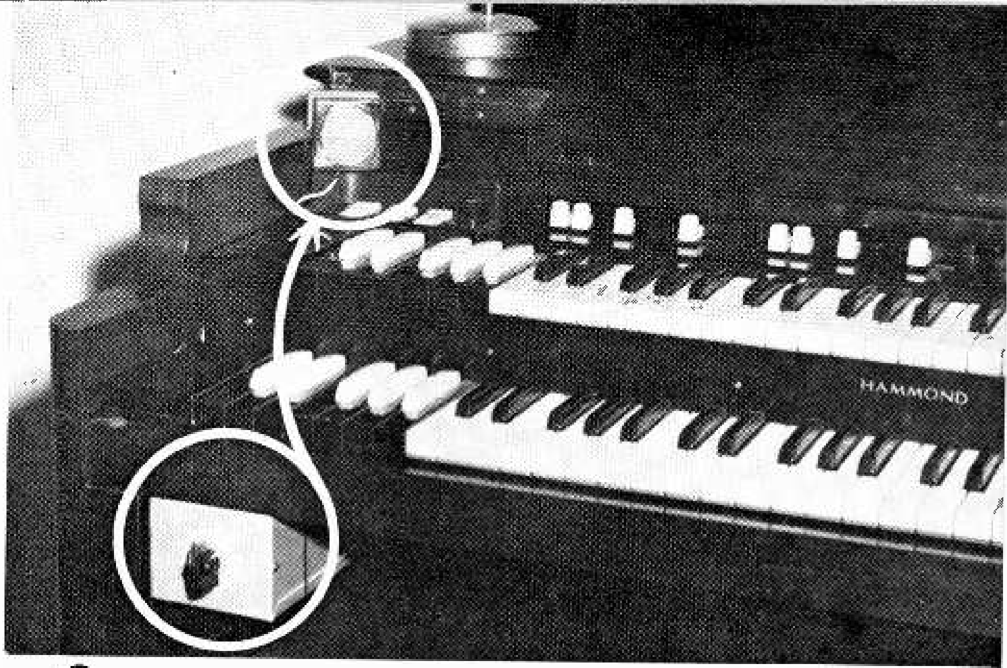
Operation. To use the counter, it's only necessary to plug the photocell into the front panel socket (or into the probe cable), plug in the power cord, flip *S1* to "light" or "dark" (depending on what kind of pulses you want to trigger the counter), and "direct" these pulses on the cell "window." Don't worry about

(*Continued on page* 163)

PARTS LIST

J1—Chassis-mounting a.c. socket (Cinch-Jones 2R2 or equivalent)
K1—S.p.d.t. relay, 115-volt a.c. coil (Guardian universal "200" series or equivalent)
PC1—Cadmium sulphide photocell mounted in octal tube base (Lafayette Radio MS-882 or equivalent)
R1—560-ohm, 1-watt resistor
S1—D.p.d.t. toggle switch
1—Counter mechanism (General Controls CE40BN502 or equivalent—available from Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill., catalog #77 P 031, for $8.35, plus postage)
1—5" x 4" x 3" aluminum utility box (Bud CU-2105-A or equivalent)
1—Line cord and plug
Misc.—Octal socket, wire, solder, etc.





On the Beat Electronically

THE FAMILIAR spring-wound, pyramid-shaped metronomes used by musicians since the time of Beethoven are giving way to the clicking of electronic timers. The transistorized electronic metronome (seen above, with remote speaker) is a compact, battery-operated unit that can be adjusted for any musical tempo. Clicks produced at the miniature speaker are of sufficient amplitude to override the sounds of most musical instruments.

You can construct the metronome to suit your own particular needs. In the photo above, the speaker is mounted in a small but attractive case, sitting on top of the organ, while the remainder of the unit is housed in an aluminum chassis box under the keyboard. Pianists may want the electronic metronome mounted all in one case, with rubber feet, to rest on top of the piano.

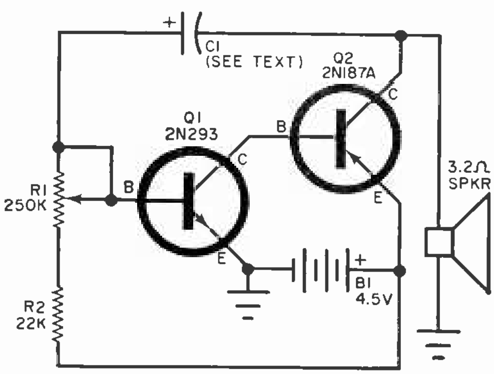
Follow the schematic diagram carefully as you wire the circuit. Resistor *R2* is a 22,000-ohm, ½-watt unit, and *C1* must be a top-quality 15-μf. electrolytic rated at 5 to 10 w.v.d.c. Be sure *C1*'s negative (unmarked) lead connects to the collector of transistor *Q2*. Then connect a fresh 4.5-volt battery, *B1*, making certain that the polarity is correct.

Now check the number of clicks with potentiometer *R1* fully clockwise, and then fully counterclockwise. The metronome should cover a range of 40 to 210 beats per minute or better. If it cannot go down to 40 beats, increase the value of *C1*. If it's necessary to increase the upper limit, lower the value of *C1*. But vary the capacitor's value by no more than 10% at a time until the desired limit is reached.

The author used a Burgess Type N3 battery with snap-in terminals to power his unit. When the battery is snapped out of the circuit, the metronome stops clicking, and the removed battery serves as a "key" to prevent unauthorized use of the device.

—*John J. Borzner*

Audio amplifier with added feedback circuit (C1) produces "motor-boating" clicks for timing beats.



Chapter 2

Hi-Fi and Stereo

BACK in the days of monaural hi-fi, building your own amplifier was a project much sought after by the audiophile. The birth of stereo hi-fi and the availability of a good supply of amplifier kits has—at least temporarily—brought this aspect of electronic project building to a halt. The same cannot be said for speaker enclosures or systems. As more and more home owners buy modern, inexpensive power tools, the idea of constructing an advanced-design handmade hi-fi enclosure becomes quite attractive.

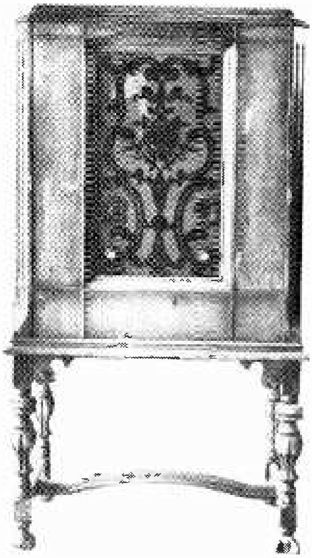
In this chapter, we are presenting detailed plans for two hi-fi speaker enclosures that we're sure you'll find intriguing. One of them, the "Mello Monster" is a take-off on the labyrinth-style enclosure that effectively and efficiently uses a single 8-inch full-range speaker; detailed plans to build the same enclosure to handle a 12-inch speaker are available from the author. Our second favorite enclosure embraces the philosophy that the enclosure walls must be "solid." Built by Dave Weems—he has been designing enclosures for POPULAR ELECTRONICS since 1957—the "Club Sandwich Reflex" may be your answer to undistorted bass note reproduction.

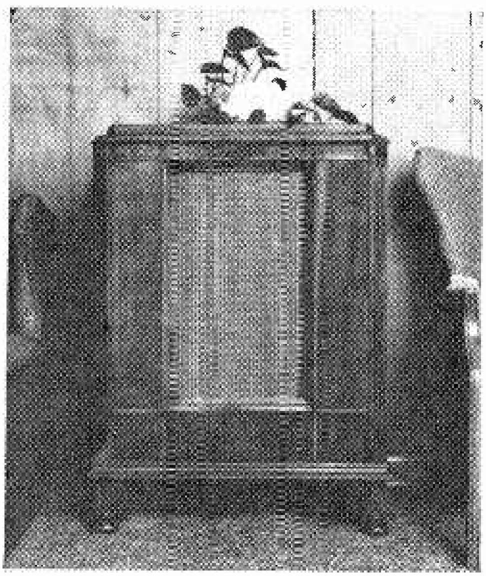
Also recommended for your appraisal is Dave Weems' second article on salvaging old-style AM radio consoles. The wood and workmanship in pre-World War II consoles was outstanding. With a few hours of patient refinishing, a console can be transformed into a novel speaker enclosure.

". . . and don't forget the Shoe Polish"

Old cabinets make perfectly acceptable baffles—and check out as one of the big bargains in hi-fi!

By DAVID B. WEEMS





STICK with shoe polish if you want to save money on hi-fi!

Salvaging electronic parts from old radio and TV sets seems to be a fairly common practice with experimenters—but all too often the procedure resembles eating the core and discarding the apple. This was first suggested to me when a lady, whose hobby is interior decorating, drew my attention to the beauty of an empty console of mine that was waiting for the incinerator.

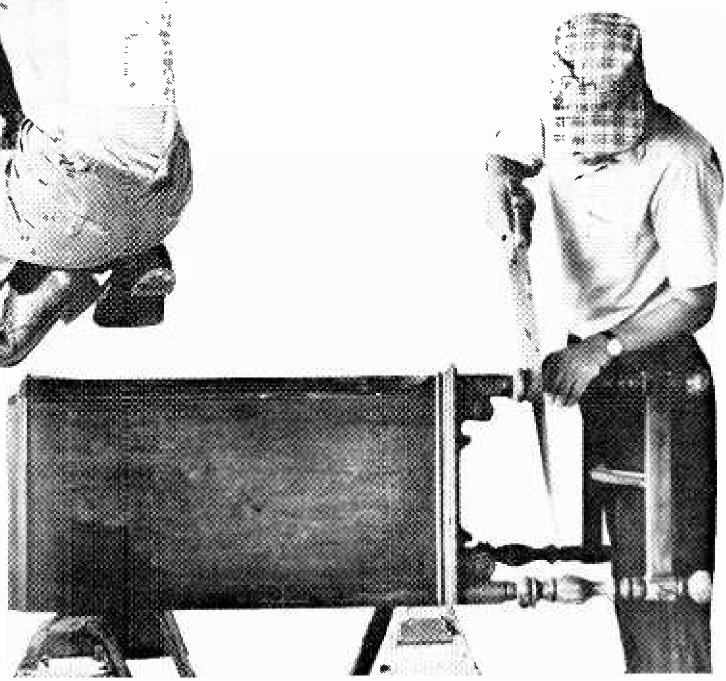
She didn't exactly "convince" me, but I did look more carefully at the wood graining of a side panel. Then I removed the sides and top and put them back together as a contemporary-styled, bass-reflex speaker enclosure (the pieces served the same purpose as prefinished plywood).

After that, I took a new look at old radio cabinets. Many were worthless in every respect, of course; others provided only bits of choice woods. But a good many of those old sets had far more "baffle value" than I had even begun to guess!

One day I generously offered to build an extra speaker enclosure for a relative's hi-fi system. His wife said, "Fine—but remember that I don't like modern furniture." Since contemporary furniture with its simple lines is relatively easy to build with a minimum of equip-

Old radio (above, left) looks pretty unpromising, but see what a little minor surgery and two coats of satin varnish produced (below, left). Although this radio was picked up for only $3.50 at a local second-hand store, it was turned into a bass-reflex enclosure worth much more.

First step in revamping an old radio cabinet is to remove the "works." The old field-coil-type speaker and the "ten-ton" chassis have to go, but the shelves can be left to serve as braces.



Structural alterations should be completed before you start refinishing. In most instances, these will entail cutting off legs and adding additional bracing.

ment, I was naturally dismayed. Then I remembered the lady decorator's comment. It had been made several years before, but I think that much time was required for me to overcome my prejudices.

There were no old cabinets on hand, so I visited the local second-hand stores and found a badly treated old radio. It cost me just $3.50, and it didn't look worth a cent more. But with a minimum of carpentry and some refinishing, the immediate problem was solved.

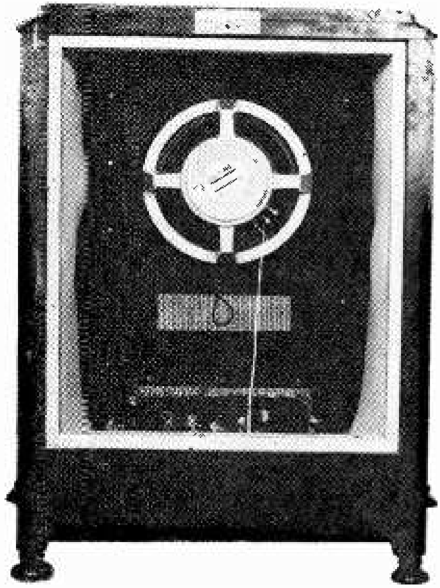
Finally, I realized the great potential lying around us in old radios and (where available) Victrola cabinets. These are made to order for hi-fi or stereo, especially if you don't have much in the way of shop equipment. All it takes is a little looking and a little imagination, both of which I had neglected for far too long.

Cabinets for Sale? In some localities, the biggest problem is finding suitable cabinets. If your town has a store operated by Good Will Industries, that might be a good place to begin. Other sources are church rummage sales, auctions, and open-air "flea markets."

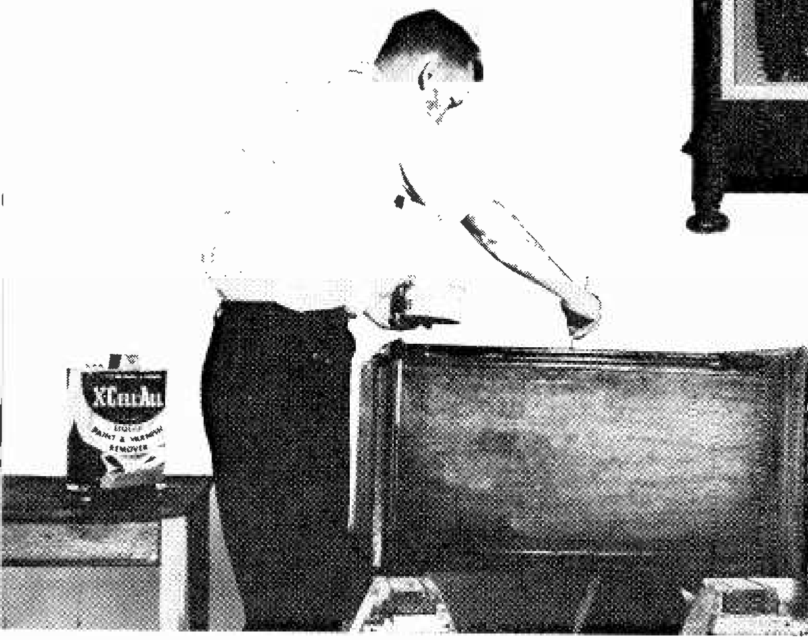
A few hints may help you to know what to look for. Obviously, the design, the kind of wood, and other esthetic considerations can only be determined by your own personal taste. Much will depend on how and where you intend to use the cabinet.

The construction is more important. Check the thickness of the sides and

Last step is to mount your new hi-fi speaker, pad a little, tune a little, and let 'er rip! Foam plastic is damping material here, with cheesecloth-wrapped fiber glass on back panel.



Old finish can be removed, if necessary, although shoe polish may save you the time and trouble. Exact procedure will depend on kind of finish you're after.



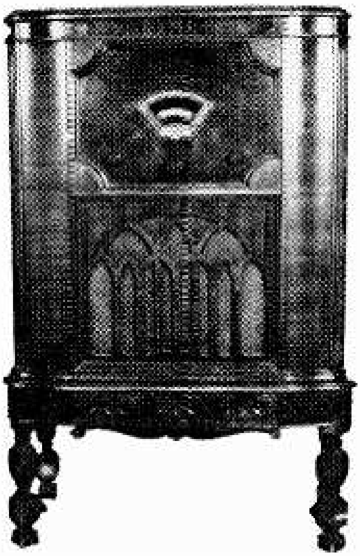
top. Other factors being equal, always choose the heavier woods, especially for speaker cabinets. But this doesn't mean you must necessarily reject a cabinet made of ¼" plywood, since it can be braced by bonding cheap ½" plywood or even Celotex to the inside walls.

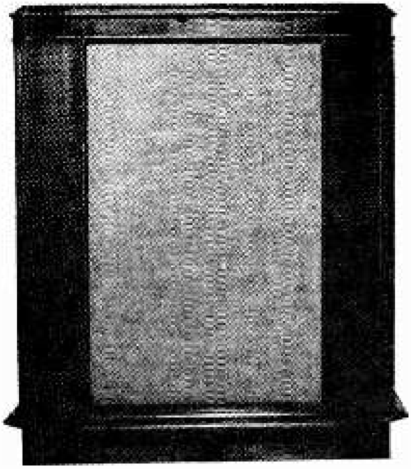
In general, the older the cabinet, the heavier the wood. Many will have walls of ¾" solid core veneer construction. This isn't as good as ¾" plywood, of course, but it's certainly adequate with Celotex glued to the inside walls. The veneers are usually walnut or mahogany and are quite handsome when refinished.

Old Victrolas are obvious candidates for equipment cabinets. However, you may have trouble locating one in some areas. And even if you find one, it may be too expensive. I purchased a really good one for $5.00 when a young friend told me about seeing it stored in a shed. And this, incidentally, is a good way to locate sets. Tell people that you're interested—children are often good agents, since they won't buy it first!

The Unexpected. You sometimes stumble across some weird items at rummage sales and auctions, so it pays to be careful. A couple of examples will serve to prove my point.

Once I paid about $6.00 for a cabinet that, superficially, appeared to be an old Victrola with a record changer in the top. Several people looked somewhat disbelievingly at me, and on close inspection I could see why. The record changer was worn out, and the cabinet





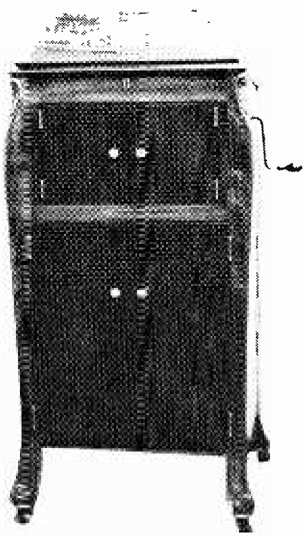
These "before and after" shots are proof enough of what can be done with "ugly ducklings." And here's the clincher: this cabinet received only a coat of shoe polish after the "gingerbread" and legs were removed.

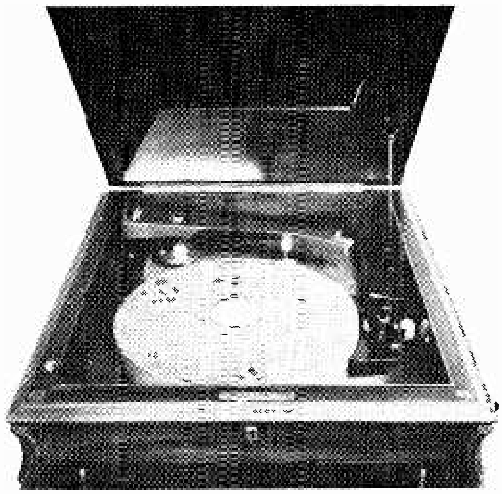
was in really bad condition. But the next day I found a sealed compartment with a shielded cable attached. Inside was a gleaming chrome hi-fi amplifier of a quality brand. It would be interesting to know the odds on that happening again!

Actually, it's much more likely that the opposite will occur. I once paid a premium price for a piece of merchandise because it was described as having a "variable speed 33⅓-rpm transcription turntable with a magnetic pickup." The turntable was 33⅓ all right—complete with spring-loaded governors and built-in flutter! The "magnetic pickup" was of a design so ancient that the magnet was actually made in the shape of a horseshoe and just about as large. The

(*Continued on page* 159)

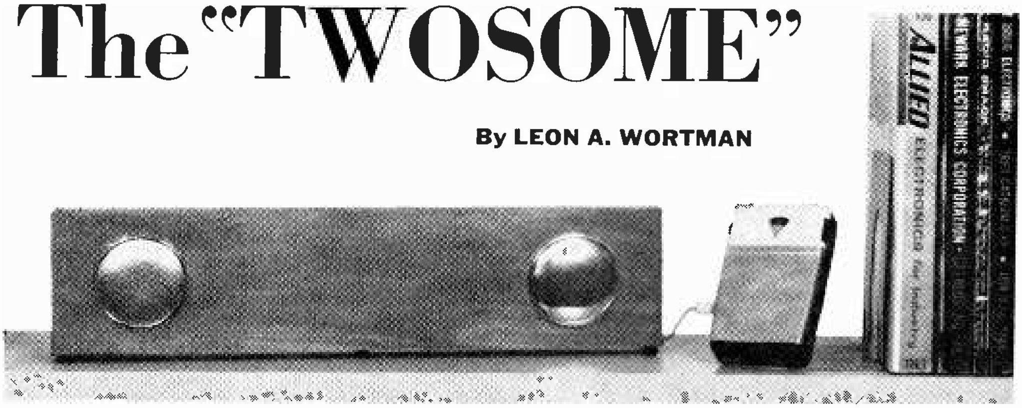
The hand crank on this relic may look inviting, but don't be misled: the motor inside the cabinet is 100% a.c.-operated, and hysteresis-synchronous at that! Amplifiers and tuner are tucked away on shelves below.





The "TWOSOME"

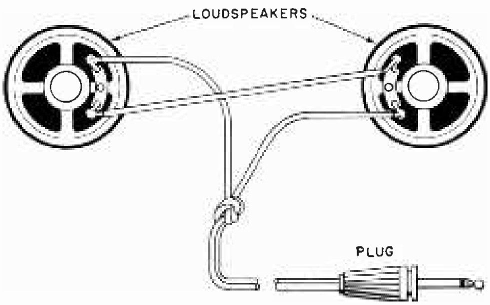
By LEON A. WORTMAN



Lonesome for "big sound" from your pocket transistor radio?

Then add a plug-in miniature speaker system called "Twosome"

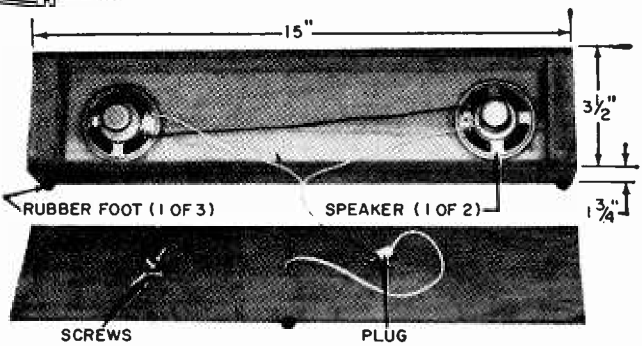
HAVE YOU EVER walked through an appliance store's radio department and noticed the "big sound?" It's caused by speakers from many receivers reproducing the same program. You can hear this kind of sound at home if you play two table radios at equal volume; each speaker alone sounds fair, but together they seem to put out "big sound." The "Twosome" speaker system can do the same thing for your transistor portable.



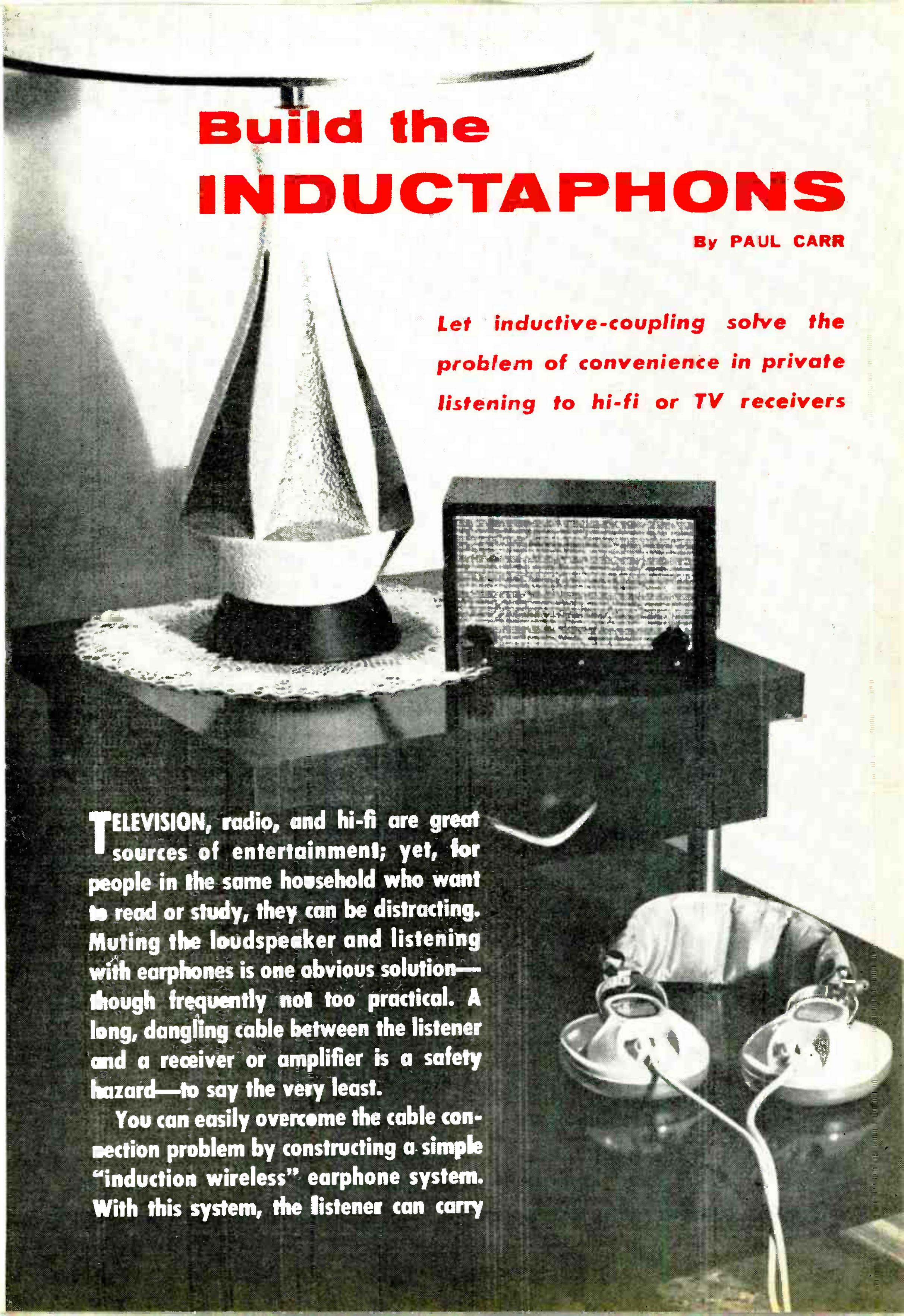
Cable and plug used to wire up the "Twosome" were part of portable's earpiece. Knot is made after cable is passed through hole in rear cover.

Few parts are needed: two 2¼" PM speakers; a plug to match your transistor radio's earphone jack; some wire; and some plywood for a box. Cut the wood and glue the pieces together to form a box like the one in the photo below. Then cut holes for the speakers and glue them in place. After you wire the unit, as shown in the diagram, put on the back cover. Finally, mount the speaker grilles to protect the exposed paper cones, and paint or stain the wood.

Now tune in a music program on your transistor radio, turn up the volume, and listen to the sound. Then plug in the "Twosome"—you should hear "big sound," with improved bass response as a result of the larger moving "wall" of air. Although speaker phasing isn't too important, you may want to reverse one set of speaker leads to see if there's any difference. —30—



Dimensions of author's model are shown at right. Exact size is not critical provided speaker centers are 12" or more apart. Rubber feet prevent scratching.



Build the INDUCTAPHONS

By PAUL CARR

Let inductive-coupling solve the problem of convenience in private listening to hi-fi or TV receivers

TELEVISION, radio, and hi-fi are great sources of entertainment; yet, for people in the same household who want to read or study, they can be distracting. Muting the loudspeaker and listening with earphones is one obvious solution—though frequently not too practical. A long, dangling cable between the listener and a receiver or amplifier is a safety hazard—to say the very least.

You can easily overcome the cable connection problem by constructing a simple "induction wireless" earphone system. With this system, the listener can carry

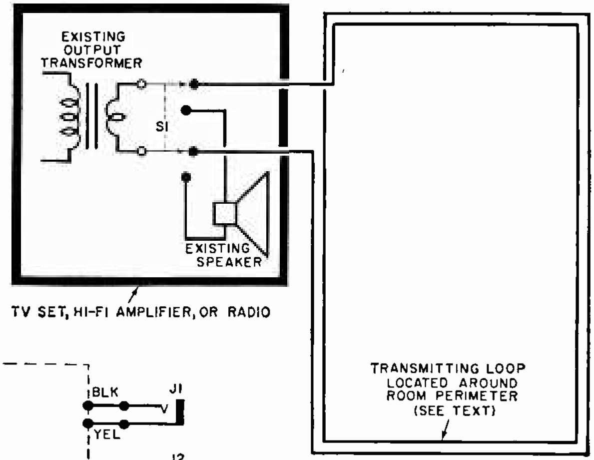


Fig. 1. Schematic diagram of the "transmitting" loop connected to TV, radio, or hi-fi unit.

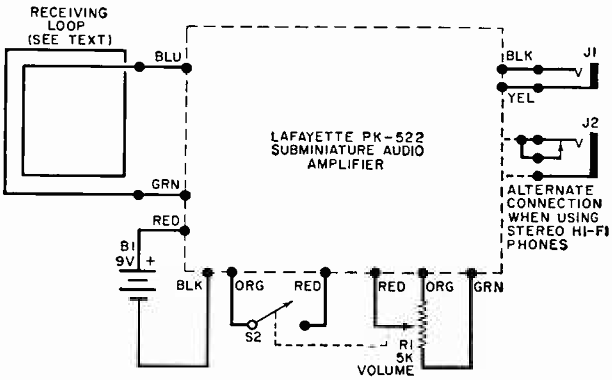


Fig. 2. Schematic diagram of the setup for the wireless earphone receiver. Parts are included in listing at right.

the miniature receiver in his pocket or place it on a table next to his chair. The amplifier or TV set "broadcasts" an audio signal that is inductively coupled to the listener's receiver through a loop antenna placed under the living-room rug. In this way, the listener has complete freedom of movement and trailing wires are eliminated.

For those who object to wearing earphones, semi-private listening is still possible using a wireless, remote speaker. This "armchair" listening post can also double as an AM radio.

In either case, it is necessary to make a simple modification on the TV set, radio, or hi-fi system. A d.p.d.t. toggle switch (*S1*) is installed between the existing output transformer and the existing speaker, as shown in Fig. 1. The switch should be mounted on a bracket and located on the rear of the instrument in a convenient position.

A multi-turn loop is also connected to the switch so that the output transformer can be switched either into the speaker for normal listening or into the loop for "wireless" remote reception.

The loop is strung around the perimeter of the room and tucked under the rug as a permanent installation. The number of turns and wire size of this "transmitting" loop are not critical, but the more turns the better. The author found that a 2-turn loop worked quite well and was the easiest to install. For this purpose, a length of small-diameter, two-conductor speaker cable was used. Thus, one turn of this wire, with the ends connected in series, formed the two-turn loop. The small size wire was not noticeable under the rug.

A loop of this type, running around an average sized room, will have several ohms resistance, providing a suitable resistive load for the output transformer in the TV receiver or amplifier.

The "receiver" for the wireless system is a second loop, many times smaller in diameter and connected to the input of an audio amplifier. The audio signal is inductively coupled from the transmitting loop to the receiving loop, which form the primary and secondary of an air-core transformer. Although the coupling efficiency between the two loops is quite low, the gain of the audio amplifier compensates for it.

At average listening levels (the same power level as when the speaker is used),

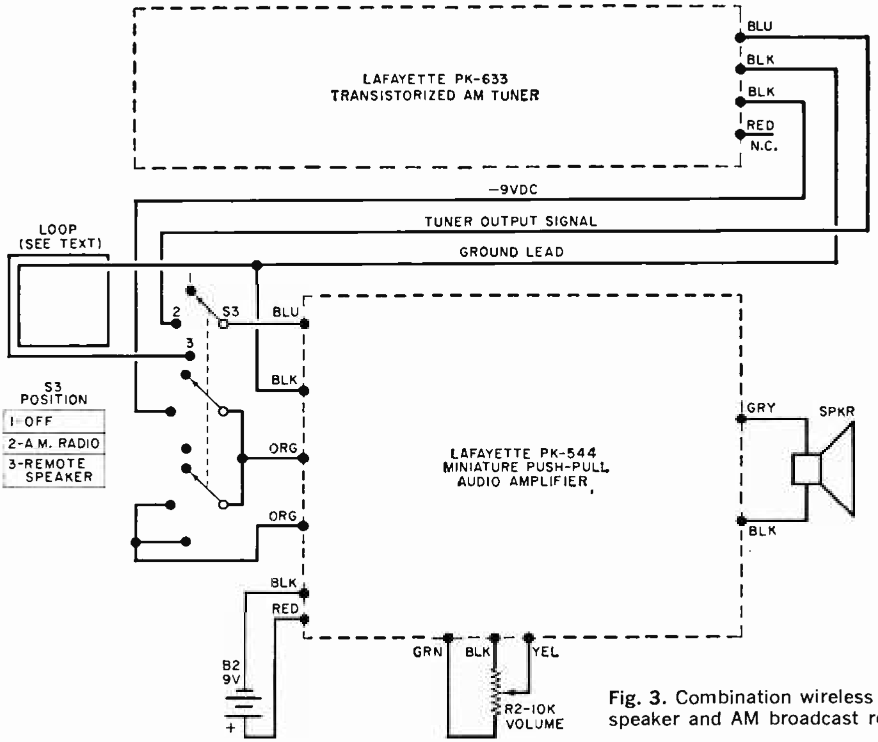


Fig. 3. Combination wireless remote speaker and AM broadcast receiver.

PARTS LIST

B1, B2—9-volt battery (Burgess 2U6 or equivalent)
J1—Standard phone jack
J2—Three-conductor phone jack (when using stereo headphones)
R1—5000-ohm subminiature volume control with on-off switch S2
R2—10,000-ohm volume control
S1—D.p.d.t. toggle switch
S2—S.p.s.t. switch (part of R1)
S3—3-pole, 3-pos. rotary switch
1—Subminiature audio amplifier (Lafayette Model PK-522)
1—Transistorized AM tuner (Lafayette Model PK-633)
1—Miniature push-pull audio amplifier (Lafayette Model PK-544)
1—TV extension speaker (Lafayette SK-76)
1—Small plastic box (3" x 3" x 1")
3—"Loop" antennas—see text

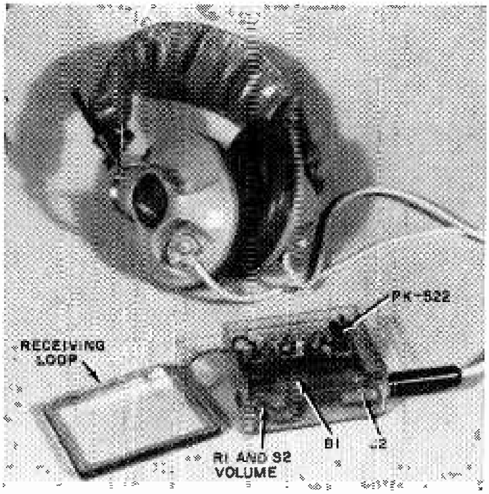
good signal will be obtained anywhere within the loop and even outside the loop at distances approximately equal to one-half its diameter.

Wireless Earphone. The schematic diagram of the wireless earphone receiver is shown in Fig. 2. A three-stage audio amplifier was used. This amplifier is available prefabricated on a printed-circuit board—see Parts List.

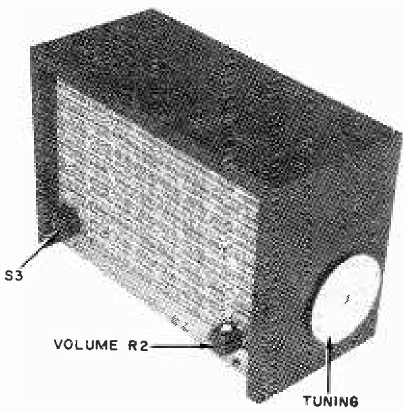
The audio amplifier, a 9-volt battery (*B1*), volume control with on-off switch (*R1*), and a phone jack were all mounted in a plastic box measuring approximately 3" x 3" x 1". The lead colors shown in the schematic of Fig. 2 correspond to the leads on the printed-circuit amplifier unit.

The receiving loop was wound around the cover of the plastic box and cemented to it. Again, the number of turns and wire size are not critical. The author used about a dozen turns of No. 28 enameled wire. The loop is connected directly to the input of the amplifier.

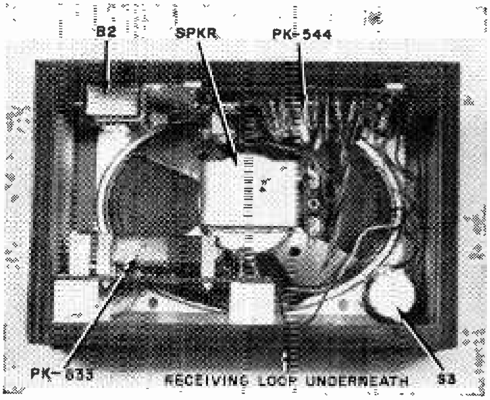
The direction in which the loop is wound is important. If oscillations occur when the unit is operated, remove the loop and rewind it in the opposite direction. Since the loop is so close to the output transformer, feedback will cause oscillation if the loop is wound in



Plastic box houses wireless earphone (above); loop is wound around cover. Below is external view of combination unit; note tuning dial on side of cabinet.



Inside view of the combination wireless remote speaker and AM tuner employing printed boards.



the same direction as the windings of the output transformer.

The output impedance of the amplifier is 8 ohms, which does a good job of matching low-impedance stereo headphones. Fidelity of the system is quite good since the power requirements of the phones are low and the amplifier need not operate at high power levels where distortion is likely to occur. For TV viewing, the hi-fi phones add a touch of realism—with the viewer finding himself smack in the middle of the action. Standard, high-impedance phones can be used, although some mismatch will occur.

Two phone jack hookups are shown in Fig. 2. The hookup using *J1* is the normal configuration when standard phones are used. Most stereo headphones are equipped with a 3-conductor phone plug. The hookup using *J2* is for stereo phone applications. The jumper lead across *J2* parallels both sections of the phones for monaural operation.

Wireless Remote Speaker/AM Radio. The wireless remote speaker is quite similar to the wireless earphone except that the audio amplifier now drives a speaker. A TV extension speaker enclosure serves as the housing for this system and the existing speaker is also utilized.

The receiving loop for this setup consists of a dozen turns of No. 28 wire which are cemented to the bottom of the wooden case. Once again, the number of turns, wire size, and loop diameter are not critical.

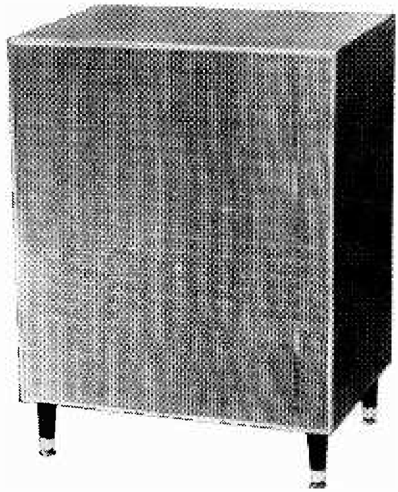
In this version, a four-stage transistorized push-pull audio amplifier was used. A volume control (*R2*) and 3-pole, 3-position selector switch (*S3*) are mounted on the front panel of the enclosure.

Along with the printed-circuit audio amplifier, a transistorized printed-circuit AM tuner is also mounted in the enclosure.

The selector switch chooses output either from the loop or from the AM tuner and feeds it into the audio amplifier. As an AM radio, the system is capable of pulling in weak stations and the audio section delivers good volume.

This unit can also be used as a telephone amplifier when the telephone receiver is held near the loop. —30—

By
ROALD E. DYBVIG



The MELLO MONSTER

You asked for it! A hi-fi speaker enclosure with a "monstrous" folded horn compressed into a small cabinet

HOW WOULD YOU LIKE to have a complete speaker system that sounds as though it were worth hundreds of dollars—for an actual cost of about $25.00? You can—by building the "Mello Monster." Very little equipment or woodworking skill will be required. And, after hearing this system, you and your friends will find it hard to believe that such wonderful sound can be obtained from a single 8″ speaker.

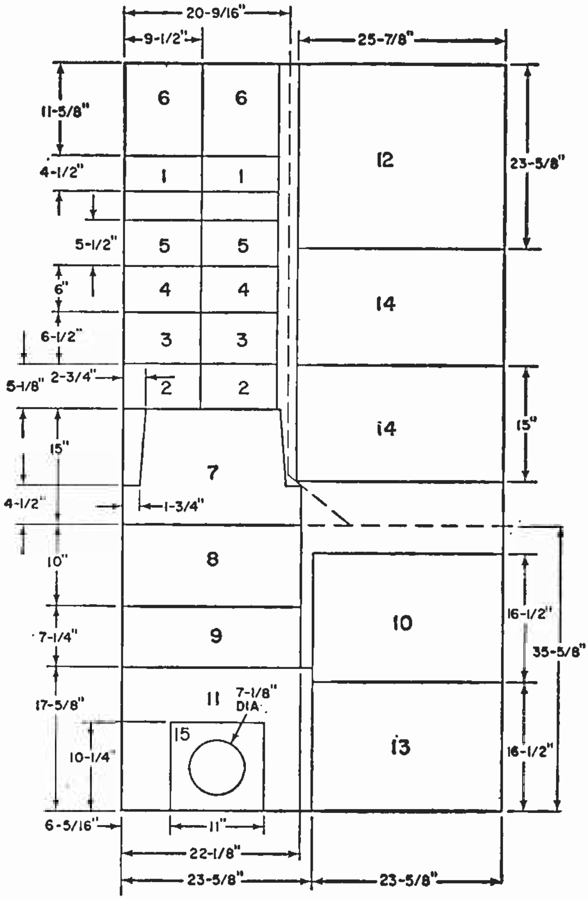
Speaker Enclosure Theory. It's pretty much common knowledge that the greatest problem in designing a speaker system is getting maximum coupling between the speaker cone and the air at all desired frequencies. By way of explanation, a speaker has the job of converting electrical energy into acoustical energy. And, just as important, its enclosure has the task of coupling the speaker to its load—the air.

The enclosure which many audio experts concede to be the best compromise for overall reproduction is the exponential horn. This type of enclosure gives the necessary bass reinforcement, and it does so "musically"—its sound or *timbre* isn't "boomy" like some bass-reflex enclosures or "mushy" like some infinite-baffle types.

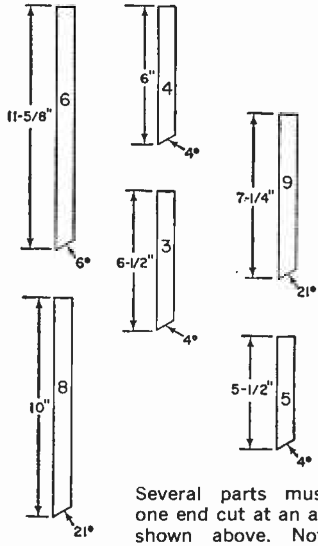
In case you don't agree with these statements, keep in mind that we enter an area that is downright intangible whenever tone qualities come up for discussion. The whole matter boils down to personal preference, since no one is in a position to say what sounds good to someone else's ear (the ear is notoriously unreliable at best, but it remains the only thing we have to hear with). Therefore, it's necessary to compare speaker enclosures on a basis of which one *sounds* best to *your* ear.

But let's get back to that word *timbre*—"the characteristic quality of sound produced by a particular instrument or voice." Singers who achieve wide public acclaim presumably have voices with a pleasing timbre. Speakers, too, have their individual "timbre" characteristics, and so do speaker enclosures.

The aim, then, is to bring together a speaker and an enclosure which will complement each other and produce pleasing sounds. Authorities agree that optimum tonal quality will result only when the enclosure is designed with the charac-



A 4′ x 8′ sheet of ¾″ plywood supplies bulk of parts. For ease in handling, the sheet can be cut into three separate sections, as indicated by the dotted line.



Several parts must have one end cut at an angle, as shown above. Note that there are two identical pieces for Parts 3, 4, 5, and 6, both of which are beveled.

BILL OF MATERIALS

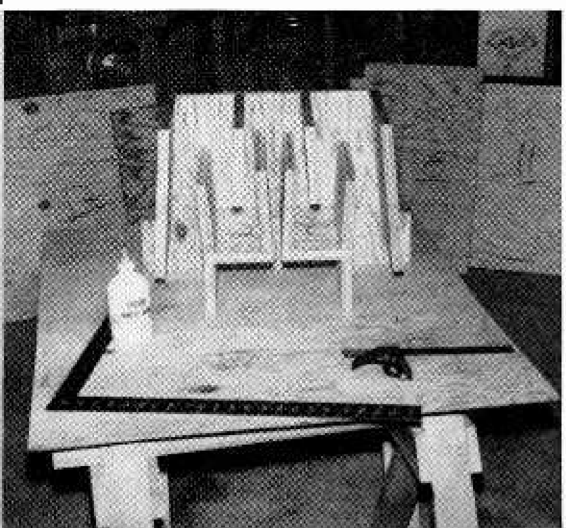
1—4′ x 8′ sheet of ¾″ plywood
1—Square yard of grille cloth
1—8″ hi-fi speaker

Misc.—Glue, flat-head wood screws, black screen enamel, molding, Formica sheet, etc.

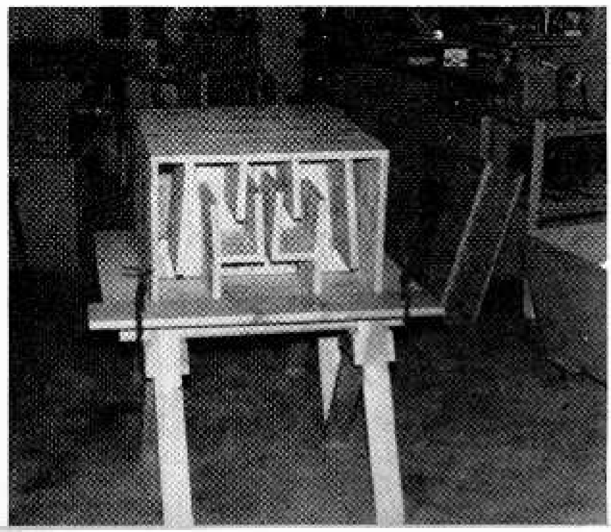
Tools You'll Probably Need

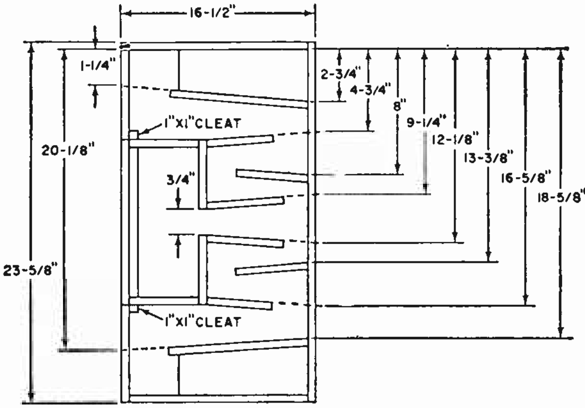
Hand saw	*Plane*
Keyhole or saber saw	*Paint brush*
Screwdriver	*Hammer*
Square	*Scissors (or knife)*

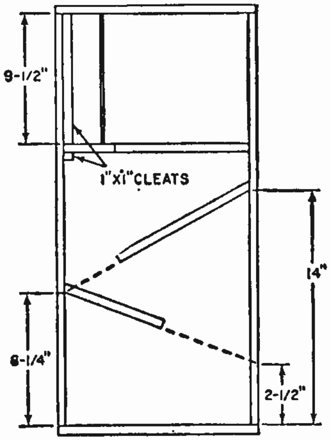
A Upper labyrinth is most complicated section of the Mello Monster and the first to be completed. This photo shows it lying face down, with all parts securely glued in place.



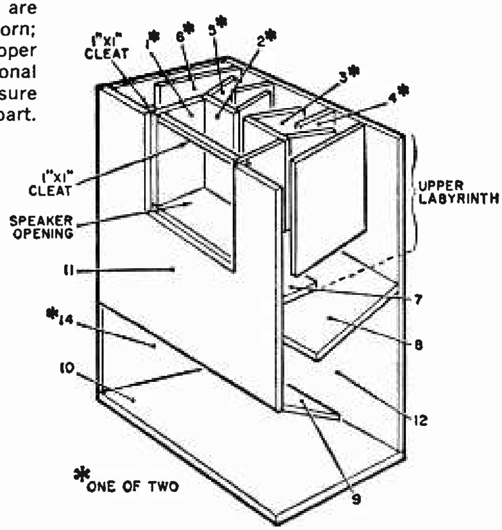
B Once the sides (Part 14) have been added, the next step is to attach the back (Part 12). Like every other part in this system, the back must make an air-tight fit with all parts that touch it.







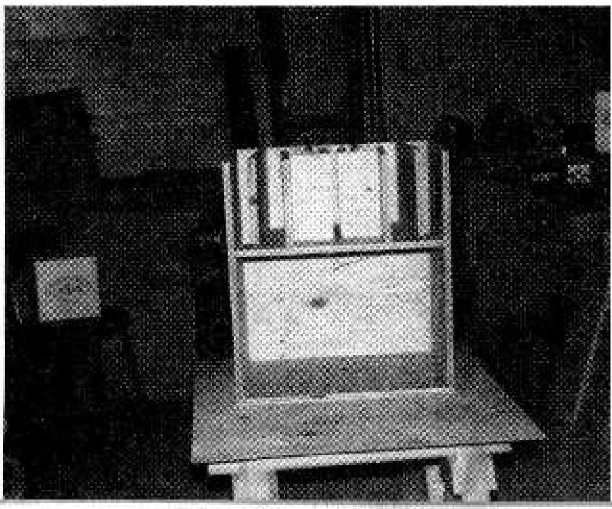
Internal construction of the Mello Monster can be gathered from the drawings on this page. Top view (above) with top of enclosure removed shows how various pieces are angled to approach the flare of an exponential horn; side view (right, above) shows relative location of upper labyrinth and baffle "plates" 8 and 9. Three-dimensional drawing (right, below) with top and one side of enclosure removed, indicates general location of every major part.



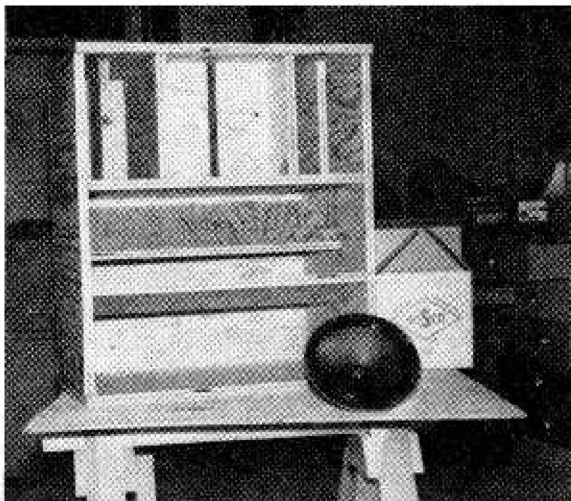
teristics of the speaker in mind. The flux density, the size of the cone, the mass of the voice coil, and so on, all influence the enclosure's design.

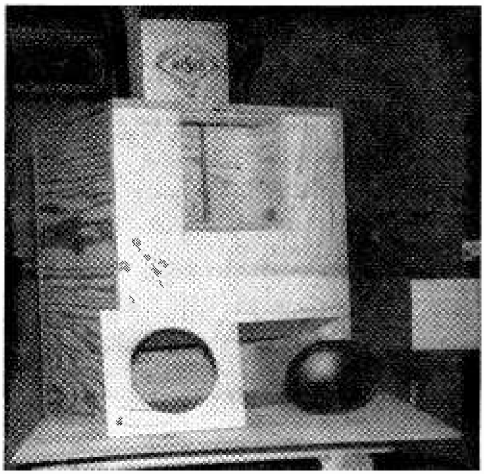
Testing the Theory. The "Mello Monster" described here uses a single 8″ hi-fi speaker, and the enclosure has been carefully adjusted to complement the speaker. But we don't mean to imply that this horn is theoretically correct, since, in theory, a port approximately 7′ x 9′ and a horn as long as 30′

C Set the assembly upright, and you'll see that the Mello Monster is beginning to "take shape." Here, only top (Part 13), baffle "plates" (Parts 8 and 9), and front panel (Part 11) remain to be added.

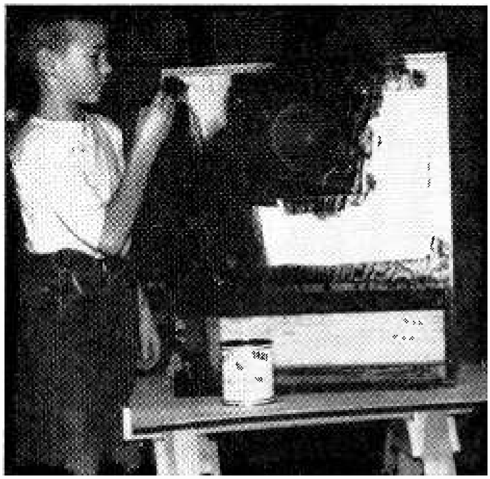


D Mello Monster is now taking on the appearance of the true "folded-horn" that it is. Author used a F-8-HF speaker made by Minneapolis Speaker Co., but any 8″ hi-fi speaker will do.





E With front panel in place, you're ready to install speaker leads. Standard lamp cord makes suitable conductor and can be run to two-terminal, screw-type connector mounted on back of unit.



F Entire front panel (including speaker panel itself) should be carefully coated with black screen enamel to hide various joints behind grille cloth. Take care not to touch speaker with brush.

would be required to reproduce 40 cycles. Obviously, "correct" theoretical design must be compromised to get an enclosure size practical for use in an average room.

And how does the "Mello Monster" sound? Well, this system has been acclaimed by novices who just "liked what they heard," by audiophiles with trained ears, and by professional musicians whose standards of comparison are live performances.

At a hi-fi show in the Midwest, two "Mello Monsters" were placed behind drapes, and people were asked to guess what kind of speaker system they were listening to. Nearly everybody guessed "big speaker" or "multiple speaker" systems. When shown the system in actual use, some wouldn't believe that such sound could come from a single 8″ speaker! Some even examined the enclosures very carefully, trying to find the hidden speakers!

Since all who have heard this system agree that it is truly amazing, let's gather the necessary materials together and get started!*

Putting It Into Practice. You can save yourself a good deal of time and trouble by getting a local lumberyard or cabinet shop to saw all the pieces to size. If you elect to do the sawing yourself, take your time and make sure the parts are exactly the right size. Number the parts for ease in identification.

Note that Parts 3, 4, 5, 6, 8, and 9 have one side cut at an angle. Part 15 (the speaker panel) is sawed from Part 11, and the speaker hole is then cut from Part 15. A keyhole or saber saw will be required to saw both Part 15 and the speaker hole.

To assemble the various parts, first collect all the partitions used in the upper labyrinth (two each of Parts 1, 2, 3, 4, 5, and 6). Attach all of the labyrinth partitions to Part 7, using plenty of glue and screws (see Photo A). Add the sides of the baffle (two Part 14's) to this upper assembly, making sure that the tops of the sides and those of the various partitions are flush with one another.

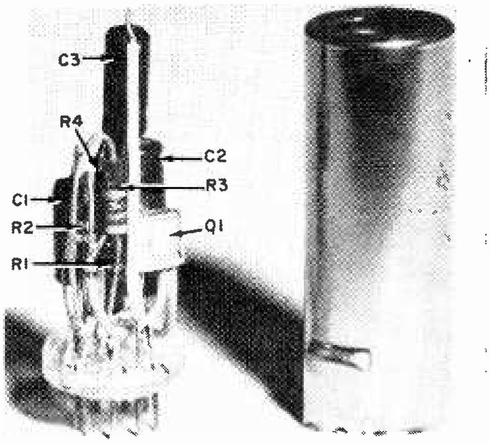
Next, attach the back of the baffle (Part 12), gluing and screwing it to all surfaces that join it (see Photo B). Attach the bottom (Part 10)—see Photo C—and then the top (Part 13), again gluing and screwing all adjoining surfaces. This done, you can install the baffle "plates" (Parts 8 and 9) as shown in Photo D, then the 1″ x 1″ cleats around the speaker opening. Finally, attach the

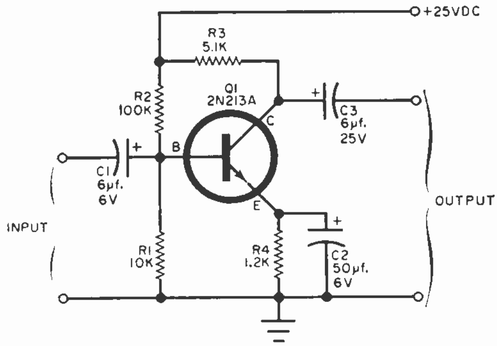
(*Continued on page* 156)

**Full-scale drawings and step-by-step construction details for building the "Mello Monster" are available for $2.00 a set. Mail your check or money order to Mr. Roald E. Dybvig, 2754 Xenwood Ave., St. Louis Park 16, Minn. (A set of plans for a similar enclosure for a 12″ speaker is available for the same price.)*

HIGH-GAIN LOW-HUM MODULE

By HAROLD REED





Plug-in module (far left) utilizes a mere handful of components connected to the pins of a defunct miniature tube. Schematic diagram (above) calls for 25 volts of B+, which can be tapped from most power supplies.

IF IT'S high gain you want at low $$, here's one way to get it. The circuit is not very startling—it's an ordinary, everyday transistor preamplifier, plain and simple. But it does use a high-gain, driver-type transistor instead of the type made specifically for low-level preamplifier service. Also, to obtain maximum gain with minimum distortion, the d.c. bias potentials have to be carefully adjusted.

In using this transistor, it was expected that the signal-to-noise ratio would be "horrible." Actually, the ratio turned out to be quite low. With a 5-millivolt signal to the input and 3.5 volts at the output, noise measured only 1 millivolt: 70 db below the 3.5-volt output signal.

Other characteristics were equally impressive, despite the fact that the 2N213A transistor employed was not hand-picked. Distortion was 0.5% at 50 cycles, 0.55% at 1000 cycles, and 1.5% at 20,000 cycles. Frequency response was flat within ±0.9 db from 50 to 20,000 cycles, down just 2 db at 40,000 cycles.

The photo shows how the amplifier can be built on a 9-pin tube base and enclosed within a shield for 7-pin tubes. The glass envelope of a defunct 9-pin tube (such as a 12AX7) is removed, leaving only the base (it's fairly easy to cut around the top of the thick glass base with a bench grinding wheel). And all the tube elements have to be removed, although the wires connected between them and the tube pins naturally remain. These wires are used for tie points for the component parts of the amplifier, and for external connections through the tube base pins.

The 9-pin glass base fits snugly into a "7-pin" tube shield and can be cemented in place after all the parts are assembled. This results in a module that can be plugged into any 9-pin socket.

The input and output capacitors are placed end-to-end—not side-by-side—to reduce any chance of coupling. Since there is no need for concern about hum pickup within the circuit, layout is non-critical and the amplifier may be used in any convenient arrangement. -30-

What to do with a Tape Recorder
(until the hi-fi arrives)

By BILL HUTCHISON

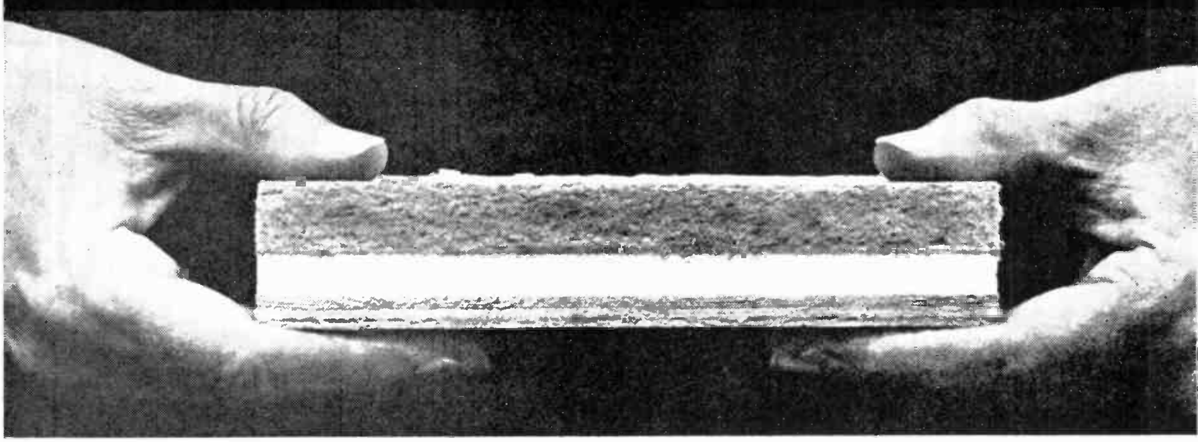
"... don't let anyone kid you; you are the brainiest executive this company, or any company, ever had ..."

"That is NOT my voice! You've fiddled with those controls to make it sound awful."

"He read in POP'tronics about someone who recorded porpoises talking together."

". . . then the Lone Ranger mounted his white horse . . ."

Panel resonance has long been a problem with speaker baffles—especially bass-reflex types. But this enclosure cuts resonances to the bone. We call it the



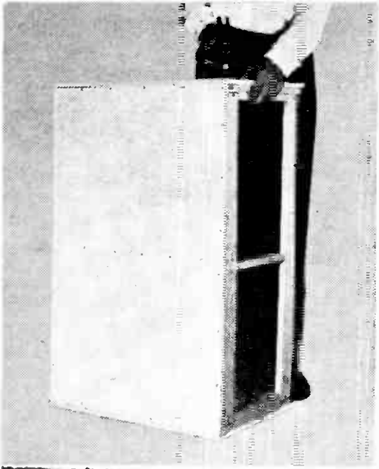
CLUB SANDWICH REFLEX

HERE'S a speaker system that's about as free from faults as any you're likely to encounter. The cabinet material is amazingly non-resonant; the enclosure itself is inexpensive and easy to construct with simple tools. Yet it looks good—so good, in fact, that you won't be tempted to hide it behind drapes when it's finished. Add the Electro-Voice 12TRXB speaker, and you'll have some magnificent sound.

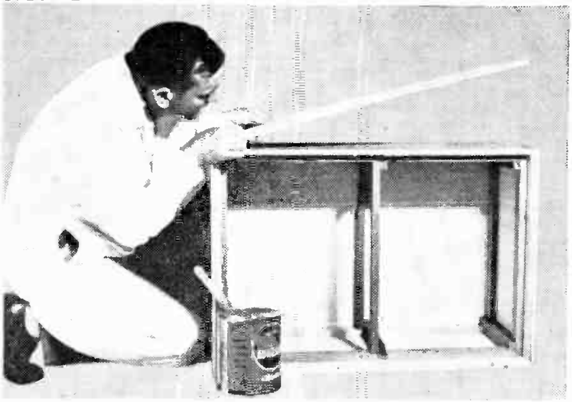
Good enclosures can be made from ordinary plywood, of course, but the sandwich-type construction used here has several advantages. For one thing, three different kinds of material stacked together club-sandwich style are much less likely to show pronounced resonances than several layers of the same type of material.

It's true that proper bracing will limit panel vibration in conventional plywood enclosures, but here we have gone to the heart of the problem by using materials which are

By DAVID B. WEEMS



Building the Club Sandwich is much like building a house—construction begins with a wooden frame. Celotex is nailed on first, and layers of Sheetrock are then glued and nailed to the Celotex, as pictured below.



Some types of adhesive must be applied to both surfaces. Exact method of applying adhesive will vary with different brands, so be sure to read instructions on can and follow them carefully for best results.

Plywood sides are glued but not nailed in place. Depending on the type of cement you use, it may be necessary to apply some pressure while the cement is setting.

inherently more "dead" than plywood. Celotex alone added to plywood is more effective in damping vibrations than simple bracing. And a look at the drawings and photos will show you that this enclosure is rather adequately braced in the bargain.

You have a considerable range of choice for the outside covering on the Club Sandwich Reflex. The author used unfinished mahogany plywood because it was readily available at a bargain price. However, prefinished plywood would eliminate much of the finishing work. The actual cost of the cabinet will depend on your decisions here as well as the kind of legs or base you choose.

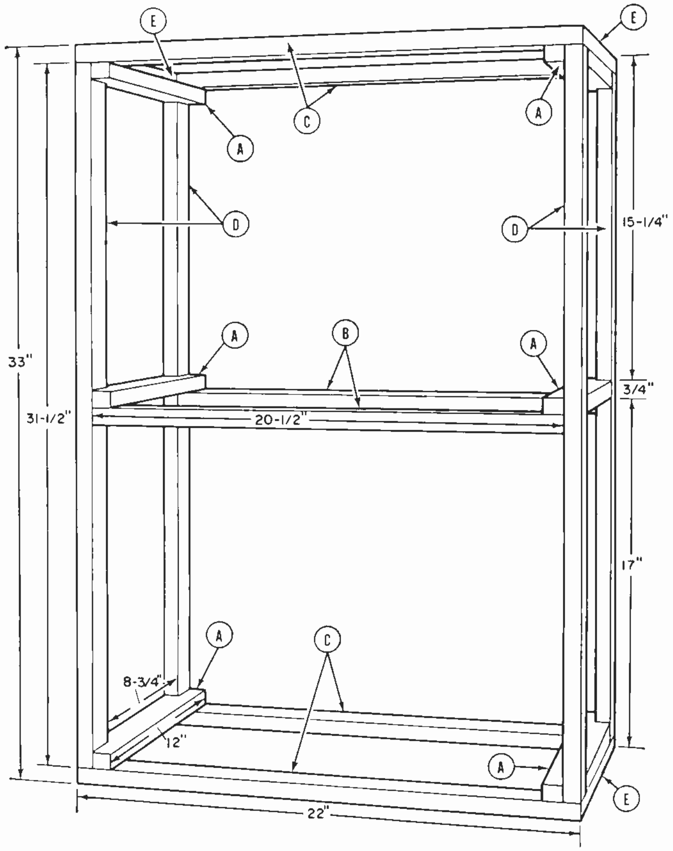
Tri-Layer Construction. If the materials seem to be more typical of house building than cabinet-making, so is the method of construction. You start by building a frame and go on from there. For this reason, any minor mistakes or rough edges in the first stages can be disregarded—they won't show up in the finished product.

Don't cut out the parts all at once, but stick to the sequence of steps outlined here—even if they seem arbitrary to you. You're likely to find that the dimensions of various parts will not be quite accurate because glue occupies some space between layers, and not everyone will use the same kind or amount of glue. The important thing is to have each piece cover what it is supposed to cover.

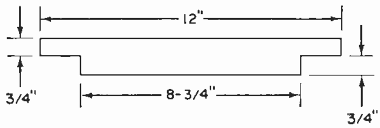
Gluing and Nailing. Glue and nail the frame first; then nail on the Celotex in the following steps: front, top and bottom, sides. This order permits the top and bottom to overlap the front, and the sides to overlap the front as well as the top and bottom. Face the rough, unpainted side of the Celotex in, and be sure to use cement-coated nails—these hold much more firmly than ordinary nails.

Next, apply glue; then nail on the Sheetrock in the same sequence as the Celotex. There are many kinds of adhesives available for this kind of work. Some, called "contact-bond" cements, stick firmly on contact. Others are slower in setting and have the advantage that parts can be moved into position after making contact. Either type is satisfactory, but the methods of apply-

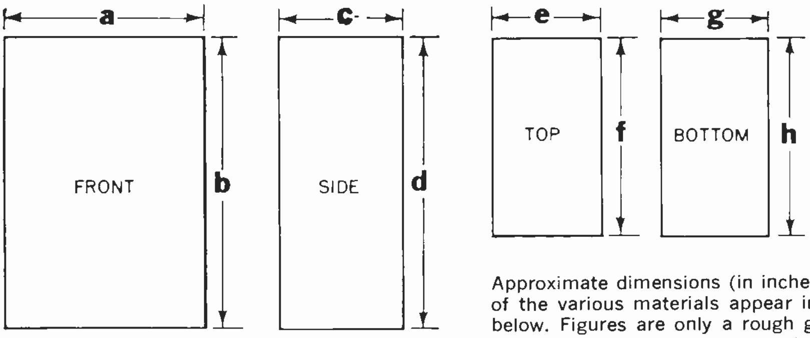
Frame for Club Sandwich is comprised of Parts [A] through [E] and is first step in constructing enclosure. It should be built exactly as shown, and made as rigid as possible through use of plenty of glue and nails or screws.



FRAME SPACER DETAIL
(ONE OF 6)



Frame spacer (identified as Part [A] on the drawing at the right) are made from six pieces of $\frac{3}{4}'' \times 1\frac{5}{8}''$ stock cut as shown in detail drawing.



Approximate dimensions (in inches) for each of the various materials appear in the table below. Figures are only a rough guide, however, since actual measurements may vary somewhat. The back will be identical—22" x 33"—for each of the different materials.

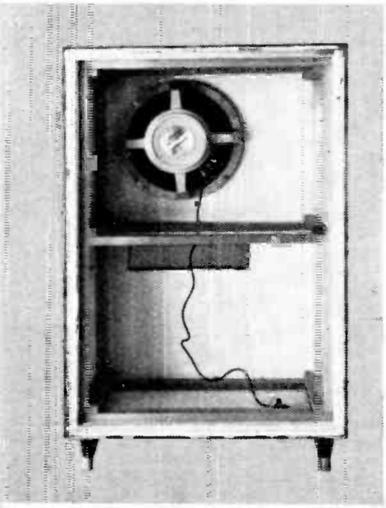
MATERIAL	a	b	c	d	e	f	g	h
CELOTEX	22	33	$13\frac{5}{8}$	33	$13\frac{5}{8}$	22	$13\frac{5}{8}$	22
SHEET ROCK	23	34	14	$34\frac{3}{4}$	14	23	14	23
FIR PLYWOOD	$23\frac{3}{4}$	$34\frac{3}{4}$	—	—	—	—	$14\frac{1}{4}$	$23\frac{3}{4}$
HARDWOOD PLYWOOD	—	—	$14\frac{1}{4}$	35	$14\frac{1}{4}$	$24\frac{1}{4}$	—	—

Final steps in building the Club Sandwich are mounting speaker and putting the back in place.

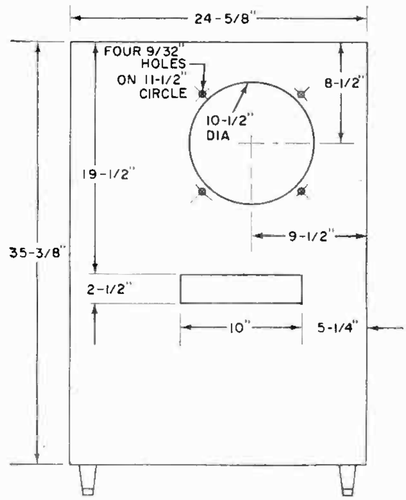
ing and bonding the adhesive will depend on the particular brand and type you choose.

The amount of cement will vary according to type, too, but you'll probably need at least half a gallon. Some is applied to one surface, some to both; some in high, wide ridges and valleys; some in narrow, thin ridges. Read all directions on the can and follow them exactly if you want satisfactory results.

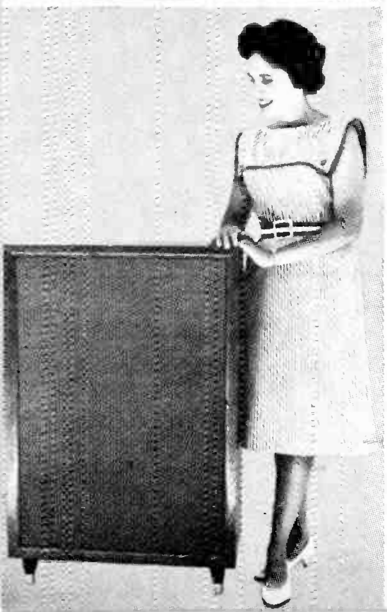
After the Sheetrock is in place, the fir plywood front can be cut to fit, then glued and nailed on. Incidentally, there should be no problem in getting a front, a back, and a bottom from the 4′ x 4′ sheet of fir plywood *if* you mark out the parts before sawing. Therefore, it's wise



The Club Sandwich was specifically designed for use with Electro-Voice 12TRXB speaker (see photo at left). Tweeter control can be mounted in bottom of enclosure as described in the text.



Location of the speaker mounting hole and port are indicated on the diagram at right. Keep in mind that dimensions are only approximate, since some of the measurements will vary with the thickness of your "sandwich."



Completed Club Sandwich is impressive-looking system. It will grace any listening room, and performancewise —well, let's just say that it's darn good.

to make accurate measurements for each part to be cut from the fir plywood *before* you start sawing.

The back can now be assembled from sheets of Celotex, Sheetrock, and fir plywood. This particular sandwich is simply glued and nailed, but it's best to apply pressure on it with weights. Use the #3 nails here, nailing from the Celotex out. If there is any tendency for the nails to penetrate the back, they can be driven at a slight angle.

Speaker and Port. The holes for the speaker and port should be cut before you paint the front flat black—otherwise, the edge of the cut Sheetrock will show through as a gleaming white rim inside the grille cloth.

In case you're wondering why the port size doesn't correspond to the exact area suggested by design charts, the explanation is that this port is based on specifications from Electro-Voice. In selecting this size, efficiency as well as bass range was considered.

Actually, with the 12TRXB speaker, port size isn't as critical as with lower quality speakers. The bass resonance of the 12TRXB is very low and presents no problem in itself, so other factors become more important in this bass-reflex design. A smaller opening—about 16 squares inches—would tune the "Club Sandwich" enclosure more critically, but less efficiently.

BILL OF MATERIALS

32—Feet of ¾" x 1⅝" wood (may be called 1" x 2" stock by lumber yard, any kind, straight and free of knots) to be cut into:
6—12" strips for spacers (A)
2—20½" strips for middle braces (B)
4—22" strips for top and bottom cross pieces (C)
4—31½" strips for sides (D)
4—8¾" strips for corners (E)
1—4' x 8' sheet of ½" Celotex
1—4' x 8' sheet of ⅜" Sheetrock
1—15" x 8' sheet of ¼" hardwood plywood
1—4' x 4' sheet of ¼" fir plywood
10—Feet of hardwood door stop or other trim
1—12" hi-fi speaker (Electro-Voice 12TRXB)
4—³⁄₁₆" x 3" bolts for speaker
24—#10 x 2" wood screws for back
1—Gallon of adhesive—see text
1—Pound of #5 cement-coated box nails
1—Pound of #3 cement-coated nails
Misc.—Grille cloth, legs, etc.

Finishing Up the Sandwich. The fir plywood bottom should be put on next, making it overlap the Sheetrock sides and the plywood front. The legs can now be attached to protect the sides when you move the cabinet. Now, measure and cut out the sides from hardwood plywood, making them the exact dimensions as the sides of the enclosure. When in position, they should overlap and hide the present Sheetrock side, the edge of the plywood front, and the edge of the plywood bottom.

The plywood sides are bonded into place without nailing. With most kinds of cement, it will be necessary to place a weight or other pressure on each piece while the cement is setting.

When the sides are in position, cut and add the plywood top, fitting it to cover the top edges of the sides and the front. At this point, it's a good idea to do any staining—if you're going to do any staining—just to make sure that no stain slops over on the grille cloth. Of course, if you use prefinished plywood, the job is virtually done.

One little task still remaining is to mount the tweeter control (it's part of the Electro-Voice 12TRXB speaker) on the rear panel. Because of the thickness of the sandwich it will be necessary to cut out a circle in the inside layer (the Celotex) for the body of the control.

Installation. With everything finished and mounted, you'll note that the Club Sandwich is becoming rather heavy (after all, one of the reasons for choosing Sheetrock was its density!). Therefore, you may not want to screw the back firmly in place until you've moved the enclosure to its permanent location. The brace across the back of the frame was meant to be just a brace, but with the back off it makes an excellent "handle" for carrying.

Coloration proved no problem when the 12TRXB was installed in the bare cabinet. No doubt this is partly due to the tri-layer construction, because some Celotex-lined enclosures sound "loud." Even so, extra padding in the form of cotton batting, foam plastic, or felt would be advisable. Electro-Voice recommends a stretched 2" thickness of "Kimsul" paper on three sides but warns against rock or glass wool which may work into the gap of the speaker. Naturally, some people will want more padding than others, depending on taste.

Now To Listen. Some enclosures are described as "good for the cost," or as having "surprisingly true bass for their size." Admittedly a much larger model would permit a somewhat lower bass range, but one thing about this system is certain. The Club Sandwich Reflex needs no qualifying phrases added to its description. In any man's language, it's *good!* —30—

Chapter 3

Communications for the Hobbyist

THE amateur radio operator, the short-wave listener, and the CB'er all have something in common—they are participants in the broad field of radio communications. In the 1964 ELECTRONIC EXPERIMENTER'S HANDBOOK, the Editors decided to emphasize all three interrelated hobbies. Listed below are projects of interest to the beginner as well as to the old-time Advanced Class ham. Technician Class hams should note the two 6-meter projects and Novices will like the low-cost, 2-meter receiver.

At the request of many college students, the Editors are publishing in this chapter some thoughts about a college-style wired-wireless broadcasting network. It is a plan that has proven to be exceptionally practical where the range of other wired-wireless systems is limited by 117-volt a.c. power line transformer isolation.

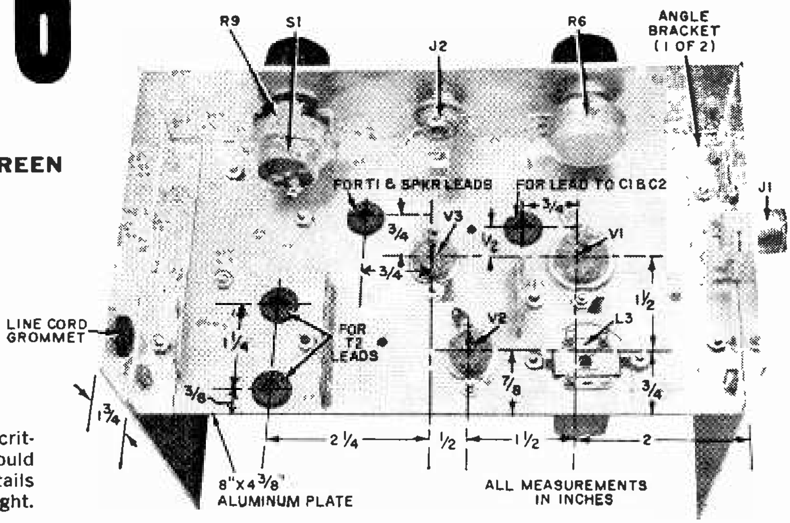
Perfect for the Technician on 50 mc., this receiver will also make an excellent standby unit for the "old pro"

SIMPLE SUPERHET FOR 6

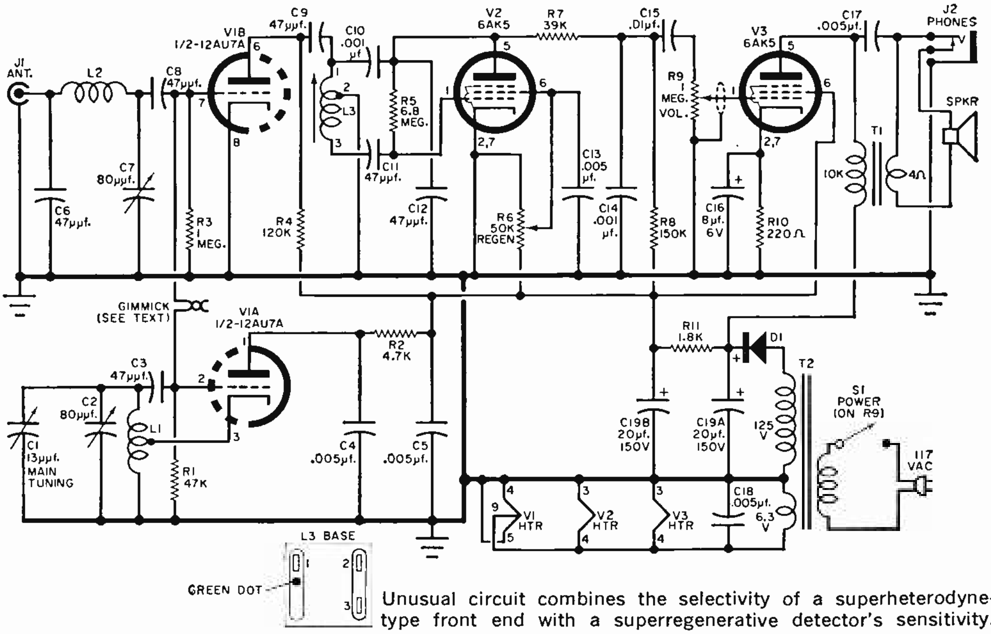
By **CHARLES GREEN**
W3IKH

WHETHER you're a brand-new Technician or a General or Extra Class ham of long standing, this 3-tube, 6-meter receiver deserves a place in your shack. It covers the main (50-53 mc.) portion of the band, and boasts a superhet-type front end with superregenerative detector. While the latter combination is unusual, it provides a degree of sensitivity and selectivity not often found in such simple sets.

What's more, the rig has its own built-in power supply and speaker, the whole package fitting comfortably into a



Parts layout is very critical, so the builder should follow closely the details given in the photo at right.



Unusual circuit combines the selectivity of a superheterodyne-type front end with a superregenerative detector's sensitivity.

middle-sized utility box. Construct it with the care that all VHF circuits require, and you'll have a peppy little receiver which takes up very little room on your operating bench. Excellent for use as a "second" or emergency unit, it's also a fine full-time performer for hams with limited budgets.

About the Circuit. Signals from antenna jack *J1* enter a bandpass network consisting of capacitors *C6* and *C7* and coil *L2*. This network is adjusted to resonate at 6 meters by trimmer capacitor *C7*. The 6-meter signals appearing at the output of the network are fed to the grid of mixer *V1b*.

Also fed to *V1b*'s grid (via a "gimmick" capacitor) is the output of oscillator *V1a*. The oscillator circuit, like the bandpass network, operates on 6 meters. Its frequency is controlled by coil *L1*, "bandsetting" trimmer capacitor *C2*, and main tuning capacitor *C1*.

The output of *V1b* is coupled to a superregenerative detector stage designed around tube *V2*. Detector coil *L3* is tuned to about 2 mc., thus establishing that frequency as the i.f. Potentiometer *R6*, which controls *V2*'s screen voltage, acts as a regeneration control.

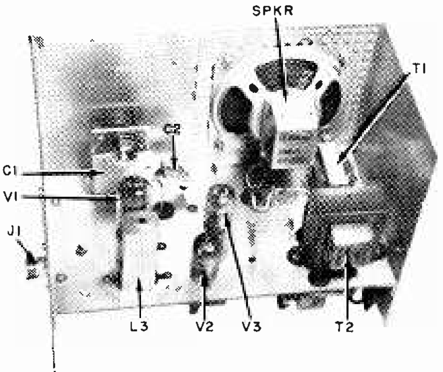
An R/C filter circuit (*R7/C14*) attenuates the superregenerative quench frequency before the detected signal is amplified by tube *V3*. Potentiometer *R9* is connected into *V3*'s grid circuit to serve as a volume control.

From *V3* the signal passes through output transformer *T1*, which matches *V3*'s plate circuit to the speaker. When a set of headphones is plugged into closed-circuit jack *J2*, the speaker is disconnected and the phones operate directly from the plate circuit.

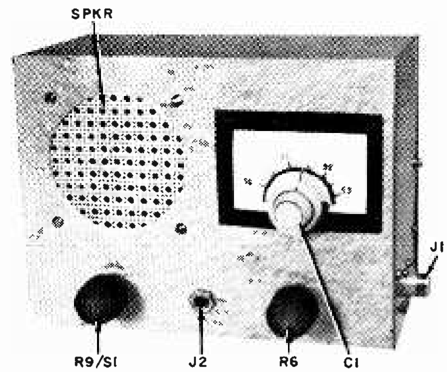
Operating voltages for the receiver are supplied by power transformer *T2*, rectifier *D1*, and a filter network consisting of dual capacitor *C19* and resistor *R11*. Switch *S1* (mounted on *R9*) turns the set on and off.

Construction. The unit is housed in an 8″ x 6″ x 4½″ aluminum utility box. As you can see in the photographs, the box is fitted with a "chassis shelf" which is cut from a piece of aluminum. Use a pair of angle brackets to mount the shelf about 1¾″ from the bottom of the box.

Try to follow the parts layout illustrated as closely as possible. As in all VHF circuits, layout is critical—and you'll stand a better chance of duplicating the author's results if you duplicate his construction. Notice that dimensions are given for locating most of the



View of receiver's top deck shows parts neatly spaced. Trimmer C2 is held in place by soldering its terminals to a ground lug and the stator terminal of C1.



Three control knobs and an operator are all that are needed to pull in those 6-meter calls after unit is assembled, aligned, and connected to an antenna.

PARTS LIST

C1—13-μμf. variable capacitor with vernier shaft (Lafayette HP-229)
C2, C7—80-μμf. mica trimmer capacitor
C3, C6, C8, C9, C11, C12—47-μμf., 600-volt ceramic tubular capacitor
C4, C5, C13, C17, C18—0.005 μf. ⎫ *600-volt*
C10, C14—0.001 μf. ⎬ *ceramic disc*
C15—0.01 μf. ⎭ *capacitors*
C16—8-μf., 6-volt miniature electrolytic capacitor
C19—Dual 20-μf., 150-volt electrolytic capacitor
D1—380-PIV, 65-ma. selenium rectifier stack (Sarkes Tarzian Type 65 or equivalent)
J1—Chassis-mounting coaxial receptacle (Amphenol 83-1R or equivalent)
J2—Closed-circuit phone jack
L1—8 turns of #16 tinned copper wire, wound 1" long and 3/8" in diameter—center-tap and provide with 1/2" leads
L2—12 turns of #16 tinned copper wire, wound 7/8" long and 3/8" in diameter—provide with 1/2" leads
L3—Oscillator coil (Meissner 14-1412)
R1—47,000 ohms ⎫ *All resistors*
R2—4700 ohms ⎬ *1/2-watt, 10%, unless*
R3—1 megohm ⎭ *otherwise specified*
R4—120,000 ohms
R5—6.8 megohms
R6—50,000-ohm potentiometer
R7—39,000 ohms
R8—150,000 ohms
R9—1-megohm potentiometer (with S1)
R10—220 ohms
R11—1800-ohm, 2-watt, 10% resistor
S1—S.p.s.t. switch (on R9)
SPKR—3.2-ohm, 3 1/2" speaker (Utah SP35RY or equivalent)
T1—Output transformer; primary, 10,000 ohms; secondary, 4 ohms (Stancor A3879 or equivalent)
T2—Power transformer; primary, 117 volts; secondaries, 125 volts @ 15 ma., 6.3 volts @ 0.6 amp (Stancor PS-8415 or equivalent)
V1—12AU7A tube
V2, V3—6AK5 tube
1—8" x 6" x 4 1/2" aluminum utility box (LMB 146 or equivalent)
1—8" x 4 3/8" aluminum plate (for chassis shelf)
Misc.—Line cord and plug, tube sockets, angle brackets for mounting shelf, 3/8" spacers, grommets, terminal strips, shielded wire, knobs, speaker grille, etc.

components and openings on the shelf.

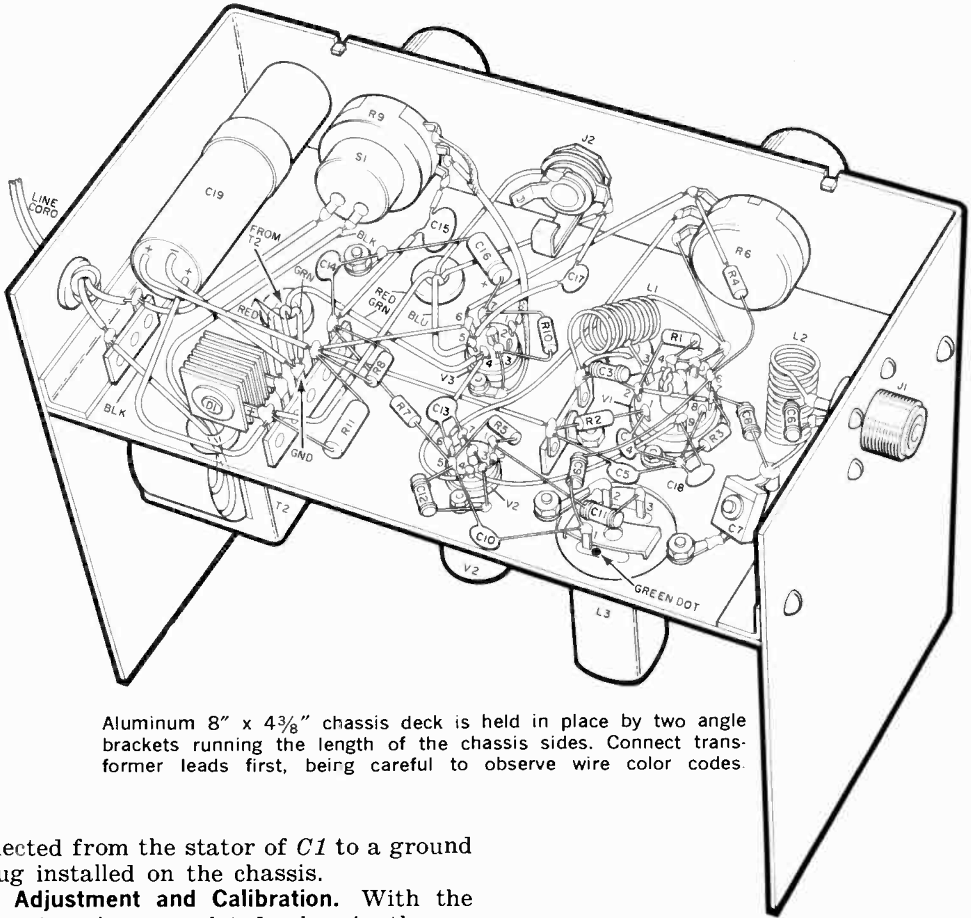
Notice, too, that output transformer *T1* has been mounted at right angles to power transformer *T2*. This minimizes the possibility of *T2* inducing hum into *T1*.

The only components placed on the box itself are potentiometers *R6* and *R9/S1*, jacks *J1* and *J2*, capacitor *C1*, and the speaker. When installing *C1*, set it back from the front panel by mounting it on 3/8" spacers. The author used a 4" square of perforated aluminum as a speaker grille; a piece of grille cloth could be employed instead—or you might simply drill a series of holes in the panel.

When carrying out the wiring, once again try to follow the author's layout as closely as possible. This is particularly important for the components associated with *V1a* and *V1b*. The major part of this circuitry is located under the chassis shelf and illustrated in the pictorial diagram.

The "gimmick" capacitor connecting the grids of *V1a* and *V1b* is made from a couple of short pieces of hookup wire. Just twist the ends of the wires together (twice), and solder the free ends into the circuit on terminals 2 and 7 on *V1*'s socket.

Capacitors *C1* and *C2* are visible only in the photo of the shelf's reverse side. As the photo shows, trimmer *C2* is con-



Aluminum 8″ x 4⅜″ chassis deck is held in place by two angle brackets running the length of the chassis sides. Connect transformer leads first, being careful to observe wire color codes.

nected from the stator of *C1* to a ground lug installed on the chassis.

Adjustment and Calibration. With the construction completed, plug in the receiver and turn it on. After a few minutes of warm-up time, adjust volume control *R9* to maximum and turn regeneration control *R6* until you hear a typical "superregenerative hiss" in the speaker. If all is well, leave the set on for about 10 minutes before proceeding.

After adjusting the slug in *L3* for maximum hiss (using a non-metallic screwdriver), connect a signal generator set at 50 mc. to *J1*. Starting with *C1* and *C2* at maximum capacity, reduce the capacity of *C2* until you hear the generator's signal in the speaker. Next, adjust *C7* for maximum volume.

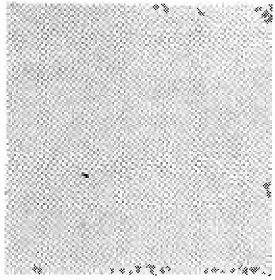
The last step is to calibrate the receiver. For this purpose, the author taped a paper scale to the front panel and glued a pointer behind *C1*'s tuning knob. You can use the same arrangement, or any other variation your imagination suggests.

The maximum-capacity position of *C1* has already been set at 50 mc. and should be so marked. All you have to do now is use the signal generator to identify the 51-, 52-, and 53-mc. positions of *C1* and mark the dial accordingly (do not disturb the settings of *C2* or *C7*).

If a signal generator is not available, adjust *L3*'s slug as before and connect a good antenna to *J1*. Capacitor *C2* can then be set so that ham signals are picked up over most of *C1*'s tuning range. Finally, adjust *C7* for maximum volume of any station received near the maximum-capacity position of *C1*.

Once you begin to use the receiver, you'll find that its built-in speaker provides adequate volume for most signals. When DX'ing, however, keep a set of headphones handy to help you pull in the weak ones. -30-

HYBRID RECEIVER ...for the Locals



Tube meets transistor in this modern adaptation of a decades-old circuit

By **MICHAEL S. ROBBINS**

ELECTRONICS ENTHUSIASTS have built countless receivers since station KDKA went on the air 'way back in 1920. Through the years, sets which incorporate grid-leak detectors have always been a favorite with the relative newcomer to this fascinating hobby. And this is one reason why the set described here should be of interest to old- and new-timers alike.

This little receiver also embodies some unusual features. It employs one tube and one transistor in a circuit which delivers room-level volume on local stations. A hybrid, it is a marriage of the old and the new—a one-tube grid-leak detector coupled to a modern transistor audio stage. The output from its 4" PM speaker, although strictly "lo-fi," is louder and more "listenable" than one would expect from such a simple hookup.

About the Circuit. A 12AE6-A tube functions as a grid-leak detector. Since this tube was designed for use as a detector and first-audio stage in "hybrid" auto radios, it works very nicely with a plate potential of about 12 volts. After detection, the audio is amplified by a high-gain 2N321 *pnp* transistor. Power for both tube and transistor is supplied by a filament transformer and a 1N34A diode rectifier circuit.

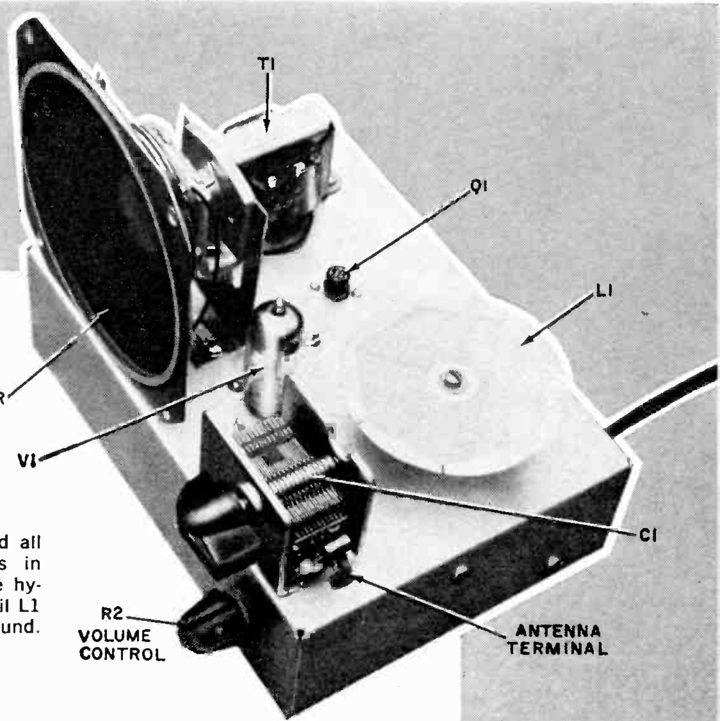
As can be seen from the diagrams and photographs, construction is simple and straightforward—neither parts placement nor component values are critical. Most of the capacitors can be almost any type your spare parts box offers, as long as the values are reasonably correct and voltage ratings are in excess of 15 volts (capacitor *C5*, of course, must be at least a 200-volt unit).

The tuning capacitor, *C1*, can be a single-section type or even a dual-section unit removed from a discarded superhet (use the larger or r.f. section in this case). Output transformer *T1* is a four-watt "universal" type in the author's model, although a 50L6-GT or a 6V6-GT type salvaged from an old receiver or television set will do the job. Resistors of the ½-watt, 10% or 20% tolerance variety will be okay.

Winding the Coil. The r.f. coil (*L1*) is wound on a form cut from a 3" x 5" filing

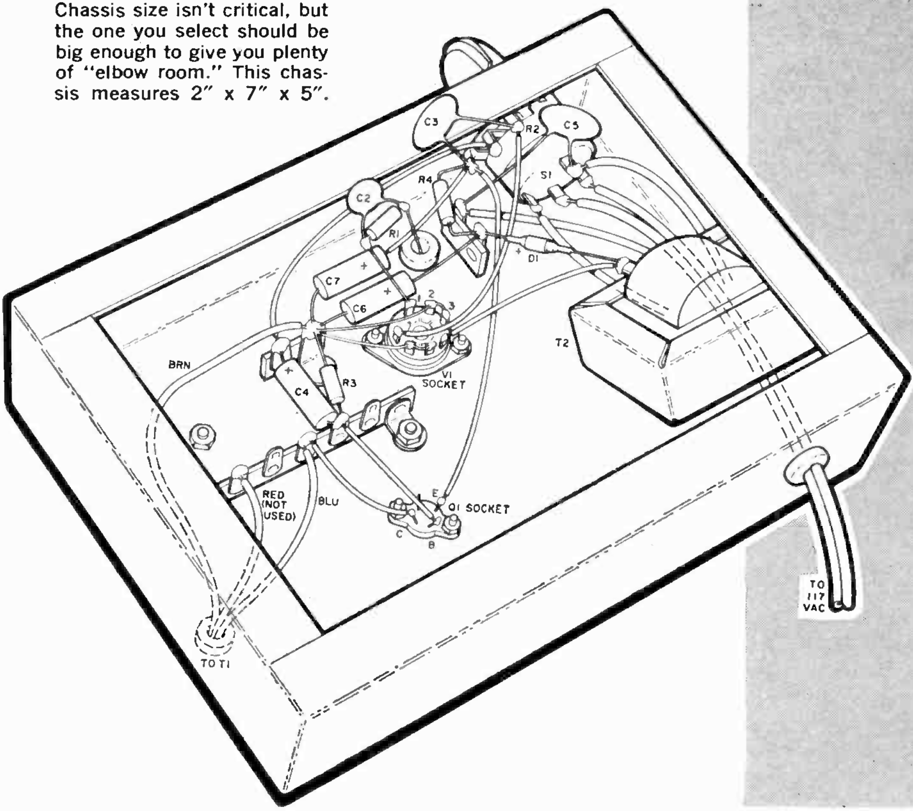
PARTS LIST

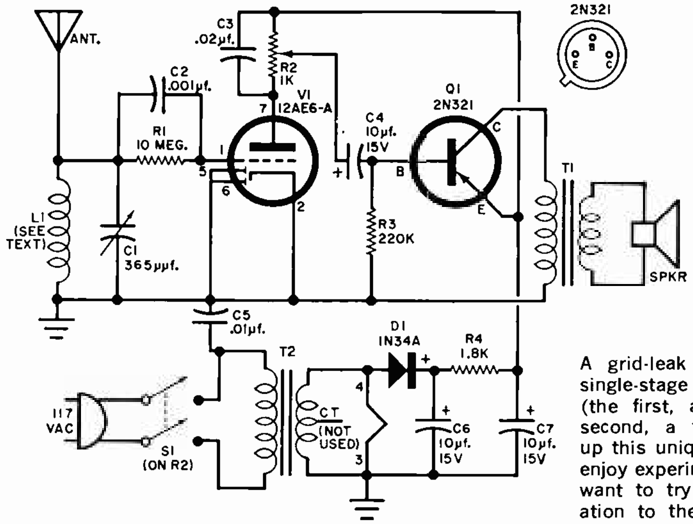
C1—365-μμf. variable capacitor
C2—0.001-μf. capacitor
C3—0.02-μf. capacitor
C4, C6, C7—10-μf., 15-w.v.d.c. electrolytic capacitor
C5—0.01-μf., 200-volt capacitor
D1—1N34A diode
L1—R.f. coil—see text
Q1—2N321 transistor (General Electric)
R1—10-megohm, ½-watt resistor
R2—1000-ohm potentiometer, linear taper
R3—220,000-ohm, ½-watt resistor
R4—1800-ohm, ½-watt resistor
S1—D.p.s.t. switch (on R2)
T1—Output transformer—see text (Stancor A-3856 or equivalent, connected as shown in pictorial, with speaker wired to lugs 1 and 4)
T2—Filament transformer; primary, 117 volts a.c.; secondary, 12.6 volts CT @ 1.5 amp. (Triad F-25X or equivalent)
V1—12AE6-A tube
1—4", 3.2-ohm PM speaker
Misc.—Chassis, line cord and plug, terminal strips, tube and transistor sockets, knobs, hardware, wire, solder, etc.



You might expect to find all tubes or all transistors in a receiver, but this little hybrid has one of each. Coil L1 (behind C1) is hand-wound.

Chassis size isn't critical, but the one you select should be big enough to give you plenty of "elbow room." This chassis measures 2" x 7" x 5".





A grid-leak detector and a single-stage audio amplifier (the first, a tube; and the second, a transistor) make up this unique circuit. If you enjoy experimenting, you may want to try adding regeneration to the detector stage.

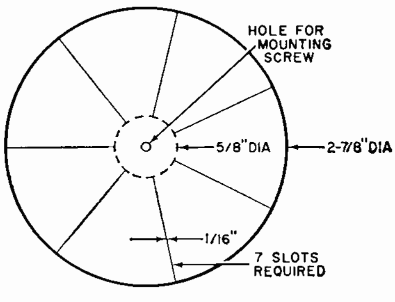
card or other thin piece of cardboard. First, cut out a 2⅞″ diameter disc, then punch a small hole for the mounting screw in the center of the disc and draw a ⅝″ diameter circle around it. Next, cut seven slots, each 1/16″ wide and spaced equidistant about the circumference, from the outer edge to the ⅝″ inner circle.

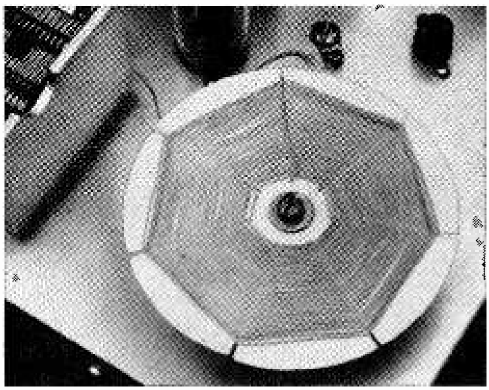
Sixty turns of #30 double-cotton-covered (DCC) wire are then wound interleaved on the form. Numbering the seven segments of the form one through seven, the first turn goes over one, under two, over three, etc., until it is completed. Since there is an uneven number of sections on the form, the second turn goes under segment one, over segment two, and so on; this means that only half the total, or 30 turns, show on one side of any segment. When the winding is completed, the coil should be mounted on the chassis just behind capacitor *C1* with a ¾″ or 1″ spacer.

Simple Antenna. An antenna consisting of eight feet of wire dropped behind a bookcase proved satisfactory in the author's case. If an antenna longer than about 15 feet is used, a small ceramic or mica capacitor (about 10 $\mu\mu$f.) should be inserted in series with the antenna at the antenna terminal on the set. No ground is required, incidentally, since the receiver is already grounded for r.f. through the a.c. line.

No adjustment or alignment of any sort is necessary—just plug the set in, turn it on, and enjoy it! —30—

Coil L1 (pictured at right) consists of 60 turns of #30 DCC wire, wound in an "over-and-under" fashion on the form shown below.

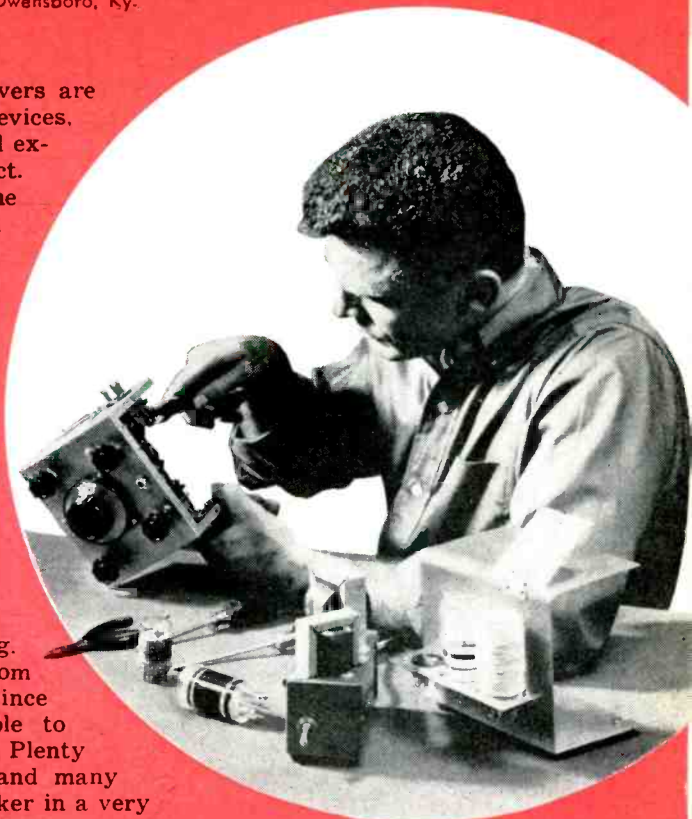




thanks to plug-in coils...

ONE RECEIVER ALL BANDS

By PHILIP E. HATFIELD, W9GFS
Receiving Tube Dept. General Electric Co., Owensboro, Ky.

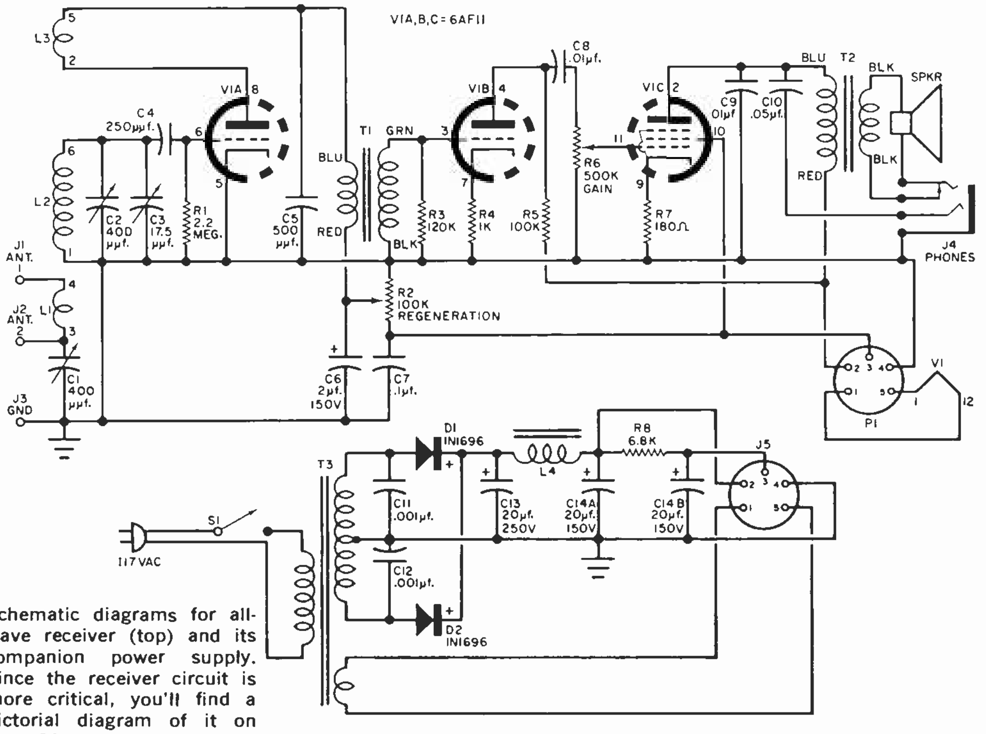


MOST of today's short-wave receivers are truly sensitive and reliable devices, but they are also rather complex and expensive for the beginner to construct. Here's a simple receiver, using one compactron tube, that will give you long-wave, broadcast-band, *and* short-wave reception. If you are considering putting your first receiver together, this one is for you. If you have an amateur-band-only receiver, this unit will fill in some of the "holes" in the spectrum. Finally, if you already have a general-coverage receiver, this set will make a good "auxiliary" to tuck away on a corner of the desk just in case your "big" one quits.

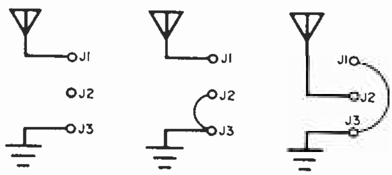
Use of a compactron allows a lot of receiver to be contained in a small box without undue crowding. The frequency range covered is from 250 kc. all the way to 16 mc.; and, since plug-in coils are used, it's possible to extend the range in either direction. Plenty of headphone volume is provided, and many signals will operate the built-in speaker in a very satisfactory manner.

The Circuit. The 6AF11 compactron contains two triodes and a pentode. One triode is used as a regenerative detector, the other as an audio voltage amplifier, and the pentode as an audio power amplifier.

Plug-in coils containing primary (*L1*), secondary (*L2*), and tickler (*L3*) windings determine the frequency range. Tuning is done with a relatively large variable capacitor (*C2*) to allow covering a wide range of fre-



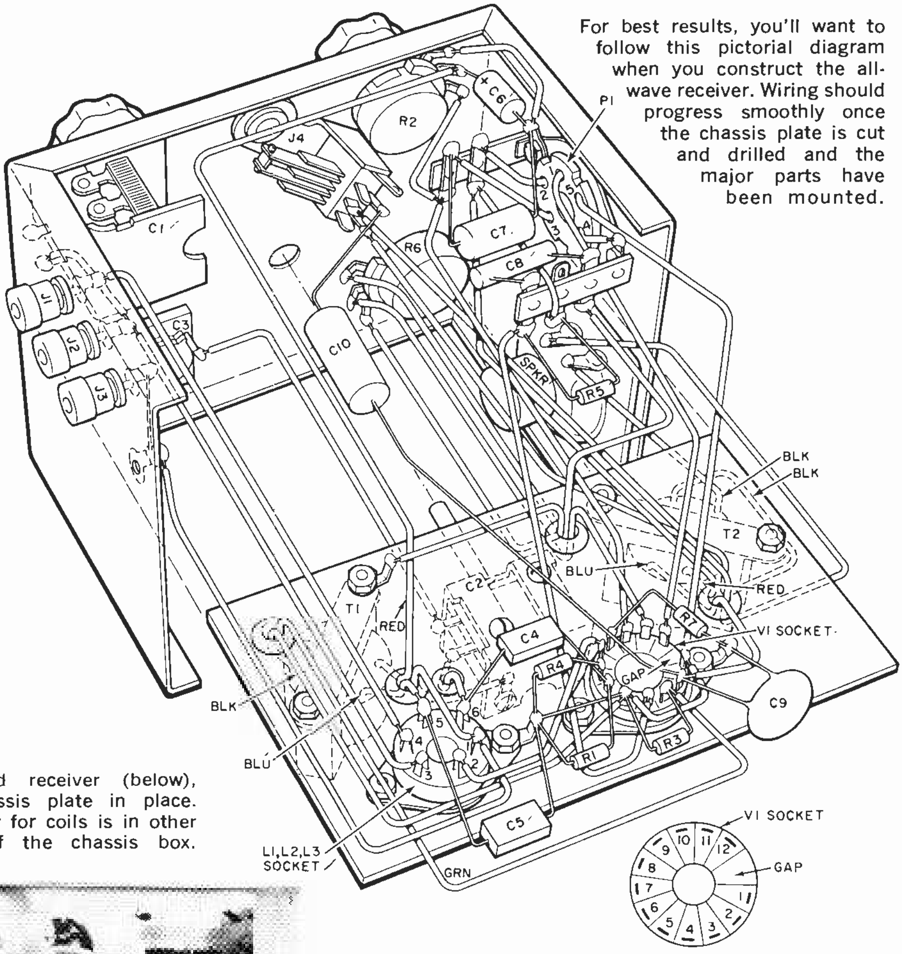
Schematic diagrams for all-wave receiver (top) and its companion power supply. Since the receiver circuit is more critical, you'll find a pictorial diagram of it on page 81; you should be able to wire up the power supply without difficulty by following parts layout shown in photos on pages 82 and 83.



Versatility is the word on antenna hookups for this receiver, and three possible configurations appear at left.

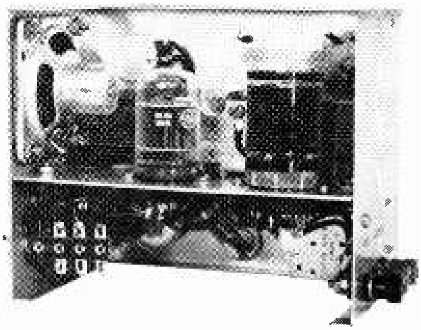
PARTS LIST

- *C1, C2—400-μμf. variable capacitor (Allied 61 L 009 or equivalent)*
- *C3—17.5-μμf. variable capacitor (Hammarlund HF-15 or equivalent)*
- *C4—250-μμf. mica capacitor*
- *C5—500-μμf. mica capacitor*
- *C6—2-μf., 150-w.v.d.c. electrolytic capacitor*
- *C7—0.1-μf., 400-volt paper capacitor*
- *C8, C9—0.01-μf., 1000-volt ceramic capacitor*
- *C10—0.05-μf., 400-volt paper capacitor*
- *C11, C12—0.001-μf., 1000-volt ceramic capacitor*
- *C13—20-μf., 250-w.v.d.c. electrolytic capacitor*
- *C14a/C14b—Dual 20/20-μf., 150-w.v.d.c. electrolytic capacitor*
- *D1, D2—1N1696 diode*
- *J1, J2, J3—Insulated binding post*
- *J4—"Closed and transfer" phone jack (Mallory 703B or equivalent)*
- *J5—5-prong socket*
- *L1, L2, L3—Plug-in coil—see page 82 for details*
- *L4—20-henry, 15-ma. choke (Chicago-Stancor C-1515 or equivalent)*
- *P1—5-prong plug*
- *R1—2.2-megohm, ½-watt resistor*
- *R2—100,000-ohm potentiometer, linear taper*
- *R3—120,000-ohm, ½-watt resistor*
- *R4—1000-ohm, ½-watt resistor*
- *R5—100,000-ohm, ½-watt resistor*
- *R6—500,000-ohm potentiometer, audio taper*
- *R7—180-ohm, 1-watt resistor*
- *R8—6800-ohm, 1-watt resistor*
- *S1—S.p.s.t. toggle switch*
- *SPKR—2½" PM speaker, 3.2-ohm voice coil*
- *T1—Interstage transformer, 1:3 turns ratio (Chicago-Stancor A-53 or equivalent)*
- *T2—Output transformer: primary, 10,000 ohms; secondary, 4 ohms (Stancor A3879 or equivalent)*
- *T3—Power transformer: primary, 117 volts a.c.; secondaries, 250 volts CT @ 25 ma. and 6.3 volts @ 1.0 amp (Stancor PS-8416 or equivalent)*
- *V1—6AF11 tube*
- *4—Six-prong coil forms, 1¼" in diameter, 2¼" long (Allied 71 H 724 or equivalent)*
- *1—6" x 5" x 4" chassis box (LMB T-F781 or equivalent)*
- *1—5" x 2¼" x 2¼" chassis box, gray hammertone finish (Bud CU-2104-A or equivalent)*
- *4—6-pin sockets*
- *Misc.—Dial, knobs, aluminum for chassis, wire for coils, hookup wire, socket for V1, line cord and plug, 5-conductor power cable with 5-pin socket and plug, hardware, solder, etc.*



For best results, you'll want to follow this pictorial diagram when you construct the all-wave receiver. Wiring should progress smoothly once the chassis plate is cut and drilled and the major parts have been mounted.

Completed receiver (below), with chassis plate in place. Trap door for coils is in other "half" of the chassis box.

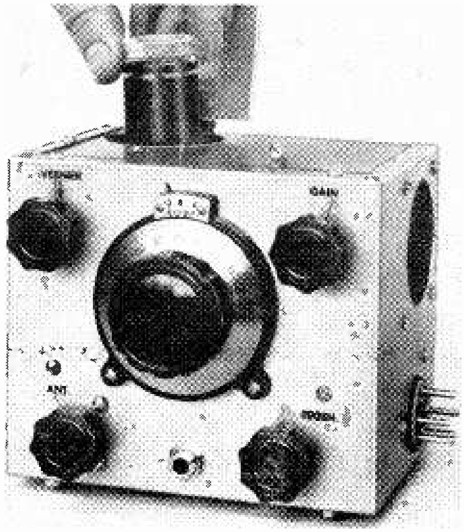


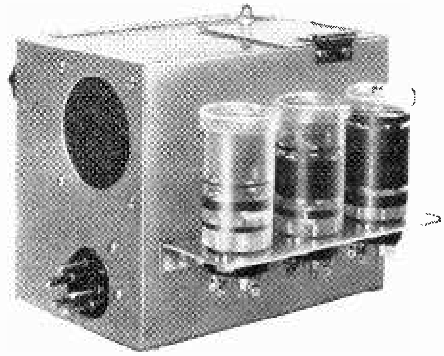
quencies with a minimum of coils. For fine tuning, a small variable capacitor (*C3*) is connected in parallel with the larger one to act as a "vernier."

The antenna coupling circuit is purposely designed for versatility. Straight inductive coupling, series tuning, or parallel tuning are possible, depending on the connections to jacks *J1*, *J2*, and *J3* (see antenna hookup diagram at left). This can be quite helpful in increasing the selectivity of the receiver and in tuning out the "dead spots" that afflict most regenerative receivers.

For maximum audio output, the headphones are operated from the pentode section of the compactron, and the phone jack (*J4*) is arranged to disconnect the speaker when the phones are in use.

The Receiver. All parts of the receiver, with the exception of the spare-coil rack, and the trap door for coil changing, are mounted on the portion of the chassis box used to form the front panel and sides. As the photos show, this makes all parts of the receiver readily accessible to the builder. In addition, since no electrical components are mounted on the removable portion of the box, all the testing that is necessary can be done





No likelihood of losing coils with this set—one, inserted through a trap door (far left), is always in use; the other three (above) rest in empty sockets mounted on aluminum flange at rear of cabinet.

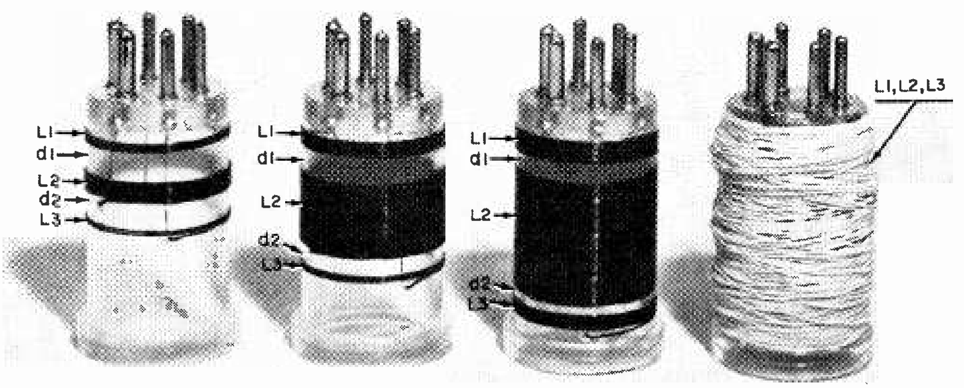
before the cabinet is "buttoned up."

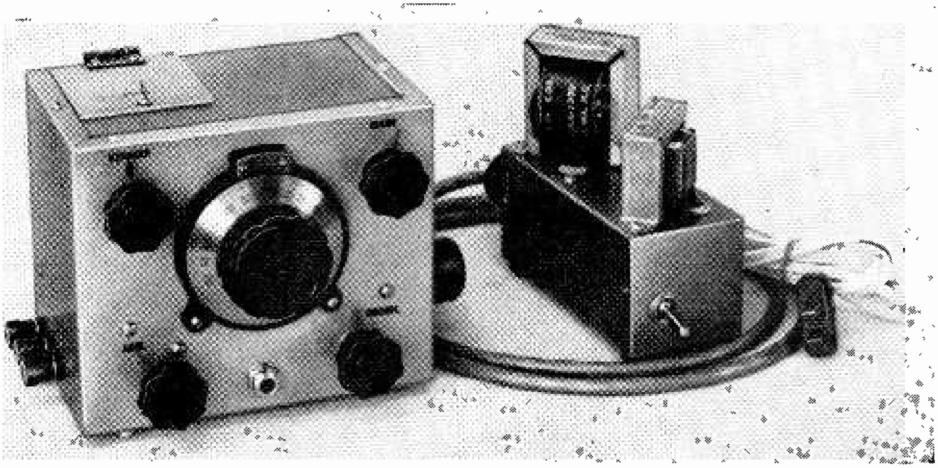
To reduce sheet metal bending to a minimum, the chassis proper is a flat plate, cut to make a fairly snug fit, and then fastened in place with four small angle brackets. All mounting holes should be cut in this plate and the chassis box before the plate is bolted in place.

After the holes have been drilled, all of the parts should be mounted, since they are all readily accessible for wiring in any sequence. In mounting the 400-$\mu\mu$f. antenna tuning capacitor (*C1*), flat washers should be used between the panel and the capacitor frame to insure that the screws don't extend through the

Winding data for receiver's four plug-in coils appears below. All of them are close-wound, except for the long-wave coil (250-600 kc.) at far right; full information on how to wind this particular coil appears in text. Vary spacing (d2) on the first three coils by sliding L3 back and forth on the form until regeneration seems "smoothest," then apply cement to hold coils in place.

	4.8-16.0 mc.	*1.75-6.1 mc.*	*510-1750 kc.*	*250-600 kc.*
L1	5 turns #26 enameled	8 turns #26 enameled	18 turns #30 enameled	30 turns #28 DCC
d1	1/4"	3/16"	1/8"	
L2	8 turns #22 enameled	25 turns #22 enameled	100 turns #30 enameled	200 turns #28 DCC
d2	1/4"	3/16"	1/16"	
L3	3 turns #26 enameled	4 turns #26 enameled	8 turns #30 enameled	10 turns #28 DCC





All-wave receiver and its power supply, ready for use. Since power requirements are comfortably low (about 150 volts d.c. @ 25 ma., and 6.3 volts a.c. @ 1.0 ampere), you may be able to "steal" the power from an existing receiver or amplifier and thus save yourself the trouble of building a separate supply.

frame far enough to interfere with the rotor.

Wiring of the receiver isn't especially critical, and the receiver is compact enough to allow component leads to furnish many of the connections. However, be careful to wire the coil socket exactly as shown, since proper wiring here is just as important as on the tube socket.

The Power Supply. A separate entity, the power supply is built on a 5″ x 2¼″ x 2¼″ chassis box. Holes for the various parts should be drilled in the box and all parts mounted before any wiring is done. Again, the wiring isn't critical, although care should be taken in connecting leads to the output socket (*J5*) to make sure that the proper socket contacts are used.

The power cable which connects the power supply to the receiver is made from a length of five-conductor, plastic-covered cable. This cable allows the power supply to be placed in some convenient spot away from the receiver. If the plastic-covered cable isn't available, individual stranded insulated wires can be used to make the cable, with bands of tape fastened at intervals to keep it together. Be sure that the wires used for the heaters are at least #20 gauge. Before testing the receiver, double-check to see that all of the plugs and sockets are correctly wired so that the voltages from the power supply arrive at the right points in the receiver.

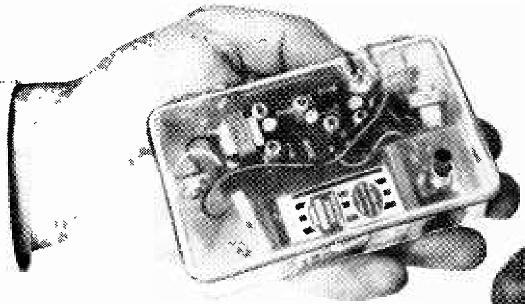
The Coils. Before the receiver can be tested, at least one of the plug-in coils must be wound. Start with the broadcast coil, since it covers the range where results are easiest to obtain.

The polystyrene forms will call for some cautious handling—when drilling, too much pressure may crack them; and, when soldering, excessive heat will soften them. Lightly filing the ends of the coil form pins to remove the plating will make soldering easier. Remember, rapid soldering is required to prevent softening of the form. Start by winding the primary, followed by the secondary, and then the tickler.

One way to make a neat job is to push the wire through the starting hole in the form and into the pin and then solder it in place. Then unwind the amount of wire from the spool that you think will be required, but don't cut the wire just yet. Instead, clamp the spool in a vise and walk away until the wire is under slight tension.

Wind the coil by turning the coil form in your hands as you walk slowly toward the vise. If you have underestimated the wire needed, or if your workshop is small, hold the coil in one hand to prevent the wire from slipping, remove the

(*Continued on page* 154)



AIRLINE

Special "pocket portable"

By GEORGE L. DOWNS
K2FG

FOR ABOUT six years, as a passenger on commercial airlines, I've been carrying a little hearing-aid-like device that enables me to overhear what the pilot is saying on his two-way radio. I call this gadget my "Airline Eavesdropper." Although I sit in the passenger cabin like every other passenger, I generally know where we are, how high we're flying, our estimated time of arrival, and whether the pilot is flying under Instrument (IFR) or Visual (VFR) flight regulations.

Once assured that the Eavesdropper is a "crystal set" and that it radiates no signals to interfere with the plane's equipment, airline personnel have no objection to its use. Stewardesses like to "listen in," and I have had various captains fill me in on their courses so I could "navigate" with them.

In addition to what the pilot is saying (you can't hear the other end of the conversation unless you're very near the control tower), you can hear the beep (or buzz) of radar signals as the plane comes within range. Around the airport you can hear other planes, the control tower, code signals from the low-frequency beacons, and even vehicle ignition noise. As a matter of fact, you don't even have to be airborne—you can hear some very interesting things just carrying (or wearing) an Eavesdropper on an airport observation deck.

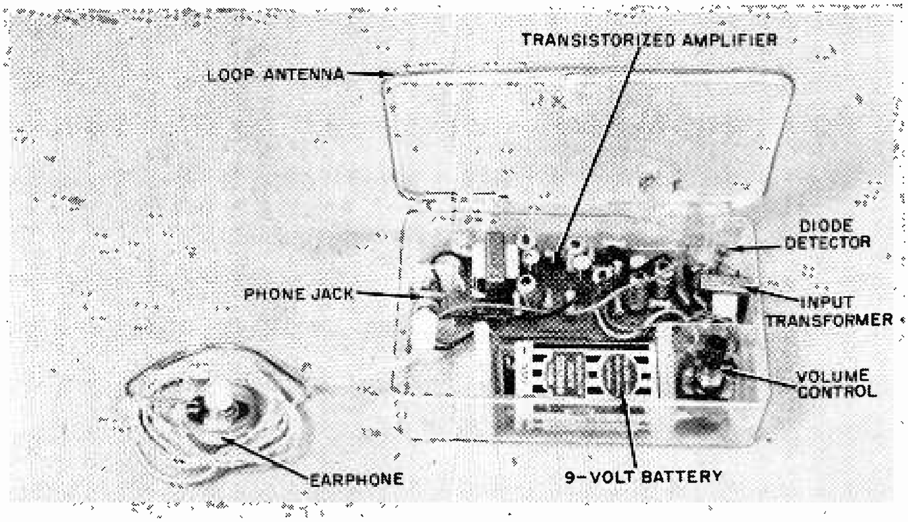
Construction of the Eavesdropper is exceedingly simple. You just group the parts in the box in some logical arrange-

PARTS LIST

B1—9-volt battery (Burgess 2MN6 or equivalent)
C1—0.002-μf. ceramic disc capacitor, working voltage not critical
D1—1N34A diode
J1—Subminiature phone jack (Lafayette MS-282 or equivalent)
P1—Subminiature phone plug (part of earphone assembly)
R1—5000-ohm subminiature potentiometer (Lafayette VC-27 or equivalent)
S1—S.p.s.t. switch (part of R1)
T1—Subminiature transistor input transformer: primary, 200,000 ohms; secondary, 1000 ohms (Lafayette TR-120 or equivalent)
1—Dynamic earphone, 6-ohm impedance (Lafayette MS-591 or equivalent)
1—$1\frac{1}{8}$" x $4\frac{5}{8}$" x $2\frac{3}{4}$" plastic case (Lafayette MS-161 or equivalent)
1—Loop antenna, one turn of #18 around case
1—3-transistor subminiature audio amplifier (Lafayette PK-522 or equivalent)
Misc.—Wire, solder, plastic dividers, knob, etc.

EAVESDROPPER

lets you listen in on pilots, control towers, and beacons



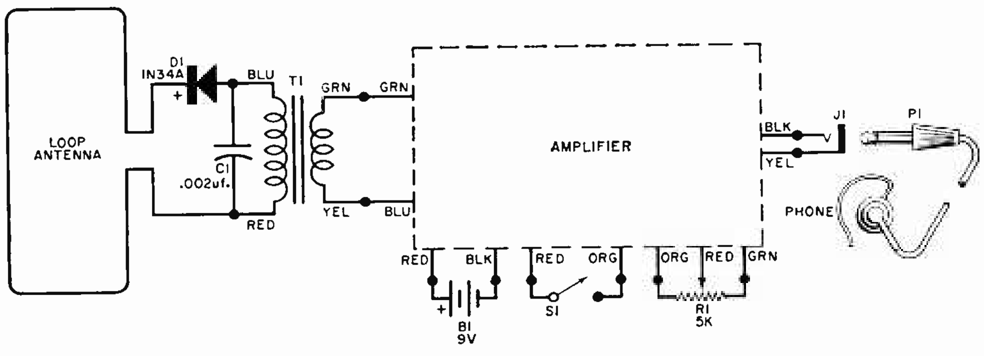
A single plastic case holds all parts—including built-in loop antenna. Phone jack, volume control, and other major components are mounted on small pieces of plastic glued to bottom of case.

ment—don't forget to leave room for the earpiece and cord, however. Then cut and cement plastic partitions in place to form supports for the various components, mount the components, and wire them up.

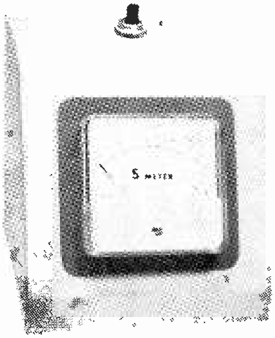
The Eavesdropper can be operated with the cover open or closed. With the cover closed, it can be slipped into a jacket pocket and worn as a hearing aid. Maximum pickup in most planes is with the loop flat against the plane's window. However, the loop is quite sensitive to orientation and a little experimentation will give you the best position. Sometimes, for example, you'll hear the hum of the 400-cycle supply used on planes. In this case, the loop should be oriented for minimum hum pickup.

If you fly regularly, you may want to obtain a copy of the Instrument Enroute Charts covering your most used routes. They are available for 25¢ each from the U.S. Dept. of Commerce, Coast and Geodetic Survey, Washington, D.C. -30-

Loop antenna and diode detector comprise r.f. portion of Eavesdropper circuit, while commercially assembled transistor amplifier makes up a.f. section. Unit lacks oscillators, thus cannot be source of interference.



ADD-ON S-METER



Now anyone can measure relative signal strength on his Citizens Band, amateur, or SWL receiver

By R. L. WINKLEPLECK

IF your communications receiver isn't equipped with an S-meter, you're losing out on more than just the chance to issue accurate signal reports. For one thing, the ability to measure signal strength is not only a great help in tuning a receiver, but it also facilitates alignment and other adjustments of the set. For another, a receiver equipped with an S-meter automatically becomes a field-strength indicator and, as such, is a great help in tuning transmitters, evaluating antenna performance, etc.

The S-meter described here can be attached to any tunable or fixed-tuned receiver (whether ham, broadcast, or CB) equipped with an automatic volume control. Its sensitive VTVM-type circuit has an input impedance of about 12 megohms and will not affect receiver performance. Self-powered, the unit requires only two connections to your set (and one of these is a simple ground).

Construction. The circuit is housed in a 4½" x 4³⁄₁₆" x 4¼" sloping-panel utility box, for which the author constructed a chassis from scrap sheet aluminum. If you wish, you can use the kind of box that comes equipped with its own chassis. Just be sure that you provide ventilation for the 12AU7 tube (*V1*).

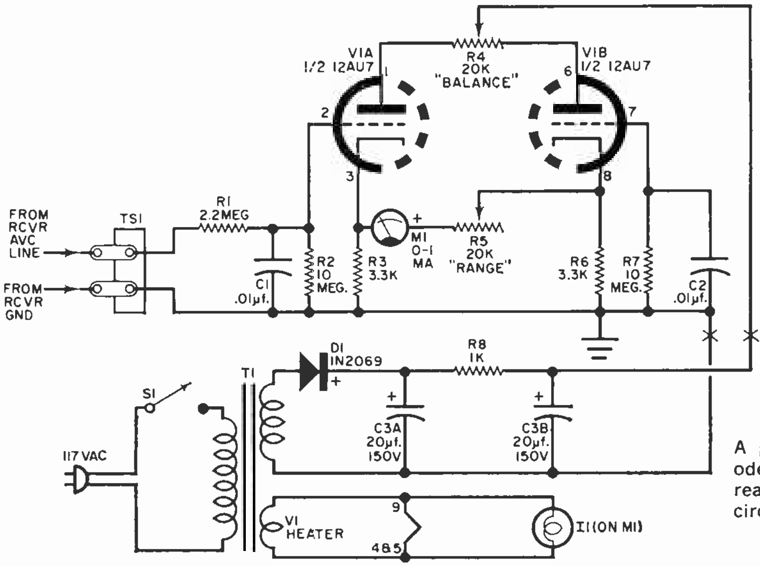
The S-meter unit (*M1*) is mounted on the sloping panel of the box, and the chassis is held in place by means of the two meter-mounting screws. Switch *S1*, as can be seen in the photos, is installed on the top of the box, and the rear apron of the chassis holds potentiometers *R4* and *R5* as well as the grommet for the line cord.

A 2-lug (one-grounded) terminal strip, *TS1*, is fastened on top of the chassis (at the rear). This strip accommodates the connections from the meter circuit to the receiver.

The other components are placed on, or under, the chassis as illustrated. The arrangement is a compact one, but you should have no trouble installing or wiring all the parts.

Transformer *T1*, switch *S1*, diode *D1*, capacitors *C3a* and *C3b*, and resistor *R8* can be eliminated if you would like to tap the necessary power from your receiver. Simply ignore all wiring below the leads marked "X" on the schematic diagram, and connect the center arm of potentiometer *R4* to a 150-volt d.c. point in your set.

Meter pilot light *I1* and the heater for *V1*, of course, should be wired to a 6.3-volt a.c. or d.c. source. The *V1* heater will operate from 12.6 volts if contact is made across pins 4 and 5 of the tube instead of across 4, 5 and 9 as shown. Naturally, if you decide to operate *V1*'s heater from 12.6 volts, you'll either have to substitute a 12-volt

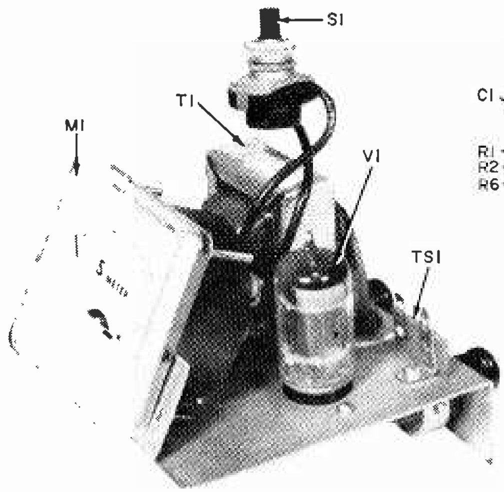


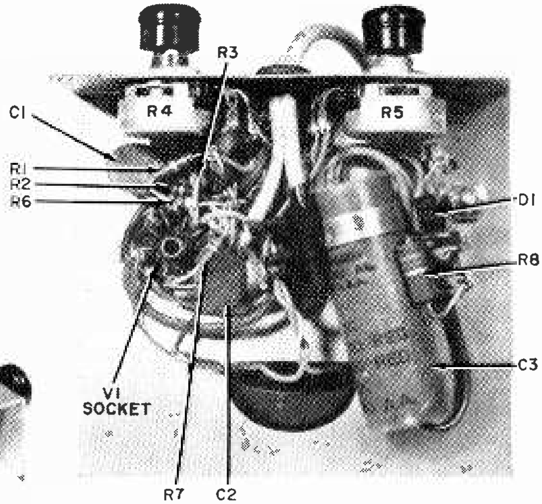
A glance at the two triode stages may cause the reader to recall similar circuits used in VTVM's.

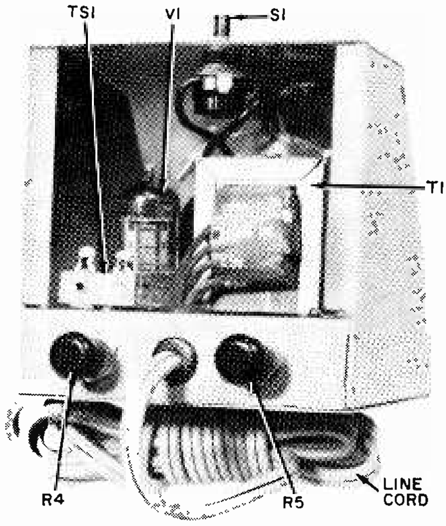
PARTS LIST

C1, C2—0.01-µf., 150-volt capacitor
C3—Dual 20-µf., 150-w.v.d.c. electrolytic capacitor
D1—1N2069 diode (Texas Instruments)
I1—6.3-volt pilot lamp (on M1)—see text
M1—2⅜"-square illuminated S-meter, 1-ma. movement (Lafayette TM-26 or equivalent)
R1—2.2 megohms }
R2, R7—10 megohms } *½-watt resistors*
R3, R6—3300 ohms }
R4, R5—20,000-ohm potentiometer, linear taper
R8—1000-ohm, 5-watt resistor
S1—S.p.s.t. switch
T1—Power transformer: primary, 117 volts a.c.; secondaries, 125 volts @ 15 ma., 6.3 volts @ 0.6 amp (Stancor PS-8415 or equivalent)
TS1—2-lug terminal strip
V1—12AU7 tube
1—4½" x 4¾6" x 4¼" aluminum sloping-panel utility box (Premier ASPC-1200)
Misc.—Line cord and plug, socket for V1, grommets, terminal strips, knobs for R4 and R5, wire, sheet-aluminum stock for chassis, etc.

Size of aluminum chassis which mounts most of the parts is determined by the dimensions of the sloping-panel utility box used. Meter M1 and switch S1 mount on utility box.







The "Add-On S-Meter," complete with its own power supply, needs only two wires from TS1 to connect to receiver a.v.c. line. Controls R4 and R5 are employed to adjust the "swing" of the meter's pointer.

bulb for pilot lamp *I1* or make some other arrangement for illuminating the meter. Probably the simplest way out is to use a VOM to determine the amount of current drawn by lamp *I1* at 6.3 volts, and then add a small series resistor to provide the required 6.3-volt drop (the value of this resistor can be computed with Ohm's law).

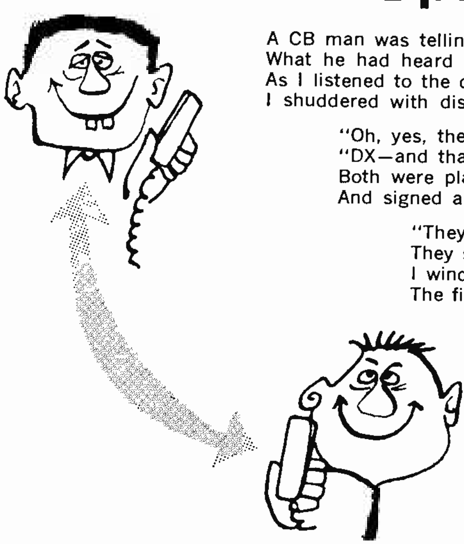
If you have room on your receiver's front panel and chassis, you might even want to dispense with the utility box and build the S-meter circuit right into the set. Smaller S-meters than the one specified for *M1* are available should panel space be limited. But be sure you get one with a 1-ma. movement.

Installation and Adjustment. Installation is simplicity itself. Connect the "ground" terminal on *TS1* to your receiver ground, then connect the other terminal to the receiver a.v.c. line (the set's schematic should show the location of the latter). If you are not using a built-in power supply, tap your receiver for power as described in the previous section.

With both the receiver and S-meter circuits warmed up, disconnect the receiving antenna and adjust *Balance* potentiometer *R4* for a zero reading on *M1*. Then reconnect the antenna and tune to a strong local signal. Adjust *Range* potentiometer *R5* so that the signal almost "pins" *M1*.

Of course, this calibration, like that of any other S-meter, isn't "exact." But your newly installed "Add-On S-Meter" will now give you the same kind of relative readings you would obtain from a commercially manufactured unit. —30—

CB Spree



A CB man was telling me
What he had heard one day;
As I listened to the charges made,
I shuddered with dismay.

"Oh, yes, they worked DX," he said,
"DX—and that's not all!
Both were plainly out of band
And signed a different call.

"They weren't made of CB stuff,
They sat and talked quite gay."
I winced and tried to figure out
The fine they'd have to pay.

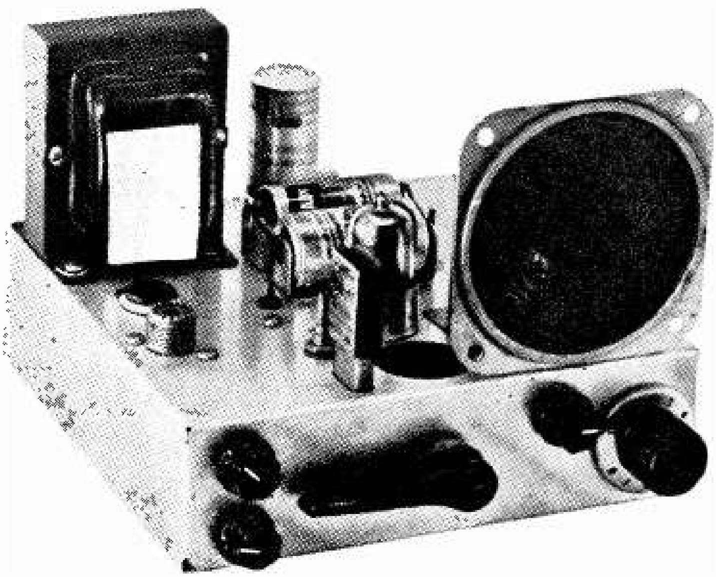
And then the final clincher came:
It really made me stew;
The FCC he would not call,
For nothing could they do.

"How come these clowns cannot be caught?
In jail they ought to land."
" 'Cause these were **hams**," my friend guffawed,
"On their 10-meter band!"

by David Moore

TRANSCEIVER FOR 6

By **MICHAEL S. ROBBINS,** K6QAH

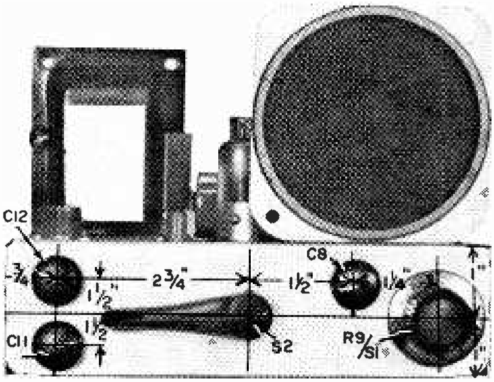


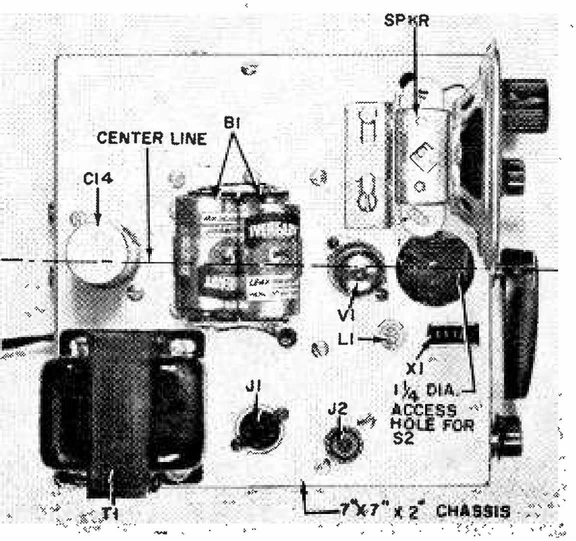
One tube serves both as a regenerative receiver and a 2-watt AM transmitter in this peppy 6-meter rig

TRANSCEIVERS have long been popular items of station equipment with hams operating on 6 meters. All kinds of units are employed, ranging from simple "handie talkies" to elaborate fixed station rigs combining multi-watt transmitters with superheterodyne receivers. But the one in use at K6QAH evolved from a project aimed at determining just how good a circuit could be designed around a single, multi-purpose tube. The results more than met the author's expectations, and if you, too, would like to try your hand at 1-tube QSO'ing on 6, complete construction details on the transceiver are given here.

Operating off the a.c. line, a triple triode does double duty as a crystal-controlled, plate-modulated transmitter and a regenerative receiver with an isolating r.f. stage and speaker output. The rig puts out a creditable 2-watt signal anywhere in the 6-meter band, and receives dependably at distances up to 25 miles. During a recent band opening, in fact, stations from the Mexican to the Canadian borders were heard at the author's

TRANSCEIVER FOR 6





Parts placement on the front (above) and top (below) of the transceiver's chassis is shown here. Follow these photographs carefully; improper layout will make wiring difficult.

Los Angeles QTH. And only a simple dipole antenna was used.

Receiving Circuit. With "transmit-receive" switch *S2* in the position shown on the schematic, the transceiver functions as a regenerative receiver. Signals from the antenna are coupled to the grid of *V1a* (one of the three triode sections of the 6EZ8 tube). This section serves as an r.f. amplifier and isolates regenerative detector *V1b* from the loading effects of the antenna. Though the transmitter's pi-network output circuit (capacitors *C11* and *C12*, chokes *L5* and *L6*) remains in series with the antenna on "receive," it tunes quite broadly and has little effect.

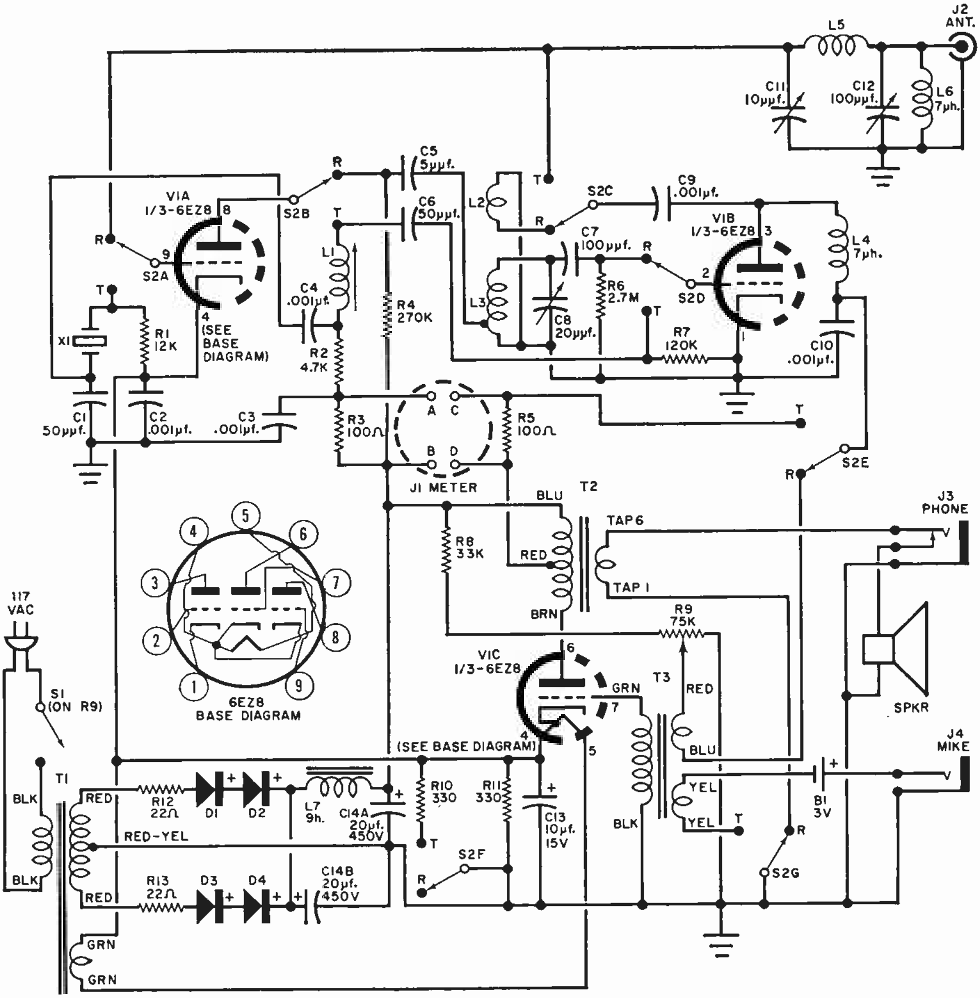
Capacitor *C8* and coil *L3* tune detector *V1b* through a range of 45-65 mc. A bandspread capacitor can be added (see "Tune-Up and Operation" section) if desired. Coil *L2* is the "tickler," coupling part of *V1b*'s plate signal back into the grid to provide regeneration. Potentiometer *R9* varies the plate voltage to *V1b* and acts as a regeneration control.

The "red-blue" primary winding of transformer *T3* couples the output of *V1b* to *T3*'s secondary, and thence to the grid of audio amplifier *V1c*. The speaker, or the earphone section of a handset (via jack *J3*), is driven by *V1c* through output transformer *T2*.

The speaker has a high-impedance voice coil so that it will come close to matching the impedance of the handset earphone (both being operated from the same output transformer). If the hand-

PARTS LIST

B1—3-volt battery (two flashlight cells in series, or equivalent)
C1, C6—50 µµf.
C2, C3, C4, C9, C10—0.001 µf.
C5—5 µµf.
C7—100 µµf.
} *all 500-volt, ceramic disc capacitors*
C8—20-µµf. variable capacitor (Hammarlund MAC-20 or equivalent)
C11—10-µµf. variable capacitor (Hammarlund MAC-10 or equivalent)
C12—100-µµf. trimmer capacitor (Hammarlund MAPC-100-B or equivalent)
C13—10-µf., 15-volt electrolytic capacitor
C14—Dual 20-µf., 450-volt electrolytic capacitor
D1, D2, D3, D4—5E4 diode (International Rectifier)
J1—4-pin socket to accept meter probes
J2—Female coaxial connector, chassis-type (Amphenol 83-1R or equivalent)
J3—2-conductor, closed-circuit phone jack
J4—2-conductor, open-circuit phone jack



The 6EZ8 tube, as shown in schematic diagram, is set for "transmit" or "receive" by 8-pole switch S2

L1—15 turns of #30 d.c.c. wire close-wound on a J. W. Miller 4400-R slug-tuned form
L2—3¼ turns of B&W 3003 coil stock (½"-diameter, 16 turns per inch) or equivalent
L3—5¾ turns of B&W 3003 coil stock or equivalent, tapped ¼ turn from ground end
L4, L6—7-μh., 1000-ma. r.f. choke (Ohmite Z-50 or equivalent)
L5—4¼ turns of B&W 3015 coil stock (1"-diameter, 16 turns per inch) or equivalent
L7—9-henry, 50-ma. filter choke (Stancor C-1215 or equivalent)
R1—12,000 ohms
R2—4700 ohms
R3, R5—100 ohms
R4—270,000 ohms
R6—2.7 megohms
(all resistors ½-watt, 10%, unless otherwise specified)
R7—120,000 ohms
R8—33,000 ohms, 1 watt
R9—75,000-ohm, linear-taper potentiometer, with s.p.s.t. switch (Ohmite CU7531 with CS-1 switch, or equivalent)
R10, R11—330 ohms
R12, R13—22 ohms
S1—S.p.s.t. switch (on R9)
S2—8-pole, 2-position rotary switch, non-shorting type (Centralab PA-1025 with one pole unused, or equivalent)
SPKR—3½" PM speaker, 45-ohm voice coil—see text
T1—Power transformer; primary, 117 volts; secondaries, 460 volts CT @ 50 ma., 6.3 volts @ 2.5 amperes (Stancor PC-8418 or equivalent)
T2—Universal output transformer (Stancor A-3823 or equivalent)
T3—Transceiver transformer; primaries, 100 and 10,000 ohms; secondary, 100,000 ohms (Triad A-21X)
V1—6EZ8 tube
X1—Crystal—see text
1—2" x 7" x 7" aluminum chassis (Bud AC-405 or equivalent)
Misc.—Sockets for V1 and X1, holder for B1, terminal strips, line cord and plug, perforated board and terminals, 1" spacers, bandspread capacitor (optional), handset or mike, etc.

set feature is not desired, a standard 3.2-ohm speaker can be used—but the connections to *T2*'s taps must be changed (see "Construction" section).

Transmitting Circuit. When *S2* is switched to the "transmit" position, *V1a* becomes a crystal-controlled oscillator—providing an output in the 25-mc. range. The crystal used at *X1* can be a "fundamental" type having a frequency between 8.350 mc. and 9.000 mc. or between 12.525 mc. and 13.500 mc. An "overtone" crystal designed for the 25.-050 to 27.000 mc. range can also be used.

Section *V1b* of the 6EZ8 is the final output tube. Doubling the 25-mc. oscillator output, it delivers a 50.1 - 54 mc. signal from crystals in the above ranges (50.1 - 54 mc. is the AM-phone portion of the 6-meter band). Since triode *V1b* is a frequency doubler, it requires no neutralization. The plate circuit of *V1b* is matched to the antenna by means of the pi-network circuit mentioned earlier.

Battery *B1* supplies the operating current for a carbon microphone (or the microphone section of a handset) plugged into jack *J4*. The mike signal is fed to the "yellow-yellow" primary winding of transformer *T3*, and is coupled to the grid of *V1c* (the latter now acting as a modulator). The primary of transformer *T2* serves as a choke to couple the output of *V1c* to the plate circuit of final amplifier *V1b*.

Power Supply Circuit. A full-wave rectifier supplies the d.c. voltages for the transceiver. Two inexpensive 400-PIV diodes in series are used in each rectifier leg, each pair (*D1/D2*, *D3/D4*) being the equivalent of an 800-PIV diode. Resistors *R12* and *R13* protect the diodes against current surges. The filter network consists of *C14a* and *C14b*, and *L7*.

The heater circuit of *V1* is not grounded at any point because the cathodes of *V1a* and *V1c* are internally connected to the heater (see base diagram on schematic). If the heater were grounded, these cathodes could not be properly biased. Bias is supplied through resistor *R11* on "receive" and through resistors *R10* and *R11* in parallel on "transmit."

Construction. The transceiver is built on a 2" x 7" x 7" aluminum chassis. When mounting the parts, follow the author's layout as closely as possible. This applies especially to switch *S2* and the socket for tube *V1*, since the wiring around these components is a bit crowded and leads must be kept short.

Specifications for the construction of coils *L1*, *L2*, *L3*, and *L5* will be found in the Parts List. Coils *L2*, *L3*, and *L5*, cut from Barker and Williamson "Miniductor" stock, are supported by their own leads—be sure to make these leads long enough for connection into the circuit. Coils *L2* and *L3* should be mounted about ¼" apart; this spacing will be adjusted more closely later (see "Tune-Up and Operation" section).

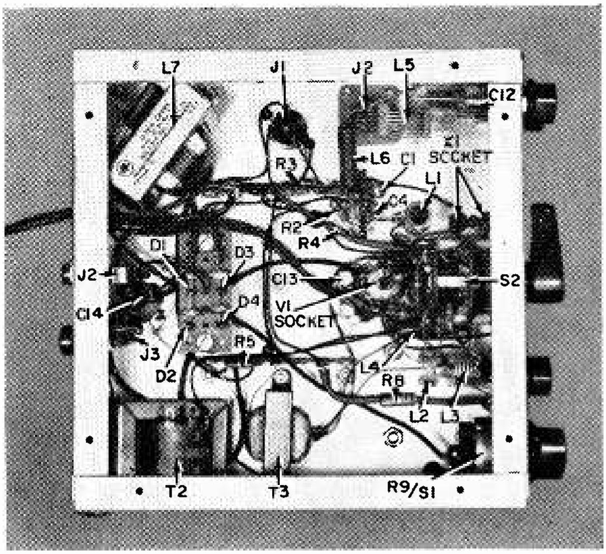
Because it would be difficult to prewire switch *S2*, and because most of the terminals would otherwise be difficult to reach once this switch is mounted in place, an access hole is punched in the chassis directly above *S2*. This 1¼"-diameter opening can be made with an ordinary tube-socket punch, and permits access to all of the switch terminals which can't be reached from the other side of the chassis.

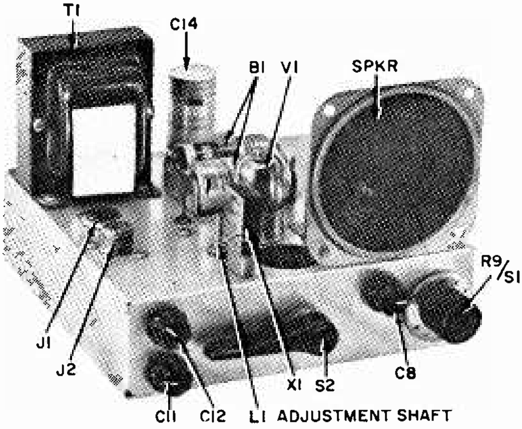
The switch specified for *S2* has two decks—four poles available on each one. Use the rear deck (the one farthest from the knob) for sections *S2b*, *S2c*, *S2d*, and *S2f*. Sections *S2a*, *S2e*, and *S2g* are wired to the front deck, and the remaining pole on this deck is left unused.

If you plan to use a handset with the transceiver, install *J3* and use taps 1 and 6 on transformer *T2* as shown on the schematic. Should the handset feature not be desired, *J3* would not be needed and a standard 3.2-ohm speaker could be substituted for the 45-ohm unit specified for the speaker; tap 1 on *T2* would remain connected as before, but the speaker would be connected between ground and tap 3.

The remainder of the construction is straightforward and needs little comment—but note that diodes *D1-D4* are mounted on a small section of perforated board. The board is installed on a pair of 1" spacers so that none of the connections will touch the chassis. Resistors *R12* and *R13* are also wired to the board (on the opposite side).

Tune-Up and Operation. Set switch *S2* to "transmit," plug in a crystal at *X1*, and connect a #47 dial lamp across *J2* as a dummy load. Now close power





Your completed 6-meter transceiver should look much like the photo above. Under-chassis view at left shows wiring of unit; care must be taken when wiring in the vicinity of V1 and S1.

switch *S1* and allow *V1* to warm up. With a VOM set to its lowest "d.c. volts" scale connected across *J1a* and *J1b* (positive to *J1b*), adjust the slug of *L1* for a dip. The "dipped" reading should range from 0.6 to 1 volt. If a wavemeter or grid-dip meter is available, check the frequency of *V1*'s output (it should be about 25 mc.).

Now connect the positive lead of the VOM (still set at the lowest d.c. volts scale) to *J1d* and the negative lead to *J1c*. With capacitor *C12* set at its minimum capacity position, adjust capacitor *C11* for a dip on the meter. If no dip is obtained, adjust *C12* so that its plates are half-meshed and try again. If you still don't get a dip with *C11*, try other settings of *C12* until you do. The "dipped" reading on the meter should be as before (0.6 - 1 volt).

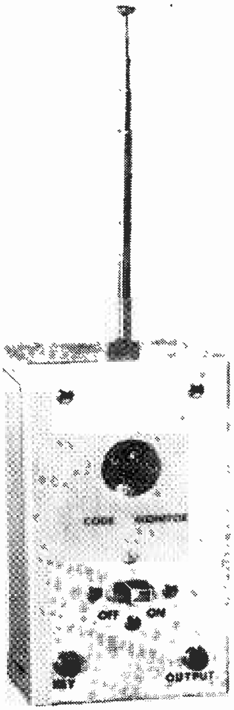
Next, adjust *C12* for maximum brilliance of the dial-lamp dummy load, continually readjusting *C11* for a dip. When maximum brilliance has been obtained, the meter reading should still be in the neighborhood of 0.6 - 1 volt. At this point, a wavemeter, grid-dip meter, or communications receiver should be used to make sure the output at *J2* is in the 6-meter band.

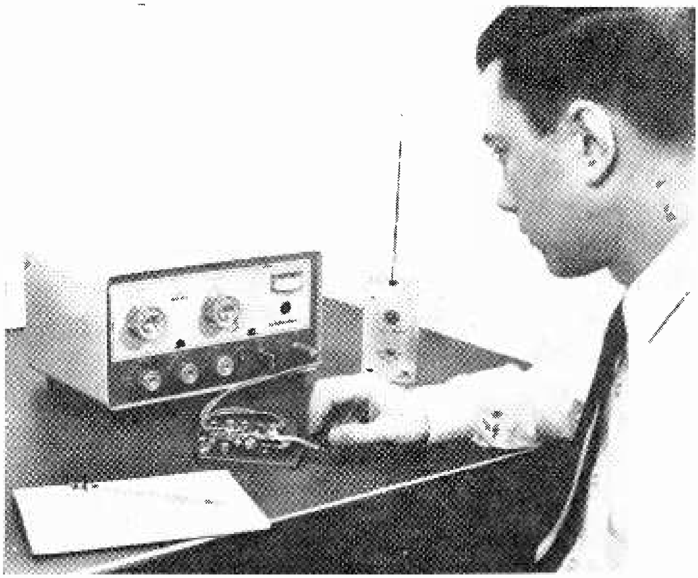
The dial lamp is now disconnected from *J2* and a 50- or 75-ohm antenna connected in its place. Retune *C11* for the dip, and the adjustment of the transmitter section is completed.

Switch *S2* to "receive" and, with regeneration control *R9* set so that you hear signals, tune capacitor *C8* through its range. The 6-meter band (50 - 54 mc.) will be found between commercial stations operating on 45 - 50 mc. and television channel 2 (54 - 60 mc.). Once you've determined that the receiver is working, tune to a weak station, set regeneration control *R9* at the midpoint of its rotation, and adjust the spacing between *L2* and *L3* for optimum reception (you may have to retune *C8* during the procedure). This will insure proper operation of *R9*.

If you would like to have provisions for bandspread tuning, install a Hammarlund MAC-5 midget variable capacitor (with all plates but one rotor and one stator removed) in parallel with *C8*. Set this bandspread capacitor to its maximum capacity and adjust *C8* to the low end (50 mc.) of the 6-meter band. Tuning through 54 mc. can now be done exclusively with the bandspread capacitor.

Finally, plug a mike into *J4* (or a handset into *J3* and *J4*), and you're ready to go on the air. And the fact that you're operating a 2-watt, 1-tube station should make enough conversation for many enjoyable QSO's. -30-





MONITOR YOUR CODE

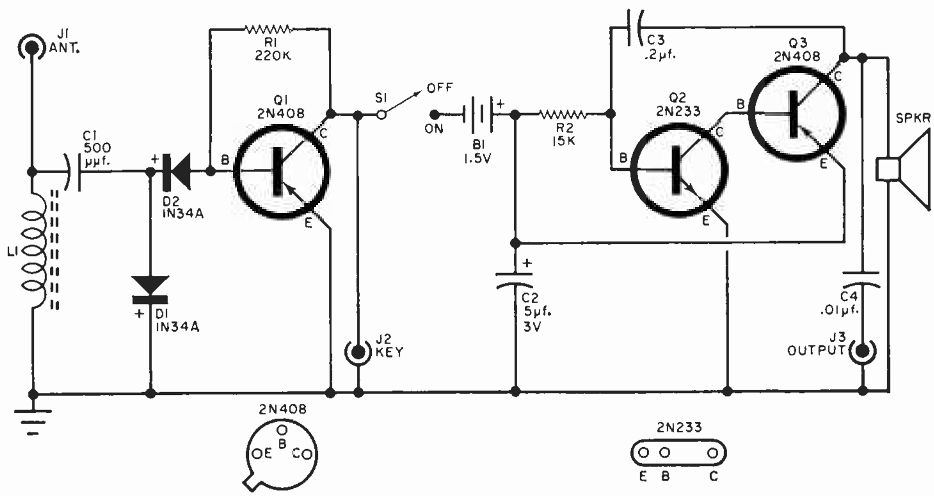
Battery-powered circuit detects c.w. signals and triggers audio tone oscillator to clue you in

By I. C. CHAPEL

THE Novice amateur who has just received his ticket often finds working c.w. a difficult chore. Reason? He probably is using his receiver to monitor his sending, and the horrible squawks issuing from the speaker make it necessary to adjust the gain controls every time he transmits. There is, however, a *painless* way to "listen to your fist" as you pound the key of your transmitter. If this is your goal, then the Code Monitor is for you.

Eavesdropping on yourself isn't the only function of the Code Monitor, though. It can help you tune up your transmitter for optimum power output, and tell you whether the keying circuits are producing a clean-cut signal. In fact, the Code Monitor can be used as a relative field strength indicator with an audio output instead of the usual meter indication. And as an extra bonus, you can plug your key into the unit and use it as a CPO to bring up your code speed or break in on a "bug."

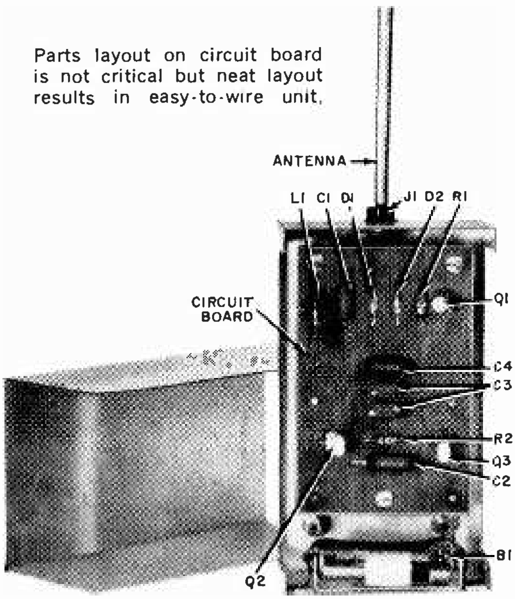
Construction. Since the circuitry for the Code Monitor isn't particularly critical, how it is put together is entirely up to you. The author elected to mount most of the components on a 2½" x 4"



Transistor Q1 serves as an electronic switch designed to close when strong r.f. signals are picked up by the antenna. Audio tone circuit (Q2 and Q3) beeps away when Q1 "closes."

PARTS LIST

B1—1.5-volt penlight battery (Burgess Type Z or equivalent)
C1—0.0005-µf., 400-volt paper or ceramic capacitor
C2—5-µf., 3-w.v.d.c. electrolytic capacitor
C3—0.2-µf., 400-volt capacitor
C4—0.01-µf., 400-volt capacitor
D1, D2 — General - purpose germanium diode (1N34A or equivalent)
J1, J2—Phono jack for front panel mounting (Switchcraft 3501FP or equivalent)
J3—Insulated banana jack (G-C Electrocraft 33-188 or equivalent)
L1—1000-µh. iron-core r.f. choke (Millen J300-1000 or equivalent)
Q1, Q3—2N408 transistor (RCA)
Q2—2N233 transistor (Sylvania)
R1—220,000-ohm, ½-watt resistor
R2—15,000-ohm, ½-watt resistor
S1—S.p.s.t. slide switch
SPKR—2¼" PM speaker, 8-ohm voice coil (Lafayette SK-190 or equivalent)
1—3" x 5¼" x 2⅛" aluminum chassis box, gray hammertone finish (Bud CU-3006-A or equivalent)
1—Battery holder for B1 (Keystone 139 or equivalent)
3—Transistor sockets
Misc.—10" antenna, 1½" spacers, 2½" x 4" phenolic or Formica sheet, self-tapping screws



Parts layout on circuit board is not critical but neat layout results in easy-to-wire unit.

Formica sheet, but a Bakelite or phenolic sheet would do just as well. The three transistor sockets were mounted at different quarters on the board to make for an uncluttered circuit layout (see photo). Holes were drilled to pass the leads from the diodes, capacitors, and resistors; these leads, in turn, were used as interconnecting leads or terminals, depending upon their lengths.

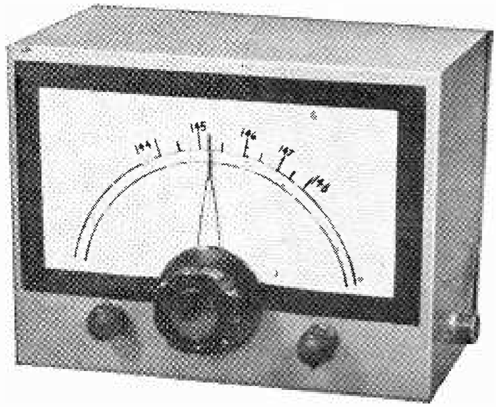
The three jacks, switch, battery holder, and speaker were mounted on the aluminum chassis. With the circuit board standing on its longer side next to the chassis, wires were connected from it to the parts on the chassis. After the wiring was completed, the circuit board was secured to the chassis on three 1½" hollow spacers.

A 10" antenna can be made from stiff
(*Continued on page* 153)

2-TUBE 2-METER SUPERREGEN

By **CHARLES GREEN,** W3IKH

Ideal for the Novice Ham, this easily built set has its own power supply, drives speaker



THIS simple 144-148 mc. receiver is a natural for Novices who want to get in some 2-meter phone operation. Both inexpensive and sensitive, it also makes a fine "extra" set for the seasoned ham.

The receiver uses two tubes (one of them dual-purpose), and has a stage of r.f. amplification, a superregenerative detector, and an audio amplifier which delivers enough power to operate a speaker. Like all VHF circuits, this one requires careful construction, but even the inexperienced builder should have little trouble if he follows directions closely.

About the Circuit. Signals from antenna jack *J1* are fed to half of a 6BZ7 dual triode (*V1a*). This triode acts as an untuned r.f. amplifier and also isolates superregenerative detector *V1b* (the other half of the 6BZ7) from the loading effects of the antenna.

Coil *L1* and capacitors *C4* and *C5* select 2-meter signals from the output of *V1a*. Capacitor *C4* is the main tuning control; *C5* serves as a "band-setting" adjustment control.

Potentiometer *R5* varies the plate voltage to *V1b*, acting as a regeneration control. The signal from *V1b* is amplified by *V2* (a 6AK6) and passes, via output transformer *T1*, to speaker jack *J2*. Potentiometer *R6*, in *V2*'s grid circuit, is the volume control.

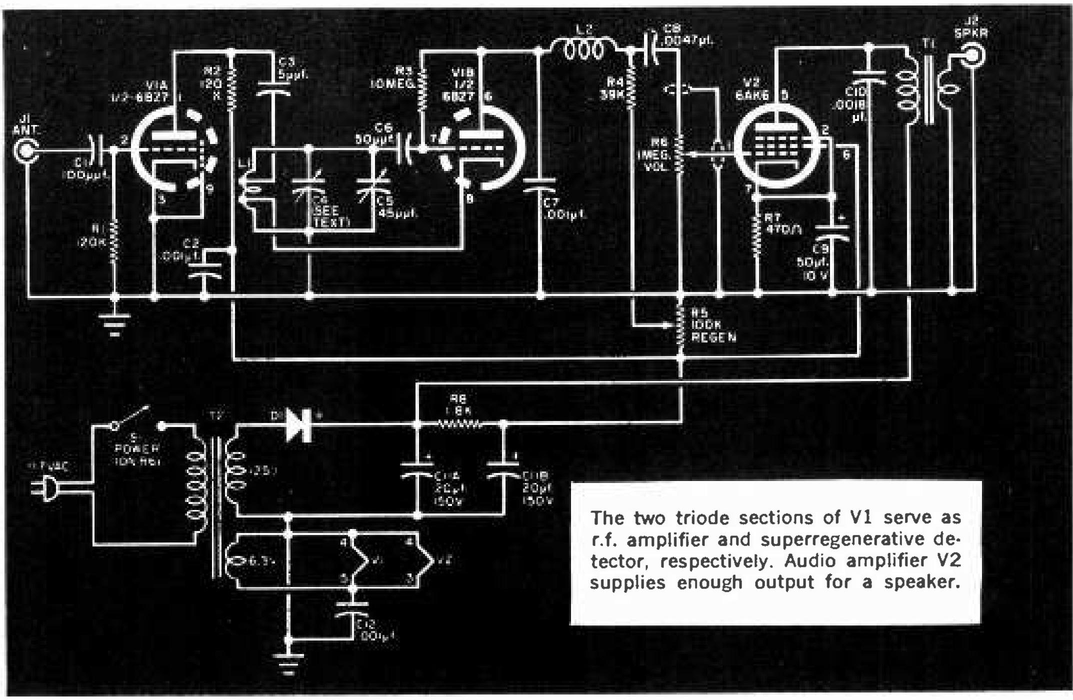
Operating voltages for the circuit are supplied by power transformer *T2*. Diode *D1* is connected as a half-wave rectifier, with capacitors *C11a* and *C11b* and resistor *R8* doing the filtering.

Construction. The receiver is housed in an 8" x 6" x 4½" utility box with most of the components mounted on an 8" x 4⅜" "shelf" made from ⅛" pegboard. Begin construction by cutting the shelf and mounting it about 2⅜" above the box bottom via a set of angle brackets (see photo of interior). Place a "box ground lug" under the mounting screw for the left rear corner of the pegboard (see pictorial diagram).

Install the components on the box and pegboard in the positions shown in the photographs and pictorial. Ground lugs must be installed under both of the mounting screws for *V1*'s socket and one of the mounting screws for *J1*, *V2*'s socket, *T1*, and *T2*, respectively.

Be sure to remove *C4*'s rear rotor plate before installation. This will change the maximum capacitance from 11 $\mu\mu$f. to the required value of about 5 $\mu\mu$f.

When carrying out the wiring, try to duplicate the layout illustrated as closely as possible. This is particularly important for the connections associated with *V1* and the tuned circuit *L1*/*C4*/*C5*. Notice that one terminal of *C5* is con-



The two triode sections of V1 serve as r.f. amplifier and superregenerative detector, respectively. Audio amplifier V2 supplies enough output for a speaker.

nected to the stator terminal of *C4* by a lead 1½" long; the other is soldered directly to the rotor terminal of *C4*. Construction specifications for coil *L1* are given in Detail A.

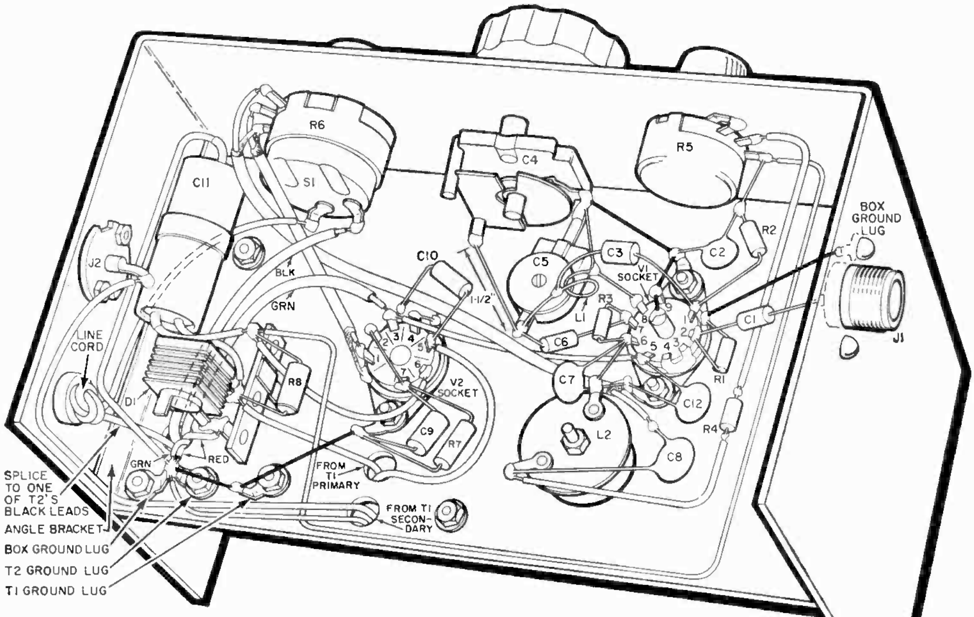
Since the circuit is built on a nonconducting surface rather than a metal chassis, the grounding arrangement is particularly important. Two ground-bus systems (the solid black wires on the pictorial diagram) are used. One runs from the "box ground lug" near *J1* to the frame of *V1*'s socket, and from there to the rotor terminal of *C4*. The other starts at the "box ground lug" at the left rear corner of the pegboard, grounds the frames of *T1* and *T2*, then runs to the frame of *V2*'s socket.

The author attached a long wire pointer to the rear of the control knob for *C4*. A dial scale was then laid out on white paper and taped to the box. If you prefer, you can use a commercial dial.

Testing and Calibration. Connect a 3-4 ohm speaker at jack *J2* and turn on the receiver. Move volume control *R6* to its "maximum" position and rotate regeneration control *R5* until you hear the typical superregenerative hiss. The posi-

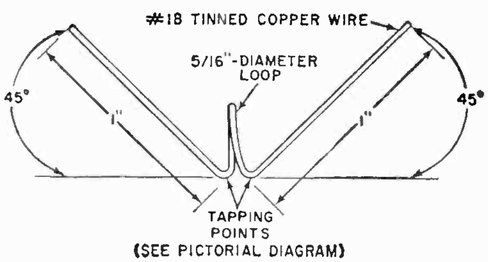
PARTS LIST

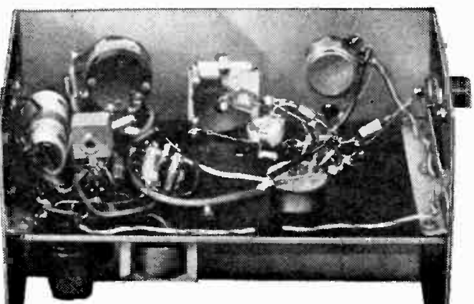
C1—100 μμf. } *1000-volt ceramic capacitors*
C2, C7, C12—0.001 μf.
C3—5 μμf.
C4—Tuning capacitor (E.F. Johnson 167-1 with rear rotor plate removed)
C5—45-μμf. ceramic trimmer capacitor (Centralab 822-BN or equivalent)
C6—50-μμf., 1000-volt ceramic capacitor
C8—0.0047-μf., 1000-volt ceramic capacitor
C9—50-μf., 10-volt electrolytic capacitor
C10—0.0018-μf., 1000-volt ceramic capacitor
C11—Dual 20-μf., 150-volt electrolytic capacitor
D1—65-ma., 380-PIV selenium rectifier (I.T.T. 1234A-II or equivalent)
J1—Chassis-type coaxial receptacle (Amphenol 83-1R or equivalent)
J2—RCA-type phono jack
L1—Tuning coil—see text
L2—100-mh. r.f. choke (J.W. Miller 960 or equivalent)
R1, R2—120,000 ohms } *½-watt resistors*
R3—10 megohms
R4—39,000 ohms
R5—100,000-ohm potentiometer
R6—1-megohm potentiometer (with switch S1)
R7—470-ohm, 1-watt resistor
R8—1800-ohm, 2-watt resistor
S1—S.p.s.t. switch (on R6)
T1—Output transformer; primary, 10,000 ohms; secondary, 4 ohms (Stancor A3879 or equivalent)
T2—Power transformer; primary, 117 volts; secondaries, 125 volts @ 15 ma., 6.3 volts @ 0.6 ampere
V1—6BZ7 tube
V2—6AK6 tube
1—8" x 6" x 4½" utility box (LMB 146 or equivalent)
1—8" x 4⅜" section of ⅛" pegboard
Misc.—Line cord and plug, knob, tube sockets, angle brackets, #18 tinned copper wire, etc.



Follow pictorial closely; parts placement and lead dress are critical.

DETAIL A





Specifications for the construction of coil L1 are given in Detail "A" (above); once the loop is formed, spread it so that distance between "tapping points" is ⅛-inch. Photo shows interior of the completed set.

tion of *R5* at which this occurs will give you highest sensitivity and may vary with the frequency to which the receiver is tuned.

Once you've established that the set is regenerating, proceed with the calibration. Ideally, the output of a signal generator should be fed to the receiver and *C5* adjusted so that the 2-meter band falls within the range of *C4*'s dial. The dial can now be calibrated using the signal generator as a reference.

If no signal generator is available, try placing another 2-meter receiver next to the one you've just built; it will pick up the radiations from the superregenerative detector, thus indicating the frequency being received at any setting of *C5* and *C4*.

In the absence of both a signal generator and extra receiver, you can locate the 2-meter band by connecting a good antenna to jack *J1* and adjusting *C5* until you pick up the greatest number of ham stations within the range of *C4*.

To operate the receiver, just set *R6* for a comfortable volume and keep adjusting *R5* to its most sensitive position as you tune across the band with *C4*. —30—

SELECTED PROJECTS from → W9EGQ

BUILD A SEMI-AUTOMATIC KEY

If you're interested in a semi-automatic speed key or "bug," here's one you can build for pennies—and it's capable of sending excellent code at speeds from 10 wpm up. Don't let the Bill of Materials scare you. The key is strictly a "junk-box special," and various spare parts can be utilized—depending on what you have on hand.

For a base, use a rectangle of Bakelite or plastic measuring 4" x 5" x ¼". This is later bolted to a 4" x 8" x ½" metal plate to keep the key from skidding across the table. The photograph shows the key's general construction, and the drilling template the hole positions.

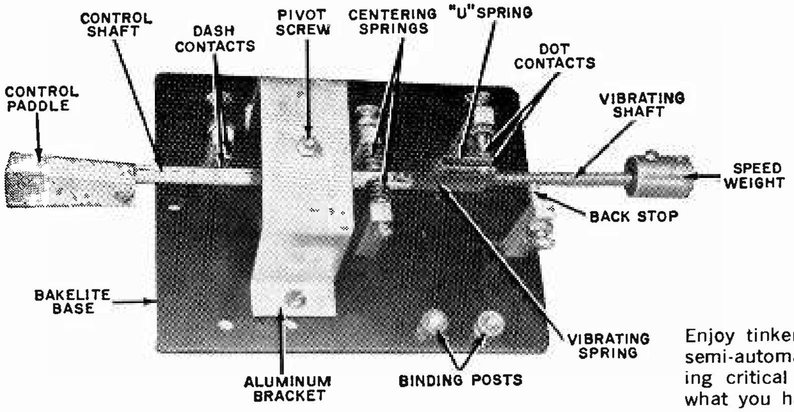
Construction. Cut the ¼" brass rod, a volume control shaft or something similar, to 3½", and drill a 7/64" hole (#35 bit) through it 1⅜" from one end. Next, file ¼" flat surfaces at each end of the rod parallel to the hole. Drill another 7/64" hole through the flat surface furthest from the first hole to fasten the control paddle to the shaft; tap both holes for *6-32* screws.

Cut a 1¼" length of spring steel approximately ⅜" wide from an old clock spring or corset stay. Cut another piece 1½" long and ⅛" wide. If necessary, you can file a wider spring to size after first heating it red-hot over a gas stove and allowing it to cool gradually. At the same time, bend this piece into a "U" with its legs approximately ⅛" apart. After shaping and filing as necessary, reheat the spring red-hot, and plunge it into cold water to restore its temper.

After cleaning both of these springs thoroughly, tin their ends with acid-flux solder (but use rosin-core solder for additional operations). Now solder one end of the 1¼" flat spring (the vibrating spring) to the ¼" brass rod, and the other end of the spring to a 2¾"-long, 3/16"-diameter brass rod (a #10 brass machine screw can be used). Keep the three pieces in a straight line during this operation.

Solder a contact to one side of the "U"-shaped spring, and then solder the other side of this spring to the side of the 2¾" brass rod (machine screw) opposite the vibrating spring.

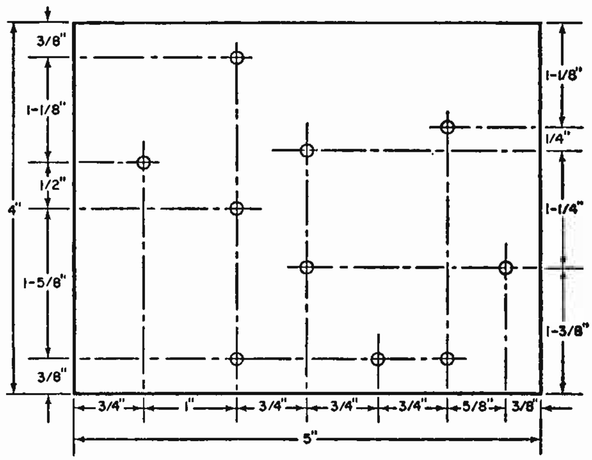
Mounting the Parts. Bend a 6½" x 1" piece of #12 or #14 aluminum into a 2" x 1¾" "U" bracket with ½" mounting feet, and mount it as shown. Now, insert



Enjoy tinkering? Try building this semi-automatic key. There's nothing critical about the parts—use what you have on hand. Properly built and adjusted, the key is capable of good c.w. from 10 wpm up.

BILL OF MATERIALS

- *1—3½″x¼″ brass rod (Centralab AK-21 volume control shaft or equivalent)*
- *1—2¾″ x 3⁄16″ brass rod (#10 brass machine screw)*
- *1—⅜″ to ¼″ brass shaft reducer*
- *2—Lengths of flat spring steel—see text*
- *2—⅝″ x ¼″ centering springs*
- *5—1¼″ x ¼″ square metal pillars*
- *4—Contacts—see text*
- *1—6½″x1″ strip of #12 or #14 gauge aluminum*
- *1—4″ x 5″ x ¼″ Bakelite (or plastic) base*
- *1—4″ x 8″ x ½″ metal plate*
- *1—Control paddle cut from a piece of ¼″ plastic*
- *1—2½″ x 6-32 machine screw*
- *2—Binding posts*
- *Misc.—Assorted 8-32 and 6-32 machine screws and nuts, solder lugs, wire*



a 2½″-long *6-32* machine screw through the center hole in the "U" bracket, through the threaded hole in the ¼″ brass control shaft, and out through the matching hole in the Bakelite base. This screw acts as a pivot for the control shaft. Turn it until the control shaft is centered on it, and then anchor it in place with a nut.

The ¼″-square metal pillars that support the key's various adjusting screws and fixed contacts were salvaged from an old surplus TU-5 tuning unit, cut to a length of 1¼″, and drilled and tapped to accommodate the mounting and adjustment screws. Similar items can be found in most spare parts boxes.

The four contacts (two for dots and two for dashes) can be salvaged from an old relay or cut from a small (foreign) silver coin. Solder the contacts to the key where indicated (see photo), aligning them carefully. Connect the two fixed contacts on the pillars to one input binding post, and the other post to the key's center pivot screw to complete the wiring.

Finally, screw the plastic control paddle to the control shaft. For a speed weight, place a ⅜″ to ¼″ shaft reducer on the vibrating shaft (the #10 brass machine screw). For the centering springs, which are positioned on *8-32* bolts as shown, you can use the coil springs from old battery clips. The coil springs should measure ⅝″ x ¼″.

Adjustment. Set the back stop so that it just touches the vibrating lever and vary the other adjustment bolts until a string of eight to ten dots is formed when the control paddle is pushed to the right, and dashes can be formed manually by pushing it to the left. If you wish, try different centering springs to give the key exactly the "feel" you like. Then start practicing!

50 - 100 WATT DUMMY LOAD

Have you ever wondered, after spending an evening sending out unanswered CQ's, whether your transmitter was still delivering its rated power output? If so, you probably touched up the transmitter's tuning "just in case," and hoped for the best. However, with the calibrated dummy load described here, you can quickly resolve all doubts by actually checking your transmitter's output —either by observing the brightness of the relative-power indicator lamps, or by plugging a 1-ma. meter into the meter jack.

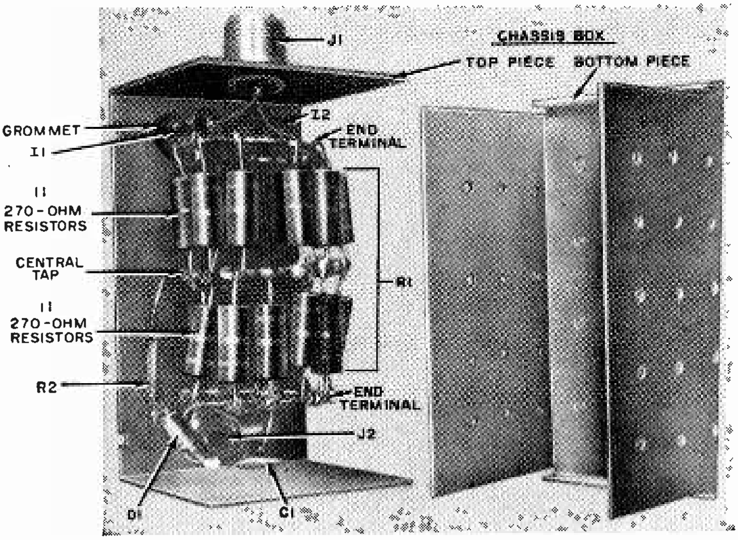
The dummy load will handle 50 watts (the nominal output of a 75-watt transmitter) for extended periods and up to 100 watts long enough to take a power reading. In addition, its 51-ohm resistance matches the rated output impedance of most modern ham transmitters, and it makes an excellent standard for checking the operation of 50- to 52-ohm SWR bridges.

Construction. Start by drilling holes in the chassis to mount jacks *J1* and *J2*, and to accommodate two ½″ grommets that will seat relative-power indicator lamps *I1* and *I2*. (See photo below.)

Take three lengths of #14 solid copper wire with the insulation stripped off, and make three wire loops about ½" in diameter. Between two of the loops, connect 11 of the 270-ohm, 2-watt resistors, spacing each evenly as staves on a barrel, and solder them in place. Connect the remaining 11 resistors to the third loop and to one of the loops already supporting the first 11 resistors. Evenly space the second batch of resistors, as before, and solder them in place.

PARTS LIST

C1—0.002-µf., 600-volt disc capacitor
D1—1N34A diode (or equivalent)
I1, I2—2.5-volt, 0.5-amp pilot lamp (GE #43 or equivalent)
J1—Coaxial connector, UHF type (Military Type SO-239A, Amphenol 83-798, or equivalent)
J2—Phone jack, open-circuit type (Switchcraft Type 11 or equivalent)
R1—49-ohm resistor network, made from 22 270-ohm, 2-watt composition resistors—see text
R2—10,000-ohm, ½-watt resistor
1—4¼" x 2¼" x 2¼" aluminum chassis box (Bud CU-2116-A or equivalent)
Misc.—½" rubber grommets (2 required), 20" length of #14 solid copper wire, screws, etc.



Completed dummy load should be checked carefully for shorts before closing chassis box—especially between the chassis box bottom piece and resistor network R1.

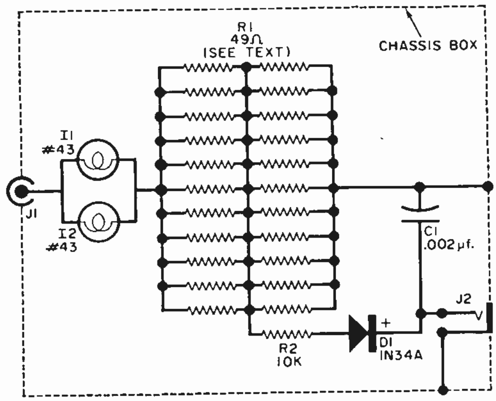
Combined resistance of 22 resistors making up R1, and lamps I1 and I2, provides adequate impedance at the input jack, J1, to match 50-to-52 ohm transmitter outputs.

The resistor network thus assembled is *R1* (see schematic diagram and photo). It has three terminals, each one located at a wire loop, and its resistance is 49 ohms measured at the end terminals.

Pre-tin the indicator lamp bases and insert the lamps into the rubber grommets—a drop of cement will prevent their dropping out. Then mount *J1* and *J2*.

Now wire the unit as indicated in the schematic diagram. Do a neat job and keep the leads to the components short since a lot of r.f. will be pouring into the dummy load. Avoid damage to diode *D1* when soldering it in place by grasping its leads with heat sinks or pliers while soldering.

Finally, drill 15 evenly spaced ¼" holes in each of the three sides of the chassis to vent the unit. Then assemble the top and bottom pieces of the chassis box with the self-tapping screws supplied.



You can check the unit's resistance by connecting an ohmmeter between the center terminal on *J1* and the chassis.

The total resistance should be about 51 ohms, due to the resistance of *R1* plus the parallel resistance of *I1* and *I2*.

Operation. Connect the dummy load to your transmitter via a short length of 50- to 53-ohm coaxial cable, and tune the transmitter in the normal manner. At 50 watts, the relative-power indicator lamps will glow normally; at 5 watts, they will glow dimly. A 1-ma. meter plugged into meter jack *J2* should read 0.6 ma. at 50 watts (approximately), 0.42 ma. at 25 watts, 0.27 ma. at 10 watts, and 0.19 ma. at 5 watts.

"SHORTENED" VERTICAL ANTENNA

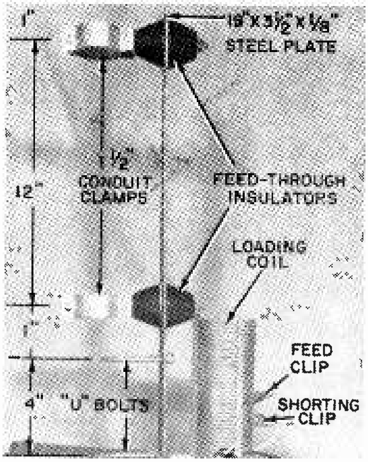
Although it's just 18½′ tall, the compact vertical antenna featured this month compares well with a full-sized version. Assuming that a good ground is used, the radiated signal will be down only about 1½ "S" units on 80 meters and about ½ "S" unit on 40 meters. There will be no loss on 20, 15, or 10 meters.

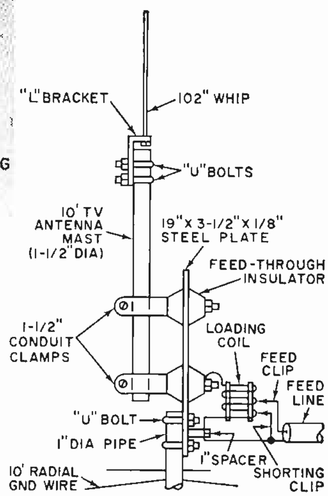
Construction. Drill mounting holes in the 19″ x 3½″ x ⅛″ steel plate (see photograph) for the two feedthrough insulators. These are centered on the short dimension of the plate; one is positioned 1″ from the top, the other 12″ below the first. Then mount two "U"-bolts below the second insulator hole as shown.

Also drill a hole for a #10 brass bolt near the bottom of the plate. The bolt will support and ground the bottom of the loading coil. Cut from B&W 3905-1 "Miniductor" stock, the 40-turn coil is 2½″ in diameter and wound of #12 wire (six turns per inch).

Install the feedthrough insulators in the plate and mount a 1½″ conduit clamp on each insulator as illustrated. Run a 2″-long, #10 bolt through the hole made for that purpose, slip a 1″-long spacer and a couple of solder lugs over the end of the bolt, then secure the assembly with a brass nut. The loading coil is installed between one of the solder lugs and a terminal of the bottom feedthrough insulator.

A real space saver, this vertical antenna performs well on 10 through 80 meters. Base assembly is seen in close-up at right; complete antenna appears in diagram. Watertight housing for coil is desirable, but not necessary.





BILL OF MATERIALS

1—102″ whip antenna (Antenna Specialists M-3B or equivalent)
4—"U"-bolts (TV antenna-mast type)
1—10′ length of 1½″-o.d. aluminum TV mast
2—1½″ conduit clamps (available at electrical supply houses)
1—19″ x 3½″ x ⅛″ steel plate (Par-Metal 6601 rack panel, or equivalent)
2—Feedthrough insulators (E. F. Johnson 135-52 or equivalent)
1—40-turn section of B&W 3905-1 "Miniductor" stock
2—Copper alligator clips
Misc.—#10 brass bolt 2″ long, #10 brass nut, 1″ spacer, solder lugs, wire for radial ground leads, 12- or 14-gauge sheet iron for "L"-bracket, etc.

Slip one end of a 10′ length of 1½″-diameter TV antenna mast through the conduit clamps just installed and tighten them. Now form a 3½″-wide "L"-bracket, with one 1½″ side and one 6½″ side, from 12- or 14-gauge sheet iron. Mount a 102″ (CB-style) whip antenna on the 1½″ side and clamp the 6½″ side to the free end of the 10′ mast with "U"-bolts.

Installation and Adjustment. Drive a 10′ (or longer), 1″-diameter pipe into the earth—leaving the last eight inches exposed. Attach six to twelve ground wires, each at least 10′ long, to the pipe, extend them out radially (like spokes of a wheel), and bury each one at least six inches into the ground.

Clamp the antenna assembly to the pipe, using the "U"-bolts provided. Then ground the shield of your coaxial feed line, as well as one end of a 6″ shorting lead, to the solder lug at the base of the loading coil. Copper alligator clips are now attached to the other end of the shorting lead and to the center conductor of the coaxial feed line.

The exact placement of the two clips on the loading coil varies with frequency and must be determined by means of a standing-wave ratio bridge inserted in the feed line at the transmitter. Pick the frequency closest to your operating frequency from the table below and set the clips to the positions indicated, then readjust them for minimum SWR.

Frequency *(kc.)*	**Feed Clip** *(turns from*	**Shorting Clip** *bottom of coil)*
3725	8½	3½
7175	30½	22½
14175	37½	29½
21150	36½	32½
28700	32½	28½

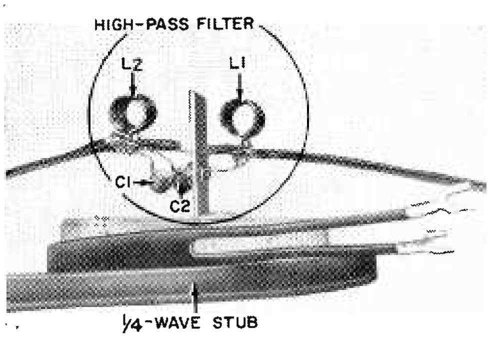
SIMPLE TVI FILTERS

If your transmitter interferes with a nearby TV receiver every time you go on the air, one of the simple TVI filters described here should help take you out of the public eye. The high-pass filter will cope with interfering signals in the 10-meter band and below, while a quarter-wave stub should take care of 6- and 2-meter interference.

High-Pass Filter. The filter shown in the schematic (p. 104) is designed to be installed in the feed line of a TV receiving antenna. It will pass TV signals but attenuate signals below 30 mc. at least 20 db.

The filter components are supported by an "L"-shaped bracket which also provides shielding between coils *L1* and *L2* (see photo). This bracket is formed from a 1½″ x 2½″ piece of stock aluminum, but the dimensions are not critical. Two 2-lug terminal strips, one located on each side of the bracket, are mounted with a single screw. And a ½″ hole drilled near the terminal strips passes the leads from capacitors *C1* and *C2*.

To prepare coils *L1* and *L2*, measure off two 25″ lengths of #18 enameled wire. Remove approximately ¼″ of enamel insulation from the center of one length



and solder on a short piece of #28 or #30 wire to serve as a center tap for *L2*.

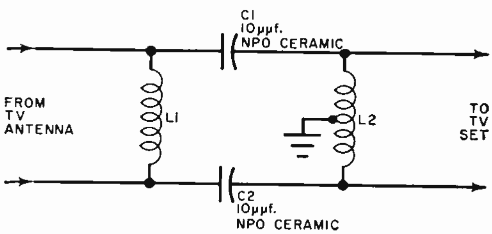
From each of the 25″ lengths of wire, make a 20-turn, close-wound coil. Use a ⅜″-diameter drill shank, or any convenient rod having similar dimensions, as a form. Leave a ¾″ lead at each end of each coil; before trimming *L2*'s leads, however, accurately position its center tap by winding or unwinding a fraction of a turn at the ends.

Mount each coil on a terminal strip, grounding *L2*'s center tap to the bracket and connecting *C1* and *C2* as shown on the schematic. Wire in a short length of 300-ohm twin-lead to serve as the filter's output connection.

To install the filter, mount the bracket directly on the chassis of the TV set being interfered with (as close to the tuner section as possible). Disconnect the antenna lead-in at a point close to the tuner and wire it across *L1*. The filter output lead should now be wired to the tuner in place of the disconnected lead-in.

Quarter-Wave Stubs. Interference from 6- or 2-meter signals can often be reduced by connecting a quarter-wave stub (at the interfering frequency) of 300-ohm twin-lead across the antenna terminals of the TV set. The normal connections from the TV antenna are, of course, left undisturbed.

The length of the stub can be calculated from the formula: $L = 2420/F$, where L is the length in inches, and F is the interfering frequency in megacycles. For an interfering frequency of 50 mc., for example, the length would be 48.4 inches.



Quarter-wave stub and high-pass filter pictured on p. 103 are simple devices for fighting TVI. Stub eliminates 6- and 2-meter interference, filter is designed for 10 meters and below. Circuit of filter couldn't be simpler, as shown in schematic above.

For best results, cut the stub slightly "long," connect it to the TV set, and trim off ¼" pieces from the end until you reach a point of minmum interference. A word of caution, though. Don't trim a six-meter stub too short, or you may spoil reception on Channel 2.

SIX-BAND NUVISTOR BOOSTER

If you own an old or inexpensive ham receiver, you already know that their two common disadvantages are low gain and poor signal-to-noise ratio on the higher frequency bands. Adding this home-brew tuned r.f. booster with band-switching won't make a $500 receiver out of an "old dog," but it *will* put new "zip" into any receiver suffering from these drawbacks.

The new RCA 7587 nuvistor tetrode insures high gain and high signal-to-noise ratio over the booster's entire tuning range, making it useful all the way from 80 to 6 meters. For that matter, a selector switch setting can be "designed in" to extend coverage to the broadcast band, if desired.

Construction. In the model shown at right, all components except coil *L3* are mounted on the "frame" of a 4" x 4" x 2" aluminum utility box. (Although *L3* is mounted alongside this unit, it would be a better idea to support it on a bracket screwed to the bottom of the box.) The construction technique used makes it easy to reach all parts from either side of the box, in spite of the booster's compactness.

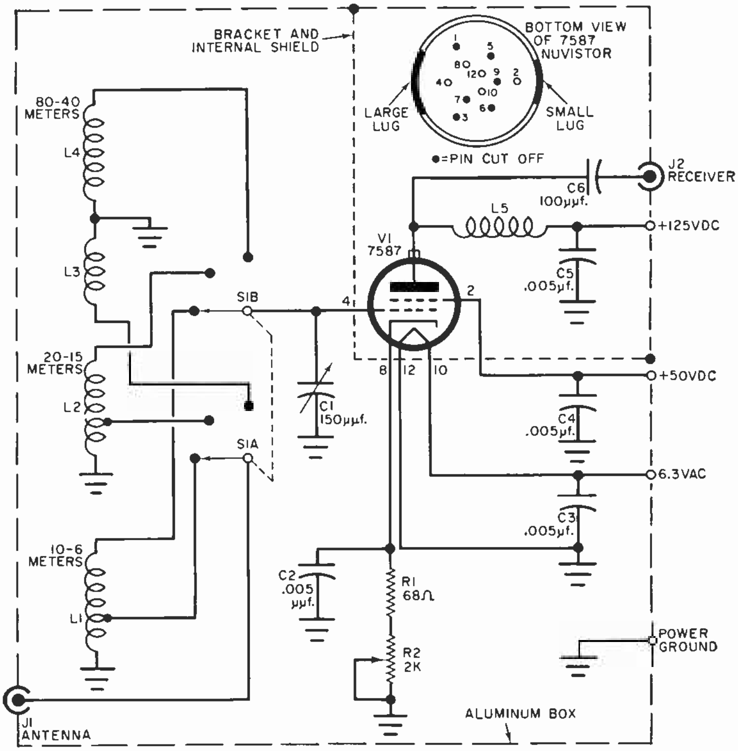
Exact parts placement isn't critical as long as leads are kept short, but it's a good idea to keep the bottom rear quarter of the box free of parts to accommodate a simple power supply. An appropriate power supply unit is described on p. 106 for those who prefer not to obtain the booster's power from the receiver.

The bracket used to support the nuvistor socket also serves as an internal shield to isolate the booster's output circuit from the remainder of the unit. It is made from a 3½" x 1¾" aluminum sheet, bent in half along its shorter dimension to form a right angle. Two ¼" mounting lips are bent at each end, as shown in the photo.

Coils *L1* and *L2* are "air-wound" for highest efficiency; coils *L3* and *L4* are slug-tuned for compactness. The input signal is fed into coils *L1* and *L2* via a tap on each one, but additional input winding (coil *L4*) is placed on coil *L3*; a few drops of cement will hold this winding in place. (Refer to the Parts List for additional coil data.)

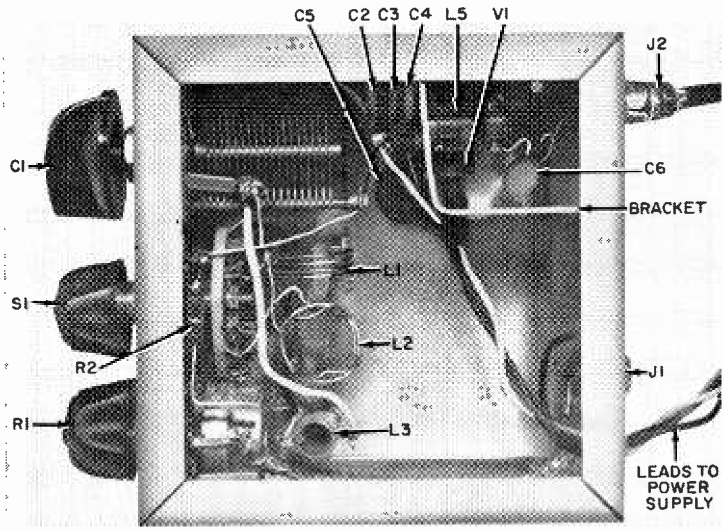
Operation. Connect the booster's heater and plate supply terminals to a suitable power supply. Connect its output jack (*J2*) to the receiver's antenna/ground terminals through a length of RG-58A/U coaxial cable. Although a length under 12" is recommended for highest gain on the 50-mc. band, cables up to five feet long can be used without too much loss.

Set the receiver and booster band switches to the desired frequency range, and advance the booster's gain control, *R2*, full on; then, tune in a signal on the receiver dial, and peak capacitor *C1* for



Nothing more than a tuned-grid r.f. amplifier, the multi-band booster uses a low-noise nuvistor to pep up those DX signals.

Bracket used to mount V1 socket also serves to isolate plate circuit coupling components from remainder of booster circuit.



PARTS LIST

C1—150-µµf. midget variable capacitor (Hammarlund HFA-140A or equivalent)
C2, C3, C4, C5—0.005-µf., 600-volt ceramic disc capacitor
C6—100-µµf., 600-volt ceramic disc capacitor
J1, J2—RCA phono jack
L1—4 turns of B&W 3003 "Miniductor" coil stock or equivalent (½"-diameter, 16 turns per inch) tapped 1¼ turns from ground end
L2—10 turns of B&W 3003 "Miniductor" coil stock or equivalent (½"-diameter, 16 turns per inch) tapped 2¼ turns from ground end
L3—10-25 µh. adjustable r.f. choke (Miller 4205, Stancor RTC-9105, or equivalent)
L4—10 turns of #30 enameled wire close-wound ⅛" below L3 on same coil form
L5—50-µh. r.f. choke (National R-33, Millen 34300-50, or equivalent)
**L6—120-330 µh. adjustable r.f. choke (Miller 4208, Stancor RTC-9107, or equivalent)*
**L7—15 turns of #30 enameled wire close-wound ⅛" below L5 on same coil form*
R1—68-ohm, ½-watt resistor
R2—2000-ohm potentiometer
S1—Double-pole, 3-position rotary switch (make from Centralab 2003 or equivalent)
V1—7587 nuvistor (RCA)
1—4" x 4" x 2" aluminum utility box (Bud AU-1083 or equivalent)
1—Nuvistor socket (Cinch-Jones 133-65-10-001)
Misc.—Knobs, wire, RG-58/AU coax cable, plate cap terminal, etc.

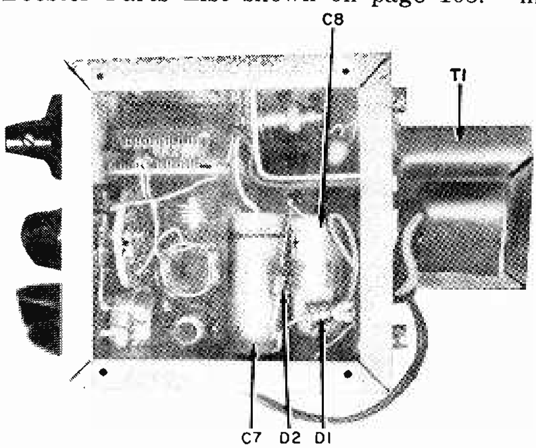
**Optional broadcast-band coils*

maximum signal strength, retarding gain control *R2* as necessary to prevent receiver overloading. Set coil *L3*'s slug to place 3500 kc. near maximum capacitance on capacitor *C1* and 7300 kc. near minimum. Now you are set up to pull in those weak ones.

Coils *L2* and *L1* for the 20-15 meter bands and the 10-6 meter bands, respectively, may need some pruning to put them right on the bands you want. But before cutting off any wire, reposition the coil slightly—the change in stray capacitance to ground may do the job.

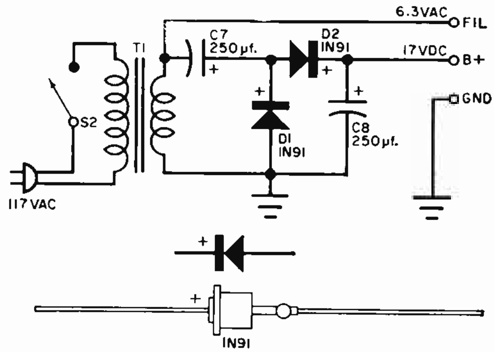
17-VOLT BOOSTER POWER SUPPLY

Originally, the booster circuit specified 125 volts d.c. for the plate and 50 volts d.c. for the screen. However, it was discovered that only 17 volts was adequate for both plate and screen with this circuit. The schematic diagram above shows how the 17 volts is obtained, and the Parts List is a continuation of the Booster Parts List shown on page 105.



It's no problem at all to fit the parts for the 17-volt power supply into the 6-band nuvistor booster. Schematic above shows how voltage-doubler rectifier circuit converts 6.3 volts a.c. to 17 volts d.c.

Two diodes, *D1* and *D2*, and two husky electrolytic capacitors, *C7* and *C8*, serve as a voltage doubler/rectifier to convert the 6.3-volt a.c. output of filament transformer *T1* to the required 17 volts d.c. Double duty is obtained from *T1* in this circuit, since its output also powers the heater of the nuvistor. Power switch *S2* needn't necessarily be mounted on the



booster's chassis; your shack setup will determine if this is advisable.

All the power supply parts fit nicely into the booster's aluminum box with the exception of transformer *T1*, which is mounted out of sight on the rear surface. Exactly how you wire the power supply in the booster is up to you, but the accompanying photo shows you how it was done in the original unit.

With the wiring completed, you're all set to tie into the receiver's antenna terminal.

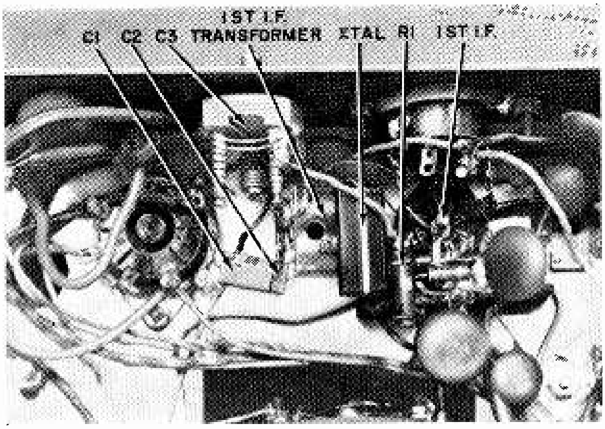
PARTS LIST

C7, C8—250-µf., 25-w.v.d.c. electrolytic capacitor
D1, D2—1N91 diode (or equivalent)
S2—S.p.s.t. toggle switch
T1—Filament transformer; primary, 117 volts; secondary, 6.3 volts @ 0.6 amp (Stancor P6465 or equivalent)
Misc.—Line cord and plug, 2-lug terminal strip, wire, solder, etc.

RECEIVER CRYSTAL FILTER

All hams are familiar with the use of a quartz crystal to control the frequency of an oscillator. Comparatively few, however, realize that the characteristics that make a good frequency controller—high *Q* and excellent electromechanical stability—can also be applied in a simple crystal filter to increase the selectivity of a ham receiver. The accompanying diagram shows an effective filter of this type which can be installed in any receiver with a 455-kc. i.f. amplifier; the photo shows the modification carried out on a Heathkit AR-3.

The filter consists of a readily avail-

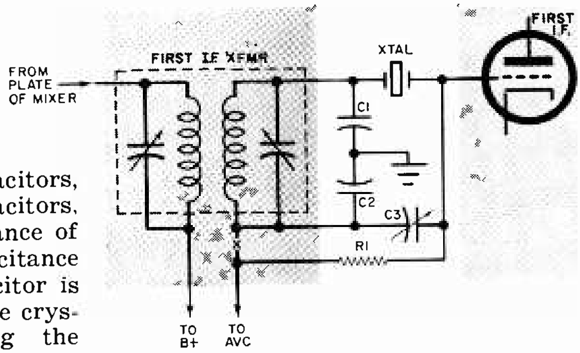


Circuitry of crystal filter as installed in a Heathkit AR-3 receiver. Both rotor and stator of C3 must be left ungrounded.

ADDED PARTS

- *C1, C2—47-μμf. ceramic capacitor*
- *C3—10-μμf. midget variable capacitor (E. F. Johnson 15M11 or equivalent)*
- *R1—470,000-ohm, ½-watt resistor*
- *Xtal—455-kc., ± 0.05% quartz crystal (Texas Crystal TX455 or equivalent)*
- *1—Crystal socket (Texas Crystal SSO-1 or equivalent)*

Schematic diagram shows how filter circuit (white area) is wired between secondary of first i.f. transformer and grid of following tube.



able 455-kc. crystal, three capacitors, and a ½-watt resistor. The capacitors, *C1*, *C2*, and *C3*, plus the capacitance of the crystal holder, form a capacitance bridge. When the variable capacitor is set to equal the capacitance of the crystal holder (thereby "balancing the bridge"), there is no output from the circuit. Now, when a frequency equal to the series-resonant frequency of the crystal is applied to the bridge input circuit, there is an output. Signals at this frequency are passed by the crystal to the first i.f. amplifier tube with little attenuation; but, because of the crystal's very high *Q*, the passband of the filter is not much more than a few hundred cycles wide.

A few construction hints may be helpful, although the photo and diagram are self-explanatory.

Construction. After you break the connection between the secondary of the first i.f. transformer and the grid of the first i.f. tube, solder the junction of one side of *C1* and one side of the crystal to the part of the broken lead going to the first i.f. transformer. To the lead from the first i.f. tube, solder the junction of the other side of the crystal and one side of *C3* and *R1*.

A similar procedure is followed with the wire connecting the other side of the first i.f. transformer secondary and the a.v.c. circuit. Break this connection and solder the junction of *C2* and *C3* to the transformer side of the broken lead. The remaining end of *R1* is now soldered to the a.v.c. side of the broken lead. Connect the remaining leads from *C1* and *C2* to ground, and that's it.

In mounting capacitor *C3*, be careful not to ground either its rotor or stator terminal. Since adjustment of *C3* varies the shape of the filter's selectivity curve, it is helpful—but not absolutely necessary—to mount this capacitor where it is easy to reach. In the installation shown, the capacitor was mounted in the hole previously occupied by the Q-multiplier jack.

The crystal seen in the photo has solder terminals, but crystals mounted in standard FT-243 holders work equally well.

Adjustment and Operation. To adjust the receiver, set capacitor *C3* approximately ¾ open and tune in a broadcast station or other steady signal. While keeping the incoming signal at a very low level with the receiver's r.f. gain control, adjust the i.f. transformers for maximum output. Now, set capacitor *C3* for maximum receiver selectivity and touch up the i.f. transformers again.

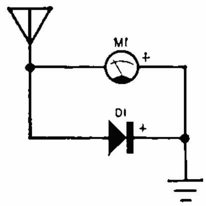
When the set is operated with the crystal filter in the circuit, signals occupy a fraction of the space on the receiver dial that they would otherwise occupy—with a corresponding decrease of interference if the bands are crowded. You'll notice that the filter reduces the receiver gain a little, but the reduction isn't serious, unless the gain was "marginal" to begin with. You may, if you wish, bend over a corner of one of capacitor *C3*'s rotor plates to disable the filter when *C3* is fully meshed.

SIMPLE FIELD STRENGTH METER

With a low-range d.c. milliammeter, a general-purpose miniature diode, and a short length of stiff copper wire, you can build a field strength meter and r.f. "sniffer" combination. A device such as the one shown in the diagram above (it was originally built by Neil Barry, W9SNF) comes in mighty handy around the ham shack. In operation, the wire acts as a pickup antenna for the r.f. signal, which is rectified by the diode, and the resulting d.c. causes the meter pointer to deflect.

Connect diode *D1* (a 1N34 or equivalent) directly across the milliammeter (*M1*) in a cabinet and connect a 20″ length of No. 12 copper antenna wire to either terminal of the meter. Be sure to bend a small closed loop, about an inch long, at the top end of the wire to prevent injury from the sharp end; the equivalent length of the antenna is now 19 inches.

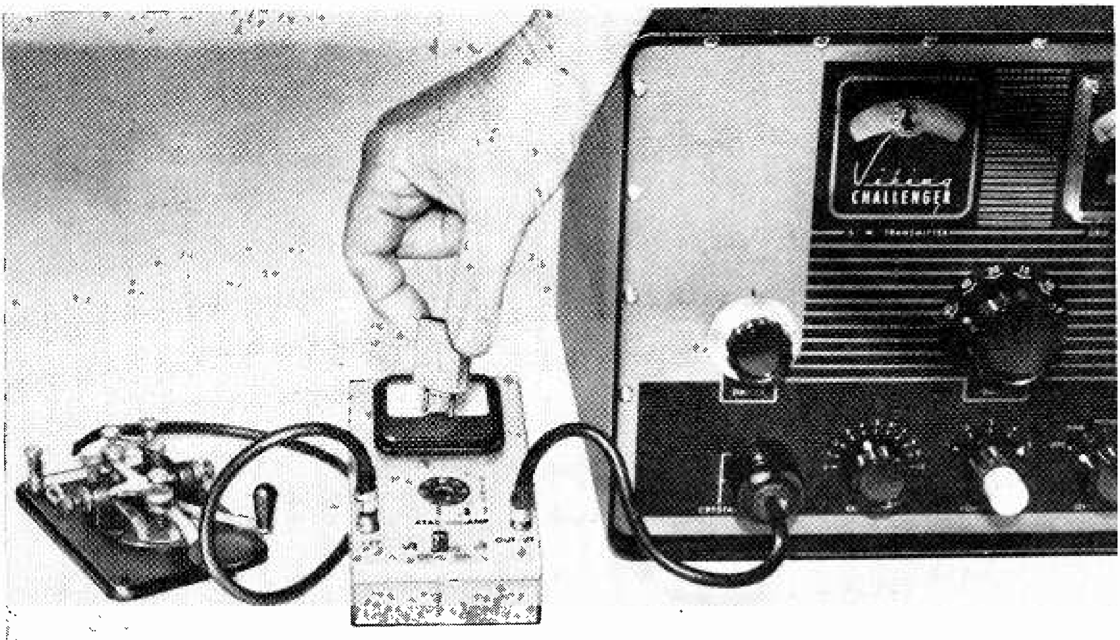
If your transmitter, like our 2-meter job, cannot readily be seen from the operating position, you can place the field



Simple field strength meter can be constructed by paralleling a diode across a low-range d.c. milliammeter (observing polarity) and connecting an antenna to one side and a ground to the other.

strength meter where *it* is visible and will indicate whether or not the transmitter comes on the air when the transmit button is pushed. The 2-meter rig is the reason for the 19″ wire (one-quarter wavelength). Longer lengths of wire give greater signal pickup on the lower frequencies, but there is usually enough r.f. energy around the shack with even a low-power, 80-meter transmitter to obtain a good meter deflection with a 19″ length, especially near the transmitting antenna's feedline.

Used as an r.f. "sniffer" and tuning or neutralizing indicator, the unit will show the presence or absence of r.f. in various sections of a transmitter, to help determine whether the corresponding circuits are functioning properly. Since the copper antenna can be bent into different shapes and straightened again, almost any point in the transmitter can be reached.



Preamplifier for "Lazy" Crystals

By I. C. CHAPEL

SOMETIMES construction projects are "born of necessity." In this case, the author had some 40- and 80-meter quartz crystals which were known to be good but which just would not excite the oscillator tube of his transmitter. And so this little "preamp" was designed to make use of them.

The unit is actually an oscillator circuit in its own right. But it imposes a lighter-than-usual load on the crystal—a circumstance that will allow even the "laziest" of crystals to oscillate.

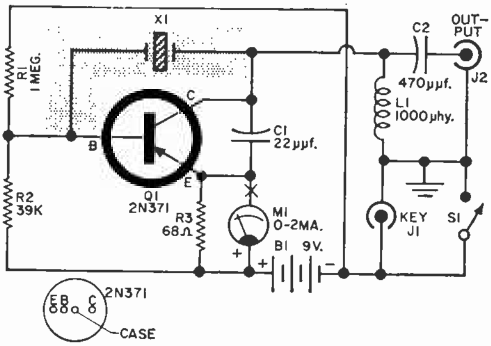
When you're not using the preamp with your transmitter, you can press it into service as an end-of-band marker for your receiver or even as a code-practice oscillator (see "Operation" section).

Construction. The oscillator circuit is housed in a 5½" x 3" x 1¼" aluminum utility box. Mount the parts as shown in the pictorial diagram and photos. Wiring is not critical, but it's a good idea to keep all leads as short as possible.

Note that an octal socket serves both as a socket for an FT 243-type crystal (pins 1 and 3) and as a 4-lug terminal strip (pins 2, 4, 5, and 6). You might want to seal up the openings except for pins 1 and 3, with glue to prevent accidental insertion of the crystal in the wrong place. Crystals with other than FT 243-style pin spacing can be accommodated by using adapters.

Meter *M1* is a 0-2 ma. unit the author had in his spare parts box. A 0-1 ma. meter can be used instead if you insert a 470-ohm resistor (½ watt is fine) in series with it at the point marked "X" on the schematic diagram. The meter serves only to indicate whether the crystal is oscillating and to measure its relative activity—so the calibration isn't important.

No transistor socket is used, and it will pay you to employ a heat sink while soldering *Q1*'s leads in place. Though a



Meter M1 will read approximately mid-scale when crystal X1 (gray area) causes circuit to oscillate.

PARTS LIST

B1—9-volt battery (Burgess 2U6 or equivalent)
C1—22 μμf. } *ceramic or mica capacitors,*
C2—470 μμf. } *voltage not critical*
J1, J2—RCA-type phono jack
L1—1000-μh. r.f. choke (Millen J300-1000 or equivalent)
M1—0-2 ma. meter (or 0-1 ma. meter with 470-ohm resistor—see text)
Q1—2N371 transistor (RCA or Sylvania)
R1—1 megohm
R2—39,000 ohms } *½-watt, 10% resistors*
R3—68 ohms
S1—S.p.s.t. switch
X1—80- or 40-meter crystal to be "preamplified"
1—5½" x 3" x 1¼" aluminum utility box (LMB 139 or equivalent)
Misc.—Octal socket, battery connector, cables for output and key, etc.

2N371 transistor is specified for *Q1*, the circuit was tested satisfactorily with both a 2N372 and a 2N374. Either of the latter two types will do the job.

Operation. Just run a cable from jack *J2* to the VFO input of your transmitter, plug the "lazy" 40- or 80-meter crystal into pins 1 and 3 of the octal socket, and turn on *S1*. An indication on *M1* means that the crystal is oscillating properly.

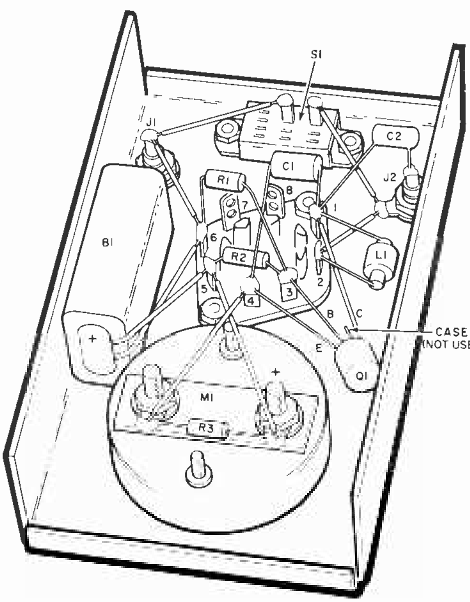
Now, tune up your rig as usual, and you're ready to transmit. For CW operation, open *S1* and plug your key into *J1*.

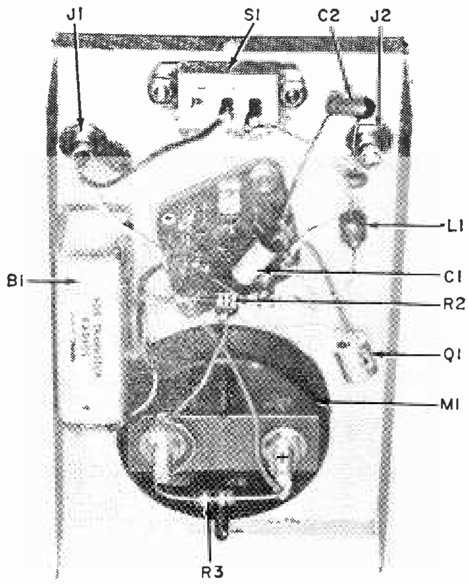
The preamp should supply plenty of drive with the 9-volt battery specified. If it does not, the voltage can be increased to 12 or 13 volts without harming the transistor.

Though no "on-off" switch, as such, is provided, the drain on *B1* is only a few microamps with *S1* open. Therefore, the battery can be left permanently connected, and you won't have to worry about running it down. The drain with *S1* closed is on the order of 10 ma.

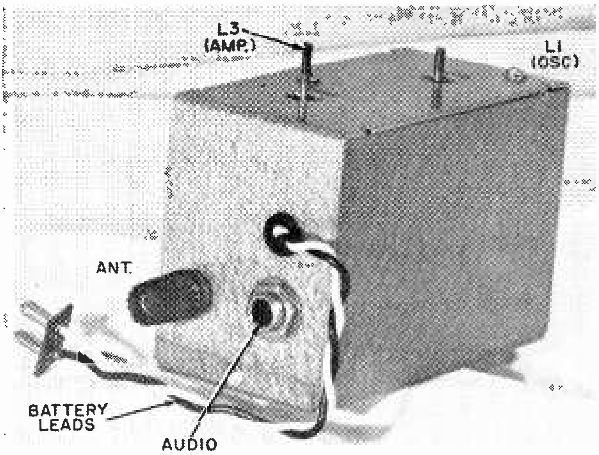
To use the preamp as an end-of-band marker, just insert a crystal of appropriate fundamental (or harmonic) frequency and turn on *S1*. You can then tune in the signal on your receiver. To practice code, plug a key into *J1* and turn on the receiver's BFO. —30—

Placement of parts is not critical but it is advisable to follow layout shown in pictorial and photograph. Unused terminals on tube socket serve as tie points.





TRANSISTORIZED TRANSMITTER FOR COLLEGE STUDENTS



A number of these micro-powered units, requiring no licensing at all, can be placed strategically throughout the campus for most complete coverage

By **THOMAS J. BARMORE**
Washington State University

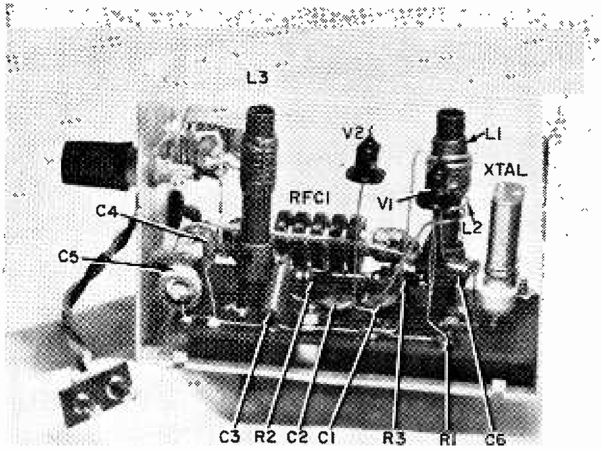
THERE ARE quite a few student broadcast stations on college campuses all over the United States. These limited-power stations usually fall into one of two categories: those which are licensed and transmit with low or medium power, and those which use the carrier-current method of transmission.

A carrier-current transmitter usually is a low-power AM transmitter which does not radiate in the usual manner. In fact, the system utilizes the power lines as a direct transmission path to the listener's receiver. Its disadvantage is that reception is blocked when the power line is interrupted by a line transformer or other obstacle.

If this is the case, it becomes necessary to consider a transmitter that will carry a broadcast signal any distance without worrying about transmission lines, and which is not powerful enough to require licensing. The answer to the problem is to use several low-power transmitters, placed at different locations throughout the campus and supplied with an audio signal of the proper amplitude.

At Washington State University, such a system is now in operation. A standard audio console and a network of balanced audio feedlines are utilized, along with ten battery-operated transistorized transmitters.

Circuit Design. Each transmitter is a two-stage, crystal-controlled, 670-kc., 400-microwatt unit (See Fig. 1.) Har-



The transmitter's chassis board consists of 1½" x 3" piece of cloth-base phenolic.

PARTS LIST

B1—6-volt battery (Eveready 744 or equivalent)
C1—0.002-μf., 100-volt ceramic capacitor
C2, C4—0.001-μf., 100-volt ceramic capacitor
C3, C6—300-μμf., 100-volt ceramic capacitor
C5—10-μf., 10-volt electrolytic capacitor
L1, L3—40-300μh. ferrite-core antenna for use with 250-450 μμf. capacitor (J. W. Miller Type 2002)
L2—8 turns of #22 wire, wrapped around bottom of L1 and insulated from it
R1, R2—150,000-ohm, ½-watt resistor
R3—1800-ohm, ½-watt resistor
RFC1—10-mh. r.f. choke
V1, V2—Npn transistor (General Electric 2N170)
Xtal—670-kc. crystal

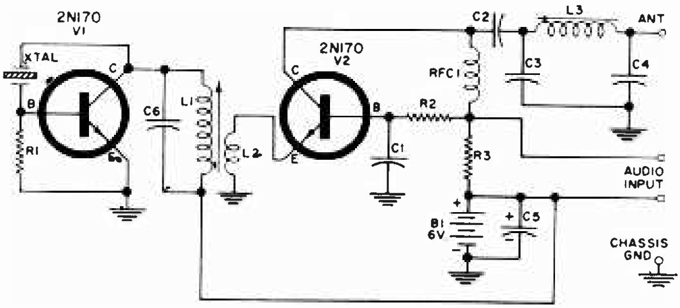


Fig. 1. Two-stage transmitter circuit utilizes two 2N170 transistors.

monic distortion is less than 1% at 100% modulation and the unit will accept modulation from 1 cycle to 50 kc. with no frequency distortion; 100% modulation occurs with an audio signal of 1 volt r.m.s.

The oscillator is a conventional grounded-emitter Pierce configuration, with base stabilization furnished by resistor *R1*. Output is developed across *L1* and couples to the emitter of *V2*.

The final is a grounded-base Class C amplifier which eliminates the need for neutralization. Resistor *R2* provides base bias for the stage, while the base is grounded (for signal) *via* capacitor *C1*. The output signal is developed across choke *RFC1* and coupled through capacitor *C2* to the *pi*-network tuned circuit consisting of capacitors *C3* and *C4* and coil *L3*. A *pi*-network was selected for its harmonic rejection rather than for its antenna-matching abilities; however, capacitor *C4* may be made variable so that the unit will better match an existing antenna.

Modulation is achieved in a modified Heising manner, with mixing occurring across resistor *R3*. Capacitor *C5* is placed across the battery to keep its a.c. internal resistance low, even though its d.c. resistance becomes high with age.

Construction. Each transmitter is housed in an aluminum box measuring 3¼" x 2⅛" x 1⅝". The chassis or wiring board is a piece of cloth-base phenolic measuring about 1½" x 3", with hollow brass leather eyelets as circuit tie points.

A binding post is used for the antenna terminal, while the audio input is supplied through a phone jack. The leads for the battery are brought out through a small grommet in the end of the case.

Operation. Each transmitter is intended for battery operation, using an Eveready 744 6-volt battery which will usually last about a year. Since the current drain is so slow, the unit is left on continuously.

Once power is applied, the oscillator tank coil is tuned to maximum output

(*Continued on page* 153)

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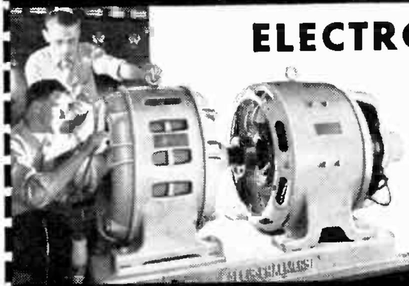

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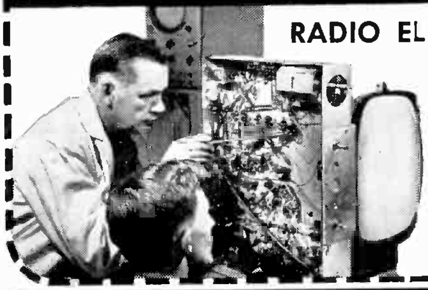

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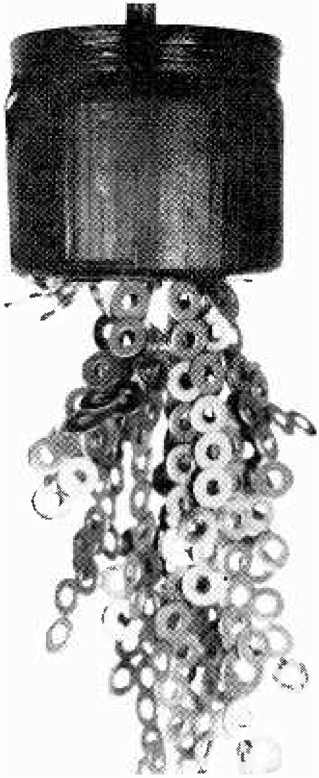
Chapter 4

Electronics for the Workshop

MANY READERS of our annual ELECTRONIC EXPERIMENTER'S HANDBOOK have told us that the most interesting circuits and construction projects appear in this chapter. Probably this is not far from the truth, because these projects do not fit in the general categories of the three preceding chapter headings. This year the circuits and projects are again unusual—especially the "Master Magnet" and "Ultrasonic Sniffer." Both have received widespread attention, the former as an unusual science fair project, the latter—oddly enough—in industry and scientific laboratories.

An innovation in this issue is a compilation of the "Best of Tips and Techniques." It has been the feeling of your Editors that much of the highly useful material appearing in the "Tips and Techniques" column should be collected and presented in this form. We hope you'll agree.



The MASTER MAGNET

Pick up aluminum, silver, or other non-ferrous metals with an a.c. electromagnet

By **WALTER B. FORD**

EVERYONE KNOWS that magnets are supposed to attract only ferrous metals like iron or steel. That's why the unusual electromagnet described here makes such an excellent "crowd stopper" at science fairs or similar gatherings. Seeming to defy the laws of physics, it will pick up half-dollar-sized pieces of copper, aluminum, silver, gold, and other non-ferrous metals.

Of course the magnet will attract ferrous metals much more strongly. And the sight of a seething mass of nails, screws, or washers dangling a foot or more from its bottom is not easily forgotten. So, if you're looking for something different in the way of a demonstration unit, or if you'd just like to build a big electromagnet for your own pleasure, here are the details.

The Magnet's Secret. Since the electromagnet's windings are powered by a.c., an alternately increasing and decreasing magnetic field is set up in its center core. When this varying field passes through a set of copper washers fastened at the end of the core, a large current is induced in them. The washers, then, act essentially as a transformer secondary.

The induced current sets up a strong, varying magnetic field in the washers. And the direction of this field is such that the washers and the core repel each other. If the washers were not anchored in place, they would spring out of their mounting as soon as the current was turned on.

The point is, though, that the varying field in the washers will induce, in turn, a large current in any metal object (ferrous or not) brought near them. This current, of course, sets up a magnetic field in the object. And the direction of the field will always be such that the part of the object in contact with the outside face of the set of washers will have the opposite magnetic polarity from that face. Therefore, the object will be attracted.

Building the Magnet Cores. Begin construction by cutting a 3½″-long section from a mailing tube about 2″ in diameter. Then make a frame for the inner core of the magnet as shown in Detail "A." The diameter of the three wooden discs forming the frame should be such that they will fit snugly inside the tube. Four ¼″-diameter dowels pass through holes drilled in the discs and are glued in place—holding the assembly together. The ¾″-diameter holes drilled in the centers of the discs will later accommodate the core material.

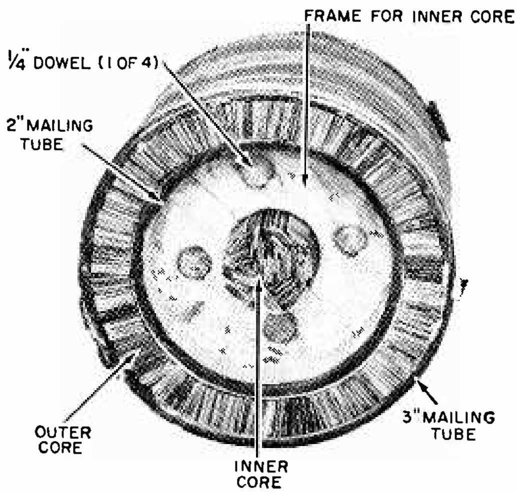
Now slide the completed frame into the mailing tube and glue it in place. One end of the frame should be flush with one end of the tube—leaving a ½″-space at the other end of the tube. Three copper washers will later be installed in this space (see Detail "B"—side view).

Set the tube on a table top with the "closed" end down and pack the center of the frame with a core of 3½″-long, approximately ¼″-wide, laminations. The laminations can be taken from an old transformer but, if one is not available, 3½″-long pieces of 18- to 22-gauge soft iron wire may be substituted. Whether you use laminations or wire, the top ends of the pieces should be cut square so that they will present a smooth surface when packed together.

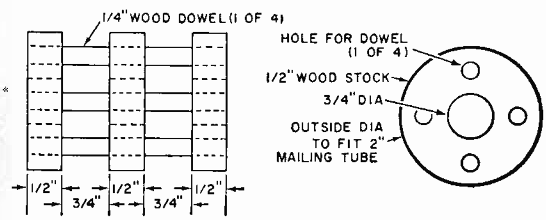
Slide a 3½″-long and approximately 3″-diameter piece of mailing tube over the finished inner core assembly and place the assembly at the exact center of the tube. Fill the space between the assembly and the tube with an outer core of 3½″-long pieces of transformer laminations or 18- to 22-gauge soft iron wire. If laminations are used, they should be wide enough to make a snug fit when packed radially around the inner core assembly (see photos and Detail "B").

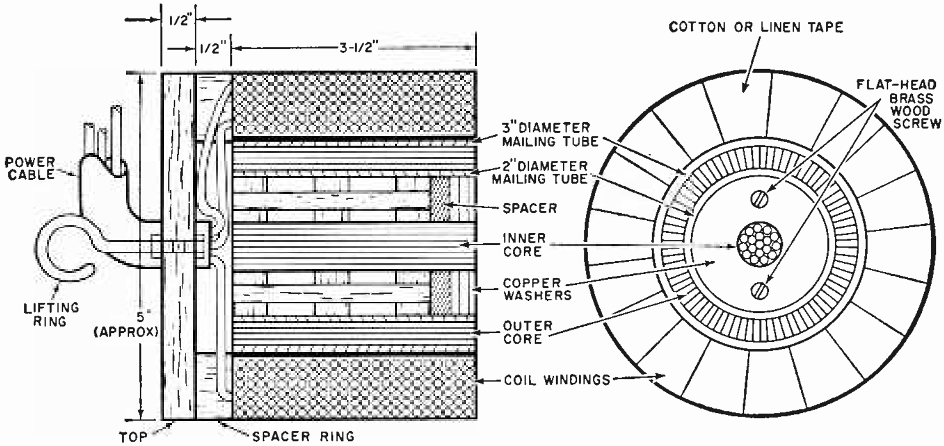
Winding the Coil. For this job you will need a jig similar to that shown in Detail "C." It consists of a wooden cylinder (3½″-long and ¹⁄₁₆″ larger in diame-

Specifications for construction of frame for inner core are given in Detail A (at right, below). In photo below, inner core has been completed and the last few laminations are being installed in the outer core. At right is finished assembly containing both cores.



DETAIL A ▼

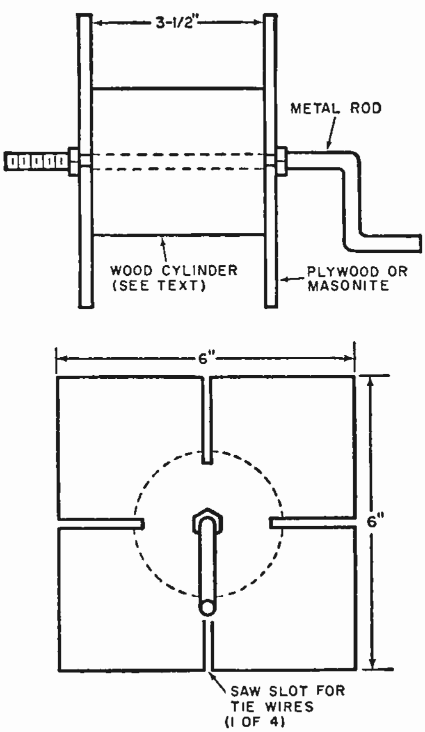




Drawings of side (in cross section) and bottom of magnet will give you a good idea of the construction.

DETAIL B ▲

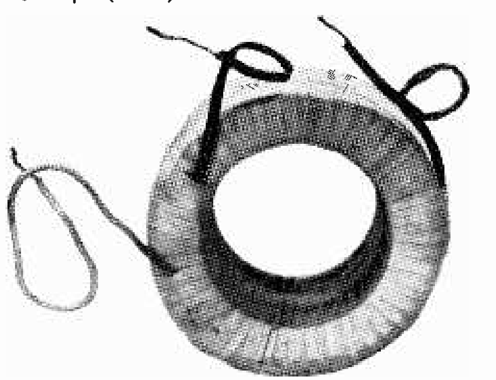
DETAIL C ▼

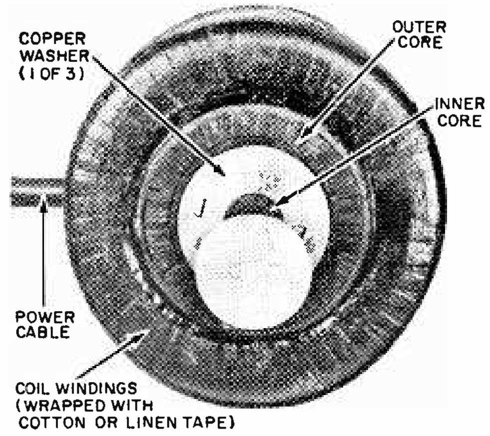


ter than the outside diameter of the mailing tube) fitted with two end-pieces. Slots are sawed in the end-pieces for the accommodation of temporary tie wires (see next paragraph), and a rod with a crank handle runs through the center of the cylinder as illustrated.

With the jig prepared, center a 12" piece of hookup wire across each of the four sets of slots and push it, through the slots, flat against the cylinder. The coil will be wound over these wires, and they will be used to hold the coil together temporarily when it is removed from the jig. Now drill a hole to fit the jig

Magnet coil is wound on a special jig (see Detail C at left). After windings are completed, they are wrapped with an overlapping layer of cotton or linen tape (below). Lead at left of coil is the tap.





Photograph of magnet bottom shows the coil, inner and outer cores, top washer. Circular object partially covering washer and cores is a half-dollar.

BILL OF MATERIALS

1—Cardboard mailing tube, 3½" long, approximately 2" in diameter
1—Cardboard mailing tube, 3½" long, approximately 3" in diameter
4—Wooden dowels, 3½" long, ¼" in diameter
1—Roll ½"-wide cotton or linen tape
1—Heavy brass or copper hook (for lifting ring)
1—Line plug
1—80-μf., 250- or 600-volt capacitor bank—see text
1—Wood or metal enclosure for above
1—6' length of #14 stranded 3-wire cable (for magnet power cord)
1—6' length of #14 stranded 2-wire cable (for line cord)
9—pounds of #14 cotton- or enamel-covered magnet wire
Misc.—½" wood stock for center core frame, magnet top and spacer ring, 1/16" sheet copper for washers, old transformer laminations or 18- to 22-gauge soft-iron wire for cores, parts for winding jig, flat-head brass wood screws, cement, insulating varnish or enamel, etc.

rod in a block of wood and clamp the block in a vise; this hole will serve as a bearing for the straight end of the rod while you crank the other end.

The coil consists of 600 turns of #14 cotton- or enamel-covered magnet wire tapped at the 350th turn; approximately nine pounds of wire will be needed. Push the end of the wire on your supply spool through a saw-slot in one of the jig's end-pieces (leave about 6″ sticking out), insert the straight end of the jig rod into the block of wood, and begin winding the wire, in layers, onto the cylinder.

When you reach the 350th turn, tap on a 6″ length of wire and bring it out through a saw-slot. The point of tapping can be varied as much as 10 turns in either direction in order to bring the tap out at the end of a layer and on the same side of the coil as the original 6″ lead. Continue winding until you reach the 600th turn, bring the end of the wire out through a saw-slot on the same side of the coil as before, and cut it off (leaving another 6″ lead).

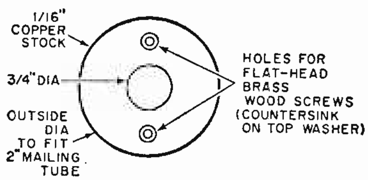
Final Assembly. Tie the windings together, using the wires previously inserted for this purpose—then disassemble the jig and remove the coil. The coil should now be completely wrapped, from the inside to the outside, with an overlapping layer of ½″-wide cotton or linen tape. Coat with glue the outside of the 3″-diameter mailing tube enclosing the magnet cores, and also coat the inside of the coil. Next, slip the coil over the cores (with the leads at the end opposite that on which the copper washers will be mounted) and allow the glue to dry.

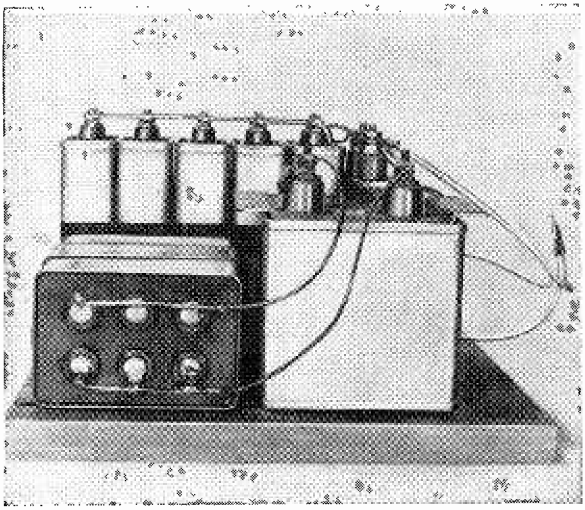
Make a wooden ring, from ½″ stock, with an outside diameter equal to the outside diameter of the coil and a 3″ inside diameter. This will serve as a spacer between the coil and its wooden top (see Detail "B"—side view). Cut grooves in the spacer for the coil leads and glue it to the top of the coil, bringing the leads out through the hole in the center.

A circular wooden top having the same outside diameter as that of the ring is now cut from ½″ stock. Mount a lifting ring (made of either brass or copper) on the center of the wooden top and also drill a hole for the power cable (a 6′

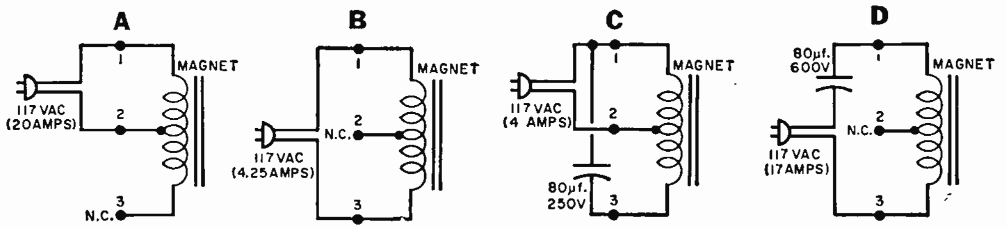
DETAIL D

Three washers like that illustrated below are required (See Detail B). Countersink screw holes on one of them.





The four schematic diagrams below indicate various methods of connecting magnet coil to a.c. line. The hookup of "C" or "D" will give you a stronger pull than that of "A" or "B," but both the "C" and "D" hookups require the use of an 80-μf. capacitor. This capacitance can be built up by paralleling a number of smaller units as shown in the photo at left.



TERMINAL 1=START OF WINDING
TERMINAL 2=TAP
TERMINAL 3=END OF WINDING

length of #14 stranded, 3-wire conductor). Push one end of the cable through the hole, connecting the coil leads to the cable leads.

The leads at the free end of the power cable should be marked "start of winding," "tap," and "end of winding" for later identification. This done, the wooden top can be secured to the spacer ring with brass wood screws. Glue the cable into its hole so that the connections cannot be pulled apart by accidental flexing, and coat the entire magnet with black insulating varnish or enamel. The coating will give the unit a professional appearance, protect it from moisture, and help to secure the cotton or linen coil wrappings.

The last job to be done in the construction of the magnet is the forming and installation of the copper washers which fill the remaining space between the ends of the inner and outer magnet cores. Specifications for the washers are given in Detail "D." The author has found that three washers (each 1/16" thick) work well, but you might like to try a different number.

The washers are secured with flathead brass wood screws driven into the frame of the inner core. Countersink the screw holes in the top washer so that the heads of the screws will be flush with the copper surface. Whatever space remains between the washers and the inner core should be filled with cardboard or wood spacers—so that the top washer will be flush with the ends of the inner and outer cores.

Do not, incidentally, substitute any other metal for the copper. The heavy current induced in the washers requires that they be made of extremely low resistance material. And, except in the unlikely event that you have silver

(*Continued on page* 152)

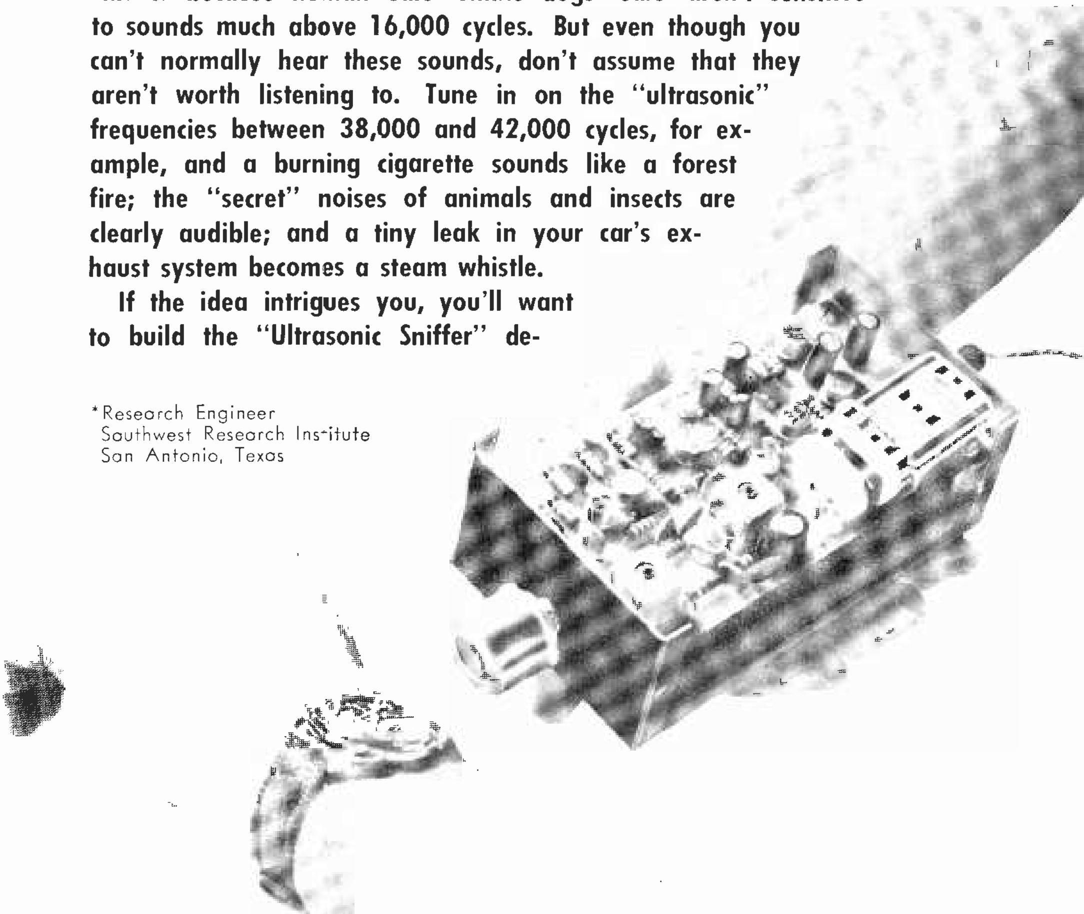
ULTRASONIC SNIFFER

Here's an old circuit with a new twist—basically a superheterodyne, it brings the not-so-audible world above 16,000 cycles to human ears

By DANIEL MEYER*

ARE YOU AWARE that a dog can hear sounds which, if you relied on your ears alone, you probably wouldn't even know existed? This is because human ears—unlike dogs' ears—aren't sensitive to sounds much above 16,000 cycles. But even though you can't normally hear these sounds, don't assume that they aren't worth listening to. Tune in on the "ultrasonic" frequencies between 38,000 and 42,000 cycles, for example, and a burning cigarette sounds like a forest fire; the "secret" noises of animals and insects are clearly audible; and a tiny leak in your car's exhaust system becomes a steam whistle.

If the idea intrigues you, you'll want to build the "Ultrasonic Sniffer" de-



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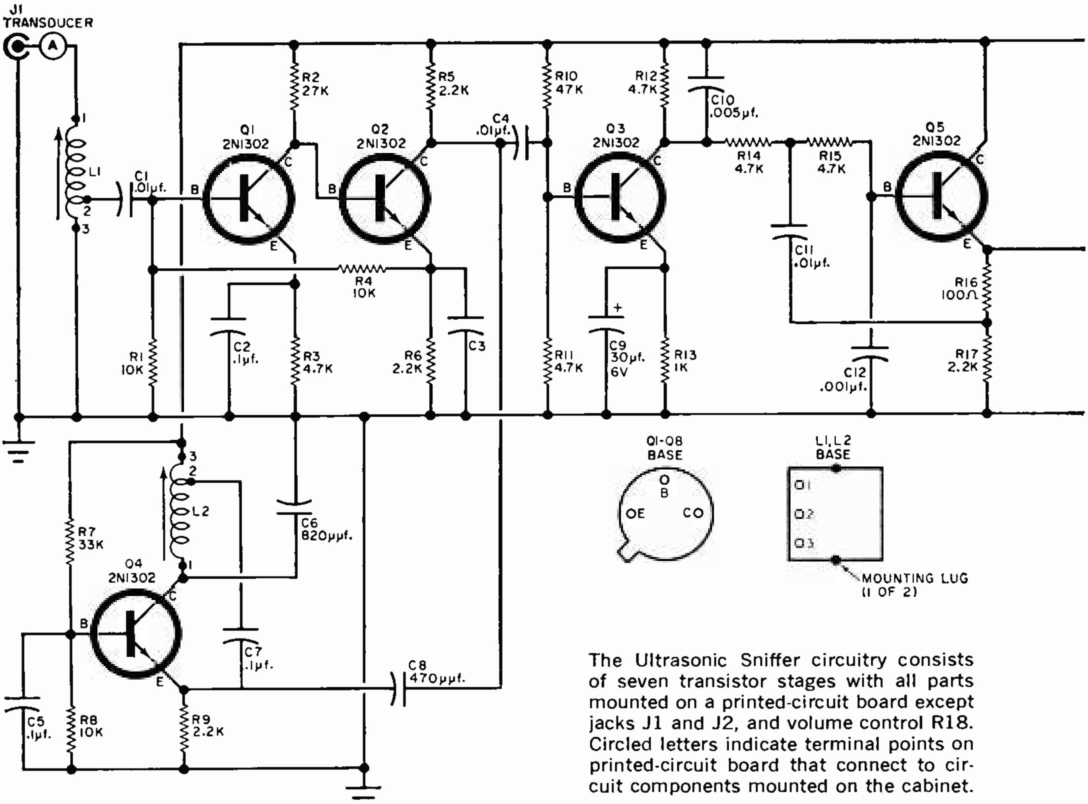
Southwest Research Institute
San Antonio, Texas



The Ultrasonic Sniffer circuitry consists of seven transistor stages with all parts mounted on a printed-circuit board except jacks J1 and J2, and volume control R18. Circled letters indicate terminal points on printed-circuit board that connect to circuit components mounted on the cabinet.

scribed on these pages. Its ingenious transistorized circuit picks up sounds in the 38 - 42 kc. range and "translates" them into frequencies low enough to be perfectly audible.

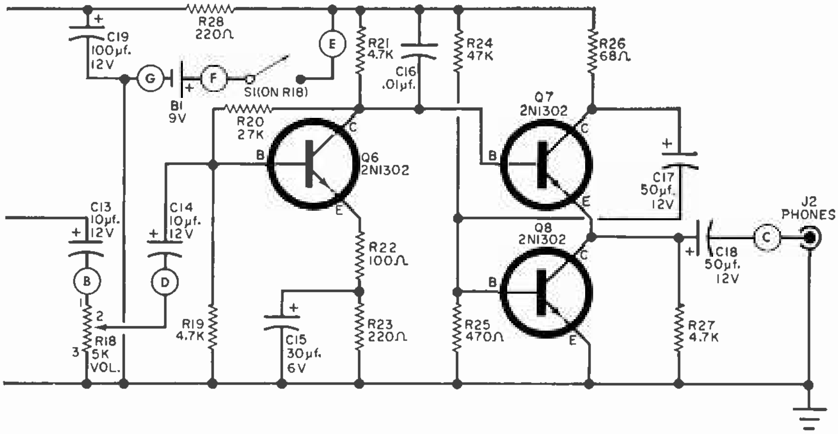
To test the Ultrasonic Sniffer, one of the first things we did after receiving the prototype model was to point it at a Bulova "Accutron" electronic watch. Appropriately (if startlingly) enough, we heard a periodic booming which sounded very much like Big Ben's chimes. Similar surprises await you, so why take a back seat to Rover? Get out your soldering gun and start that flux flowing now!

About the Circuit. The Ultrasonic Sniffer is similar in design to an ordinary superheterodyne receiver. Taking the place of the antenna is an ultrasonic transducer, or "microphone," of the type used in TV remote-control systems.

When the transducer is plugged into jack *J1*, it forms a tuned circuit with coil *L1*. The circuit, analogous to a radio set's r.f. tuning coil and capacitor, resonates between about 37.5 and 42.5 kc. All sounds that the transducer picks up within this range are passed along to transistor *Q1*. Transistors *Q1* and *Q2*, equivalent to the r.f. amplifiers of our hypothetical superhet receiver, amplify the 37.5 - 42.5 kc. ultrasonic signals.

Oscillator *Q4* provides a 37.5-kc. signal which is coupled to the base of mixer *Q3* along with the 37.5 - 42.5 kc. signals from *Q2*. These signals combine in the mixer to generate "difference" frequencies between 0 and 5 kc. Capacitor *C10* partially filters the "sum" frequencies from the output of *Q3*, but it leaves the 0 - 5 kc. "difference" frequencies virtually untouched.

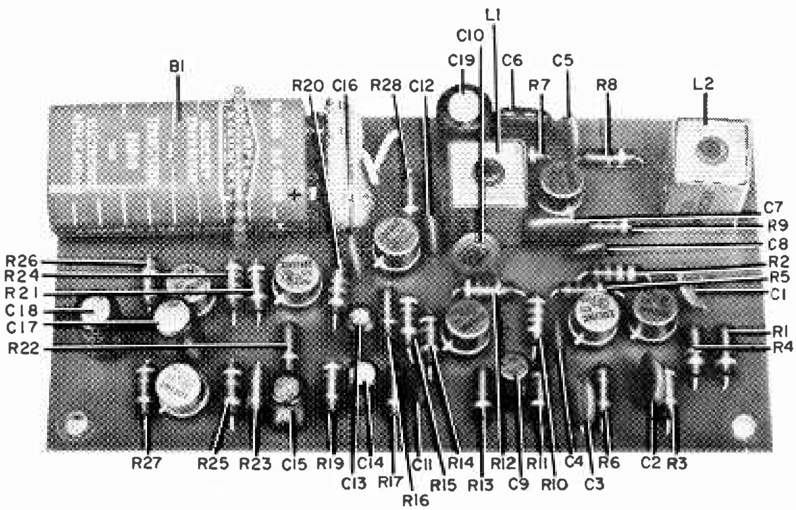
The "difference" frequencies retain the basic "sound pattern" of the original, inaudible, ultrasonic signals. They lie well within the normal audio range, however, and need only amplification to be heard. Here the analogy to a superhet



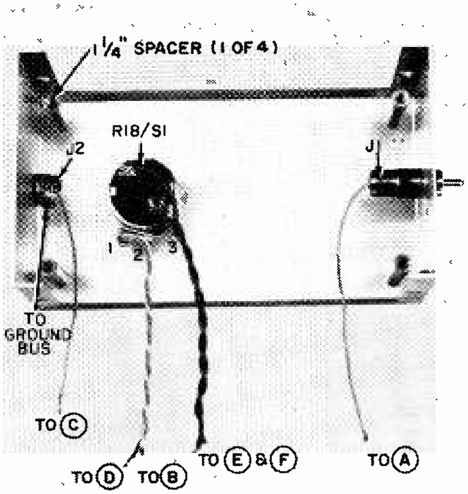
PARTS LIST

B1—9-volt battery (Burgess 2MN6 or equivalent)
C1, C4, C11, C16—0.01-μf., 150-volt ceramic disc capacitor (Centralab DM-103 or equivalent)
C2, C5, C7—0.1-μf., 10-volt ceramic disc capacitor (Centralab UK10-104 or equivalent)
C3—2-μf., 6-volt electrolytic capacitor (Lafayette CF-161 or equivalent)
C6—820-μμf., 300-volt silvered-mica capacitor (Elmenco DM-15-681J or equivalent)
C8—470-μμf., 1000-volt ceramic disc capacitor (Centralab DD-471 or equivalent)
C9, C15—30-μf., 6-w.v.d.c. subminiature electrolytic capacitor (Lafayette CF-167 or equivalent)
C10—0.005-μf., 150-volt ceramic disc capacitor (Centralab DD-M502 or equivalent)
C12—0.001-μf., 1000-volt ceramic disc capacitor (Centralab DD-102 or equivalent)
C13, C14—10-μf., 12-w.v.d.c. subminiature electrolytic capacitor (Lafayette CF-173 or equivalent)
C17, C18—50-μf., 12-w.v.d.c. subminiature electrolytic capacitor (Lafayette CF-176 or equivalent)
C19—100-μf., 12-w.v.d.c. subminiature electrolytic capacitor (Lafayette CF-177 or equivalent)
J1—Shielded phono plug (Lafayette MS-593 or equivalent)
J2—Phone jack to match plug on headset
*L1, L2—Special ultrasonic coil (Admiral 69C251-1-A)**
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8—2N1302 transistor (Texas Instruments, G.E.)
R1, R4, R8—10,000 ohms
R2, R20—27,000 ohms
R3, R11, R12, R14, R15, R19, R21, R27—4700 ohms
R5, R6, R9, R17—2200 ohms
R7—33,000 ohms
R10, R24—47,000 ohms
R13—1000 ohms
R16, R22—100 ohms
(All resistors ½-watt, 10%, unless otherwise specified)
R18—5000-ohm potentiometer, audio-taper (with s.p.s.t. switch S1)
R23, R28—220 ohms
R25—470 ohms
R26—68 ohms
S1—S.p.s.t. switch (on R18)
1—5¼" x 3" x 2⅛" aluminum utility box (Bud CU-2106-A or equivalent)
*1—Special printed-circuit board**
*1—Ultrasonic transducer (Admiral 78B147-1-G)**
1—100-to-1000 ohm headset (Telex HFX-91 or equivalent)
Misc.—1¼" spacers, battery connector, knob, wire, solder, etc.

*The coils, printed-circuit board, and transducer are available from Daniel Meyer, 430 Redcliff Dr., San Antonio 16, Texas, for a total of $10.00, postpaid.



Only those parts specified in the Parts List or exact replacements with the same physical size should be mounted on the printed-circuit board. Any odd replacement parts may make wiring unit difficult.



Parts mounted on chassis cover are prewired with extra long leads. Circled letters indicate connection points so indicated on schematic diagram.

breaks down, since the output of a superhet mixer is an i.f. signal which must be "detected" (to extract the original audio modulation) before it can be heard.

The output of *Q3* is fed to *Q5*, which is connected as an "emitter follower." Transistor *Q5*'s main function is to provide a proper impedance match between *Q3* and volume control *R18*. It also acts as another filter, helping *C10* to attenuate unwanted ultrasonic signals.

Audio signals from *R18* feed transistor *Q6*, which is the audio amplifier. And the output of *Q6* is fed to transistors *Q7* and *Q8*, which form an "augmented emitter follower." Their output, available at jack *J2*, will match a set of low-impedance headphones.

Power for the circuit is supplied by 9-volt battery *B1*, and controlled by switch *S1*.

Construction. Building the Ultrasonic Sniffer is a relatively simple job, thanks to the availability of a specially-etched circuit board (see Parts List). All holes in the printed board should be drilled with a No. 60 drill from the copper side of the board. The holes for *L1* and *L2* will have to be drilled with a slightly larger size drill since the lugs on these parts are larger than the leads on the other components.

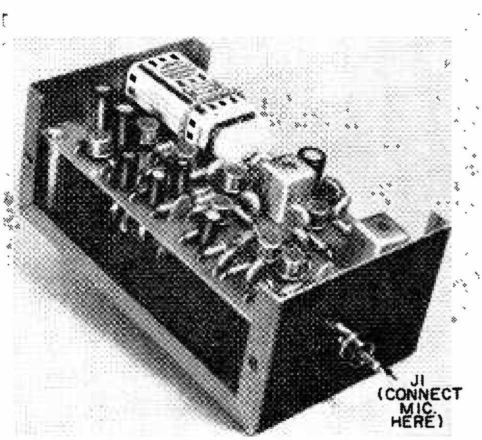
Because of the critical space limitations on the board, the Parts List gives rather complete specifications for all capacitors. Try to pick up the exact units listed—but if you can't, be sure that whatever you do buy will fit. Keep in mind that the voltage ratings for the electrolytics are fairly critical, but anything over ten volts will do for the other capacitors.

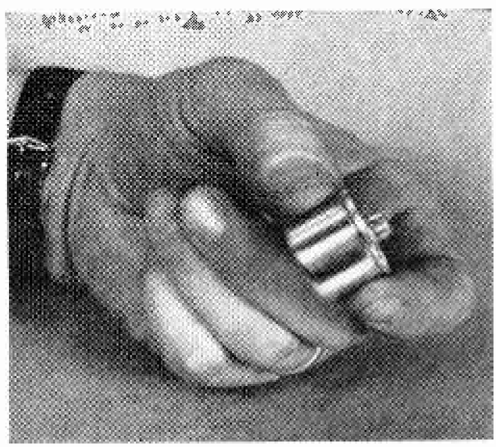
There should be no problems in hooking up the components. The transistors and coils will only fit one way, and, with the exception of the electrolytics, there are no polarities to worry about. Polarities for each electrolytic capacitor must be carefully checked before you solder them in place.

Use *only* rosin core solder when soldering components to the board. "Ersin"

(*Continued on page* 148)

After unit is wired (left, below), close up chassis box to protect parts, then connect microphone (right) to jack J1, plug in headset, and advance volume control until a rushing sound is heard.

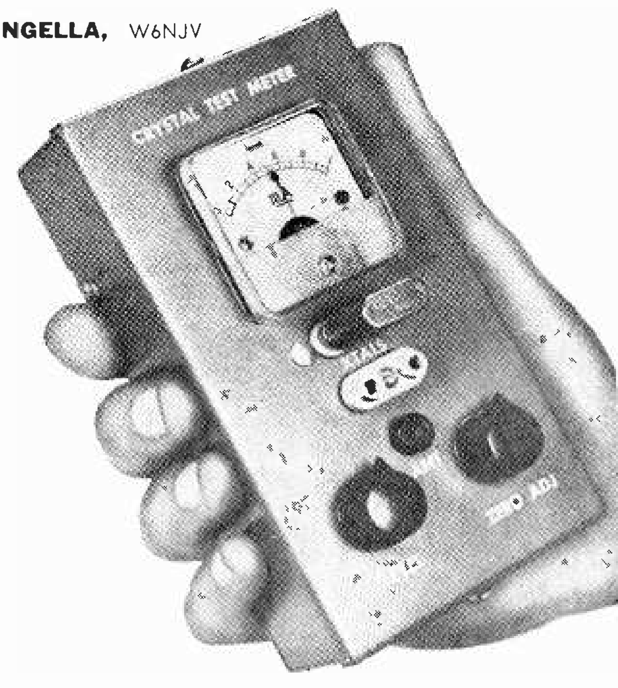




CRYSTAL TEST METER

Now you can rate the relative activity of transmit and receive crystals in your "shack" or even in the store where you buy them

By CHARLES CARINGELLA, W6NJV



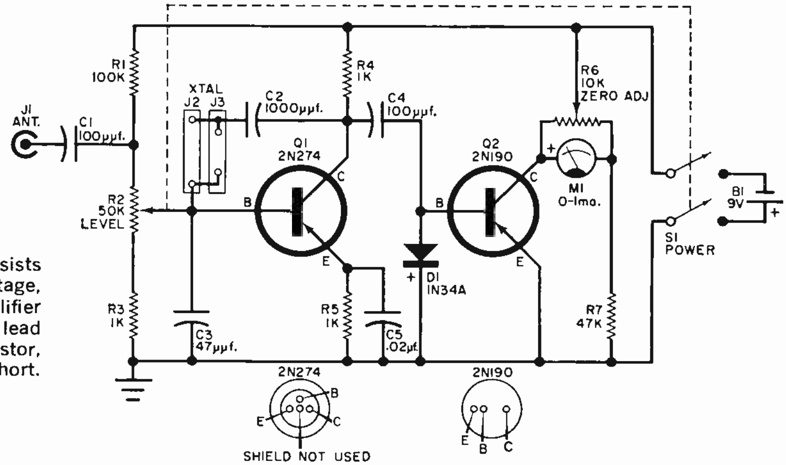
THE HOME workshops of hams, CB'ers, and experimenters frequently boast many varieties of test equipment in addition to the usual VOM or VTVM. Tube checkers, signal generators, capacitor and resistor substitution boxes, and even expensive oscilloscopes are not at all uncommon. But not many people have equipment for testing transmitting or receiving crystals—even those who buy and use them the most.

The inexpensive "Crystal Test Meter" described here has been designed to remedy that lack. It will indicate the relative "activity" of crystals of all commonly used frequencies. In addition, since it's battery-powered and small enough to slip into a coat pocket, the unit can be used to evaluate bargain-priced "surplus" crystals right in the store.

But that isn't the end of the usefulness of this little device. With an appropriate crystal plugged into its socket and a small antenna attached, it serves as an oscillator for checking receiver calibration or alignment. Pull the crystal out, and you have a broadband field strength meter sensitive to frequencies from the broadcast band to well over 150 mc.

About the Circuit. Transistor *Q1*, a high-frequency r.f. type, is connected in a Pierce crystal oscillator circuit. The crystal to be tested is plugged into jack *J2* or *J3*, and the resulting r.f. output is detected by diode *D1* and amplified by transistor *Q2*. Meter *M1*, in *Q2*'s collector circuit, then shows a reading which indicates the relative activity of the crystal.

Because of transistor *Q1*'s normal leakage current, meter *M1* may show a slight reading even when no crystal is in the circuit. This is balanced out by means of "Zero-Adjust" potentiometer *R6*. "Level" potentiometer *R2* controls *Q1*'s base bias and, therefore, the strength of



Tester circuit consists of an oscillator stage, Q1, and d.c. amplifier stage, Q2. Shield lead from 2N274 transistor, not used, is cut short.

PARTS LIST

B1—9-volt battery (Burgess 2U6 or equivalent)
C1, C4—100 μμf.
C2—1000 μμf.
C3—47 μμf. } *All mica capacitors, voltage not critical*
C5—0.02-μf. paper capacitor, voltage not critical
D1—1N34A diode
J1—Nylon-insulated tip jack (E. F. Johnson Type 105 or equivalent)
J2—Crystal socket (Millen 33302 or equivalent)
J3—Crystal socket (Millen 33102 or equivalent)
M1—0-1 ma. d.c. panel meter (Lafayette TM-400 or equivalent)
Q1—2N274 transistor (RCA)
Q2—2N190 transistor (G.E.)
R1—100,000-ohm, ½-watt resistor
R2—50,000-ohm potentiometer
R3, R4, R5—1000-ohm, ½-watt resistor
R6—10,000-ohm potentiometer
R7—47,000-ohm, ½-watt resistor
S1—D.p.s.t. switch (on R2—see text)
1—5½" x 3" x 1¼" aluminum utility box (LMB 139 or equivalent)
Misc.—Terminal strips, battery connector, knobs for R2 and R6, etc.

oscillation. It can be adjusted to prevent extra-active crystals from "pinning" *M1* or to obtain a readable meter indication from sluggish ones.

Power for the circuit is supplied by a small 9-volt battery (*B1*) and controlled by switch *S1* (on *R2*). Though the author used a d.p.s.t. switch for *S1*, a s.p.s.t. switch (wired in series with either of the battery leads) will work as well.

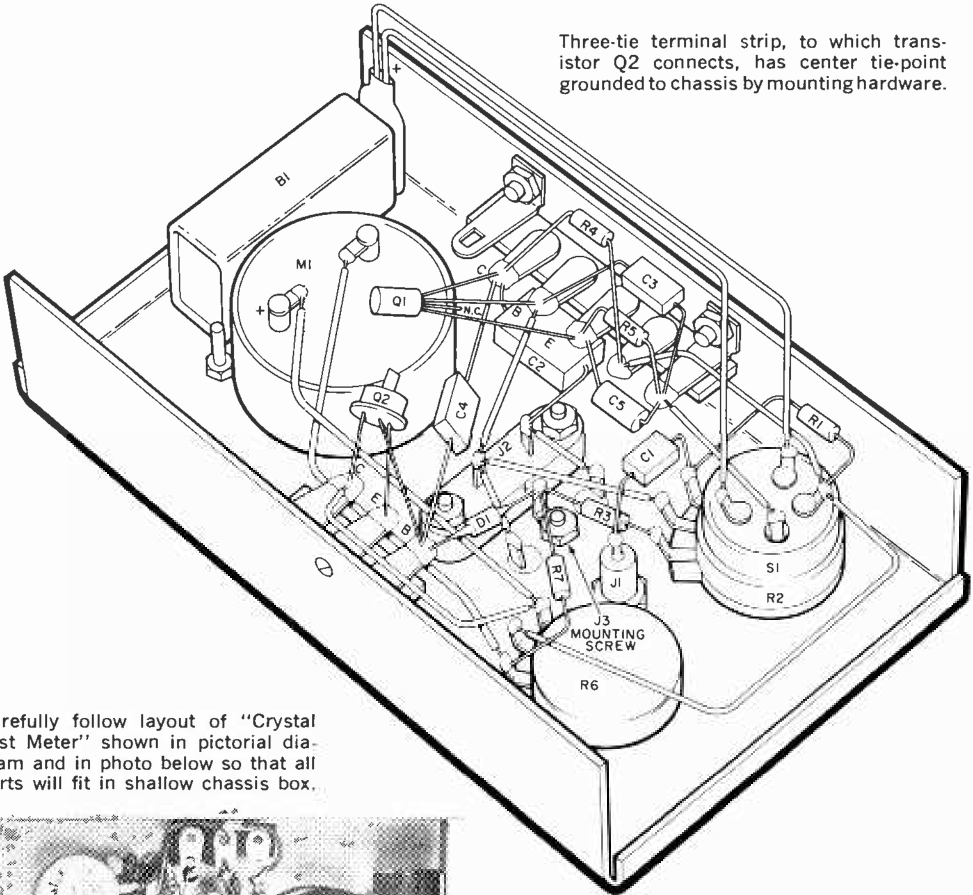
An antenna is plugged into jack *J1* when the "Crystal Test Meter" is to be used as a marker/alignment oscillator or as a field strength meter. In the former case, this antenna radiates the output of *Q1* into the receiver to be checked.

In the latter case, r.f. energy from a transmitter or oscillator is picked up by the antenna and coupled to the base of *Q1*. This transistor then acts as an r.f. amplifier (no crystal is used in the circuit, of course). And, as before, *Q1*'s output is detected by *D1*, further amplified by *Q2*, and indicated by meter *M1*.

Construction. The unit is housed in a 5½" x 3" x 1¼" aluminum utility box. Place meter *M1*, jacks *J1*, *J2*, and *J3*, and potentiometers *R2* and *R6* on the front panel as shown. Transistors *Q1* and *Q2*, as well as many of the resistors and capacitors, are mounted on terminal strips which are installed on each of the two side walls of the box.

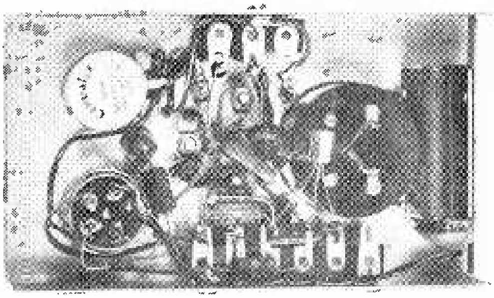
The author found that a couple of strips of masking tape were sufficient to hold battery *B1* in its position above *M1*. However, you may want to make (or purchase) a battery clamp instead.

When carrying out the wiring, try to place all components and leads exactly as illustrated in the pictorial diagram, and to keep all leads as short as possible. Also be sure to use a heat sink when soldering the leads of *Q1* and *Q2* in place and to carefully observe the indicated battery polarity.



Three-tie terminal strip, to which transistor Q2 connects, has center tie-point grounded to chassis by mounting hardware.

Carefully follow layout of "Crystal Test Meter" shown in pictorial diagram and in photo below so that all parts will fit in shallow chassis box.



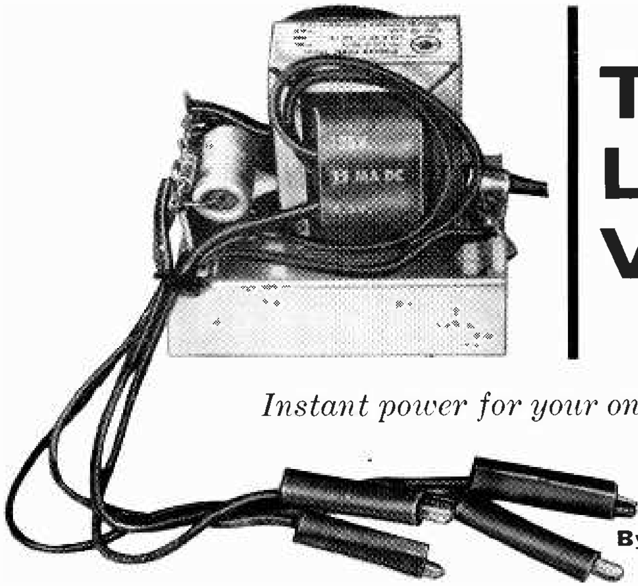
Operation. To check a crystal, turn on switch *S1*, keeping "Level" potentiometer *R2* turned all the way down. Then set meter *M1* to zero indication by means of "Zero Adjust" potentiometer *R6*. Plug in the crystal and slowly advance *R2* until you observe an indication on *M1*.

Any indication on *M1* is a sign that the crystal is oscillating, but the crystal's relative activity can only be determined by comparison with other units. Check a number of crystals which are known to be satisfactory so that you can get a feeling for the meter readings to be expected at various positions of *R2*.

Almost all of the crystal styles normally encountered will be accommodated by either *J2* or *J3*. For special purposes, other types of sockets—or even a set of clip leads—can be installed.

"Overtone" crystals (such as the third overtone units commonly used in CB work) can also be tested, but only at their fundamental frequencies. This is because the unit contains no tuned circuits for frequency multiplying.

As has already been pointed out, the "Crystal Test Meter" may be used as a marker/alignment oscillator or as a field strength meter. (It does a particularly good job as a marker/alignment oscillator due to its crystal-controlled accuracy.) During operation as an oscillator, *R2* serves as an output level control. When the unit is employed as an FSM, *R2* acts as an input sensitivity control. –30–



THE LITTLE VOLTER

Instant power for your one- or two-tube projects

By **FORREST H. FRANTZ, Sr.**

ALTHOUGH experimenters are devoting more and more of their time to transistors these days, circuits always seem to come up which require the use of one or two tubes. And it's for just such circuits that this inexpensive little power supply was designed.

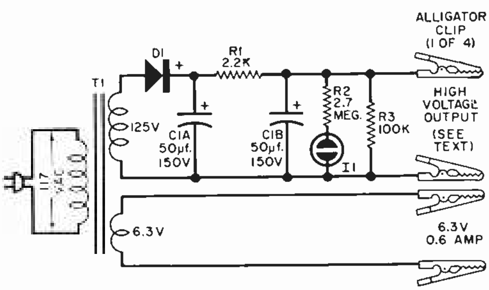
The high-voltage output is about 150 volts under a 1-ma. load, and drops to about 110 volts under the maximum load of about 13 ma. This range is fine for most one- or two-tube equipment intended for 90-180 volt operation. A heater supply of 6.3 volts at 0.6 ampere is also incorporated in the unit.

The simple circuit of the "Little Volter" (see schematic diagram below) is assembled on a 1¾" x 3⅛" x 1" aluminum open-end chassis. Dual-section filter capacitor *C1* is installed under the chassis, and there's room on top for transformer *T1* and all of the other components. A 5-lug terminal strip mounts diode *D1*, resistors *R1*, *R2*, and *R3*, and neon "on-off" indicator *I1*.

To keep expenses down and simplify construction, the author used no power switch or output jacks. You turn the unit on and off by simply inserting its plug into a wall outlet or pulling it out. As for the output connections, they are made by means of leads which are wired directly into the supply at one end and terminated in insulated alligator clips at the other.

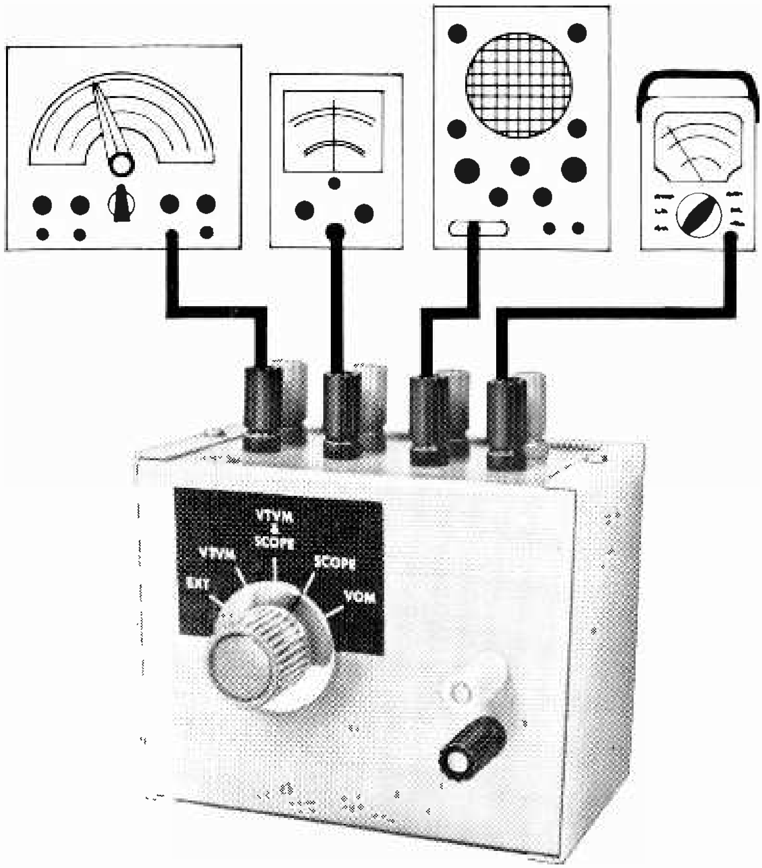
If you wish, you can dress up the "Little Volter" a bit by housing it in an appropriate box. But don't forget to provide openings for ventilation and for viewing indicator *I1*. –30–

Schematic diagram of the "Little Volter." Neon "on-off" indicator I1 operates from high-voltage output.



PARTS LIST

C1—Dual 50-µf., 150-volt electrolytic capacitor
D1—200-PIV, 20-ma. (or greater) silicon rectifier
I1—NE-2 neon lamp
R1—2200 ohms
R2—2.7 megohms — *all ½-watt resistors*
R3—100,000 ohms
T1—Power transformer; primary, 117 volts; secondaries, 125 volts @ 15 ma., 6.3 volts @ 0.6 amp. (Stancor PS-8415 or equivalent)
1—1¾" x 3⅛" x 1" aluminum open-end chassis (Premier ACH-1351 or equivalent)
Misc.—Line cord and plug, terminal strip, insulated alligator clips, wire, etc.



TEST EQUIPMENT CONTROL CENTER

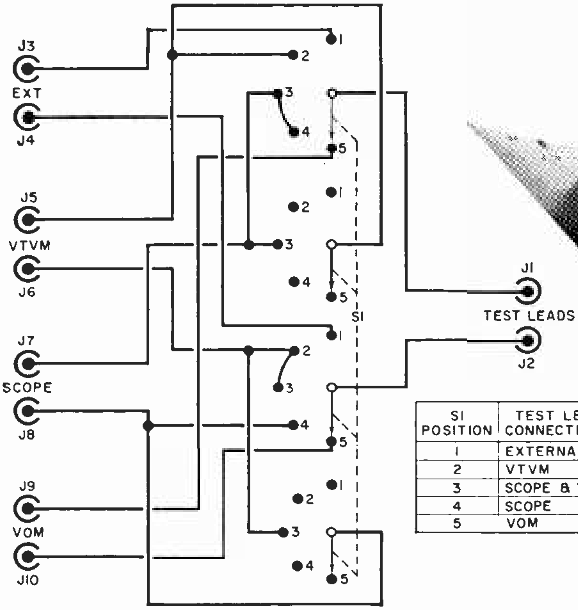
By ROBERT J. SPENCER

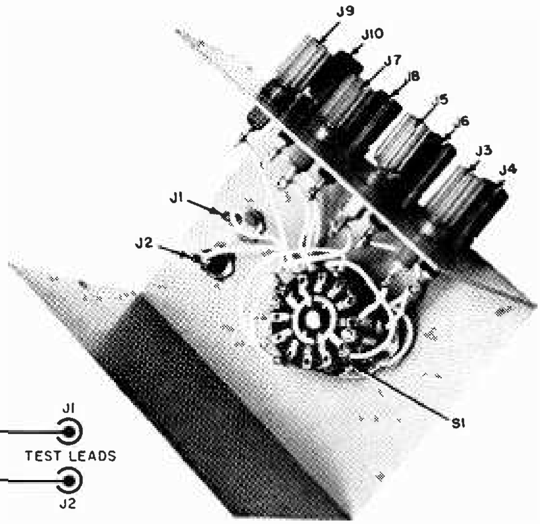
TANGLED test instrument leads is the price usually paid by the home experimenter or serviceman for having a fully equipped workbench. Selecting the particular leads he wants to use may be difficult or impossible, depending on how severely the leads are tangled. To solve this problem, the author constructed a simple switching box, tabbed the "Test Equipment Control Center," and eliminated all but two test leads—which are used for all types of measurements.

The photo above shows how the unit works. Four pieces of test gear (signal generator, VTVM, oscilloscope, and VOM) connect to binding terminals on the top of the unit. With the test equipment seated on a shelf, and the "control center" located at the rear of the workbench, all the interconnecting leads can be positioned out of harm's way, keeping the working area clean.

The two test leads connect to the front panel binding posts, and they

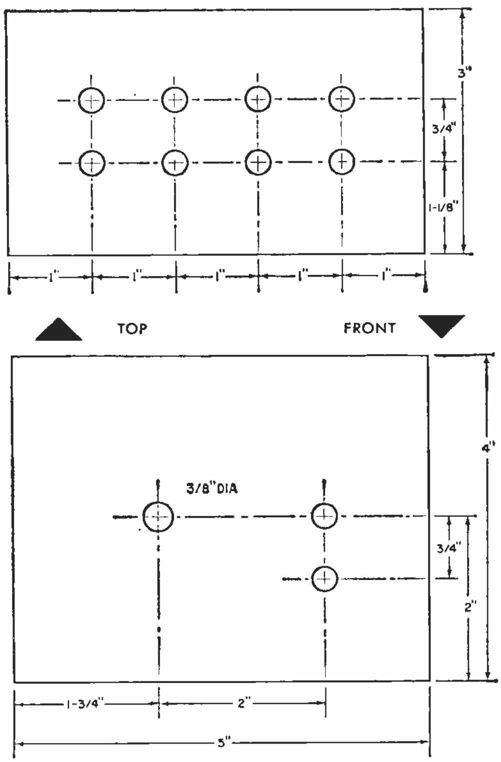
To learn how the "control center" works, trace the circuit for each test instrument input and switch setting. Additional switch positions can be added to box if more than five functions are needed.





S1 POSITION	TEST LEADS CONNECTED TO:
1	EXTERNAL
2	VTVM
3	SCOPE & VTVM
4	SCOPE
5	VOM

Binding posts J3-J10 are mounted on top of aluminum chassis box. Keep leads relatively short; shielded wire is not required except for extremely low level signals. Screw-type terminal blocks can be used instead of binding posts if you prefer. To make your unit look like the author's, follow detail drawings below; unmarked holes are 5/16" in diameter.



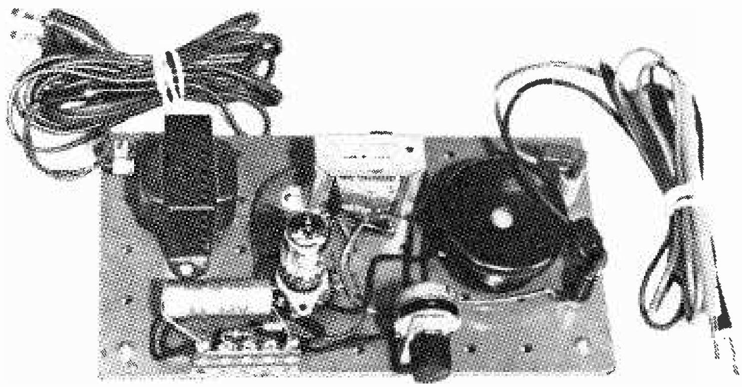
PARTS LIST

J1, J3, J5, J7, J9—Binding post, red (E. F. Johnson Type 111-102 or equivalent)
J2, J4, J6, J8, J10—Binding post, black (E. F. Johnson Type 111-103 or equivalent)
S1—4-pole, 5-position rotary switch (Centralab Type 1013 or equivalent)
1—3" x 4" x 5" aluminum chassis box, gray finish (Bud CU-2105A or equivalent)
1—Knob, optional (National HRS-4, gray)

are all the leads you really need. If you want to make a voltage check in a circuit, just set the rotary switch (*S1*) on the "control center" to *VTVM*; the probes on the bench are now connected to the VTVM. The same is true for the other positions of the switch.

One switch position, marked *VTVM & SCOPE*, connects the inputs to these two test instruments in parallel, so that you can look at a waveform and measure its peak-to-peak voltage. The switch's *EXT* (external) position is used to connect other types of test gear.

Since the unit is light in weight, it's best to screw it to the workbench. And a little black paint and press-type lettering will make your "control center" as beautiful as it is useful. —30—

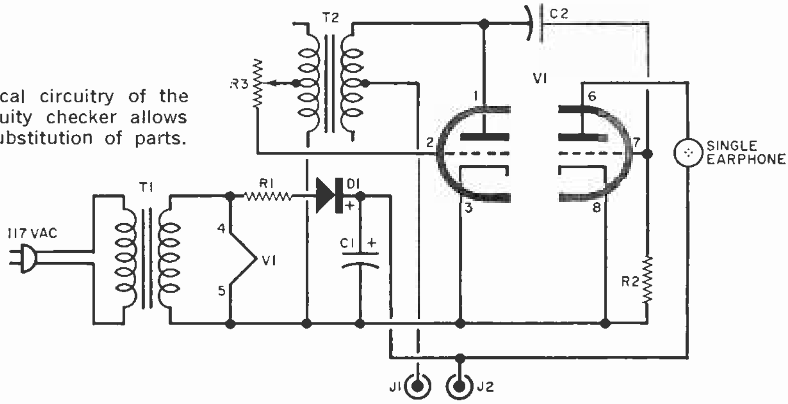


AURAL CONTINUITY CHECKER

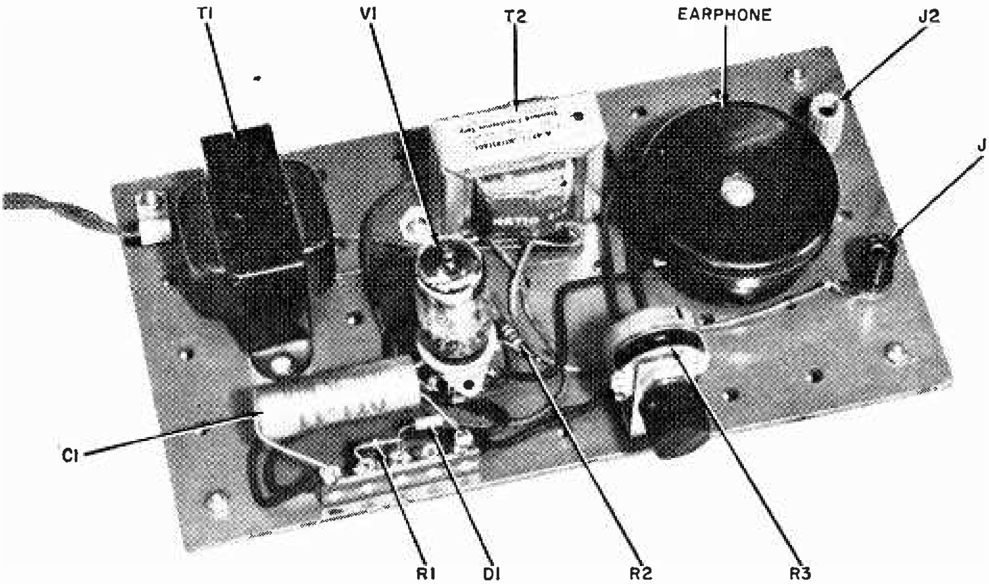
By PHILIP E. HATFIELD, W9GFS
Receiving Tube Dept., General Electric Co.

THOSE OF YOU who have used an ohmmeter for continuity checks know that it is sometimes desirable to have "two heads." After all, how else can you keep your eyes on the meter scale and the test probes at the same time? The answer is that you don't have to—if you use your eyes *and* your ears. With an aural continuity checker, you can keep your eyes on the test probes and *listen* for the "sound" of your circuit.

A number of aural continuity checkers can be constructed but they have certain faults. If you build a checker that employs a dry cell in series with a headphone, you'll find it difficult to distinguish between an open circuit and a capacitor. If you use a buzzer and a dry cell, you can remedy this defect, but the



The noncritical circuitry of the aural continuity checker allows for broad substitution of parts.



With four rubber feet on the bottom of a 5" x 9" pegboard and all the parts on top, the checker can either be hung on a wall or left on a workbench top.

PARTS LIST

C1—25-µf., 25-w.v.d.c. electrolytic capacitor
C2—0.005-µf. paper, ceramic or mica capacitor
D1—1N34A diode (or equivalent)
J1, J2—Five-way binding post (Superior DF30BC or equivalent)
R1—150-ohm, ½-watt carbon resistor
R2—470,000-ohm, ½-watt carbon resistor
R3—250,000-ohm potentiometer
T1—Filament transformer; primary, 117 volts; secondary, 12.6 volts @ 0.15 amp (Triad 3F778 or equivalent)
T2—Audio transformer—see text
V1—Dual triode—see text
1—5" x 9" pegboard
Misc.—Phone jack, pair of test leads, line cord and plug, 5-lug terminal strip, bracket for pitch control, 9-pin miniature tube socket, hardware, etc.

high current required by the buzzer will probably damage some of your parts. With the unit described here, however, you won't encounter these problems. Better yet, you'll probably have the necessary components right on your bench.

This device will enable you to distinguish between a large electrolytic capacitor and a continuous circuit, and will also give you an idea of the magnitude of the resistance in the circuit being tested. The checker operates with a very low current, preventing possible damage to circuit parts.

Construction. Neither parts nor layout is critical. The unit is built on a 5" x 9" pegboard (any suitable board will do), with rubber feet attached at the four corners. A single earphone is mounted directly on the board, but for noisy locations you might want to install a phone jack to accommodate a pair of headphones.

The author used a push-pull interstage audio transformer for *T2*; however, any single-ended audio transformer will do the job provided that the winding impedances are greater than 5000 ohms (such as the Stancor A-53). And you have a choice of a 12AT7, 12AU7, or 12AX7 for *V1*.

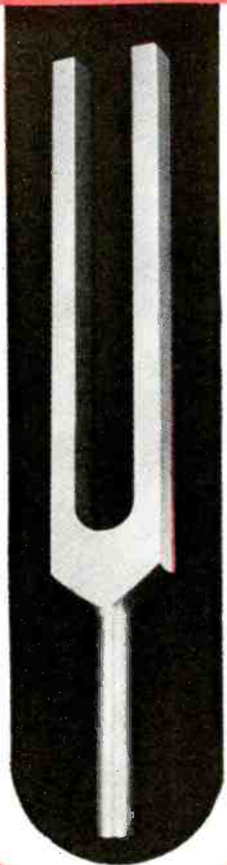
Checking Out the Checker. Plug in the unit and, after a suitable warm-up period, touch the leads together. A tone will be heard in the earphone, the pitch of which you can adjust by varying *R3*. If no tone is heard, reverse the leads of either winding of *T2*.

Make continuity checks just as you would with an ohmmeter, but now listen for an audible tone to denote a continuous circuit. To estimate the magnitude of the circuit's resistance, compare this tone to the tone obtained by shorting the test leads. In the author's model, a resistance of about 1.1 megohm gave a low—but still audible—tone. If there is a capacitor in the circuit, the tone should sound and then die away. The time length of the tone is dependent upon the capacity. —30—

The 440 Fork

Two-transistor tuning fork oscillator makes an ideal frequency standard

By
FRED IPPOLITO
and
PAT BROCATO
Sylvania Electronic Systems-Central
Sylvania Electric Products Inc.



AS you no doubt know, a tuning fork is a steel instrument designed to produce a pure musical tone of a definite pitch. But while it's a familiar object in piano tuners' tool kits, the tuning fork is seldom used to full advantage by electronics experimenters and hobbyists.

Usually, a tuning fork is set into vibration by striking it with a mallet; then, its stem can be rested against a sounding box or musical instrument to amplify its output. The disadvantage of this method, of course, is that you have to strike the tuning fork repeatedly in order to keep it going. Furthermore, there's no ready way of coupling its output into electronic circuits.

The tuning fork oscillator pictured on the following pages has no such shortcomings. It vibrates continuously and is therefore much more useful as a tone source or a frequency standard. Its design not only takes advantage of the well-known frequency stability and accuracy of a tuning fork, but it also incorporates provisions for feeding the signal into a variety of equipment. Finally, the little "440 Fork" is relatively inexpensive to put together.

Since the oscillator is intended primarily for tuning musical instruments, it is built around a 440-cycle tuning fork (this frequency corresponds to the "A" above middle "C" on the musical scale). But don't think the unit is limited to tuning musical instruments—it can also be used to calibrate audio oscillators, serve as a master oscillator for frequency divider or multiplier circuits, and so on.

About the Circuit. Transistor *Q1* is connected as a conventional common-emitter amplifier and functions as an audio oscillator; transistor *Q2*, also a common-emitter amplifier, serves as a buffer and amplifier stage. Coils *L1* and *L2* are the coil-and-magnet assemblies removed from a pair of 2000-ohm earphones; they act as "driver" and "pickup" coils, respectively.

When the circuit is first turned on, current flows through coil *L1*, which exerts a pull on the tuning fork, tending to set it in motion. Any movement of the fork will affect the magnetic field around coil *L2*, which, you'll notice, is coupled back into the base of transistor *Q1* through capacitor *C1*. The varying magnetic field around *L2* results in a small output from the coil, which is amplified by *Q1* and again transmitted to the tuning fork through *L1*. This process continues to repeat itself, with the tuning fork vibrating at its natural frequency.

Since *Q1* is substantially overdriven, the waveshape at its collector is distorted. However, it was found desirable to overdrive *Q1* in order to obtain maximum signal through *L1*—this tends to set the tuning fork in motion much more quickly when the circuit is first turned on, and it also reduces the unit's sensitivity to shock and vibration.

Capacitor *C2* couples the 440-cycle signal picked up by *L2* into *Q2*. Due to the close proximity of *L1* and *L2*, a certain amount of unwanted coupling exists. As a result, the input waveshape to *Q2* is also somewhat distorted.

Completed tuning fork oscillator is self-contained and has but one control—a s.p.s.t. on/off switch.

To correct this situation and deliver a sine-wave signal at the output of *Q2*, emitter resistor *R6* was not bypassed and capacitor *C3* was shunted across the output of *Q2*. This arrangement reduces *Q2*'s gain quite a bit, but *Q2* was inserted primarily for isolation and waveshaping.

Construction Tips. As mentioned earlier, coils *L1* and *L2* are removed from a pair of 2000-ohm earphones.* To modify the earphone set, first unscrew the ear caps and remove the diaphragms. Next, unscrew the magnet and coil assemblies from their holders and remove them from the headset. Save the screws and nuts, since they'll come in handy for mounting the coils to their brackets.

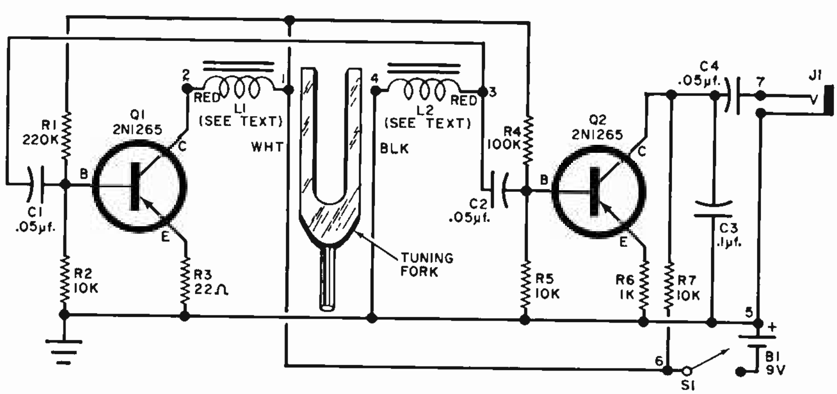
The three brackets which hold the coils and the tuning fork can be made from ⅛"-thick aluminum strips bent to form an "L"; naturally, the dimensions of the brackets will depend on the particular earphones and tuning fork you have selected for use in the device.

Mount the tuning fork on its bracket as rigidly as possible. If desired, a small metal strip can be bent around the tuning fork base, much like a cable clamp, to facilitate attaching it to the bracket.

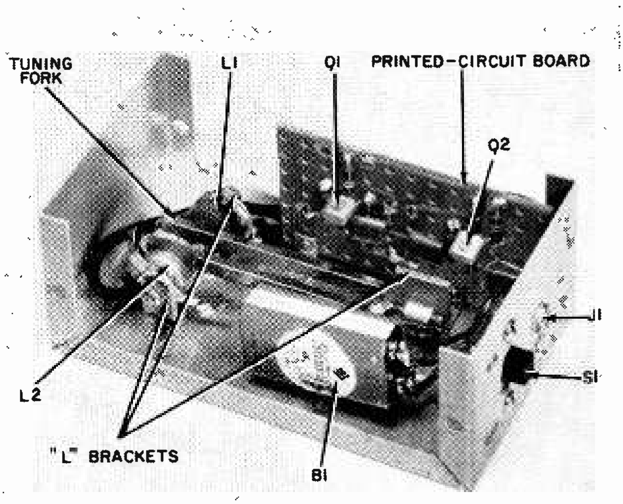
When mounting the coil brackets to the chassis, be sure to make some pro-

**The earphones used by the authors were purchased from Olson Electronics Inc., 260 S. Forge St., Akron 8, Ohio. These earphones (Cat. No. PH-6) are no longer available, but another earphone set, The Calrad RH-40 (Olson Cat. No. PH-10) can be used instead ($1.95 plus postage). The latter phones, which have an impedance of 4000 ohms, contain a double-magnet coil and will require the use of two mounting brackets per coil.*

Circuit of oscillator relies on interaction between coils L1 and L2 and tuning fork for its of Vectorbord; numbered points on schematic (left) correspond to those on pictorial (right)



Coils and fork are supported by "L" brackets. Placement of other parts isn't critical, but author also mounted Vectorbord on brackets.



vision for adjusting the position of the coils relative to the tuning fork; the easiest way to do this is to drill out slots rather than holes. Position the coils near the tips of the tuning fork and as close to the fork as possible without allowing the magnets to actually touch it.

None of the circuit wiring is critical except for connecting up the leads to coils *L1* and *L2;* phasing is important here to obtain oscillation. The schematic diagram indicates the color coding and hookup for the coils used in the unit designed and assembled by the author.

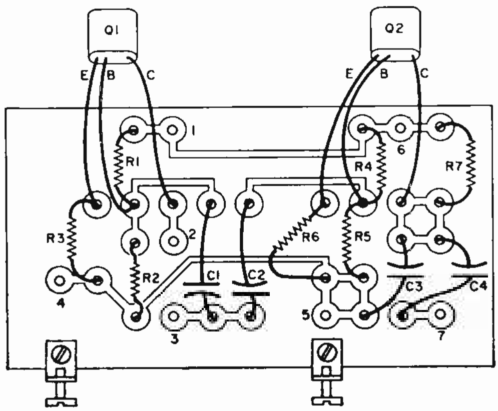
Operation. Once the oscillator has been assembled, it's a simple matter to put it in operation. A high-impedance earphone (1000 or 2000 ohms) should be connected to the output jack for monitoring the output signal while making final adjustments. Alternatively, you can feed the output into an oscilloscope or into an audio amplifier and speaker.

Switch the unit on and tap the tuning fork lightly with your finger or a pencil. You should hear a 440-cycle signal, which should continue for as long as the power remains on. If the signal isn't sustained, move the two coils closer to the tuning fork. Also, recheck the hookup of these coils for proper phasing; if necessary, try reversing the leads to one coil or the other—not both!

Once you've obtained a continuous signal, turn the power off for a few seconds and then switch it back on. Note the length of time it takes before the signal builds up to full strength again, then adjust the position of the coils for the fastest start-up time.

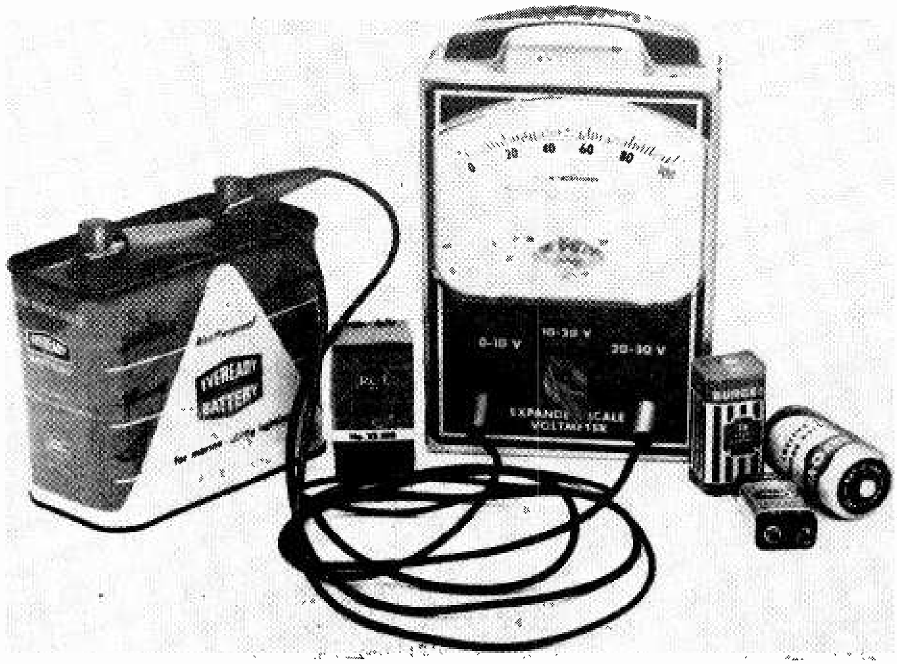
With a sustained vibration of the tuning fork and a continuous 440-cycle sinewave signal at its output jack, your tuning fork oscillator is now ready for use in any one of many possible applications. —[30]—

operation. Many components are mounted on piece and show where coils and battery should be wired in.



PARTS LIST

B1—9-volt battery (Burgess 2U6 or equivalent)
C1, C2, C4—0.05-µf., 75-volt ceramic capacitor
C3—0.1-µf., 75-volt ceramic capacitor
J1—Open-circuit phone jack, miniature type
L1, L2—Coil and magnet assembly removed from earphone—see text
Q1, Q2—2N1265 transistor (Sylvania)
R1—220,000 ohms
R2, R5—10,000 ohms
R3—22 ohms
R4—100,000 ohms
R6—1000 ohms
(All resistors ½ watt, 10%)
S1—S.p.s.t. slide switch
1—440-cycle tuning fork
1—5¼" x 3" x 2⅛" aluminum utility box, gray hammertone finish (Bud CU-2106-A or equivalent)
Misc.—Mounting brackets for tuning fork, L1, and L2; battery holder; 1¾" x 3⅜" section of Vectorbord; wire, solder, hardware, etc.



IMPROVED EXPANDED SCALE VOLTMETER

New circuit will read peak a.c. voltage, or d.c. volts, regardless of lead polarity

By DOROTHY LOUISE ZACHARY

IF you built the "Expanded-Scale Voltmeter" described in the August 1961 issue of POPULAR ELECTRONICS, or if you're still thinking about building one, you'll be interested in this useful modification. As you may recall, the original instrument had three d.c. voltage ranges (0-10, 10-20, and 20-30), each spread out over the full scale of a 4½"-wide panel meter. Overload protection was automatically provided by the zener diodes used in the circuit; these diodes had the effect of "locking" the meter at its maximum scale reading regardless of the amount of overvoltage applied at the input jacks.

The improved expanded-scale voltmeter retains all of the original features, but each of the three d.c. voltage ranges can now be used to read the peak a.c. volts as well. In addition, you don't have to worry about polarity when using the instrument on d.c. No matter which of the input jacks is positive and which is negative, the meter reads in the proper direction. To get these extra bonuses, you have only to add four diodes, a capacitor and a couple of terminal strips.

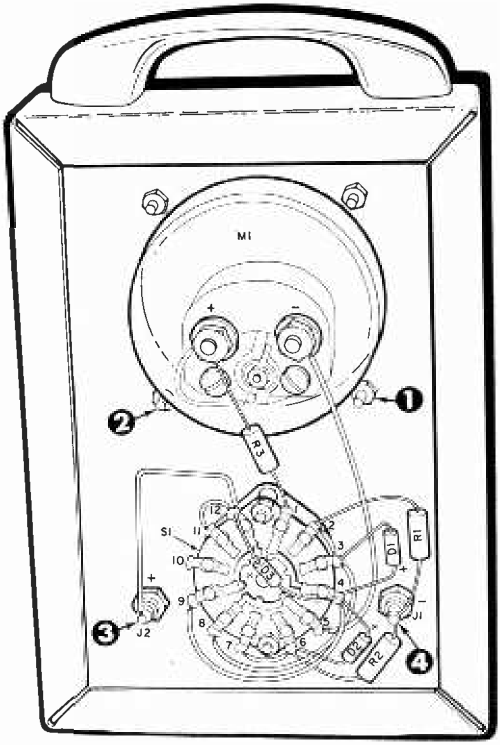
About the Circuit. No changes have been made in the circuit of the original meter, shown in the shaded area of the schematic on p. 140. (For a discussion of this circuit, see article mentioned earlier.) The modification involves adding a simple diode-bridge input consisting of diodes *D4-D7* and capacitor *C1*. The new circuit is connected to the old one at the points (marked "X" on the schematic) where input jacks *J1* and *J2* were originally wired in. These jacks are rewired to the diode bridge as shown.

If d.c. is now fed into the meter with *J1* plus and *J2* minus, diodes *D5* and *D6* conduct; diodes *D4* and *D7* do not conduct, since they are reverse-biased. The current then flows from *J2*, through *D6*, to the original negative input lead of the meter. Leaving the meter circuit through the original positive lead, the current passes through *D5* and out jack *J1*.

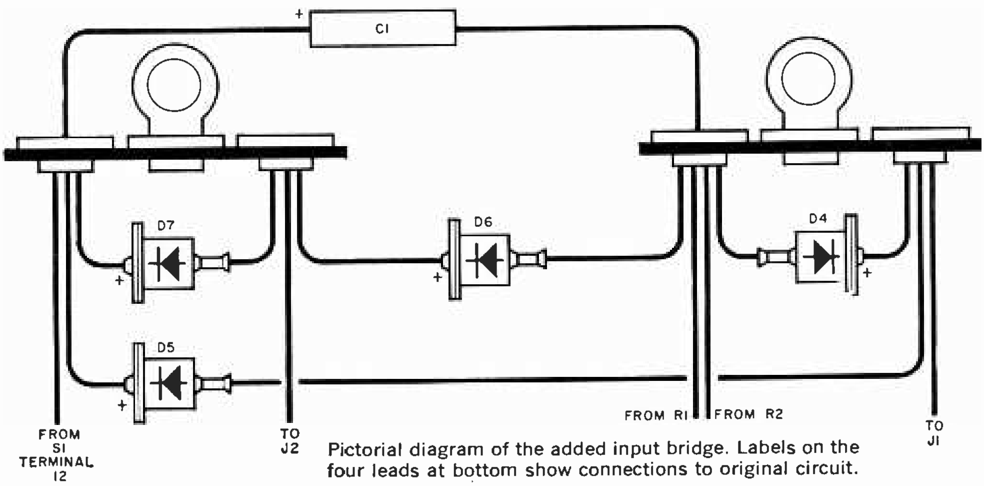
Should the situation be reversed (with *J1* minus and *J2* plus), diodes *D4* and *D7* would conduct—but diodes *D5* and *D6*, being reverse-biased, would not. In this case the current flows from *J1*, through *D4*, then to the original negative input lead of the meter and out the other lead as before. Passing through diode *D7*, the current finally flows out jack *J2*.

If jacks *J1* and *J2* are connected to an a.c. source, *J1* and *J2* become alternately positive and negative. When *J2* is negative, the current flows as in the first example discussed above; when *J1* is negative, the current flows as in the second example. Since the flow of current through the meter must always be in the same direction, rectification takes place. The net result is that the meter reads peak a.c. volts on each of its ranges. Capacitor *C1* acts as a ripple filter for the rectified a.c.; during d.c. operation, it serves to increase the damping factor of the meter.

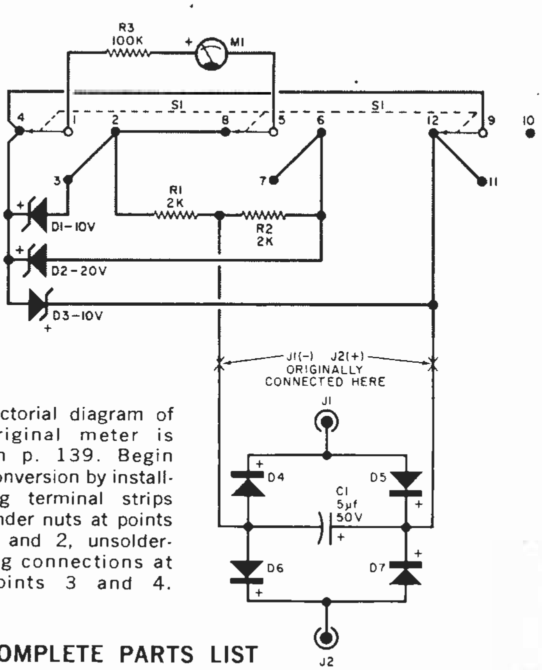
Making the Modification. Even if you've already built the expanded-scale voltmeter, installing the added components is no problem at all. Pictorial diagrams of the original circuit and the new input circuit are included for your convenience, as well as a photograph of the wiring of the author's modified unit.



Begin by removing the nuts from meter *M1*'s two bottom retaining screws. A 2-lug terminal strip is then installed



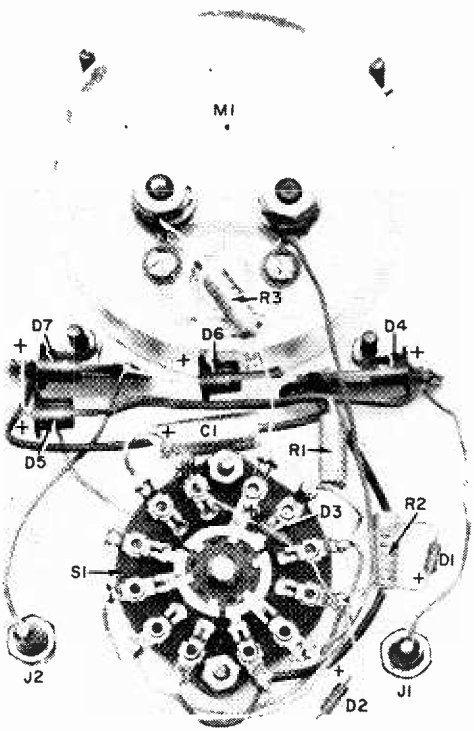
Pictorial diagram of the added input bridge. Labels on the four leads at bottom show connections to original circuit.



New circuit (below X's) is added to old one (grey area) at the points formerly connected to jacks J1 and J2.

Pictorial diagram of original meter is on p. 139. Begin conversion by installing terminal strips under nuts at points 1 and 2, unsoldering connections at points 3 and 4.

Rear view of converted unit (below) shows wiring clearly. Note that extra components fit with no overcrowding.



COMPLETE PARTS LIST

*C1—5-µf., 50-volt miniature electrolytic capacitor**
D1, D3—10-volt zener diode, 1-watt, 5% (Motorola 1N3020B or equivalent)
D2—20-volt zener diode, 1-watt, 5% (Motorola 1N3027B or equivalent)
*D4, D5, D6, D7—1N91 diode**
J1, J2—Insulated tip jack
M1—0-100 d.c. microammeter (Beede Model 230 or equivalent)
R1, R2—2000-ohm, 1-watt, 1% precision resistor (either deposited-carbon or wire-wound)
R3—100,000-ohm, 1-watt, 1% precision resistor (either deposited-carbon or wire-wound)
S1—3-pole, 3-position rotary switch
1—2" x 7" x 5" aluminum chassis (Bud AC-402 or equivalent)
Misc.—Carrying handle, 2-lug terminal strips, wire, solder, etc.*

**Used in modified version only*

on each screw, and the nuts replaced and tightened down. Disconnect the lead (from *S1*'s terminal 12) running to *J2* and the leads (from resistors *R1* and *R2*) running to *J1*. These leads are connected to the terminal strips as shown in the pictorial diagram of the input circuit.

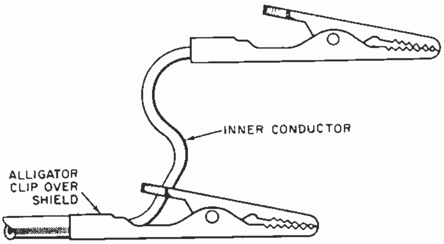
Still referring to the pictorial, install diodes *D4*-*D7* and capacitor *C1* on the terminal strips, then wire in the new leads to *J1* and *J2*. Be sure to use a heat sink when soldering in the diodes (they can easily be ruined by the application of too much heat) and to observe carefully the polarity of both capacitor *C1* and the diodes. The modification is now complete and the instrument is ready for use.

Reading the Meter. The procedure for reading the meter, whether you're measuring a.c. or d.c., is exactly the same as that used with the unmodified version. Just mentally convert *M1*'s 0-100 scale to read 0-10 volts; but add 10 volts to all measurements taken on the 10-20 volt range and 20 volts to all measurements on the 20-30 volt range. —30—

The Best of TIPS & TECHNIQUES

ALLIGATOR CLIPS ON SHIELDED CABLE

Test leads and other shielded-cable leads terminating in alligator clips can be a bother: the shielded wire frays, breaks, or shorts something out. If this is your problem, cut the shielding as if you were attaching a coaxial connector—leave about ¼" of shielding exposed and fold it back over the



outer insulation of the cable. Open up the tabs at the back of an alligator clip, place them around the shield and crimp them closed. To insure good contact, solder can be applied where the two tabs meet. Attach the clip to the center conductor as you normally would. —*Joel Fentin*

TRACING PAPER KEEPS WORK CLEAN

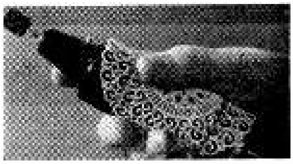
To keep track of how far you've gone on a construction project, it's a good idea to mark the schematic in some manner. However, this makes for a very messy schematic when the job's finally done. Instead, you can simply place a sheet of tracing paper over the schematic and trace each wire and component as you connect it. When the project is finished, a quick comparison of the traced schematic with the original one will show any omissions, and the original schematic will still be clean and readable. —*J. A. Singer*

MAKE YOUR OWN PLUG-IN CAPACITORS

Capacitors that plug in like vacuum tubes make servicing and replacement easy. Although many commercial plug-in units are available, you probably have some loose capacitors around the shack that you can install in an octal plug yourself. Start out by mounting an octal tube socket on the chassis. Then insert the leads of the capacitors to be used in the circuit into the pins of an octal base—from an octal base and shield combination such as the Millen 74400—and solder them in place. Next, wire the corresponding socket pins into the circuit. Fasten the shield over the octal base, and your plug-in capacitor is ready to go. —*James V. Conklin*

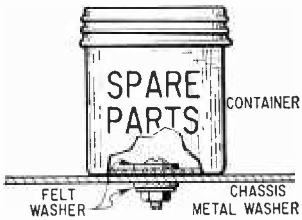
NON-SKID GRIP FOR SMALL POWER TOOLS

Do small power tools slip through your moist hands in hot weather? The solution to this problem is an easy one. Just wrap the tools with inexpensive plastic doilies from the dime store. The perforations provide a sure grip and allow air to circulate between the tool and your hand. You can square off the doilies with a scissors, if you like, and hold them in place with rubber bands. —*Ken Murray*



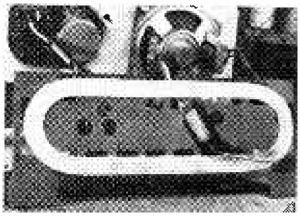
BUILD IN SOME SPARE PARTS CONTAINERS

Ever spend frustrating "hours" digging up a replacement fuse for a power supply or a new pilot lamp for your receiver? With spare parts containers mounted right on the units themselves, you can save all this fuss and bother. Just get some plastic containers with screw-on caps, drill holes through the base of each plastic container and chassis, and bolt the container in place. Use a felt washer between the head of the screw and the base of the container, so that the plastic will be less likely to crack. —*Martin J. Leff*



NEW RADIO BACKS FROM LINOLEUM SCRAPS

The backs on small table-model radios always seem to get torn and loose. But it's quite easy to make a replacement from a scrap of linoleum. Using the old back as a template, trace the outline onto the linoleum.

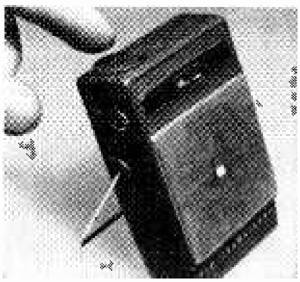


Then cut the linoleum with a pair of heavy shears or tin snips. Finally, remove the loop antenna—or loopstick—from the old back, and fasten it to the new one.

—*H. L. Davidson*

COPPER PENNY IMPROVES TRANSISTOR PORTABLE'S RECEPTION

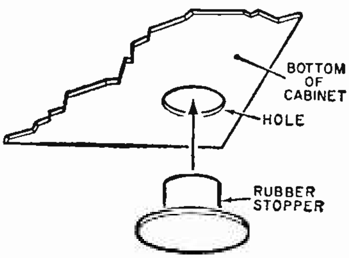
Does your portable transistor radio refuse to pull in those distant stations? Try placing a copper penny on the set's cabinet—right over the built-in antenna. If it does the trick, fasten the penny to the cabinet with Scotch tape. In the case of the Channel Master set shown here, reception was improved amazingly.



—*John A. Comstock*

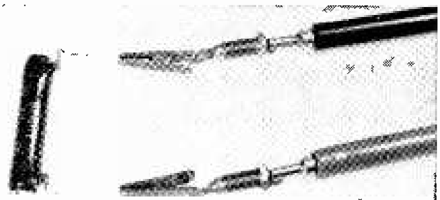
PRESS-FIT RUBBER FEET ON YOUR EQUIPMENT

Small flat-head rubber stoppers from medicine and chemical bottles are well suited to the task of protecting furniture against scratches from metal equipment cabinets. No screws are needed to install these plug-in rubber feet on your equipment. Drill a hole (slightly smaller than the stopper diameter) in each corner of the chassis or cabinet, then insert the stopper for a tight fit.—*George Lodenquai*



ADAPTERS CONVERT PROBE TIPS TO ALLIGATOR CLIPS

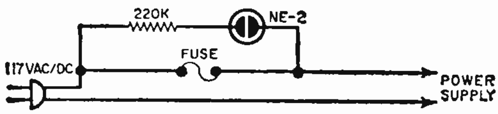
If your multimeter has test leads terminating in probe tips, you've probably had occasion to wish that they were equipped with alligator clips instead. You could make up an extra set of leads having clip terminations, of course, but the adapters pictured here are a neater solution. Just solder alligator clips to a set of pin jacks as shown. The probe tips will slip into the jacks—and you're all set.



—*Stanley E. Bammel*

BLOWN FUSE INDICATOR

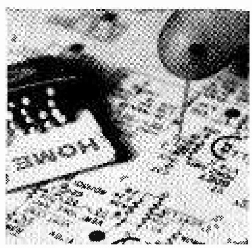
A neon lamp and a resistor are all that are needed to indicate a blown line fuse in your equipment. Solder a 220,000-ohm, ½-watt resistor in series with an NE-2 neon bulb and connect them across the fuse, as indicated in the diagram. Now, when the fuse blows, the bulb will glow. With the bulb mounted on the front panel of your receiver or transmitter, you'll never be in doubt as to whether a line fuse has blown when the equipment stops operating.



—*Charles D. Rakes*

PIN-POINTING DIAGRAM PARTS

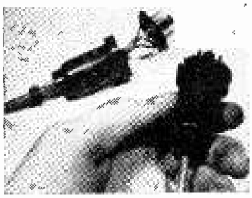
Color-coded dressmaker's pins are very handy for identifying wires, parts, and connections on diagrams. Just attach the diagram to the wall or a piece of cardboard and stick the pins in. When building equipment you can identify parts or wires already soldered, and when servicing equipment the colored pins can mark the unsoldered parts or wires.



—*Charles Lang*

CONVERT OLD METAL TUBES TO INEXPENSIVE PLUGS

Don't throw out those metal tubes you've removed from old pieces of electronic equipment; you can put them to use as inexpensive plugs for auxiliary power sockets. With a screwdriver, pry open the tabs that hold the body and base together. Then break the glass bond between the base and body—a tap or two against a hammer head or some other hard surface should do the trick—but be sure to wrap the tube in a cloth first, so glass fragments will not fly loose and inflict injury. Now, using a soldering iron and pliers, remove the wires connecting the tube elements to the pins, and discard the elements. If there is a grid cap, break it off and enlarge the hole to accept a rubber grommet—if not, drill a suitable hole and insert the grommet. After hooking up the cable—as shown in the photograph above—bend the tabs back in place to secure the body to the base.



—Robert E. Kelland

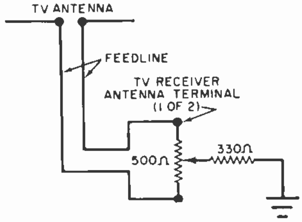
BREADBOARDING WITH FLEA CLIPS

"Fleas" are handy little things to have around when you're hooking up experimental circuits. The "fleas" in question are flea clips, of course, and they're especially useful for breadboarding. Solder some of these clips to potentiometers, capacitors, resistors, and other components—as well as to wires of various lengths—and you won't need a soldering gun during your experimenting. When you want to try out a new circuit, you can quickly connect and disconnect the leads. And there's almost no limit to the parts these can be used on—tube sockets, for example, can have a clip for every pin connection. In addition, a stiff wire equipped with "fleas" can serve the dual purpose of acting as both a jumper and a support for components.

—Francis J. Leyva

PHASE CONTROL ELIMINATES TV GHOST

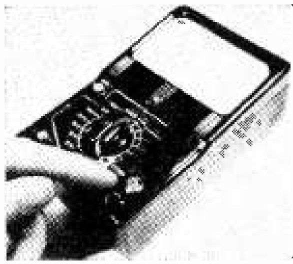
Do you have an unwanted guest whenever you watch television? Well, if he's only a ghost on your TV screen, a flick of the wrist —while holding the right knob—can cause him to vanish. Simply install a 500-ohm, non-inductive potentiometer across the antenna terminals of your TV set (see schematic) and a 330-ohm resistor from the potentiometer center tap to ground. (Use a water pipe, or any source other than the chassis for the ground connection.) When you see a ghost, just vary the pot—in most cases, you'll kill him on the spot. You're actually loading one side of the feedline and in turn balancing out the other side—matching the feedline and antenna impedance to that of the TV set.



—Dudley McCown

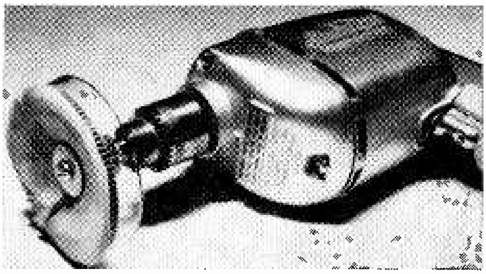
PUSH-BUTTON SWITCH AIDS ZERO-ADJUSTING

Simplify zero-adjusting your ohmmeter by installing a momentary-contact, push-button switch across its jacks. Then you won't have to remove the meter's test clips from the circuit being measured in order to short them together. If your meter is a VOM and the jacks are also used for voltage testing, be sure the switch you install is rated at a high enough voltage not to arc over. Be sure, too, that the switch's bushing is long enough to pass through the meter's front panel. *—Robert E. Kelland*



HOMEMADE DISC SANDER

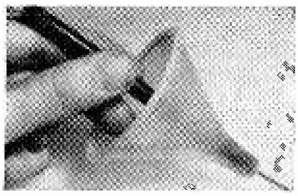
Next time you need a disc sander—but feel that the investment is hardly worth the occasional use the sander will get—construct your own. Pick up a large TV tuning knob and a flat-head bolt—with matching nut and washer—at your local parts store, and you have the makings of a good disc sander. Drill out the shaft-hole so that you end up with a hole clear through the knob. Now place a sandpaper disc over the front of the knob, push the bolt through the



washer and sandpaper into the hollowed-out knob, and tighten the nut on the bolt. Be careful not to apply too much pressure to the bolt and nut, as you might crack the knob. Then place the bolt in the chuck of your drill. —*Homer L. Davidson*

PLASTIC FUNNEL IS SHOCK PROTECTOR

When using test prods around activated transmitters or high-voltage power supplies, you can employ a 2-ounce plastic funnel as a shield to protect your hand (see photo). The "spout" of such a funnel is just the right size to slip over a standard test prod and can be cemented permanently in place if desired. This simple, inexpensive little device may save you from unpleasant shocks and burns. —*Jerome Cunningham*



BITS HOLDER FROM CORRUGATED CARDBOARD

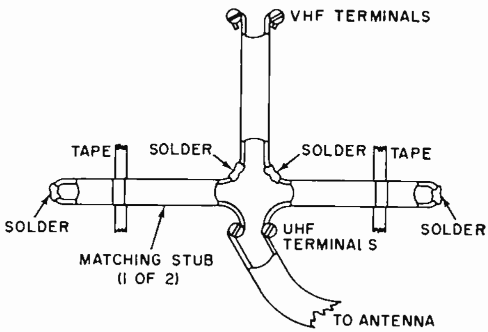
A handy container for drill bits can be made from any small box—a flip-top cigarette box will do nicely—which is just large enough to hold your longest bit. Once you have the box, cut a number of pieces of corrugated cardboard—sized so that they will fit snugly inside the box and still allow the tips of the bits to protrude slightly. You'll find that bits up to ¼" in diameter will easily slip into the open ends of the cardboard sections. Larger-size bits can be accommodated by cutting the smooth surface covering one of the corrugated channels on two pieces of cardboard so that they are opposite each other when placed in the box. —*Augusto R. Azanza*

HEAT SINKS FROM ALLIGATOR CLIPS

When leads from a pair of heat-sensitive components (such as transistors, diodes, miniature capacitors, etc.) are being soldered together, two heat sinks are required. Though long-nosed pliers do a fine job of drawing away heat, it's not easy to hold two pairs and solder, too. So before starting on your next project, try making up a heat sink like the one pictured here. It's nothing more than a pair of alligator clips connected together with a short piece of heavy, stranded wire. Clip it across a joint before soldering and your troubles are over. —*Robert E. Kelland*

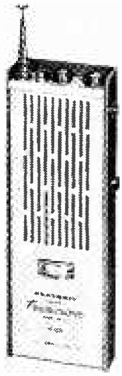
UHF RECEPTION WITH VHF ANTENNA

If you haven't gotten around to installing a UHF antenna—but are otherwise all set to pick up standard VHF stations—try the

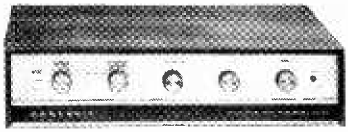


hookup shown here. The two 3¼" matching stubs are made from 300-ohm TV twin-lead, and each has the leads on one end shorted and soldered together. Attach your antenna lead-in to the UHF terminals on your TV set, and hook up one lead of each matching stub to these terminals as well. Now solder the remaining lead of each stub to the leads of another piece of twin-lead—the other end of which has been connected to the set's VHF terminals. —*Kent A. Mitchell*

FOR HAM RADIO—Heathkit 80 Meter SSB Transceiver, Kit HW-12, $119.95.

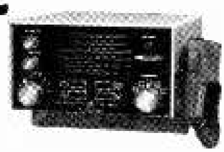


FOR SPORTS — Heathkit 1-Watt Walkie Talkie, Kit GW-52, $74.95.

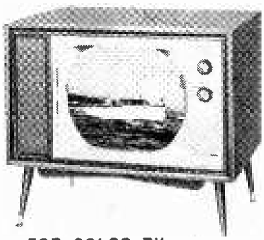


FOR STEREO/HI-FI—Heathkit 40-Watt All-Transistor Stereo Amplifier, Kit AA-22, $99.95.

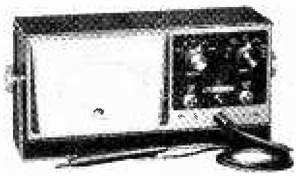
Here are a few Heathkit values... there are 245 more where these came from!



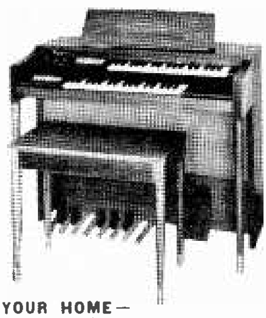
FOR YOUR BOAT—Heathkit 25-Watt Radiotelephone, Kit MWW-13, $164.95.



FOR COLOR TV—Heathkit GR-53, $349.00.



FOR TEST EQUIPMENT—Heathkit "Service Bench" VTVM, Kit IM-13, $32.95.



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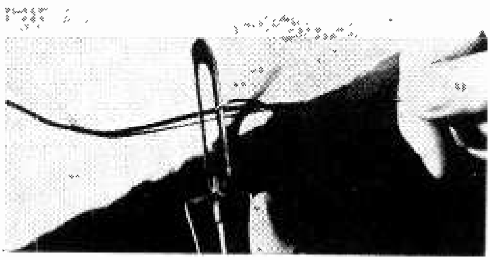
VEGETABLE PEELER IS INSULATION STRIPPER

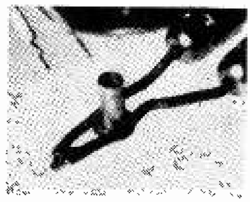
A vegetable peeler of the type shown in the photo makes an ideal tool for stripping insulation from long lengths of wire, a job which conventional strippers can't do. And, unlike a pocket knife, the peeler won't accidentally slip and cut through the wire. For best results, hold the peeler against your bench and pull the wire through it.



—*Robert E. Kelland*

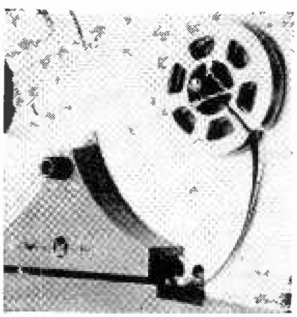
SOLDERING POT FOR YOUR GUN TIP

A soldering pot, useful for tinning wire tips and lugs, can be devised for your soldering gun. Just wedge a small container, such as a discharged 22-caliber shell, between the heating elements of the gun, and you're all set. If a cartridge is not readily available, a large hollow rivet will probably do the job just as well. —*Jerome Cunningham*



8-MM. FILM REELS HOLD RECORDING TAPE

Did you know that plastic 8-mm. film reels are ideal for storing small quantities of magnetic recording tape? They will fit the spindles of almost any tape recorder, and a 50-foot reel will hold up to 200 feet of standard, 1½-mil tape. Don't try to use a metal reel, however; if it is made of ferrous material, it may demagnetize the tape. —*Glen F. Stillwell*



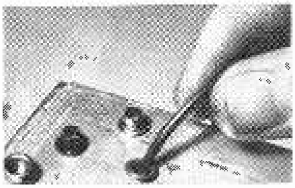
TOOL HOLDER FROM ADHESIVE BANDAGE CONTAINER

An adhesive bandage container makes a good tool holder. Just tack the lid of the container on the wall of your workshop, and it will accommodate screwdrivers, pliers, wrenches, etc. Since these containers come in various sizes, the size tools they will hold also varies. Another use for containers of this type is for storing small parts.

—Wayne Floyd

HOLLOW RIVETS SERVE AS MINIATURE GROMMETS

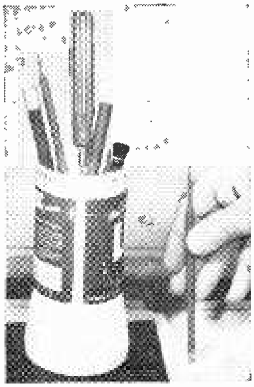
If you're looking for a miniature grommet to feed a small wire through a chassis hole, a small hollow rivet will do the job. You can get such rivets, in almost any size you might require, at any large industrial hardware store. And there's no need for a special crimping tool; the rivet works just as well for this purpose if it's simply cemented into a close-fitting hole.



—John A. Comstock

DETERGENT "BOTTLES" BECOME CONTAINERS FOR TOOLS OR PARTS

Don't let the lady of the house throw away those empty detergent "squeeze bottles." With their tops cut off (a hacksaw does the job nicely), they make handy containers for your work bench. The larger sizes (like the one illustrated) will hold aligning tools, screwdrivers, etc. The smaller ones are fine for miscellaneous hardware. If you want to, you can cover up the advertising labels on the bottles by applying a couple of coats of dark paint.



—H. Leeper

Ultrasonic Sniffer

(*Continued from page* 124)

60/40 is recommended and available from most radio supply stores. As a soldering aid, buff the board lightly with fine steel wool until the copper is bright and shiny; do this before inserting the components.

Battery *B1* is fastened in place by means of a piece of hookup wire. Pass the wire around *B1* and through a couple of holes drilled in the board; then tie the ends of the wire together. The battery leads are wired to the board at points *F* and *G* (see schematic diagram).

The remainder of the construction is relatively easy. Potentiometer *R18* and jacks *J1* and *J2* are mounted on a 5¼" x 3" x 2⅛" aluminum utility box. The board is held in place in the box by means of four 1¼" spacers. These are installed at the corners of the box top and placed to mate with the mounting holes in the board.

Run the "hot" leads from *J1* and *J2* to points *A* and *C* on the board, respectively. Potentiometer *R18's* arm is wired to *D*; the "high" end of *R18* goes to *B*; and switch *S1*'s terminals run to *E* and *F*. Finally, solder the ground lead (from the "frame" terminal of *J2* and the "low" end of *R18*) to the ground bus which circles the board at its edges.

Complete the construction by running a bead of solder around one of the 1¼" spacers where it touches the ground bus. This will insure good contact between the board and the box.

Adjustment. Before closing up the utility box, you must adjust coils *L1* and *L2*. For this task, you'll need a signal generator that can be tuned up to 38 kc.

Begin by plugging a headset of 400 ohms impedance or higher into *J2*, and the input transducer (microphone) into *J1*. This is important, as the tuning of *L1* is affected by the transducer. Turn switch *S1* on, and set potentiometer *R18* to about the middle of its travel. Set the signal generator to 37.5 kc., turn the generator output control to minimum, and loosely couple the output lead to the insulated wire connecting *J1*'s center contact to *L1*. You can do this by

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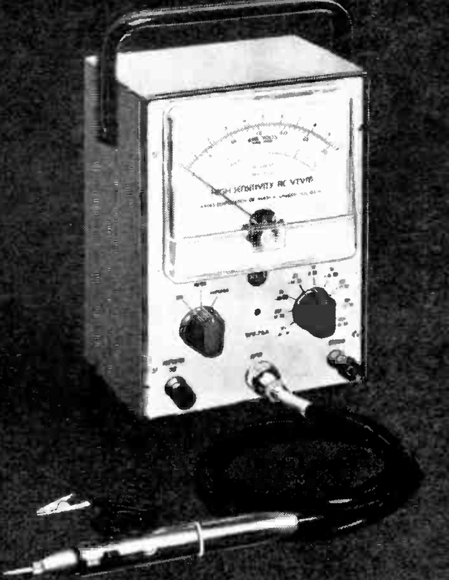

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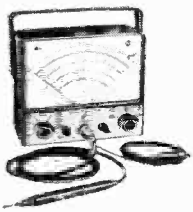

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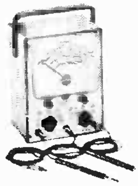

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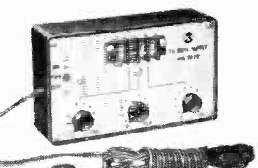

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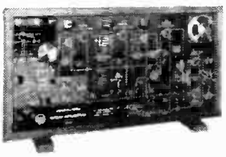

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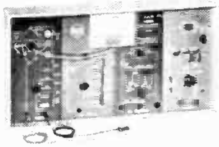

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looping two or three turns of the generator output lead around the *J1-L1* lead wire. Now turn up the generator output control until a tone is heard in the phones, and adjust the slug of coil *L2* until the tone "zero beats."

Next, retune the generator to 38 kc., producing a 500-cps tone in the phones. Adjust the slug of *L1* for maximum headphone volume, reducing the generator output as necessary to avoid overloading. Remove the generator lead from the *J1-L1* lead, install the chassis cover, and the Ultrasonic Sniffer is ready.

Operation and Applications. Don't expect to be overwhelmed with sound as soon as you turn the unit on. Though there are many ultrasonic sounds to be heard, these high frequencies are easily blocked and absorbed. Furthermore, the transducer element is quite directional.

A good test for proper operation is to rub your fingers together (lightly) at arm's length from the transducer. With *R18* set at maximum, you should be able to hear the sound clearly. Now have someone jingle a bunch of keys from 10 to 15 feet away; this sound, too, should be clearly heard.

Insect and animal life provides a fascinating source of ultrasonic sound. Take the unit out to a wooded area some evening and probe around the trees and bushes. You should be rewarded with ultrasonic "signals" from tree locusts, tree frogs, and other wild life.

If you happen to live in an area where bats are common, you'll be able to hear the pulses these animals send out to find their way or locate food. They begin at about 100 kc., then shift downward to about 20 kc., and can be detected as they pass through the sensitive range of the transducer.

On a more practical level, gases escaping under pressure generate high intensities of ultrasonic sound. For this reason, the Sniffer makes an excellent "leak detector." It can be used, for example, to check auto exhaust systems for tightness.

The author has even employed the unit to set valve tappets on his car. Since the microphone is very directional, it can be aimed to hear sounds from one valve only. The tappet-adjusting nut is turned (while the engine is running) until no clicks are heard.

One last tip: the instrument is an excellent tool for testing ultrasonic remote-control transmitters for TV sets. Each control button should produce a tone, and all tones should be of about the same magnitude. With a little experience, you'll be able to spot malfunctions quickly. —30—

The Master Magnet

(*Continued from page* 120)

available, copper best meets that requirement.

Electrical Hookup. If the a.c. line is connected between terminals 1 and 2 of the magnet coil (see Schematic "A"), current consumption will be in the neighborhood of 20 amperes—a bit excessive for use around the house. Connecting terminals 1 and 3 (Schematic "B") results in a current flow of about 4.25 amperes, but the strength of the magnet is reduced proportionately. In both cases, however, the current performs little useful work because, in this inductive circuit, it lags about 90° behind the voltage.

The lag can be partially offset by adding an 80-μf. phase-shifting capacitance as shown in the modified parallel-resonant circuit of Schematic "C." The current drawn from the line is then about 4 amperes, while the currents flowing between terminals 1 and 2 and terminals 2 and 3, respectively, are 18.5 amperes and 9 amperes. This hookup results in a more powerful magnetic field than that of either Schematic "A" or Schematic "B."

Maximum magnetic pull is obtained with the series-resonant circuit illustrated in Schematic "D." In this case, 17 amperes flows through the whole coil; and the magnet will hold six or more half-dollar coins, or an equivalent weight of any other non-ferrous metal, at one time.

The 80-μf. capacitance specified in Schematics "C" and "D" is built up by paralleling several smaller capacitors. These must be of the non-electrolytic type, with ratings of at least 250 volts if connected as in Schematic "C" or 600 volts if connected as in Schematic "D." Such capacitors are available for the least money in surplus stores—where they are usually easy to find. Units totaling less than 80 μf. could be employed, provided that they have the proper voltage ratings, but the current flowing through the magnet winding would be reduced.

Since high voltages appear across the capacitors, and since they are apt to retain their charge after being disconnected from the line, it's best to enclose them in a wooden or metal box. As an added precaution, the capacitors should always be discharged with a tool having an insulated handle before any work is done on the circuit.

Because of the peculiarities of the magnetic field around the copper washers, the magnet will not attract pieces of non-ferrous metals narrower than the inside diameter of the washers or wider than their outside diameter. Designing an electromagnet to attract pieces of metal narrower or wider than the range covered by this unit might be an interesting project for you experimenters.

A final word of caution: since the washers carry considerable current, they get quite hot under prolonged use. Heating can be kept to a minimum if the magnet is connected to the line only when actually in use. -30-

Transistorized Transmitter

(*Continued from page* 112)

using an oscilloscope as an indicator. The transmitter is then placed in the desired location, connected to the antenna and audio lines, and the output tuned for maximum signal strength, using a portable receiver.

Since this transmitter falls under rules concerning limited-radiation devices, care must be taken to insure that the field strength does not exceed 15 μv. per meter at a distance of 234 feet (for 670 kc.) *from the radiating device.* This may be taken to mean "from the antenna," which can be a length of wire running around the side of the building in which the transmitter is placed. (See FCC Rules and Regulations, Paragraphs 15-2 to 15-7.) -30-

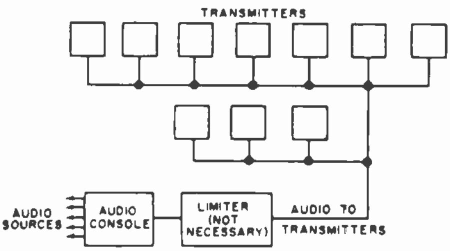

Fig. 2. The same audio signal is supplied to a large number of on-campus transmitters.

Monitor Your Code

(*Continued from page* 95)

wire or rod and a banana jack. Or you may be able to pick up or fabricate a collapsible antenna as shown in the photos. Install the transistors in their respective sockets, and then snap in the penlight cell, being careful to observe the correct polarity.

How It Works. The Code Monitor consists of two transistor circuits connected in series—the trigger circuit and the audio tone circuit. The trigger circuit is made up of transistor *Q1*, voltage doubler diodes *D1* and *D2*, and iron core r.f. coil *L1*. A signal picked up by the antenna is applied across *L1*, rectified and doubled by the diodes, and applied to *Q1*, causing the transistor to conduct heavily. When *Q1* conducts, it connects battery *B1* to ground, thereby providing power to the tone circuit. Closing the circuit across *Key* jack *J2* has the same effect as a conducting *Q1*.

The tone circuit is basically an audio frequency amplifier consisting of *Q2* and *Q3*, with a feedback path provided by *C3* which causes the amplifier to oscillate at an audio frequency. *Output* jack *J3* permits the connection of an a.c. voltmeter, if desired, when the Code Monitor is employed as a relative field strength indicator.

Testing and Operation. Turn the unit on and connect a telegraph key across *Key* jack *J2*. When the key is closed, a clean, crisp tone will come from the speaker. (If you prefer to use a headset rather than the speaker, connect it to *Output* jack *J3*.)

Now plug an antenna into jack *J1*, on top of the unit, and key your transmitter on either the 80- or 40-meter band. A tone should be heard. If the tone is too loud, move the unit away from the transmitter and transmission line; and if the tone is too weak or inaudible, move it closer. In extreme cases of low level r.f. fields, it may be necessary to connect the Code Monitor's case to a window screen or some other longer antenna. —30—

One Receiver—All Bands

(*Continued from page* 83)

spool from the vise, unwind more wire, reclamp the spool, and continue winding. If you take your time, you should have a professional-looking winding job with the wire tightly wound and uniformly spaced.

When the proper number of turns has been wound on, cut off the wire (leaving a lead of about 6"), put the wire through the proper hole in the form, place your thumb over the hole to hold the wire in place, remove the insulation from the wire, push the wire through the proper base pin, and solder it in place.

Incidentally, it's especially important that the secondary and tickler coils (*L2* and *L3*, respectively) be wound in the same direction. If they're not, the regenerative detector won't operate properly. In the event that you experience trouble in getting the set to oscillate, try reversing connections to either *L2* or *L3*—not both!

Although information on the other coils is given below, it will probably be better for you to skip over to the "Operation" section at right, read that material, and try the receiver. Then you can come back and wind the other coils.

Three of the coils are single-layer affairs, and are all wound in the same manner (one being the broadcast-band coil described above). However, it's impossible to place enough wire in a single layer on the 250-600 kc. coil, so a different winding style is used for this one.

To wind the 250-600 kc. coil, drill all of the holes in the form, but wind the secondary coil (*L2*) first. Solder one end of the wire in place and make several large looping turns up to the hole at which the secondary coil will end. Now start back down the coil and wind in the same manner, reaching the hole in the form where the coil started in only a few turns. Continue winding up and down the form until the specified number of turns are in place. The purpose of this winding method is to make as many of the turns as possible cross at angles rather than lie parallel and thus reduce the distributed capacitance.

After the secondary has been completed, wind the primary (*L1*) and tickler (*L3*) coils at the proper ends of the form. These coils should be scramble-wound, with the turns touching the ends of the secondary. Strips of plastic cement or coil dope can be run vertically at ½" intervals around the forms to hold the wires in place.

Operation. Check the wiring, connect the power supply to the receiver with the power supply cable, and plug in the broadcast coil. Connect an antenna to the *ANT 1* binding post (*J1*), and a ground to the *GND* binding post (*J3*). Set the *REGEN* control (*R2*) in the extreme counterclockwise position, the *ANT* (*C1*) and *GAIN* (*R6*) controls in the extreme clockwise position, and the *VERNIER* control (*C3*) in the center of its range.

Turn on the power supply. After warm-up, turn the *REGEN* control clockwise until a hissing sound is heard in the speaker. Now back off the control until the hiss just stops; this is the most sensitive point for reception of AM stations.

If you have trouble separating strong local stations, turn the *ANT* control counterclockwise. This increases the selectivity by decreasing the coupling of the antenna to the receiver. With extremely strong local stations, it may be necessary to use a very short antenna to limit the signal strength.

When you use the short-wave coils, you'll find that adjusting the tuning and regeneration controls is more critical. Tuning is best done by adjusting the main dial to the vicinity of the station you wish to hear and then doing the fine tuning with the *VERNIER* capacitor. Set the regeneration control to the point where the hiss starts to receive c.w. signals; and just below this point to receive phone signals. If the receiver refuses to oscillate at certain dial settings, change the antenna coupling by means of the *ANT* capacitor, or try the alternative antenna connections shown in the diagram on page 80.

With the long-wave coil in place, the receiver should handle about as it does on the broadcast band. And don't forget that additional coils to extend the range in both directions can be wound in a cut-and-try fashion. —30—

The Mello Monster

(*Continued from page* 62)

front panel (Part 11) to the enclosure (see Photo E).

Drill a small hole in the center of the

back just above Part 7, and insert two wires for the speaker leads. Next, lay the speaker over the hole in Part 15, and mark the four mounting holes. After you've drilled these holes, you can attach the speaker to the panel, and solder the lead wires to the speaker. Next, mount the speaker panel in the cabinet opening, using four #8 x 1½" flat-head wood screws. Don't glue this panel, since you may find it necessary to service the speaker some day.

Finalizing the Project. This is the time to stop work, hook up the system, and listen to the fruits of your labors. Chances are you'll want to congratulate yourself for having started the project, and then proceed to apply the finishing touches.

There are many ways to finish the enclosure. One of the easiest is to apply Formica sheet to the top, sides, bottom, and back, using "contact-bond" cement to hold it in place. For the front, a coat of black screen enamel is desirable (see Photo F); this prevents the cabinet openings from showing through the grille cloth.

Fabricate a frame from some molding (you'll find a large variety at almost any lumber yard) to fit the cabinet front; then finish the frame to match the covering you've applied to the cabinet. Staple the grille cloth to the frame, attach the assembly to the enclosure front, and you can sit back and listen with pride! —30—

Transistor Controls Temperature

(*Continued from page* 43)

Allow the oven temperature to stabilize for five or six on/off cycles and then note and record the temperatures at which the light goes on and off. The difference in readings at these two points represents the circuit's maximum operating range.

Now, all that remains to be done is to calibrate the dial of temperature control potentiometer *R1*. Turn *R1* counterclockwise (i.e., toward a lower temperature) a few degrees at a time and allow the oven temperature to stabilize each time you change the control position. The dial should be marked for the temperature midway between the minimum and maximum readings (lights on, lights off) for each setting of the control. Lower than ambient room temperature can be achieved by placing ice cubes (in a plastic container) inside the oven.

If less than maximum circuit sensitivity is desired, turn *R1* fully clockwise and allow the oven to stabilize at the highest temperature; then rotate sensitivity control *R4* counterclockwise a few degrees at a time. Allow the oven temperature to stabilize, and record the temperatures at which the light goes on and off.

The difference in temperature readings indicates the sensitivity for the setting of *R4*. Continue to vary *R4* until the desired sensitivity is obtained, then calibrate the control for *R1* as above.

Installation. If the thermostat is to control the heating unit of a house, the contact terminals of relay *K1* should be connected directly to the mercury-switch leads of a commercial thermostat. As a result, the transistor thermostat will "take over" whenever the commercial thermostat is set for a room temperature which is lower than desired.

In a permanent installation, the control circuit can be located in the basement with the sensing transistor and temperature-control potentiometer mounted at a convenient location in the house. If you make *R1* a subminiature potentiometer, you'll be able to house the "upstairs" unit in a "package" as small as a conventional thermostat. -30-

Don't Forget the Shoe Polish

(*Continued from page* 53)

player had been used by the Army or Navy for the old standard-groove, 33⅓ transcriptions and was probably "war surplus" before World War II.

The moral: always consider the electronic or mechanical gear as worthless when you figure the value of any old cabinet. In addition, always gauge the price against the cost of new material.

Make Way for a Speaker. When you have found a suitable cabinet, do the major surgery first. For a typical speaker enclosure, you'll need to brace the walls; perhaps add a new speaker board cut for your speaker size; and, very likely, put in some new grille cloth.

You can derive the port area from a bass reflex design chart if you have one available. If not, make the port area equal to the effective piston area of your speaker (about 85 sq. in. for a 12" speaker, 30" sq. in. for an 8" speaker), and tune. If you have trouble tuning the enclosure, try tacking several layers of cloth over the port to broaden the Q. Also, don't forget to pad heavily.

You'll probably have to add cleats to the sides, top, and bottom to accept screws for the back. And this, in many cases, is the only part you'll need to buy.

Bringing Out the Beauty. Your next step is to decide how the wood will be refinished. If it has been badly scratched or if it's darker than you desire, the decision is simple. You'll have to use varnish remover and go all the way down to the bare wood.

Follow directions with the varnish remover—brush it on, and let it work for the specified time before you start scraping. A putty knife will serve at first, but "gingerbread" or other kinds of tooled surfaces will require the use of a wire brush or steel wool. If you use steel wool, be careful to remove the small shreds or the magnet may attract them into the speaker voice coil gap. (A rag dampened with paint thinner will often pick them up very nicely.)

Most of the really old cabinets seem to have had a darkening agent applied. This must be removed from the pores of the wood if you want to apply a lighter, more natural finish. Dark woods can be bleached, but bleaching is a tricky process unless you're experienced at refinishing work.

When you have removed the old varnish and filler, you're ready to put on a new coating. New filler isn't necessary, but in some cases it will make a smoother surface without the slightly dimpled effect of unfilled wood.

If you try to match another piece of furniture, you'll probably find it impossible to purchase the proper stain. Actually, minor deviations usually go unnoticed, anyway. I prefer to use the "old-fashioned" oil stains, which seem to give a cleaner appearance than the "painty" stains. The latter are useful mainly to cover up undesirable grain or make cheap wood look like something better. Since these cabinets are usually made of high-grade veneers, the problem is to find a clear stain that adds the color you want without clouding the beauty of the wood.

The Shoe Polish! There are various kinds of "final coat" materials. Varnish is probably most common, lacquer almost as much so. Each has advantages. Varnish is easy to brush, lacquer more difficult. But lacquer dries dust-free almost immediately. Both will give a durable finish if you buy a good product and use it properly. (I've learned by experience that it *never* pays to economize.)

If you choose varnish, let it dry thoroughly (this is usually a matter of days) between coats for best results. Lacquer jobs can be rushed more. With either type of material, make sure the wood is cleaned with a cloth dampened with solvent and allowed to dry before you begin. Work only in good light and with as little dust as possible.

Some may question the sense of applying expensive finishes to a cheap cabinet, especially if it's only to serve as a remote speaker enclosure. And this is where shoe polish comes in. A can of paste shoe polish in the color desired can do an admirable job of staining and waxing the cabinet. In fact, some people like the waxed wood effect better than conventional treatments.

Apply the polish after you've removed the old varnish. With some cabinets, the whole refinishing job will amount to nothing more than dabbing on shoe polish to fill minor scratches and add new luster. The camouflage possibilities of shoe polish are almost unbelievable if the old finish is even remotely good.

White Elephants. Although the majority of the cabinets I've reworked have been from old radios, the possibilities are endless. Just recently I came across some old walnut buffets which were for sale. They were of a dated style, which brought the asking price down to the $5.00 level. All were about six feet long with an identical compartment in either end. It shouldn't take too much imagination for someone to convert such white elephants into very acceptably styled stereo enclosures with equipment in the central portion and speakers at either end.

One thing you can be sure of—if you do decide to rework any of these old pieces, your hi-fi or stereo rig will be unique, to say the least! —30—

The Lodestar

(Continued from page 24)

and 2′ long, will serve to support the loop. Fasten a wooden handle to the Masonite cross-member, and the sensing coil is ready for "prospecting!"

Trying It Out. No tricky adjustments are necessary to put the unit into operation. Set the tuning capacitor at about half-capacity, then adjust the tuning slug in coil *L2* until the "zero beat" is heard in the phones. Disregard any minor beats or whistles you may hear—the main beat-note signal will be very pronounced. If you have any doubt about the oscillators functioning, a quick excursion through the 1000-kc. region on an ordinary AM receiver will serve as an easy check.

Incidentally, capacitor *C5*, which couples the signal from the search oscillator to the mixer input, actually doesn't appear in the author's model—the proximity of this oscillator to the mixer induced enough coupling. Should additional coupling be necessary in your layout, simply install a "gimmick" capacitor for *C5*. The gimmick can consist of two 1″ lengths of hookup wire which are twisted together.

Successful operation of the Lodestar, or, for that matter, any other metal locator, hinges on the skill of the operator. Listening for a small change in tone is purely subjective, so the more practice you have in detecting these changes, the better your chances will be out in the field. It might actually be a good idea to bury various small metal objects in the back yard and then go "hunting" for them to get the feel of things.

The depth at which the Lodestar will detect buried metal objects in the ground will vary with the condition of the soil.

This is known as the depth of penetration. If the soil is wet, the depth of penetration will be less than that of dry soil.

In general, an object the size of a shovel or a steel water pipe can be detected by the Lodestar two feet or more underground. A small coin can be detected several inches away. -30-

1-2-3 Totalizer

(*Continued from page* 45)

the frequency of the pulses—you'll find that the unit will count almost any succession of pulses (it's capable of registering better than 400 counts per minute).

One good way to check the operation of the device is to cut out a circle of stiff cardboard about 2" larger than your phonograph turntable. Cut out a ½"-diameter hole about 1" from the outer edge of the cardboard and place the cardboard disc on the turntable. Then, when you place the photocell under the cardboard in line with the hole and a source of light (a flashlight should do very nicely) above the hole, the unit will count the number of times the hole passes by. If the speed of your turntable is 78 rpm, for example, the counter will register 78 counts per minute, assuming your turntable speed is correct.

Counting with a remote switch or relay requires only that the switch or relay be plugged into jack *J1* and the line cord into a 117-volt outlet. In this case, there's no need to plug in the photocell, since you'll be using another device to trigger the counting mechanism. -30-

The Fish Finder

(*Continued from page* 34)

will remain. And, when adding hot or cold water to make adjustments, always mix well so that the temperature will be uniform throughout the liquid.

Now set potentiometer *R5* at midrange and place *RT1* in the water. Wait several seconds for the temperatures of the Thermistor and surrounding water to equalize, and depress *S2*. Then adjust potentiometer *R2* so *M1* reads "Zero."

Prepare another jar of water as above, but this time set the temperature at 90°F (or at the upper limit of the temperature range you desire). Place *RT1* in the water and wait several seconds. Then depress *S2* and adjust *R5* for a reading of exactly full scale on *M1*.

If you have used both the specified meter and the temperature range employed by the author, this just about completes the calibration procedure.

It is not really necessary to make up a new face for *M1* as the author did; the meter, as supplied, has exactly 50 divisions, so each division represents one degree. Since the resistance change of *RT1* is not exactly linear with respect to temperature, however, there will be a slight error around the mid scale of the meter (the 40° and 90° points, of course, remain accurate). For most purposes, this error is small enough to be ignored.

Should you use a different model meter (any 0-1 ma. unit will work) or temperature range, though, you might find it impossible to use the meter face supplied. In this case, after setting *R2* and *R5* as above, you must gradually vary the temperature of the water in your calibrating bath, marking each degree on the meter as indicated on your thermometer.

With the temperature adjustments taken care of, only one more step remains before the Fish Finder is ready for service. Just press *S1* and *S2* simultaneously (the temperature of *RT1* makes no difference here) and note the meter reading. This is the battery voltage reference point (see below) and should be marked by a small dot on the meter face.

Using the Fish Finder. All you have to do is lower the Thermistor to the desired depth, wait a bit, and press *S2* to take a reading. Continuous readings may be taken by holding *S2* in the depressed position and slowly lowering *RT1* from the surface. Be sure you allow enough time for the temperature change to register at each level before you move on.

From time to time, depress *S1* and *S2* simultaneously and check to see that *M1*'s reading corresponds to the battery voltage reference point. If it does not, adjust *R5* until it does. When *R5* will no longer perform this adjustment, it's time to change the battery. —30—

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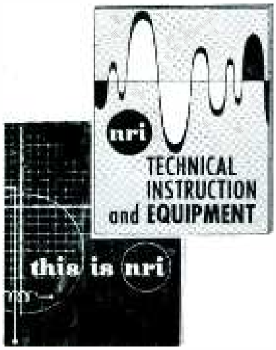

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