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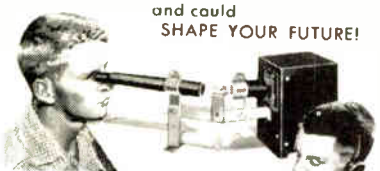

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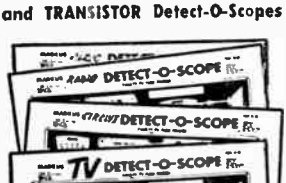

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Cover photograph by BOB LOEB

ZIFF-DAVIS PUBLISHING CO., One Park Avenue, New York 16, New York. William B. Ziff, Chairman of the Board (1946-1953); William Ziff, President; W. Bradford Briggs, Executive Vice-President; Michael Michaelson, Vice-President and Circulation Director; Hershel B. Sarbin, Vice-President; Charles Housman, Financial Vice-President; Richard Kislik, Treasurer.

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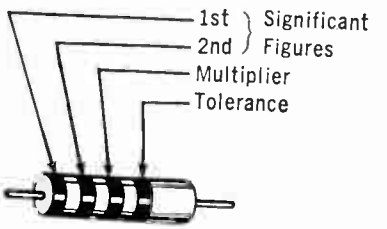
Resistor Color Code Chart

The standard resistance color code shown below is used on all carbon and composition resistors to show resistance value and tolerance. Some of these resistors have their values printed directly on them, but it is still a good idea to know how to read the color code for several reasons. Numbers printed on the resistors are usually very small and difficult to read. What is more, they are frequently rubbed off, or the resistor is wired in the circuit in such a way that the numbers are not visible. By using the resistance color code, resistance values may be read off easily and conveniently. Use this chart often and you will begin to remember what colors go with what numbers. —30—

AXIAL LEADS



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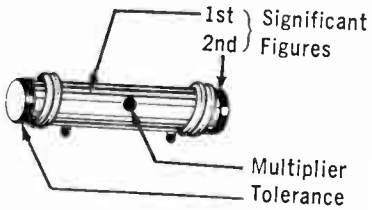

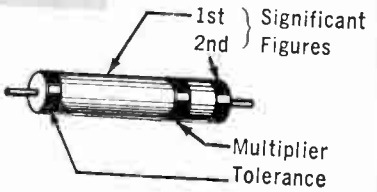

Brown Bodies—Insulated.

Black Bodies—Non-Insulated.

Wire-wound—1st digit band double width.

RESISTANCE IN OHMS			
COLOR	DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	1	±20%
BROWN	1	10	±1%
RED	2	100	±2%
ORANGE	3	1000	±3%*
YELLOW	4	10,000	GMV*
GREEN	5	100,000	±5% (EIA Alternate)
BLUE	6	1,000,000	±6%*
VIOLET	7	10,000,000	±12 1/2%*
GRAY	8	.01 (EIA Alternate)	±30%*
WHITE	9	.1 (EIA Alternate)	±10% (EIA Alternate)
GOLD		.1 (JAN and EIA Preferred)	±5% (JAN and EIA Pref.)
SILVER		.01 (JAN and EIA Preferred)	±10% (JAN and EIA Pref.)
NO COLOR			±20%

*GMV = guaranteed minimum value, or −0 + 100% tolerance.
±3%, 6%, 12 1/2%, and 30% are ASA 40, 20, 10, and 5 step tolerances.

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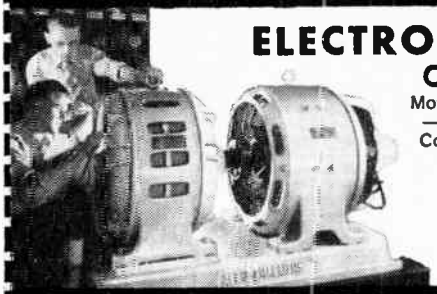

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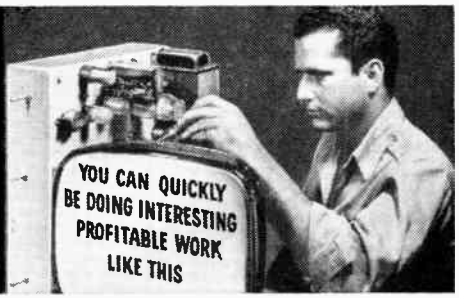

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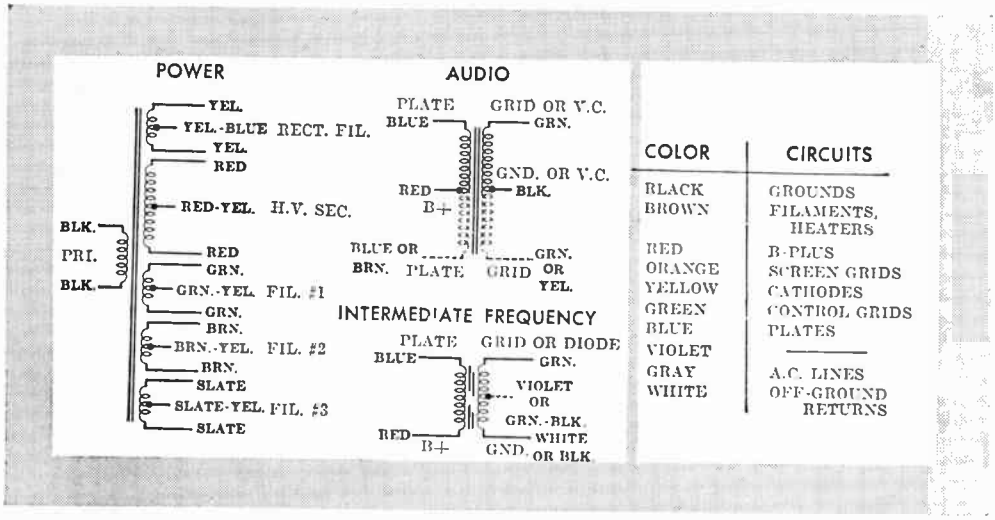
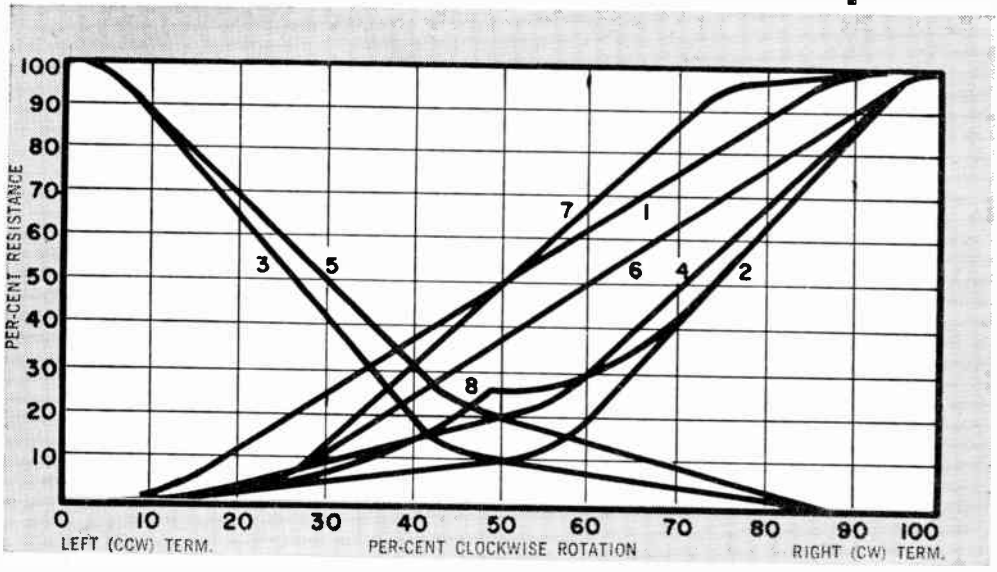
Transformer Wiring Color Code Chart



Standard Resistance Control Tapers



1 Linear—TV Rcvr. Uses

2 Semi-Log (10% R @ Cntr)—Audio Volume or Tone

3 Right-Hand Semi-Log—Reverse of 2

4 Modified-Log (20% R @ Cntr)—Audio Volume or Tone

5 Right-Hand Modified-Log—Reverse of 4

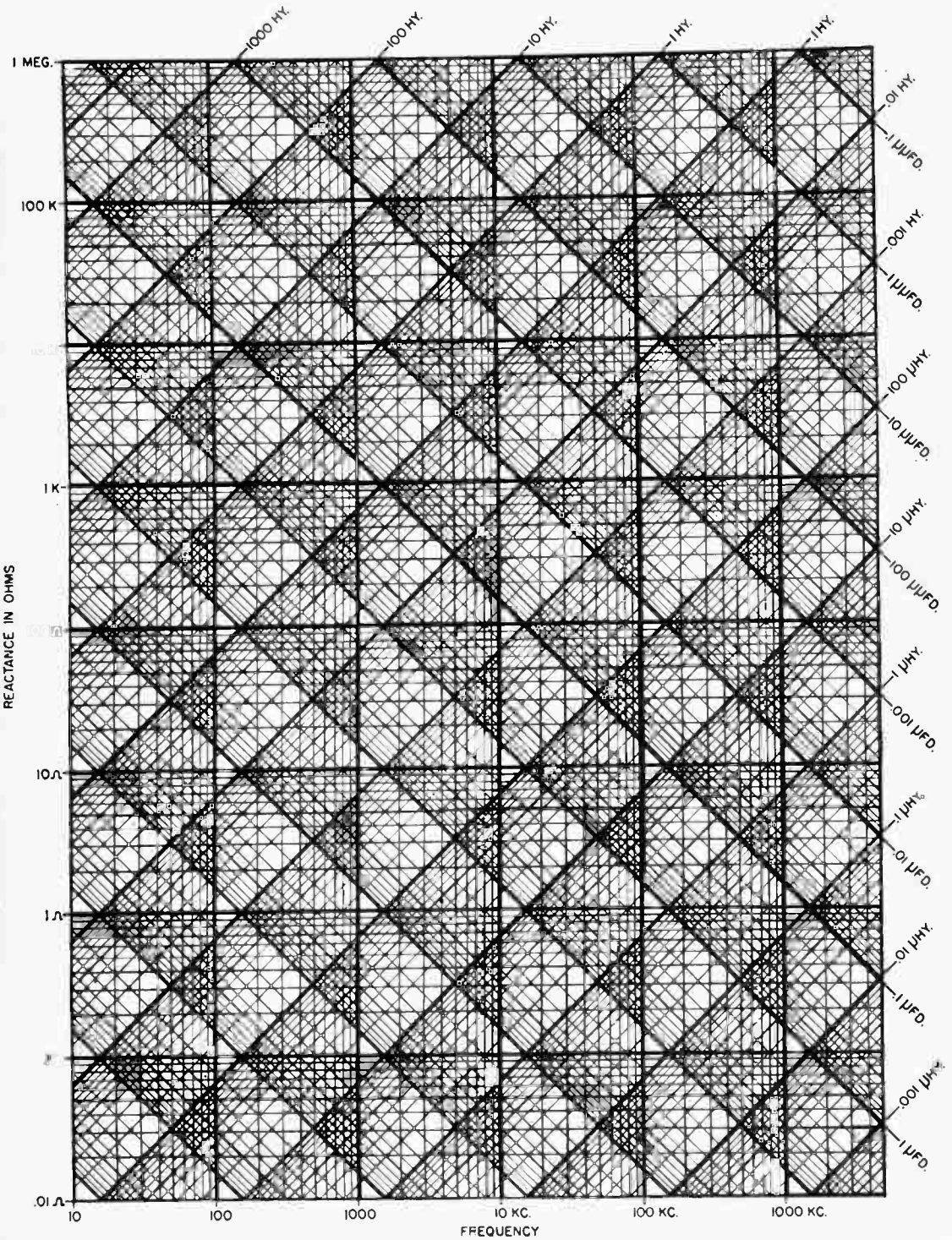
6 Modified-Log (40% R @ Cntr)—Vol. Cont., Ant. Shunt, Bias Cont.

7 Straight-Line with Slow Changes at Ends—Tone Control

8 Tapped-Log—Tone Control with Bass Compensation

The Reactance Chart on the facing page can be used to determine the inductive reactance of coils and the capacitive reactance of capacitors over a wide frequency range. Remembering that at resonance these two reactances are equal, it is also possible to determine how much inductance and capacitance are needed to produce a resonant circuit at a given frequency. Note that inductance values are read along diagonal lines sloping upward; capacitance values are read along diagonal lines sloping downward on the reactance chart. ▶

REACTANCE CHART



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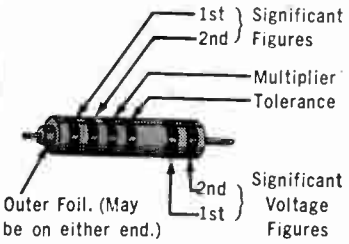
Color Code Chart

PAPER CAPACITORS

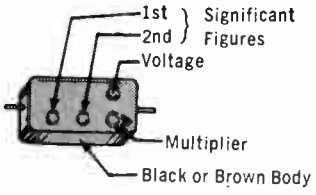
CAPACITY IN μμ FD.			
COLOR	DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	1	20%
BROWN	1	10	
RED	2	100	
ORANGE	3	1000	
YELLOW	4	10,000	
GREEN	5	100,000	5%
BLUE	6	1,000,000	
VIOLET	7		
GRAY	8		
WHITE	9		10%
GOLD			5%
SILVER			10%
NO COLOR			20%

MOLDED TUBULAR

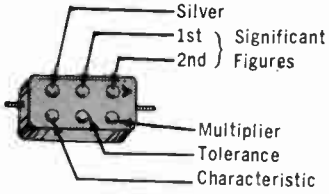


Add two zeros to voltage figures. One band indicates voltage ratings under 1000 volts.

MOLDED FLAT (COMMERCIAL CODE)



MOLDED FLAT (JAN CODE)

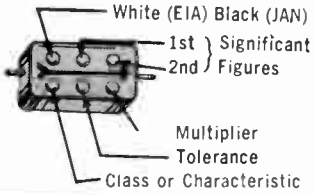


MICA CAPACITORS

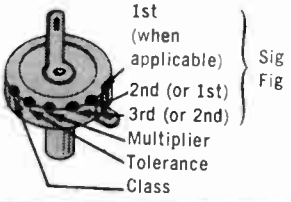
CAPACITY IN μμ FD				
COLOR	DIGIT	MULTIPLIER	TOLERANCE*	CLASS OR CHARACTERISTIC**
BLACK	0	1	20%	A
BROWN	1	10	1%	B
RED	2	100	2%	C
ORANGE	3	1000	3%	D
YELLOW	4	10,000		E
GREEN	5		5% (EIA)	F(JAN)
BLUE	6			G(JAN)
VIOLET	7			
GRAY	8			I(EIA)
WHITE	9			J(EIA)
GOLD		.1	5% (JAN)	
SILVER		.01	10%	

*or ±1.0 μμ FD., whichever is greater.
**Specifications of design involving Q factors, temperature coefficients, and production test requirements. All axial lead mica capacitors have a voltage rating of 300, 500, or 1000 volts.

MOLDED FLAT



BUTTON SILVER



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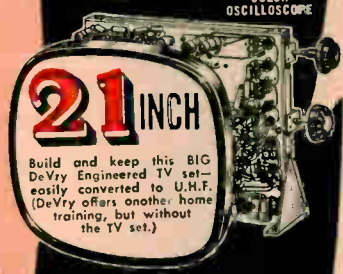

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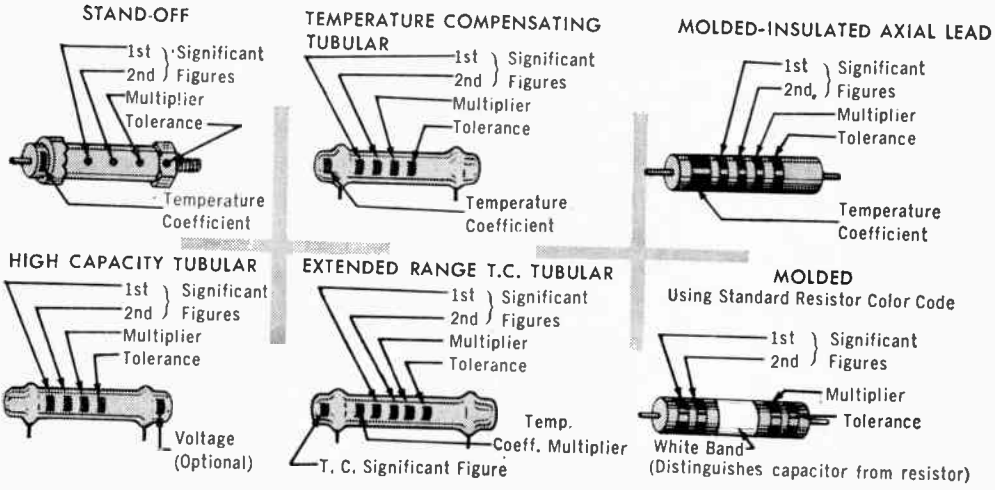
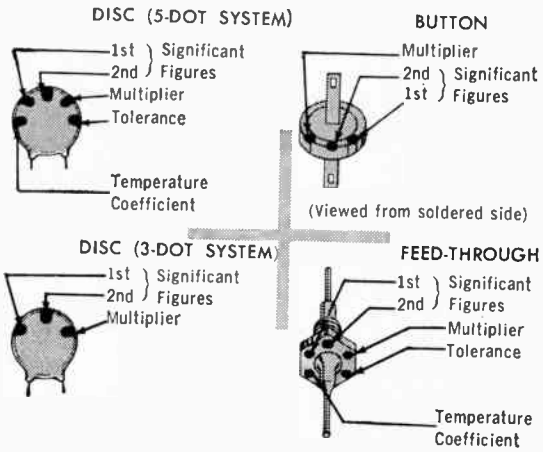
CERAMIC CAPACITORS

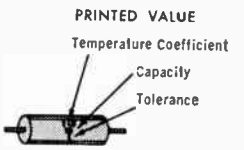


Color Code Chart



CAPACITY IN μμ FD							
COLOR	DIGIT	MULTIPLIER	TOLERANCE		TEMPERATURE COEFFICIENT PPM/°C	EXTENDED RANGE TEMP COEFF	
			10 μμ FD. or less	Over 10 μμ FD.		Sig Fig	Multiplier
BLACK	0	1	±2.0 μμ FD.	±20%	0(NPO)	0.0	—1
BROWN	1	10	±0.1 μμ FD.	±1%	—33(N033)		—10
RED	2	100		±2%	—75(N075)	1.0	—100
ORANGE	3	1000		±2.5%	—150(N150)	1.5	—1000
YELLOW	4	10,000			—220(N220)	2.2	—10,000
GREEN	5		±0.5 μμ FD.	±5%	—330(N330)	3.3	+1
BLUE	6				—470(N470)	4.7	+10
VIOLET	7				—750(N750)	7.5	+100
GRAY	8	.01	±0.25 μμ FD		+30(P030)		+1000
WHITE	9	.1	±1.0 μμ FD.	±10%	General Purpose Bypass & Coupling +100 (P100, JAN)		+10,000
SILVER							
GOLD							

Voltage ratings are standard 500 volts, for some manufacturers, 1000 volts for other manufacturers.



JAN LETTER	TOLERANCE	
	10 μμ FD. or less	Over 10 μμ FD.
C	±0.25 μμ FD	
D	±0.5 μμ FD.	
F	±1.0 μμ FD.	±1%
G	±2.0 μμ FD.	±2%
J		±5%
K		±10%
M		±20%

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Model T-61F (Kit). Net Price: $124.95

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You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 20 Receiver, Transmitter, Square Wave Generator, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

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You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are twenty Receiver, Transmitter, Code Oscillator, Signal Tracer, Square Wave Generator and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

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You will receive all parts and instructions necessary to build 20 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instructions Manuals, hook-up wire, solder, selenium rectifiers, volume controls and switches, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

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J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Troubleshooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

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A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

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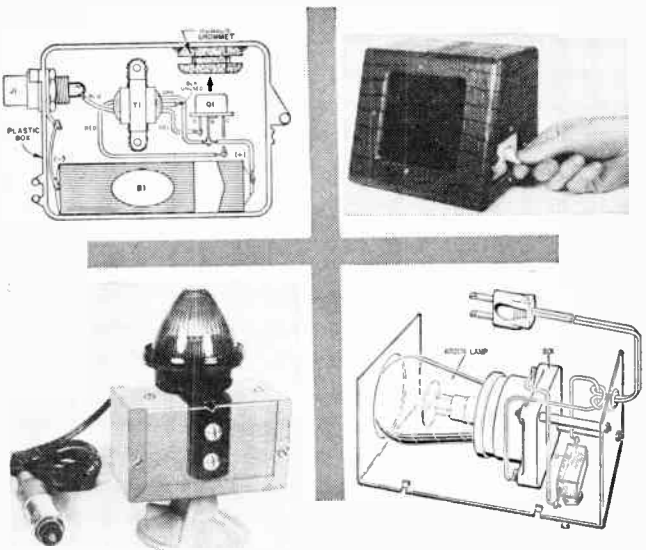
High-Power Crystal Set 42
One Transistor Pocket Radio 45



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TESLA'S Trickery

Famed inventor Nikola Tesla liked to startle friends with his own brand of lightning. Build this tiny Tesla coil and you, too, can be an electronic trickster

By KENNETH RICHARDSON

NIKOLA TESLA, father of artificial lightning, often produced 48'-long lightning bolts in his laboratory. He enjoyed demonstrating such pyrotecnics to unsuspecting guests visiting his workshop.

You can reproduce Tesla's feats on a smaller scale—and experiment with 20,000 volts—by building this simple Tesla coil. You'll amaze your friends with its eerie purple glow and the multitude of tricks you'll be able to perform. The Tesla coil has practical applications, too—you can use it for testing the vacuum in radio tubes, for instance.

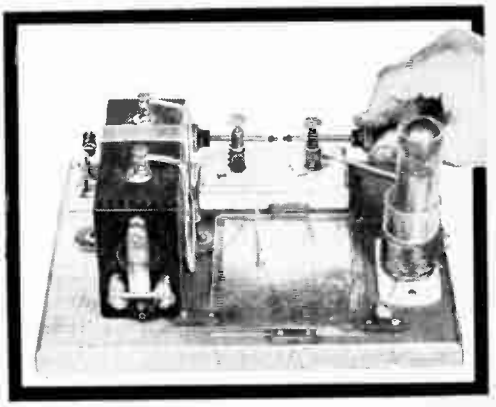
This miniature unit costs about ten dollars to build—even less if you have a well-stocked junk box. Three parts must be homemade: the glass-plate capacitor (*C1*), the spark gap (*SGP1*), and the Tesla transformer windings (*L1* and *L2*). All other parts are standard except the Ford spark coil (*T1*) which is available from Polk's Model Craft Hobbies, 314 Fifth Ave., New York 1. N. Y., for $5.25, prepaid. Auto ignition coil *T2*, auto radio vibrator *VB1*, and capacitor *C2* can be used in place of the spark coil as shown on the schematic diagram.

Construction. Assemble the parts on a plywood baseboard or a kitchen cutting board 8½" x 12". Attach a banana jack to the baseboard in the center of the Tesla primary so that it can be connected to the Tesla secondary. Use No. 14 insulated wire for interconnecting wiring.

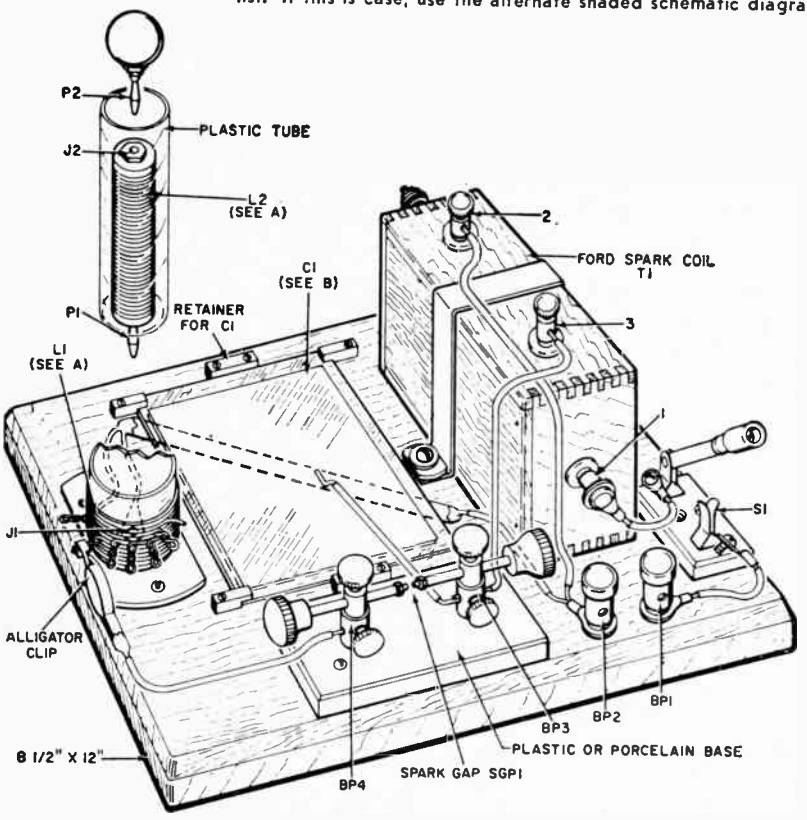
Capacitor *C1* can be made from a 4" x 5" piece of glass 1/16" thick. Cement pieces of aluminum foil to both sides of the glass, using either quick-drying clear lacquer or coil dope. The foil should be about 3¼" x 4¼" in order to leave a margin of ⅜" around the glass plate.

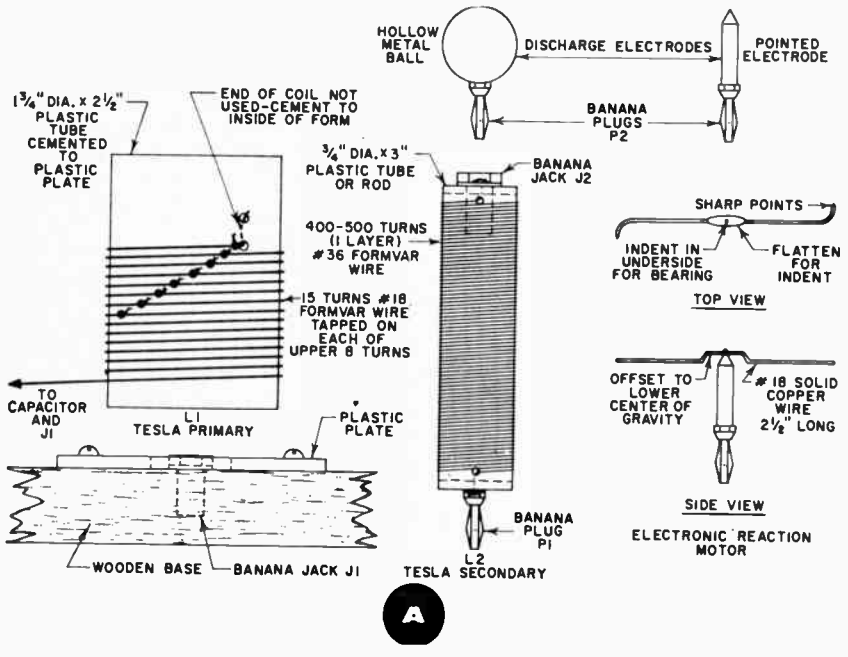
Spark gap *SGP1* consists of two metal rods held in binding posts so that the distance between the rod ends can be adjusted. Mount the spark gap on a 2" x 4" x ½" plastic or porcelain base.

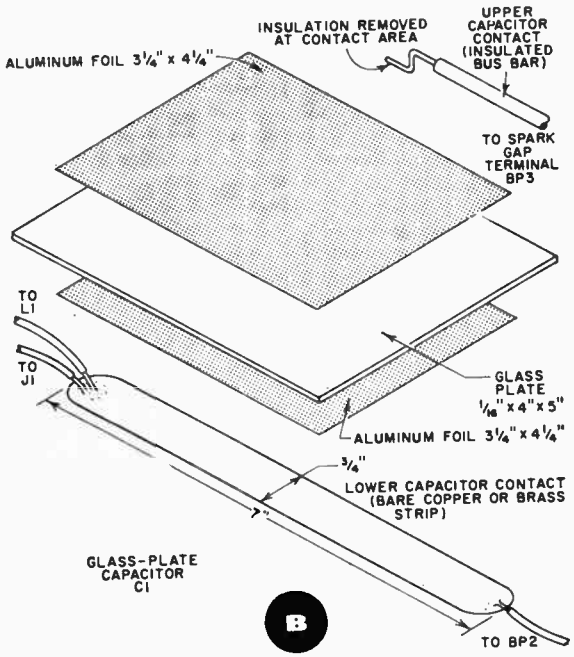
The Tesla transformer itself is made up of two windings. The primary is wound on a tube which is then cemented to the baseboard. The secondary is wound on



Spark coil T1 can be replaced with vibrator and ignition coil combination, if desired. Parts required for vibrator supply appear as "optional" items in the parts list. If this is case, use the alternate shaded schematic diagram shown on page 18.







PARTS LIST

BP1, BP2, BP3, BP4—Screw- or pressure type binding post
C1—Glass-plate capacitor*
C2—0.1-μf., 1000-volt capacitor (optional)
J1, J2—Banana jack
L1, L2—Tesla transformer winding*
P1, P2—Banana plug
S1—Knife switch
SGP1—Spark gap*
T1—Ford (Model T) spark coil
T2—6-volt auto ignition coil (optional)
VB1—6-volt auto radio vibrator (optional)
1—4" x 5" x 1/16" glass plate*
1—8½" x 12" breadboard
1—6-volt battery or 10-12 volt a.c. power supply*

Misc. plastic tubing, Nos. 18 and 36 Formvar wire, No. 14 hookup wire, aluminum foil, alligator clip, binding posts for T1, etc.

* See text for details

another tube and is constructed so that it can be plugged in and out of the primary. This makes it possible to experiment with various secondary windings at will.

For the Tesla primary, wind fifteen turns of No. 18 Formvar enameled copper wire on a plastic or Bakelite tube about 1¾" in diameter and 2½" long. A cylindrical plastic jar or pill bottle can also be used. Start winding near the bottom end of the tube. Space the turns from each other by simultaneously winding a string of about the same diameter as the wire between each turn. The upper eight turns should each be wound with a projecting twist; the twists should be staggered around the tube as shown. To keep the wire and string in place, paint or spray the coil with clear quick-drying lacquer or coil dope.

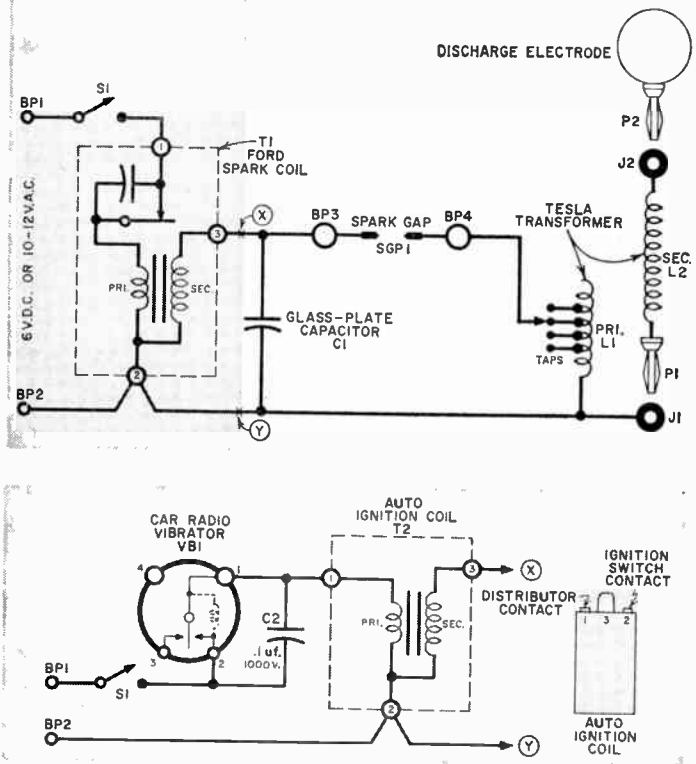
Obtain a plastic tube or cylindrical plastic pill bottle about ¾" in diameter and at least 3" in length for the Tesla secondary. Close the tube ends with plastic discs drilled for banana plugs and cut to fit the tube snugly. Attach plug *P1* to the bottom disc and jack *J1* to the top disc and cement in place.

The Tesla secondary should be wound closely in one layer consisting of 400 to 500 turns of No. 36 Formvar wire spaced to fit on 2½" of the tube. Solder the wire ends to *J1* and *P1* and cement the winding in place. Slip a 1"-i.d. plastic tube around *L2* as shown in the pictorial to prevent corona discharge from *L2*'s sides.

The power supply for the unit can consist of four No. 6 dry cells in series, or a 6-volt "hot-shot" battery, or any 6-volt storage battery. Or, instead of a battery, a 10- to 12-volt transformer operating from the 117-volt a.c. line can be used—a large chimes transformer is ideal. The higher voltage is needed for a.c. operation to overcome *T1*'s primary impedance. To make connections to *T1* more easily, solder three binding posts to *T1*'s terminals (1, 2, and 3) as shown.

Adjustment. With the wiring completed, plug the Tesla secondary (*L2*) into jack *J1* as is shown on the pictorial diagram. Adjust the length of the spark gap (*SGP1*) to about 1/16" to ⅛". Then connect the alligator clip from *BP4* to one of *L1*'s taps. Be sure that the upper wire on glass-plate capacitor *C1* is making good electrical contact; bend the wire if necessary. Open switch *S1* and connect *BP1* or *BP2* to an a.c. or d.c. supply.

Now close switch *S1*. A steady stream of brilliant crackling sparkle should appear at spark coil *T1* and spark gap *SPG1*. If there is no sparking at *SGP1*, adjust its spacing to about 1/32". Be careful not to touch the spark gap or capacitor terminals —you'll get a nasty but harmless shock if you do. Keep the small fry at bay!



HOW IT WORKS

The high-voltage discharge at the output of the Tesla coil is the result of two step-up transformers cascaded so that the output of the first is stepped up again by the second. Automobile spark coil *T1* serves as the first transformer. The vibrator in the primary circuit interrupts the d.c. input and induces a very high voltage in the secondary. Operation is essentially the same with a 60-cps a.c. input.

The second transformer is the Tesla transformer (*L1, L2*). In this transformer, the spark gap serves the same general function as the vibrator in the primary of *T1*, and it also converts the output of *T1* into extremely jagged pulses, rich in harmonics throughout the r.f. region. A narrow band of r.f. is selected by tuned circuit *L1-C1* and stepped up by the action of the Tesla transformer. The very high r.f. voltage appears across *L2*.

Wiring the unit is simple once components are assembled on 8½" x 12" breadboard (see pictorial, shown on page 16). Detail "A" (below the pictorial) gives data on the Tesla transformer primary and secondary winding L1 and L2. Detail "B" (on page 17) shows how to construct glass-plate capacitor C1. In all cases, wiring is point-to-point, using No. 14 insulated hookup wire.

Hold a piece of metal close to the Tesla discharge electrode. You should see a small discharge taking place, perhaps ¼" long. The discharge can be seen best if room lighting is subdued or extinguished entirely. To adjust for maximum power, turn the unit off and move the clip up or down turn by turn on primary winding *L1*, testing after each adjustment. You'll eventually find the optimum position for the clip. When the unit is working properly, sparks should leap a distance of about an inch or an inch and a half to a bare finger or to a piece of metal held in the hand.

Operation. For best results, place the unit in a pitch-dark room with the spectators gathered closely around. Close switch *S1* and you'll see a beautiful corona discharge from the high-voltage electrode. The corona is caused by ionization of the surrounding air due to the high-voltage, high-frequency discharge. After a few moments you'll notice a pungent odor around the unit; this indicates formation of ozone, a form of oxygen generated by some commercial air purifiers.

Now hold a small fluorescent or neon lamp near the discharge electrode. It will start glowing even when several inches away. Wave it rapidly and you'll see a series of flashes in the lamp, one for each of the sparks occurring across the spark gap. Shield the spark gap if its light interferes with viewing the discharge.

Try holding the glass part of an ordinary clear-glass 117-volt light bulb in your hand while touching the metal base to the discharge electrode. Lightning-like (but harmless) sparks will jump from the filament to your fingers. Also, a striking blue or lavender-colored glow will appear inside the lamp due to its nitrogen content.

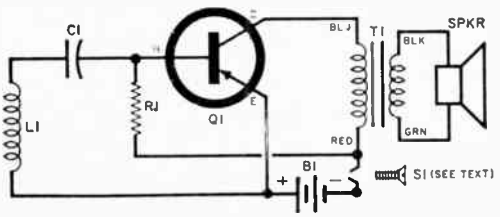
You can build a tiny "motor" that will spin at high speed when mounted on the pointed discharge electrode (see Detail A). It reacts mechanically to the discharge from the sharp points on the rotor (the discharge creates an electronic "wind"). –30–

By KENNETH RICHARDSON

Complete construction plans for a box that talks back.

WHAT makes this black box talk? It's a safe bet that guests at your next party will be stumped. Close inspection makes it obvious that the box is empty. Yet it tells fortunes, brings back voices from the past, and asks questions that reveal rare insight and intelligence.

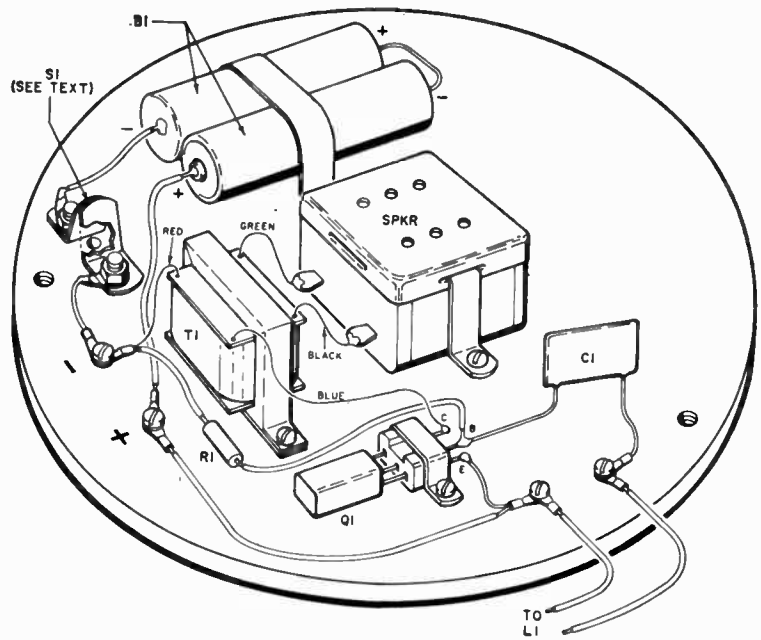
Schematic diagram of tiny, one-transistor amplifier which is the "heart" of black box. It is easy to build and inexpensive.

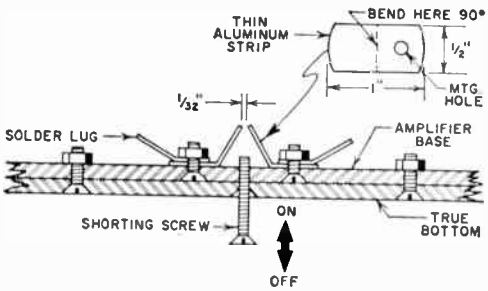


There's some trickery involved, of course. The black box is actually part of a huge air-core transformer. The transformer's "primary" is a large coil of wire hidden under the carpet in the room where your

PARTS LIST

B1—3-volt battery (two penlight cells in series)
C1—0.1-μf., 50-volt capacitor
L1—Pickup coil, 2000 feet of #30 to 34 enameled wire (see text)
Q1—CK721 transistor (or equivalent)
R1—47,000-ohm, ½-watt resistor
S1—S.p.s.t. "on-off" switch (see text)
T1—Miniature output transformer; 2000-ohm primary, 11-ohm secondary (Argonne AR-114 or equivalent)
Spkr.—Subminiature loudspeaker (Telex 9155 "Mini-Mike" or equivalent)
1—Length of #20 to 30 covered wire (see text)
2—⅛" plastic or Masonite sheets (see text)
Misc.—½" and ¾" plywood, felt, hardware, etc.





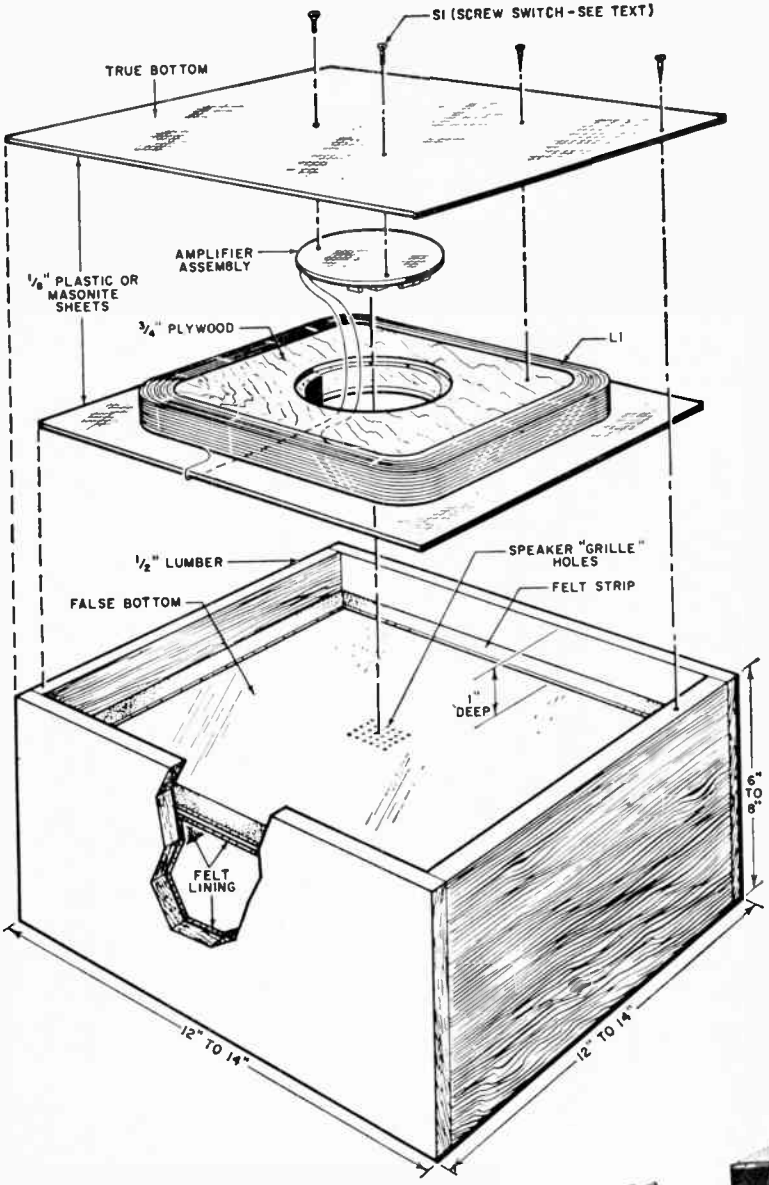
Transistor amplifier for black box is built on disc cut from plastic or Masonite sheet and attached to larger sheet. (See pictorial above and exploded view at right.) "Screw-switch" S1 (detail above) is optional; batteries can be wired permanently into circuit.

guests are seated. Its "secondary" is a coil of wire hidden in the base of the black box itself.

You'll need an accomplice to make it work, but he needn't be a ventriloquist—the black box is entirely electronic in operation. Unknown to your guests, your accomplice is seated in an adjoining room with a pair of amplifiers: a "talk" amplifier and a "listen" amplifier. A microphone concealed near your guests brings him their questions through the "listen" amplifier; his answers are returned through a second microphone plugged into the "talk" amplifier. A radio could serve as one of the amplifiers, if convenient.

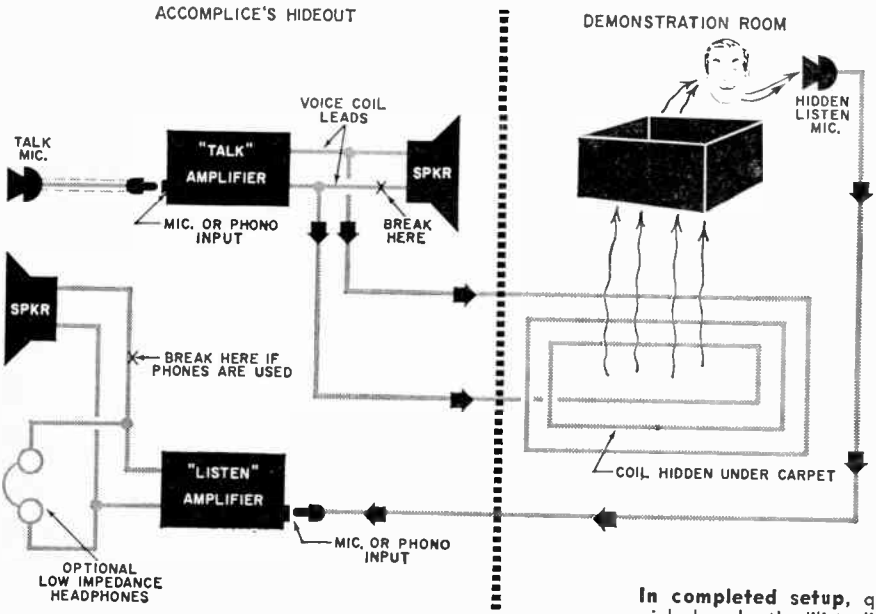
The concealed "primary" coil of wire is connected to the output of the "talk" amplifier. The "secondary" coil in the black box picks up the signal from the "primary" and feeds it to a tiny, one-transistor amplifier and subminiature speaker (also hidden in the box), thus allowing your accomplice's voice to emanate from the apparently empty box.

Construction. Make the black box from ½" plywood. It should measure from 12" to 14" on a side, and from 6" to 8" high.



The box is open on one end and sealed with a false bottom about 1" from the opposite end (see exploded view above). Perforate about 1 sq. in. of the false bottom in its exact center—the holes will act as a speaker grille. The entire inside of the box can be lined with felt or other cloth to conceal the grille holes and to give the box an "empty" look.

Inserted in the false-bottom cavity is a "sandwich" made of two 1/8" plastic or



In completed setup, questions are picked up by the "listen" microphone and fed to the accomplice's hideout. The "talk" amplifier sends his answers back to the demonstration room where hidden coils transfer them electrically to the amplifier in the black box.

Masonite sheets separated by a 11½" x 11½" (for a 14" x 14" box) square of ¾" plywood with rounded corners. Cut the inside plastic sheet the same size as the false bottom; the outside sheet is the true bottom and is cut to fit the bottom of the box. Cut a 5"-diameter hole in the center of the inside sheet and in the plywood.

After assembling the plastic and plywood sandwich, wind pickup coil *L1*—about 700 turns of No. 30 to 34 enameled wire—around the inside of the sandwich on the ¾" plywood. To facilitate winding, mount the sandwich in a homemade jig so it can be turned like a wheel as this "secondary" coil is wound.

The one-transistor amplifier and speaker are mounted on the plastic or Masonite disc cut from the inner sheet of the sandwich. Reduce the disc diameter by about ½" so it will fit in the false-bottom cavity.

A "screw-switch" (*S1*) can be made for the amplifier as shown in the pictorial detail. Simply bend two thin strips of aluminum and mount them about ¼" apart; then bend them until they are 1/32" apart. Drill a hole in the disc between the strips and in the corresponding place in the true bottom. Threading a machine screw through this hole and screwing it flush with the true bottom shorts the strips and closes the switch.

If desired, the switch can be eliminated and battery *B1* wired directly to the amplifier. No-signal current drain is about 2 ma., so the battery will last for some time before replacement is necessary.

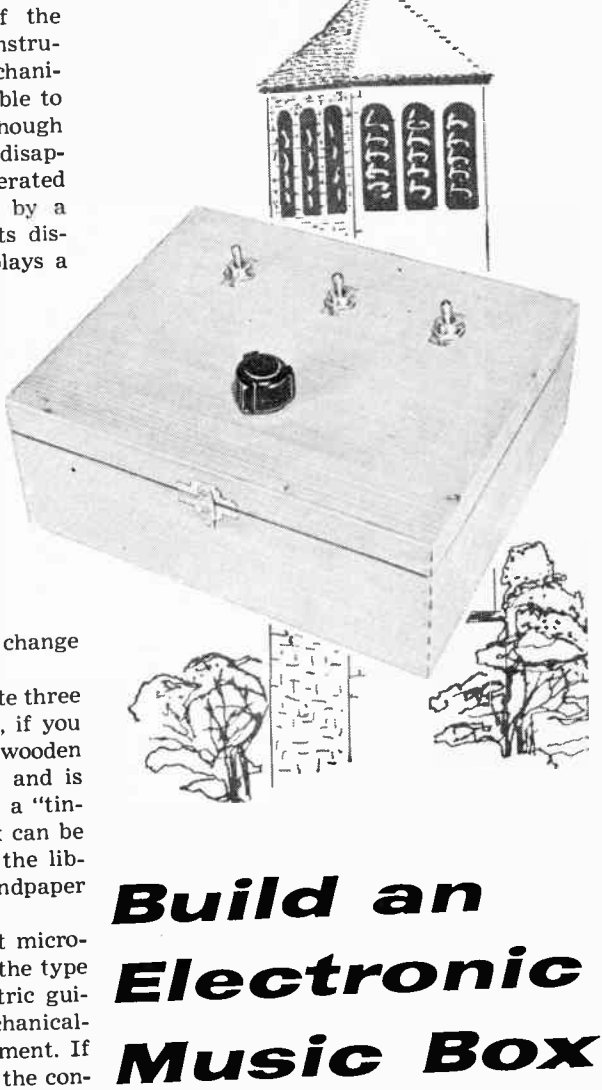
Using the Black Box. The "primary" coil to be hidden under the carpet is made up of several turns of No. 20 to 30 wire. Experiment with the coil diameter and the number of turns for best results.

Place the "primary" coil under the edge of the carpet. If your demonstration room has wall-to-wall carpeting, or if the coil proves to be too bulky under the carpet, wind it on the baseboard or ceiling molding instead.

Then disconnect the speaker voice coil from your accomplice's "talk" amplifier and connect the secondary of its output transformer to the "primary" coil. Ordinary lamp cord is ideal for use as interconnecting wire.

Connect the concealed "listen" microphone to the "listen" amplifier, or use a wireless mike if you wish. Your accomplice can listen with headphones or through the loudspeaker of the "listen" amplifier if its level is not too high.

To bring back voices from the past, simply have your accomplice play a suitable phonograph record through the "talk" amplifier at the appropriate time. —30—



Build an Electronic Music Box

You can get "bell-tower" effects from your audio system with this inexpensive unit

By E. G. LOUIS

REMEMBER the old-fashioned music boxes? Before the invention of the phonograph, these unique wind-up instruments were the only source of mechanically reproduced music for those unable to afford an expensive player piano. Although the music box, as such, has largely disappeared from the scene, battery-operated music box movements are stocked by a number of the large electronics parts distributors. Each of these tiny units plays a single 18-note melody and is operated by a miniature electric motor which can run on a single flashlight cell.

For less than $10 and a few hours' pleasant work, you can assemble one or more of these movements into a modern music box which can be played through any standard audio amplifier. Its festive repetitive chime-like quality is perfect for outdoor reproduction on holidays—and there's no need to change records or tapes!

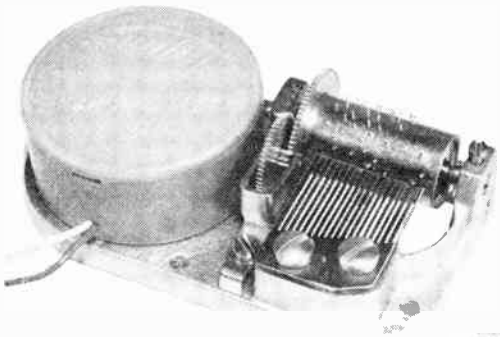
Construction. You can incorporate three movements in the unit as shown or, if you wish, use a single movement. A wooden cigar box makes an excellent case and is preferable to a metal box—to avoid a "tinny" sound. The printing on the box can be spray-painted over or removed by the liberal application of a scraper, sandpaper and elbow grease.

A commercially available contact microphone is used as a pickup. (This is the type of microphone employed with electric guitars and the like.) It is coupled mechanically to the tone plate of each movement. If you use a single movement, attach the contact microphone directly to one of the tone plate mounting screws.

If you use two or more movements, fabricate a coupler from strips of stiff sheet metal. Solder the strips together and attach them to the contact microphone with a standard machine screw and nut. One end of each strip fans out and attaches to a single tone plate, as shown.

Wiring. Each music box motor (*M1, M2, M3*) is controlled by a separate toggle switch (*S1, S2, S3*). Power is supplied by three-volt battery *B1* made up of two flashlight cells connected in series. Series resistance *R1-R2* provides a control over motor speed and permits tempo adjustment. Capacitor *C1* serves as a bypass for electrical noise developed by sparking of the d.c motor brushes.

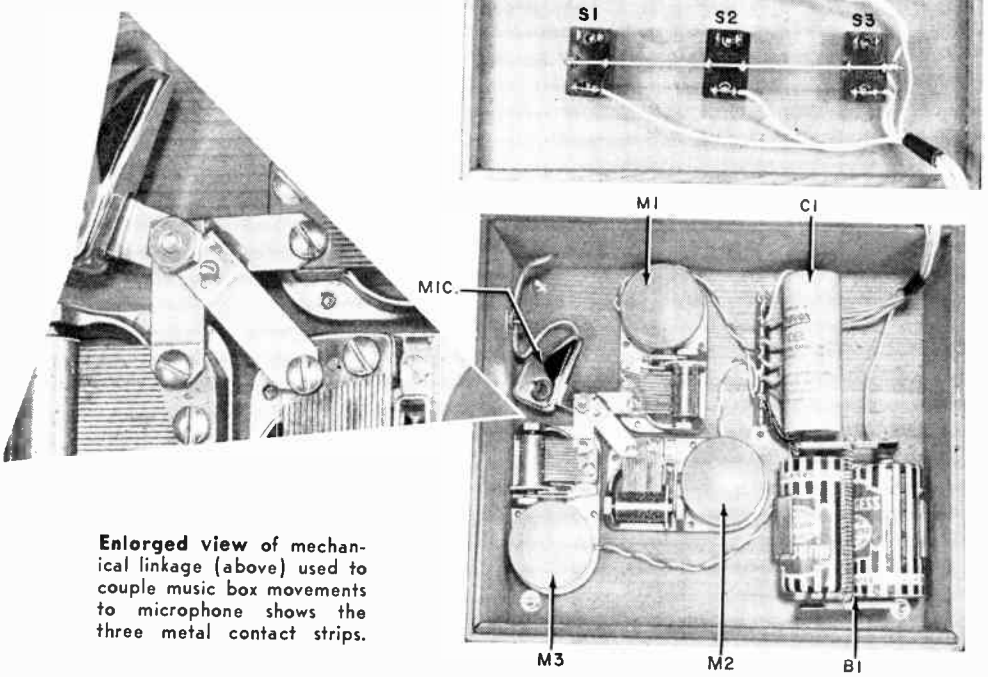
There are a number of possible part substitutions. For example, a 50 to 100 ohm control should be used for speed adjustment, but in the model a 350-ohm control (*R2*) found in the junk box was employed



Music box movement consists of small d.c. motor in round can (above left) and a revolving "pipped" drum which plucks the metal rods.

which required a 100-ohm shunt resistor (*R1*). Toggle, slide, rotary or push-button switches can be used for *S1*, *S2*, and *S3*. Capacitor *C1*'s value is not critical—any unit from 50 to 5000 μf. at from 3.0 to 25 volts or higher will do.

Terminate the microphone cable in a plug (*PL1*) to match the input jack of the amplifier used. Lead dress is not critical but care should be taken to observe d.c.

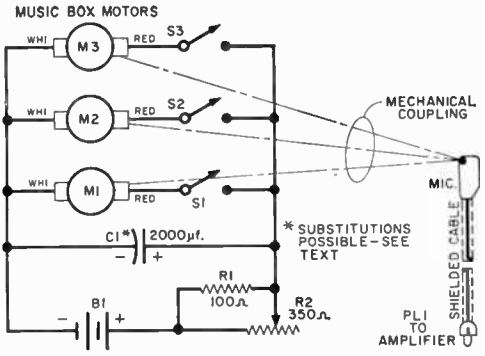


Enlarged view of mechanical linkage (above) used to couple music box movements to microphone shows the three metal contact strips.

Speed control and on-off switches are in cover of the music box (upper right). Movements, capacitors, and batteries are mounted in bottom of box (lower right).

polarities—otherwise the motors will operate in reverse.

Operation. Check all wiring, install the batteries and close switches *S1*, *S2*, and *S3*, one at a time, while adjusting tempo control *R2*. All three movements can be operated at the same time by turning *R2* to its minimum resistance position. If trouble is encountered, recheck the wiring and make sure there are no cold-soldered joints.



Three movements are shown in schematic of music box at left. A less expensive unit could have only one movement and a single fixed resistor (50 to 100 ohms) for R1 and R2.

PARTS LIST

B1—3-volt battery (two size D cells)
C1—2000-μf., 6-volt electrolytic capacitor
M1, M2, M3—Electric music box movements (Olson Radio X-766—"Around the World in 80 Days"; X-767—"Tea for Two"; X-768—"How Dry I Am")
PL1—Phono plug or other connector
R1—100-ohm, 1-watt resistor
R2—350-ohm, 2-watt potentiometer
S1, S2, S3—S.p.s.t. switch
MIC.—Contact microphone (Argonne AR-18)
1—Two-cell battery holder
1—Wooden cigar box
Misc. terminal strips, rubber feet, knob, hardware

To use the electronic music box, connect *PL1* to the microphone input or "mag. phono" jack of the amplifier. Close one of the motor switches and adjust *R2* for the tempo you want. Gradually increase the amplifier volume until the desired level is reached. Experiment with the amplifier's tone control setting to achieve the most pleasing balance.

For unusual sound effects, try switching from one music box movement to another while the unit is operating. You can do this by closing one switch and then quickly opening another. With care, a medley of all three tunes can be "played." Other effects may be obtained by adjusting *R2* to slow or speed the tempo. For real fun, try operating *two* of the movements *at the same time*, letting your friends guess the "tune" you are playing. -30-

AN ELECTRONIC SIREN

By EDWARD H. DINGMAN

WHEN the need for a fire siren arose at the plant in which the author is employed and cost and emergency power requirements precluded the purchase of a commercial unit, the following simple circuit was designed as a substitute. It gives a realistic siren sound whose volume can be governed by the volume control setting of the factory's p.a. system.

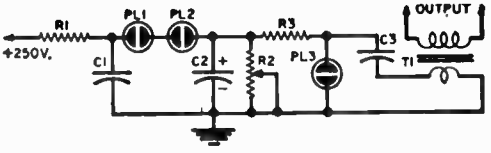
The circuit is, in effect, a double neon tube oscillator. Assuming a discharge condition at the start, the following action takes place. *C1* starts charging through *R1*. When the voltage level has reached a value to break down the neon bulbs, *PL1* and *PL2* are extinguished.

In the meantime, *C2* is charging *C3* through *R3*. When the voltage level reaches the breakdown value of *PL3*, *C3* discharges *via* the path through *PL3*. *R2* is adjusted for whatever cycling rate of the siren is desired.

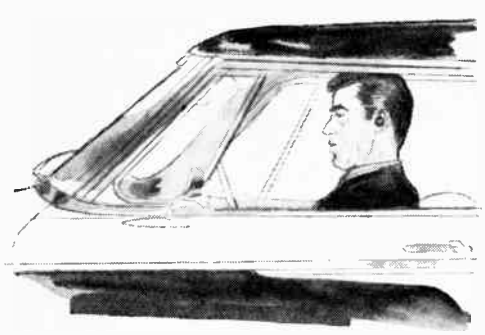
Because of the effect of coupling on the required frequency, it is desirable to use a low-impedance to high-impedance coupling transformer. However, capacity coupling can be used if a very small unit of approximately one-tenth the value of *C3* is selected. This will require a high-impedance, high-gain stage following it.

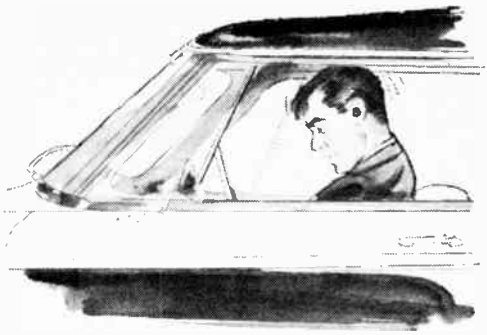
As neon bulbs vary in characteristics, some experimentation with resistor values may be required. Use only oil or paper capacitors in this construction. Since current drain is low, ¼-watt resistors will be suitable. -30-

Schematic diagram of electronic siren.



R1—500,000 ohm, ¼ w. res.
R2—10 megohm pot
R3—1.2 megohm, ¼ w. res.
C1—.1 μf., 400 v. oil or paper capacitor
C2—10 μf., 400 v. oil capacitor
C3—.0001 μf., 400 v. capacitor
T1—Coupling trans. Any unit with primary impedance of 100 ohms or more to highest available secondary impedance (UTC SO-1 "Subouncer" is suitable)
PL1, PL2, PL3—NE-2 type neon bulb





Transistorized

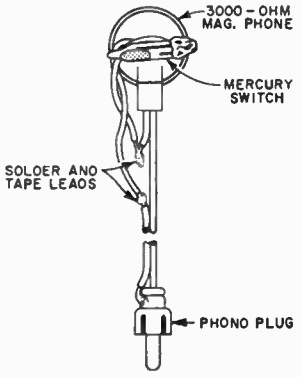
Easy-to-build co-pilot keeps you awake on long drives.

IF YOU'VE EVER found yourself nodding on long drives—or during classes—you'll be interested in this driver alarm. The complete gadget consists of a one-transistor oscillator in a plastic case plus an earphone and miniature mercury switch.

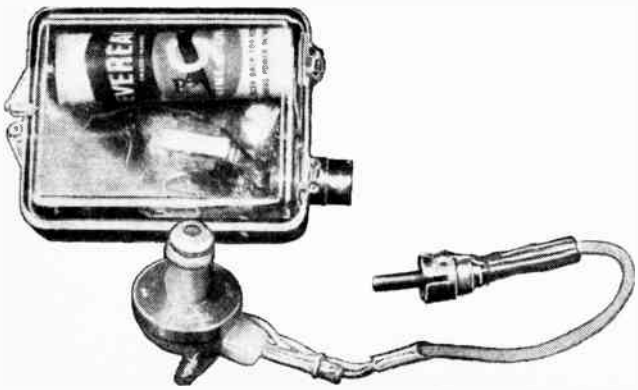
The mercury switch is the heart of the device and the secret of the alarm's action. Affixed to the headphone, it switches on the oscillator whenever the user begins to nod. The volume and harshness of the generated tone (it's loaded with harmonics) would have awakened Rip Van Winkle if transistors and mercury switches had been available in his day.

You can construct the gadget in any sort of container you wish. Since the circuit consists of only three components, detailed instructions are superfluous. Just make sure that the transistor and battery polarities are correct and that you follow the transformer color code accurately.

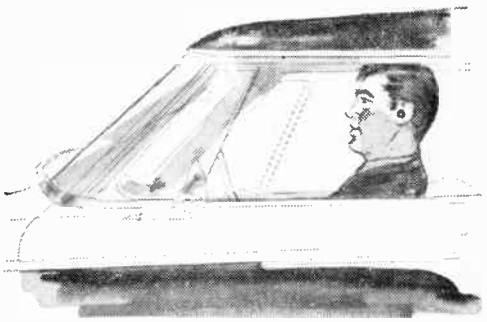
Solder the transistor directly into the



Store the unit in the glove compartment of your car with earphone unplugged. It will be ready for those long trips when you're liable to doze off.



Glue the switch to the back of the earphone so that the switch length is perpendicular to the wires leaving the earphone. Take care in soldering the leads from the earphone as they are delicate.



Driver Alarm

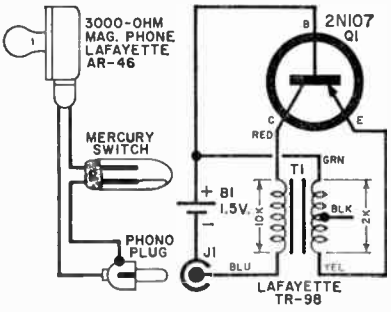
By DAVE GORDON

circuit, and leave its leads long to avoid heat damage. Use two or three miniature alligator clips clipped to the transistor lead as a heat sink and a hot well-tinned iron for rapid soldering.

The transformer, the penlight cell, and the rubber grommet in which the transistor is mounted are all glued to the plastic case. Glue the mercury switch to the rear of the earphone at an angle that will provide convenient operation. (The mercury switch can be purchased from City Electric Distributors, 510 West 34th St., N. Y. 1, N. Y. for $1.36, including postage. Specify Microswitch AS408A1.)

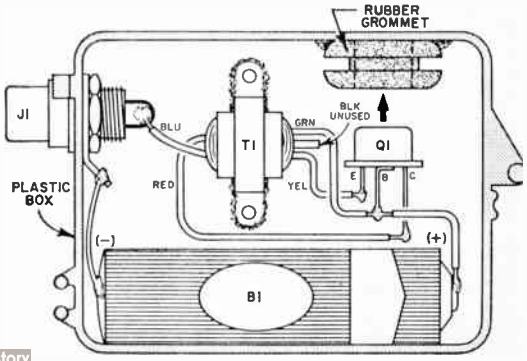
In use, the earphone is rotated in the ear until there is an absence of tone when the head is held upright. A slight nod should then trigger the oscillator.

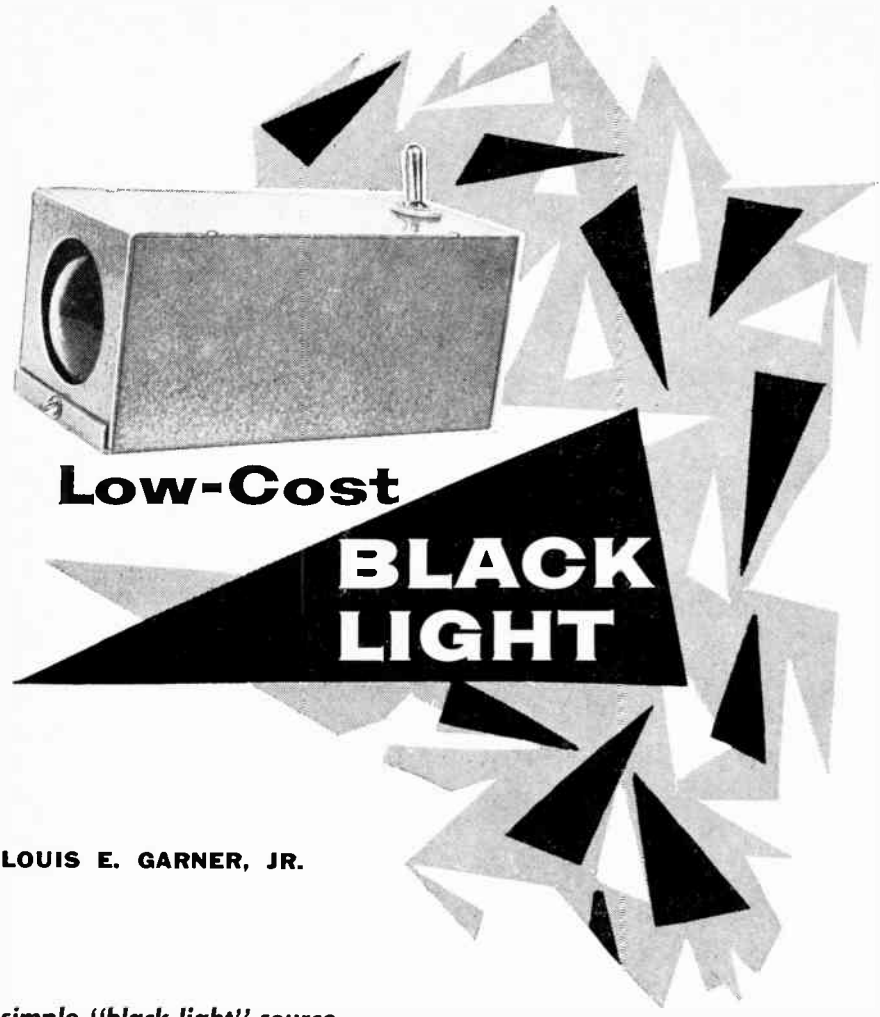
When this gadget starts to sound off while you're driving, it is far safer to pull over to the side of the road and catch 40 winks than to continue to drive. —30—



Actual alarm is one-transistor feedback oscillator. The center tap of the transformer (black lead) is not used. Install a Switchcraft 3501 FP phono jack and attach a mating plug on the earphone leads. Note that the mercury "shorts" the two internal contact rods in the switch, completing the oscillator circuit. There is no drain on the battery when the switch is open.

Transformer connections constitute most of the wiring. After the transistor is soldered, it is pushed into the rubber grommet which is glued to the side of the container.





Low-Cost BLACK LIGHT

By LOUIS E. GARNER, JR.

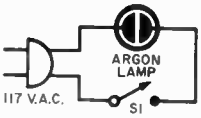
This simple "black light" source can be built in a couple of hours, and it promises loads of fun.

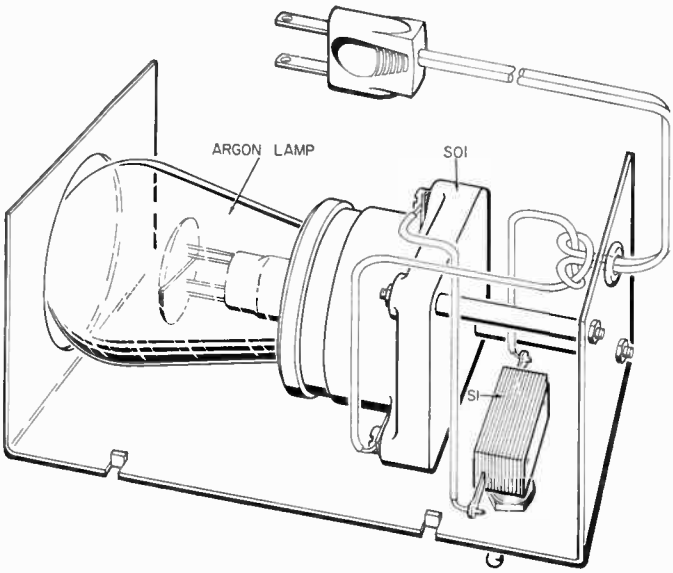
ULTRAVIOLET or "black light" is used extensively in criminal investigation work, prospecting, and chemical analysis. Under the pale-purple light of the ultraviolet lamp, many minerals, dyes, greases, and even familiar household substances glow in weird colors.

This characteristic glow—known as fluorescence—is the secret of many commercial products. It is found in the familiar fluorescent lamp; in dyes and inks which seems to "glow" in sunlight; and even in a popular laundry detergent—a fluorescent additive makes clothes appear whiter and brighter than normal in sunlight.

You can assemble your own low-power "black light" source from readily available components at a total cost of less than five dollars. Unless you're a slowpoke, you should be able to complete the job in less than two hours.

Construction and Testing. The circuit is extremely simple and requires only wiring a switch in series with an argon lamp. The lamp is mounted in a light-proof box to protect the eyes from direct exposure





Space lamp socket from box with two bushings. Bulb must be inserted before socket is mounted.

PARTS LIST

SI—S.p.s.t. toggle switch
SOI—Edison-base lamp socket (Allied Radio 52E850)
1—Type AR-1 two-watt argon lamp (Allied Radio 52E810)
1—5" x 2¼" x 2¼" aluminum box (Bud CU-2104A or equivalent)
Misc.—Hardware, line cord and plug, etc.

to it. Since the ultraviolet output of the lamp is harmful to the retina, the lighted bulb should not be viewed directly unless you wear glasses. Even then, it's best not to expose your eyes to the lighted argon lamp unnecessarily.

After you complete the wiring, plug the unit into a wall outlet (either a.c. or d.c.) and close the on-off switch. The half-moon electrodes of the argon bulb should glow with a faint purplish light. (If you obtain an orange glow, someone has slipped you a neon bulb in error; there is a neon-filled bulb which is externally and internally identical to the argon bulb, and the two types of bulbs are sometimes mixed in the stockroom.)

For best results, carry out your experiments in a darkened room. Use the completed instrument to examine minerals powders, detergents, oils, greases, and other common substances. Often, you'll find a substance that is one color under normal room light will glow an entirely different color when viewed under "black light."

Visible and Invisible. The argon lamp gives off energy in both the visible and the invisible (ultraviolet) region of the spectrum. The visible light is a deep purple color. The invisible output from the lamp is spread over a number of wavelengths in the ultraviolet region but is concentrated mainly in the long-wave portion (see the spectrum diagram below). Although ultraviolet rays are invisible to the eye, a visible light is produced when they strike some substances. This phenomenon is called "fluorescence." —30—

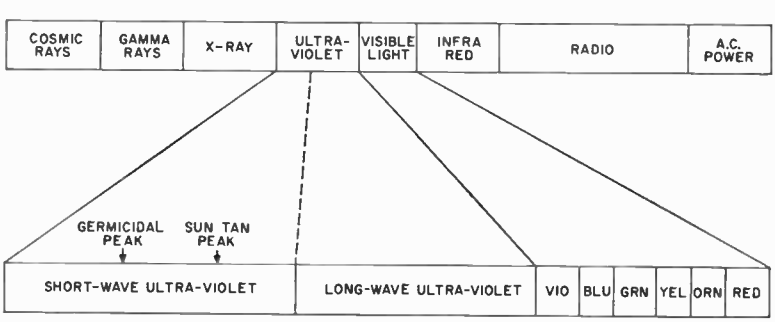


Chart shows the relative position of ultraviolet radiation in the electromagnetic spectrum.

transistorized pocket receiver

By LOUIS E. GARNER, JR.

A single-evening's construction project that pays big dividends in personal satisfaction.

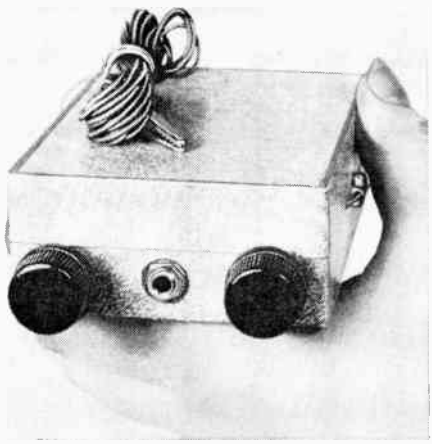
HERE'S a little receiver you can assemble in a single evening. It is an excellent construction project for the hobbyist who has "graduated" from the crystal set but isn't quite ready to tackle a superhet. The small size of the completed unit makes it especially attractive: the entire receiver is about as big as a package of king-size cigarettes.

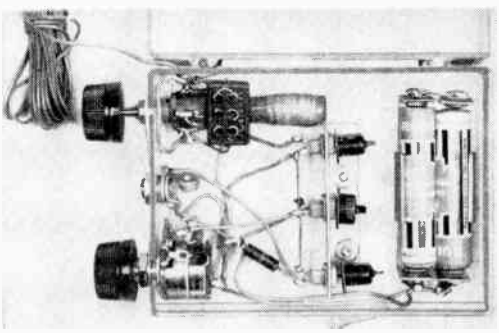
Although the radio lacks some of the features of commercial superheterodynes, its three-stage circuit has amazing sensitivity. You'll find that it will pick up most local stations within its tuning range with the short external antenna specified.

Construction. The receiver is housed in a small clear-plastic case. In the author's model, the case was given a finished appearance by applying a layer of self-adhering Contact plastic. But you can leave the case "as is," if you prefer, or finish it with a coat or two of enamel.

Small transistor sockets are mounted on a tiny "L-shaped" chassis cut from a scrap piece of aluminum. Operating power is supplied by a 3-volt power pack made up of two penlight cells in series. A standard battery holder is used for convenience in replacing batteries; positive terminals are identified with dabs of red fingernail polish.

Adjusting coil *L1*'s ferrite "slug" tunes the set. But since the variation in coil inductance is not adequate to cover the entire AM broadcast band (540-1600 kc.), a





compression-type, 45-380 $\mu\mu$f. capacitor (*C1*) is used to tune *L1* for best coverage of stations in your area. Simply set *C1* for optimum local-station pickup with *L1* in the middle of its range.

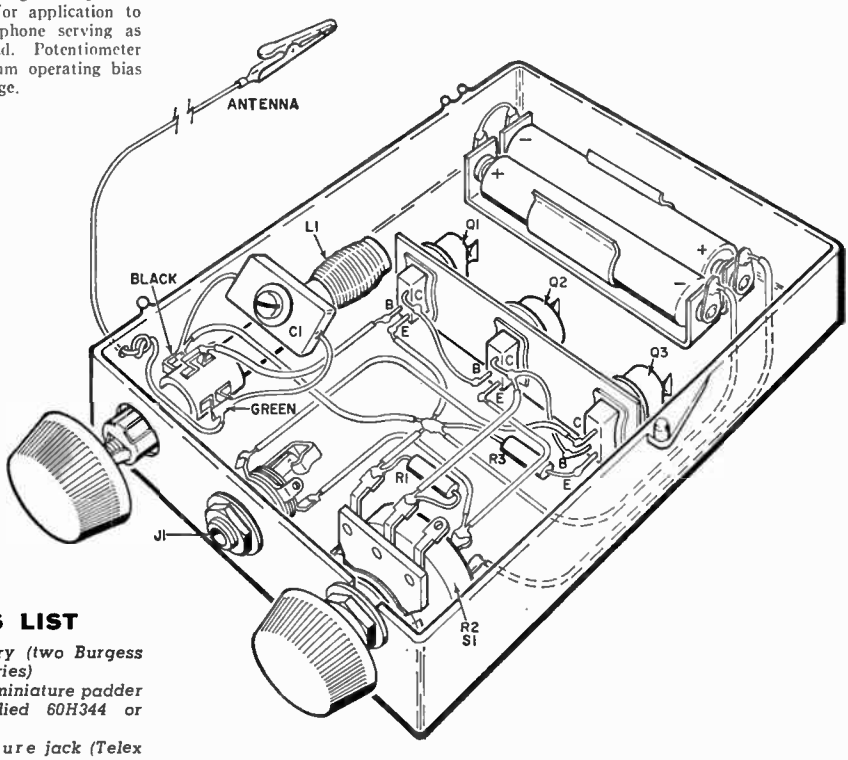
Attach a 6' to 8' flexible lead to *L1*'s green terminal to act as an external antenna. Solder a small alligator clip at the end so the lead can be clipped to a window screen or a longer antenna for reception of more distant stations.

Operation. Install the battery and the transistors, after trimming the transistor leads to about ¼". Extend the antenna lead and connect a high-impedance (at least 2000-ohm) magnetic earphone to output jack *J1*.

Turn the set on and adjust *R2* until you hear a slight hissing in the earphones. Then tune in the desired station by adjusting *L1*'s slug; re-adjust *R2* for best volume. –30–

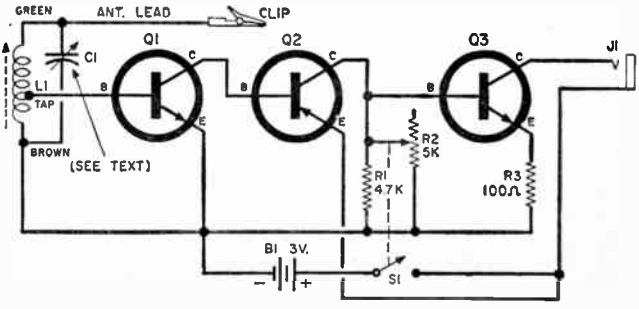
HOW IT WORKS

The receiver is basically a detector followed by two stages of audio amplification. All stages are direct-coupled through use of complementary *n-p-n* and *p-n-p* transistors; the common-emitter arrangement is employed in all three stages. First-stage transistor *Q1*, operated without base bias, detects the incoming r.f. signal selected by tuned circuit *L1-C1*. Transistors *Q2* and *Q3* amplify the signal for application to the magnetic earphone serving as *Q3*'s collector load. Potentiometer *R2* selects optimum operating bias for the output stage.



PARTS LIST

B1—3-volt battery (two Burgess #7 cells in series)
C1—45-380 $\mu\mu$f. miniature padder capacitor (Allied 60H344 or equivalent)
J1—Subminiature jack (Telex JPM-02)
L1—Ferrite antenna coil (Lafayette MS-299)
Q1, Q3—2N170 transistor
Q2—2N107 transistor
R1—4700-ohm, ½-watt resistor
R2—5000-ohm miniature potentiometer, with switch S1
R3—100-ohm, ½-watt resistor
S1—S.p.s.t. switch (part of R2)
1—Small aluminum chassis (see text)
1—3⅝" x 2¾" x 1 3/16" (approx.) plastic box
1—High-impedance magnetic-type earphone (Lafayette MS-260 or equivalent)
Misc. battery holder, miniature knobs, alligator clip, etc.



auto

safety flasher

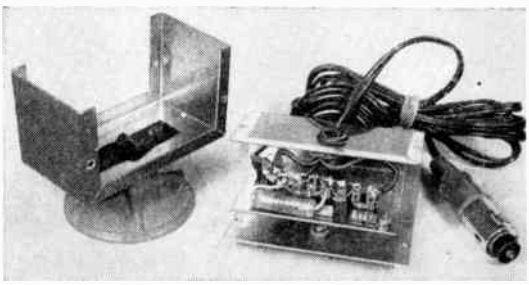
By LOUIS E. GARNER, JR.

Avert tragedy by equipping your car with this flashing "trouble light", built at small cost.

A SIMPLE engine breakdown or flat tire can turn from a minor inconvenience to a major tragedy if it occurs at night on an unlit highway. The parked car, even if driven off the highway onto the road's shoulder, can become a deadly target for other motorists.

Such danger can be minimized with this easily assembled safety flasher. Plugged into your car's cigarette-lighter receptacle, the device supplies a rapidly flashing bright-red light to warn approaching motorists. What's more, the unit's transistorized circuit requires so little current that the instrument can be left operating for hours—even overnight—without excessively draining your car's battery.

Construction. The circuitry is assembled on a small aluminum chassis which is in turn mounted inside an



aluminum Minibox. The chassis can be made from a discarded cookie sheet: simply cut out a small piece using a pair of tin snips or a hacksaw, then bend it to shape in a vise.

Take special care to observe all d.c. polarities when wiring. This applies not only to electrolytic capacitors *C1* and *C2,* but also to plug *P1.* Most American-made automobiles manufactured since 1955 have a negative ground, but you'd best check your car battery to determine whether its positive or negative terminal is grounded to the car frame. Wire *P1* accordingly.

Machine screws hold transistor *Q1* in place, with base

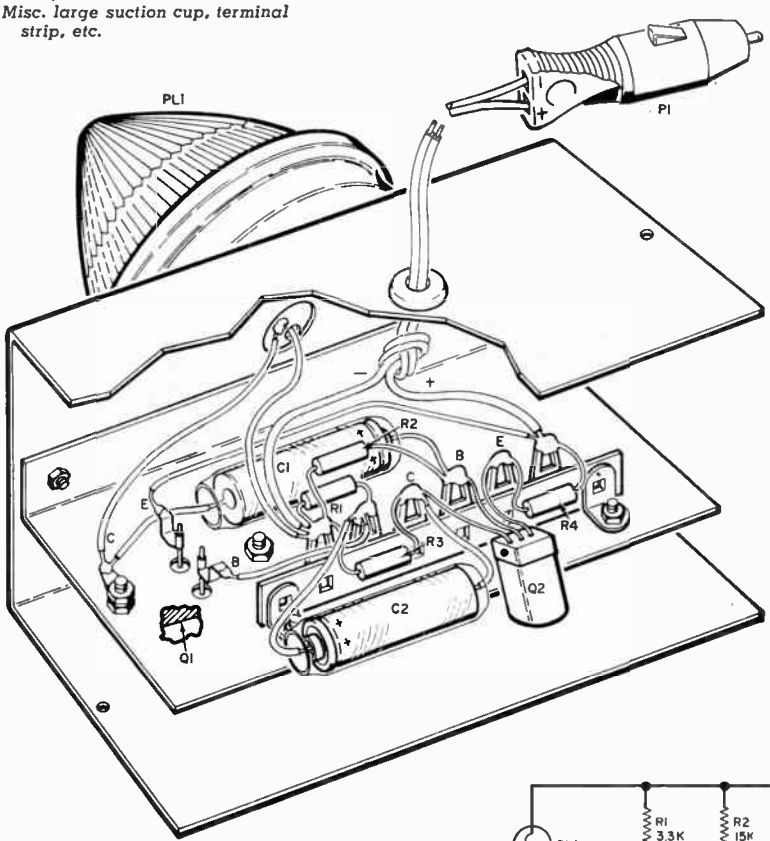
PARTS LIST

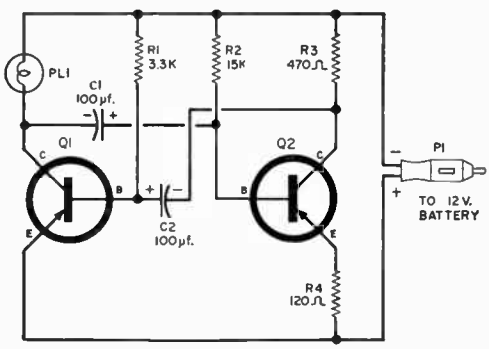
C1, C2—100-μf., 15-volt electrolytic capacitor
P1—Cigarette-lighter plug and cord (Mallory R675)
PL1—12-volt clearance-light assembly
Q1—2N554 or 2N307 transistor
Q2—CK722 transistor
R1—3300 ohms *all resistors*
R2—15,000 ohms *½ watt*
R3—470 ohms
R4—120 ohms
1—4" x 2¼" x 2¼" Minibox
1—Small aluminum chassis (see text)
Misc. large suction cup, terminal strip, etc.

and emitter connections made with small clips. The smaller transistor, *Q2*, is soldered directly to the terminal strip which acts as a tie-point. Use care when installing *Q2* to avoid overheating. In soldering, grasp each lead with a pair of long-nose pliers between the point being soldered and the body of the transistor itself. The pliers serve as a heat-sink to conduct heat away from the transistor.

Operation. To use the completed unit, uncoil the power cord and attach the flasher to your car's body (a large suction cup on the bottom will hold the flasher on the car's top, hood, or rear deck). Remove the car's cigarette lighter and insert the flasher's power plug (*P1*) in its place.

If the flasher doesn't operate immediately, unplug it, wait a few seconds, then plug it in again. —30—

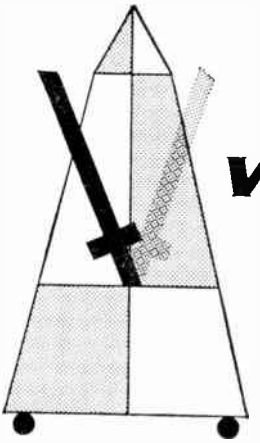




HOW IT WORKS

The flasher is a collector-coupled multivibrator with a low repetition rate. In operation, transistor *Q1* conducts, supplying a signal which "cuts off" transistor *Q2*. After a period determined by the time constant of *R2-C1*, transistor *Q2* starts conducting, cutting off the first unit. After a period determined by the time constant of *R1-C2*, *Q1* repeats its cycle.

Current drawn by transistor *Q1* lights 12-volt bulb *PL1* which serves as *Q1*'s collector load. Since the heavy current flow is in relatively short pulses, the average current drain is quite low, assuring minimum drain on the car's battery.



Wireless Metronome

By MARTIN H. PATRICK

Single-transistor unit transmits beat to broadcast radio.

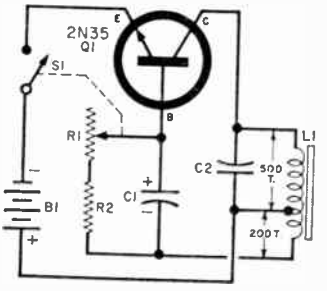
MUSIC LOVERS, both classical and rock 'n' roll, can get on the beat with this simple self-powered metronome that "sounds" through a radio without need for wired connections. And for just "puttering" around, you'll find that the damped-wave "putt-putts" from this unit can be fun at parties and the like.

Assembled in a small plastic box, the entire unit is powered by three 1½-volt cells (Eveready #912 or the equivalent). A 2N35 *n-p-n* audio transistor (*Q1*) is connected as a Hartley oscillator, and a 25-μf., 12-volt electrolytic capacitor (*C1*) provides the audio feedback. (If you want to use a *p-n-p* transistor, *C1* and the battery should be reversed.) Shunted across *C1* is a 6800-ohm resistor (*R2*) in series with a one-megohm potentiometer (*R1*), as the timing control.

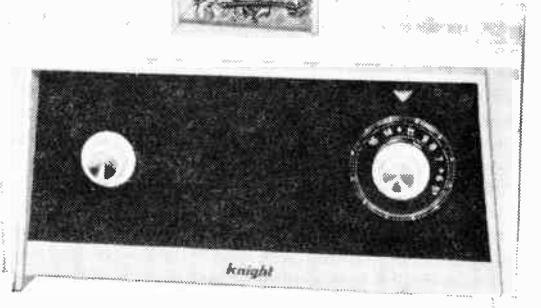
Coil *L1* is made by scramble-winding about 700 turns of #25 enamel-covered wire on a ¼" iron bolt, about 1½" long. At the five-hundredth turn, twist the wire to a pigtail for the tap and continue adding the remaining two hundred turns. You'll find it easier to wind *L1* if you place two plastic end stops on a bolt. Coil *L1* is tuned by capacitor *C2*, a .01-μf. unit.

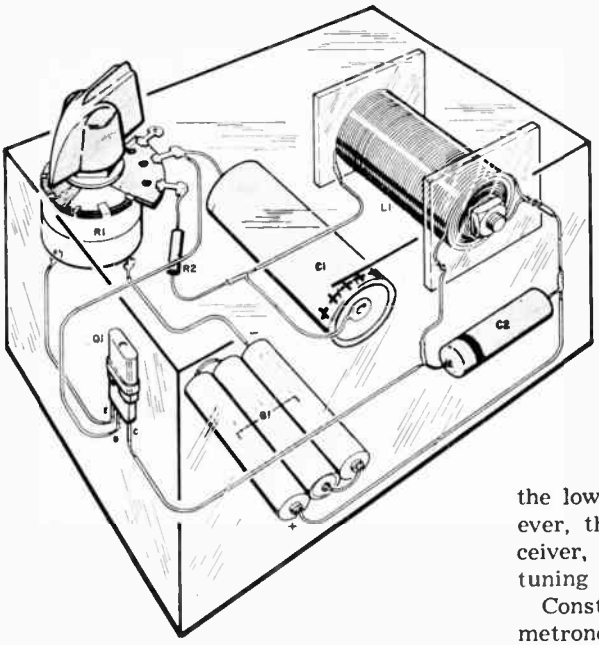
Set the metronome on top of a radio, select a dead spot on the dial, and adjust *R1* for timing. Turning the metronome in one direction or another will give different results.

The power radiation of this circuit is extremely small, so the



A p-n-p transistor with a similar power rating can be used instead of the n-p-n unit shown but connections to battery and capacitor C1 must be reversed.

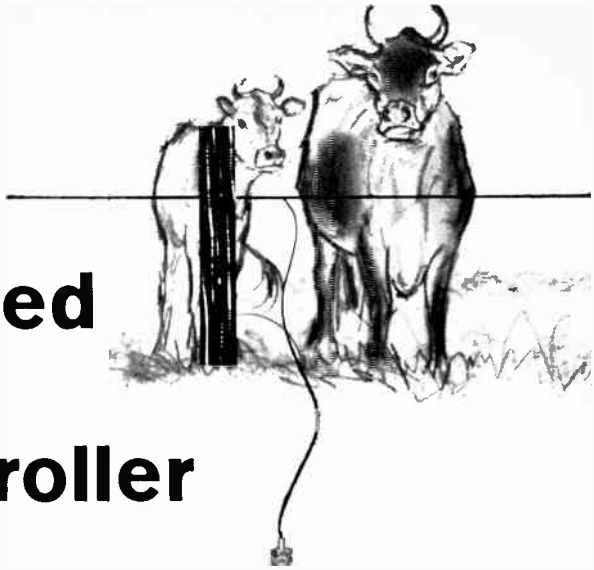




To vary the range of the metronome's oscillation, try connecting capacitor C2 across the entire coil (L1) or its two-hundred turn winding.

wireless metronome should be placed as close to the radio as possible. The author found that the clicks produced by the metronome appeared to have a more mechanical quality with the receiver tuned to the low end of the broadcast band. However, this may vary from receiver to receiver, depending on its selectivity and tuning characteristics.

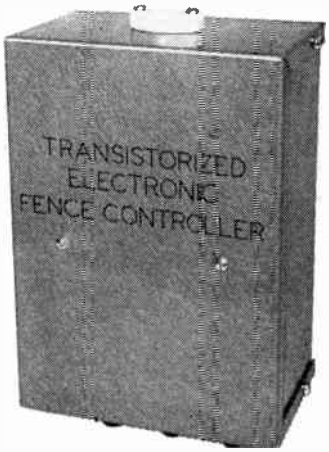
Construction and wiring of the wireless metronome is quite simple and straightforward as may be seen from the layout shown in the above drawing. Parts placement is not at all critical, and other arrangements can be utilized if desired or to fit a differently shaped housing. —30—



Transistorized Electronic Fence Controller

Inexpensive unit keeps animals in.

By R. L. WINKLEPLECK



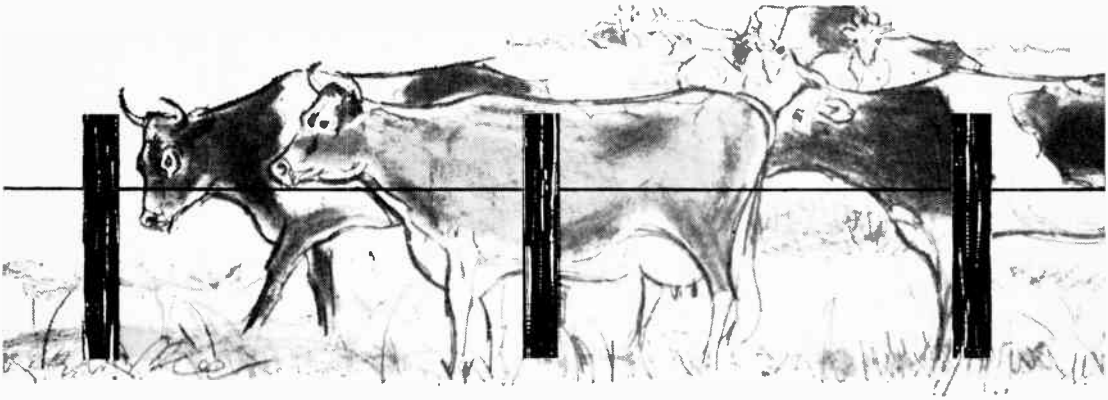
Output of controller is fed to a bare wire fence. With the controller connected, animals touching the wire will receive a harmless shock.

AN ELECTRONIC fence controller, or "charger," is a useful device for keeping animals either in or out of an enclosed area. It supplies a pulsed high-voltage output to a length of bare fence wire and thus delivers an annoying jolt to any animal that touches it. And, in addition to being ideal for keeping livestock within desired boundaries, the fence controller can also be connected to such things as garbage cans—to prevent dogs or pranksters from knocking them over.

No moving parts are used in the transistorized fence controller described here. There is nothing to wear out except the battery, and—thanks to the circuit's high efficiency—battery replacement should be infrequent. The controller complies fully with safety regulations; it will give a stinging shock, but it can cause no serious harm to anyone coming in contact with the charged wire.

You can build the unit, ready for action, for just a shade over ten dollars.

Construction. The fence controller fits in a 3" x 5" x 7" Minibox. First, assemble the transistor circuitry on a 2" x 5" perforated phenolic circuit board. Then wire the components point-to-point, using solder lugs or "flea" clips where necessary. Attach completely wired phenolic circuit board to the mounting bracket on the spark coil



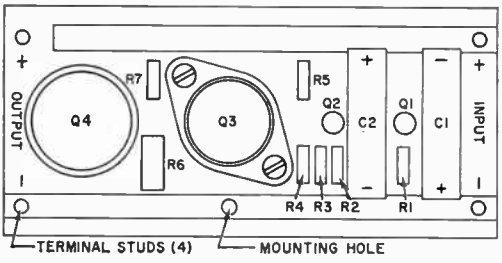
or to any other convenient point. Spark coil *T1* may be a 6- or 12-volt model depending on the voltage of the battery you decide to use.

Connect the high-voltage output of *T1* to the standoff insulator on the top of the box with auto ignition wire. Battery and ground connections are made to the three binding posts on the bottom of the box. As a final touch, fasten a bracket to the box so that you can mount it on a fence post.

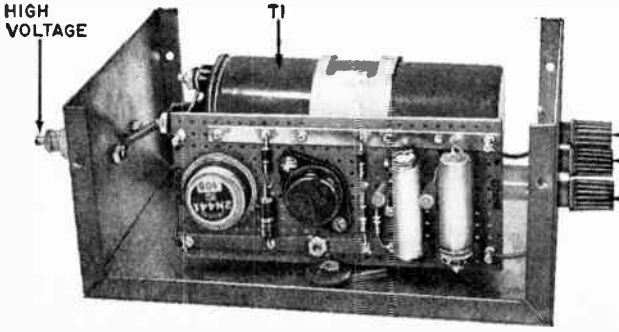
Test the finished controller by connecting a 6- or 12-volt "hot-shot" or storage battery to the positive and negative binding posts, being sure to observe polarity. Check for a spark between the standoff insulator and the ground binding post by scratching a well-insulated wire between these terminals. Don't use bare wire or you may be knocked off your feet.

After the unit is checked out, spray the circuit board and the outside of the box with an insulating spray lacquer to guard against dirt and moisture.

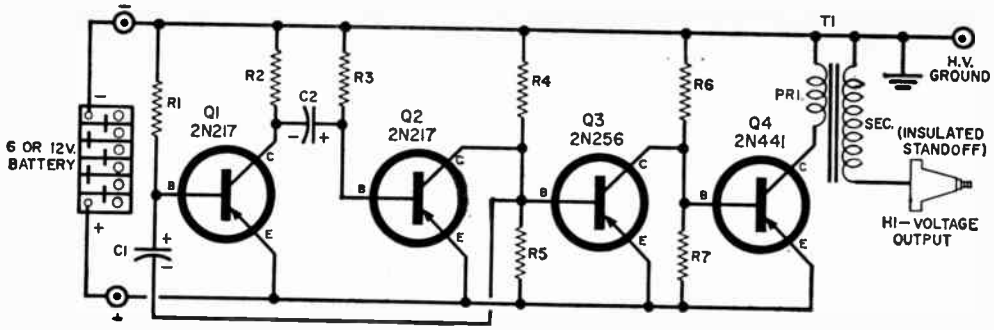
Operation. String single- or double-stranded bare wire around the area to be enclosed. Use insulators



Most components are mounted on phenolic board. Wiring is made easier through the use of copper strips on either side of the board.



High-voltage output to fence is taken from a terminal at one end of the charger. Terminals at other end are connected to battery and ground.



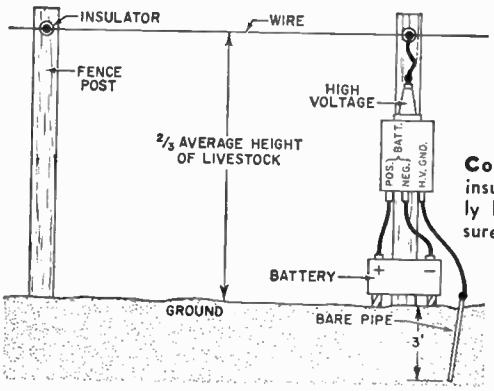
Transistors Q1 and Q2 operate as a multivibrator, Q3 and Q4 as common-emitter amplifiers. Capacitor C1 is feedback capacitor in multivibrator circuit.

PARTS LIST

B1—6- or 12-volt storage battery (see text)
C1—20-μf., 50-volt electrolytic capacitor
C2—100-μf., 50-volt electrolytic capacitor
Q1, Q2—2N217 transistor (RCA)
Q3—2N256 power transistor (CBS)
Q4—2N441 high-power transistor (Delco)
R1—100,000 ohms
R2—2200 ohms
R3—82,000 ohms
R4, R5—220 ohms
R6—82-ohm, 1-watt resistor
R7—82 ohms
All resistors ½ watt unless otherwise noted
T1—6- or 12-volt automobile ignition coil
1—3" x 5" x 7" Minibox (or equivalent)
1—2" x 5" perforated phenolic circuit board

(ceramic or plastic) to fasten the wire to the fence posts; the wire should be at a level roughly two-thirds the average height of the livestock. Then mount the controller on a fence post, preferably in a spot where it will be well protected from the weather.

Connect the controller's standoff terminal to any convenient point along the wire; auto ignition wire is best for this purpose if the wire is very long. The controller's ground terminal is connected to a pipe or rod driven at least three feet into the ground. When the battery is connected, the fence will immediately become "alive."



Connect the completed charger to an insulated fence. Check fence carefully before connecting the battery to insure that there are no paths to ground.

Use a lightning arrester to prevent damage to the controller. Connect the arrester between the porcelain standoff insulator and ground. The gap on the arrester should be wide enough (about ¼") to keep the normal output of the controller from jumping the gap.

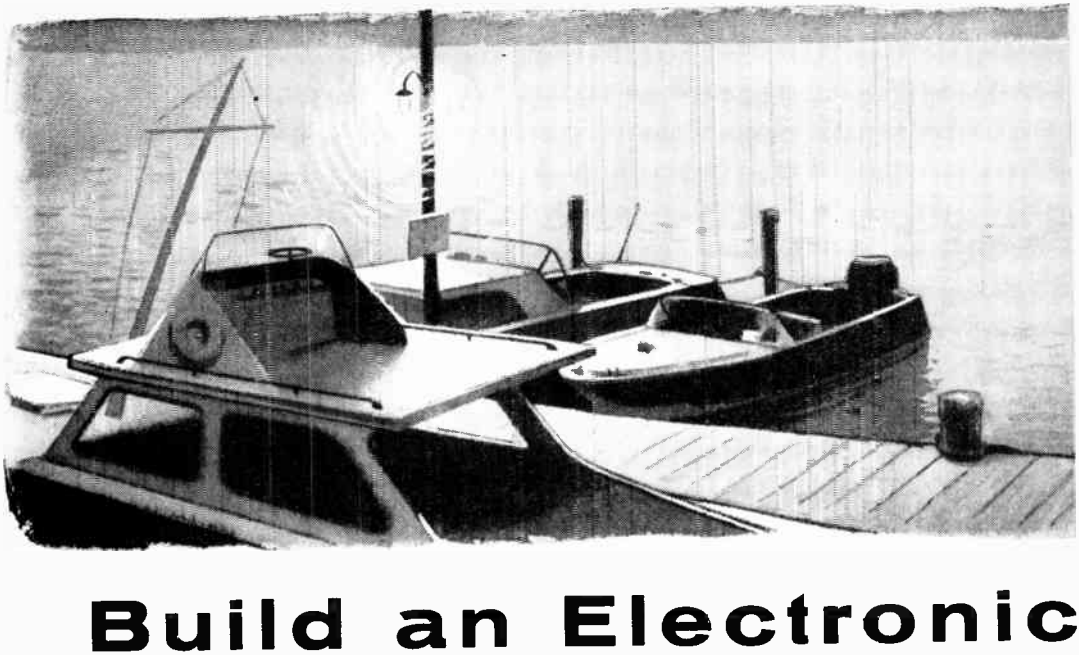
To turn off the controller, disconnect either battery lead. Animals soon learn to respect and to avoid a charged fence; once they have been shocked they will often be wary of it for weeks after the power is disconnected.

To keep the neighbor's dog from knocking over your garbage can, just set the can on insulating blocks and connect the controller to it as described above. —30—

HOW IT WORKS

Transistors *Q1* and *Q2* are connected in a multivibrator circuit which oscillates due to feedback from the collector of *Q2* to the base of *Q1*. Transistors *Q3* and *Q4* are common-emitter amplifiers. In oscillation, *Q1* and *Q2* conduct alternately. When *Q1* conducts, it biases *Q2* to cutoff. With *Q2* thus cut off, *Q3* conducts, and cuts off *Q4*. When *Q2* conducts, it biases *Q3* to cutoff, which allows *Q4* to conduct.

Since the output of the multivibrator is non-symmetrical, *Q4* is cut off for a longer time than it conducts. Transistor *Q4* therefore acts as an automatic switch to trigger the spark coil. The charger's "off" time is determined primarily by the time constant of *C2-R3*, its "on" time by *C1-R1*. With the values shown, *Q4* is cut off for nearly a second and then conducts heavily for a fraction of a second.



Build an Electronic Burglar Alarm

By ED DUDA

BEFORE the new boating season gets going, you'll want to take steps to protect your shipboard gear from burglary and vandalism. Here's an inexpensive and simple burglar alarm that can turn on a warning light, a horn, or even a siren, if any unauthorized persons attempt to remove equipment from the craft. It can also be used to protect ham gear in your car, or guard your home while you're away on vacation.

The alarm uses only a few parts and will operate for months on its self-contained battery—standby current is only 50 microamperes. Due to the low operating voltage and current, there is no danger of shock. Even so, the relay in the alarm can carry up to 2 amps at 125 volts, enough to operate most bells and sirens.

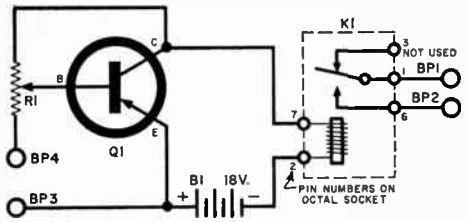
Construction. The model was built into a 6" x 3⅛" x 1½" plastic box with a hinged top, as shown in the pictorial. The accompanying test unit was built into a 2⅞" x 1¼" x 1⅛" plastic box and is designed to plug into the burglar alarm. Other containers or layouts can be used, if you wish, since the circuit is not critical.

Relay *K1* plugs into a standard octal tube socket and transistor *Q1* into a transistor socket. All other parts are supported by their leads except "five-way" binding posts *BP1*, *BP2*, *BP3*, and *BP4*, which are mounted at one end of the box. Be sure to position *BP1* and *BP2* exactly ¾" apart in order to match the spacing of banana plugs *P1* and *P2* on the test unit. If desired, potentiometer *R1* and transistor *Q1* can be mounted in a separate plastic box.

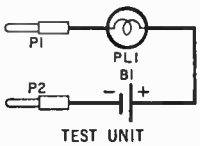
The relay should be waterproofed before it is installed in the alarm. To do so, remove the four screws from the relay's plastic cover. Then, using lacquer or clear nail polish, coat the area between the octal base and the metal flange, both inside and outside the relay. Replace the cover and screws, and coat the mating area between the relay cover and the metal flange. Use plenty of lacquer around each of the four screws.

Adjustment. Before adjusting the alarm be sure that the relay and transistor are firmly seated in the sockets and that the 18-volt battery is properly connected. Wrong battery polarity can ruin the transistor.

Next, plug *P1* and *P2* of the test unit into binding posts *BP1* and *BP2* of the burglar alarm; lamp *PL1* on the test unit should light. Connect binding posts *BP3* and *BP4* with a length of wire and adjus



Single transistor (Q1) energizes relay K1 when circuit across BP3 and BP4 is opened. Test unit plugs into BP1 and BP2; lamp PL1 lights when K1 is energized.



PARTS LIST

B1—18-volt battery (two Burgess 2N6 9-volt batteries or equivalent in series)
B2—1.5-volt penlight cell (test unit)
BP1, BP2, BP3, BP4—Five-way binding post (Lafayette MS-566 or equivalent)
K1—S.p.d.t. relay, 4000-ohm coil; 2-amp., 125-volt contacts; 1.9-ma. operating current (Kurman 23DB42 or equivalent)
P1, P2—Banana plug
PL1—1.5-volt flashlight lamp (test unit)
Q1—2N188A transistor
R1—250,000-ohm, 2-watt potentiometer (Ohmite CLU-2541 or equivalent)
1—Octal tube socket
1—Transistor socket
Misc.—Hardware, plastic boxes, battery clips, penlight cell holder, penlight bulb socket, etc.

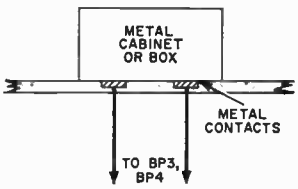
potentiometer *R1* until the lamp goes out. When you remove the jumper wire, the lamp should light once more. The burglar alarm should now be ready for installation.

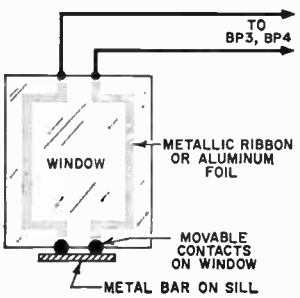
Be sure to keep a jumper wire across *BP3* and *BP4* when the unit is not connected to an alarm circuit. This keeps current drain on battery *B1* at a minimum.

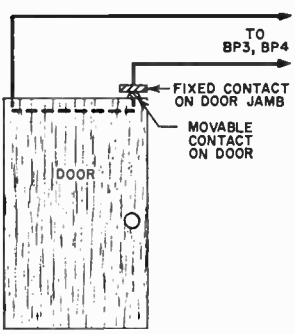
Installation. One of the most important considerations in any burglar-alarm system is to prevent the burglar from disabling the alarm. Once a convenient hiding place has been selected for the alarm, the next step is to hook up binding posts *BP3* and *BP4* to a "sensing" circuit at the property requiring protection. The sensing circuit is nothing more than a switch that is inadvertently operated by the burglar when he attempts to remove equipment or open a window or door. Typical sensing circuits, one for each of these three cases, are shown at left.

The final step is to connect binding posts *BP1* and *BP2* to the warning circuit, which can be any of a number of electrical signaling devices. Two typical warning circuits are shown at right. On your car or boat, you can use your horn for an alarm. To do this, connect one lead from binding post *BP1* to one horn-button terminal and another lead from *BP2* to the other horn-button terminal. In other installations, *BP1* and *BP2* can be connected to an alarm gong, flashing light, siren or even to a door bell.

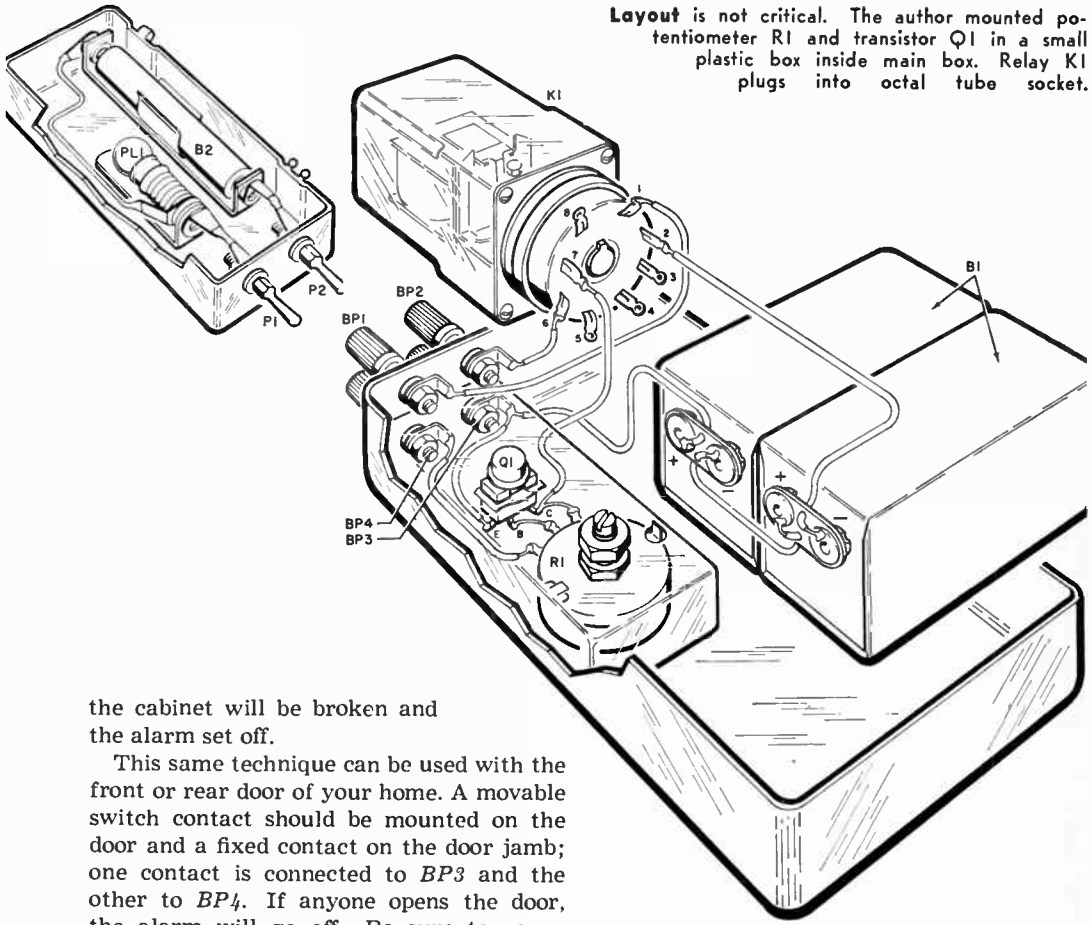
If the equipment to be protected is a piece of mobile electronic gear housed in a metal cabinet, attach leads from *BP3* and *BP4* to separate metal plates underneath the cabinet. Should the cabinet be lifted off the metal plates, the circuit through







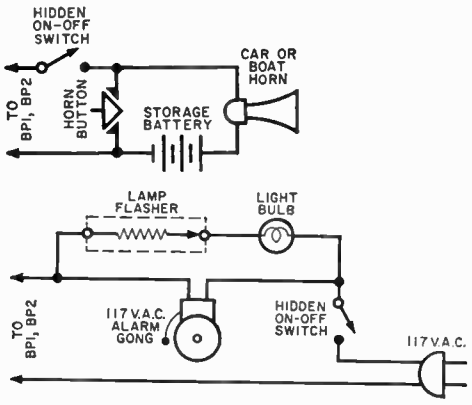
Sensing circuits are "switches" which trip alarm when they are opened. As current is only 50 microamps, alarm is safe to operate near children or pets.



Layout is not critical. The author mounted potentiometer R1 and transistor Q1 in a small plastic box inside main box. Relay K1 plugs into octal tube socket.

the cabinet will be broken and the alarm set off.

This same technique can be used with the front or rear door of your home. A movable switch contact should be mounted on the door and a fixed contact on the door jamb; one contact is connected to *BP3* and the other to *BP4*. If anyone opens the door, the alarm will go off. Be sure to use a sensing switch that will remain open once the door has been opened; otherwise the thief could close the door after him and thus silence the alarm. —30—



Warning circuit on boat or car can use horn to sound the alarm. Installations in homes or stores can operate a 117-volt a.c. system. Open hidden switch to silence alarm after it has been tripped.

HOW IT WORKS

The burglar alarm employs a single transistor (*Q1*) with a relay (*K1*) as its collector load. In operation, *BP3* and *BP4* are connected to each other at the equipment under protection. Potentiometer *R1* acts as a voltage divider in series with battery *B1* and relay *K1*.

The arm of *R1* is set to a point where the base of *Q1* is only slightly less positive than *Q1*'s emitter. This setting of *R1* keeps *Q1* in the non-conductive state; insufficient current flows to energize relay *K1*. When the circuit across *BP3* and *BP4* is opened, the base of *Q1* goes very negative and *Q1* conducts heavily, energizing *K1*. With *K1* energized, normally open contacts 1 and 6 of *K1* close and connect binding posts *BP1* and *BP2*. This switches on the warning device and thus sounds an alarm.

When plugs *P1* and *P2* of the test unit are plugged into *BP1* and *BP2*, battery *B2* will light warning lamp *PL1* if there is a break in the circuit connecting *BP3* and *BP4*. In actual use, a bell, siren, or other warning device is substituted for the test unit.

High-Power Crystal Set

Voltage-doubler circuit drives miniature speaker.

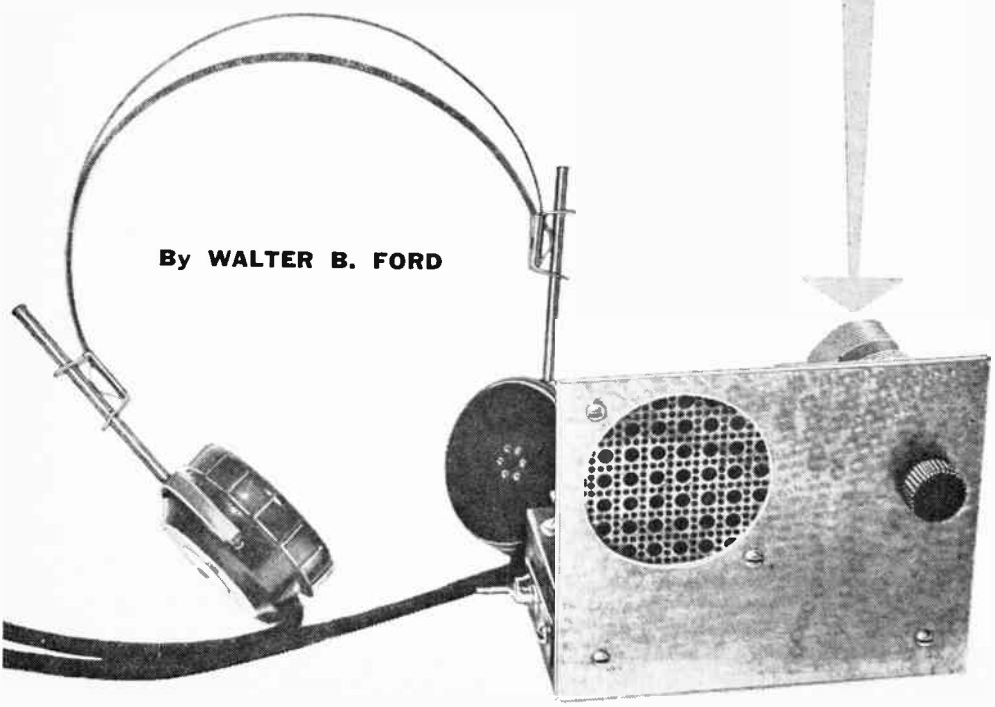
By WALTER B. FORD

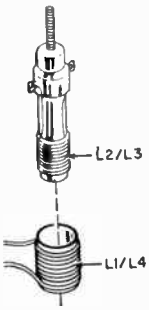
HERE'S a pint-sized crystal radio with enough oomph to drive a 2½" speaker. This little unit's selectivity is far better than you'd expect to find in a crystal receiver and volume is equal to that obtained with sets using a transistor. No external power source is required.

The unusual selectivity of this radio is due to its special double-tuned circuit. A pair of diodes connected as a voltage-doubler provides the extra kick to operate the small speaker. An output jack is provided for headphone listening and for connecting the set to an amplifier.

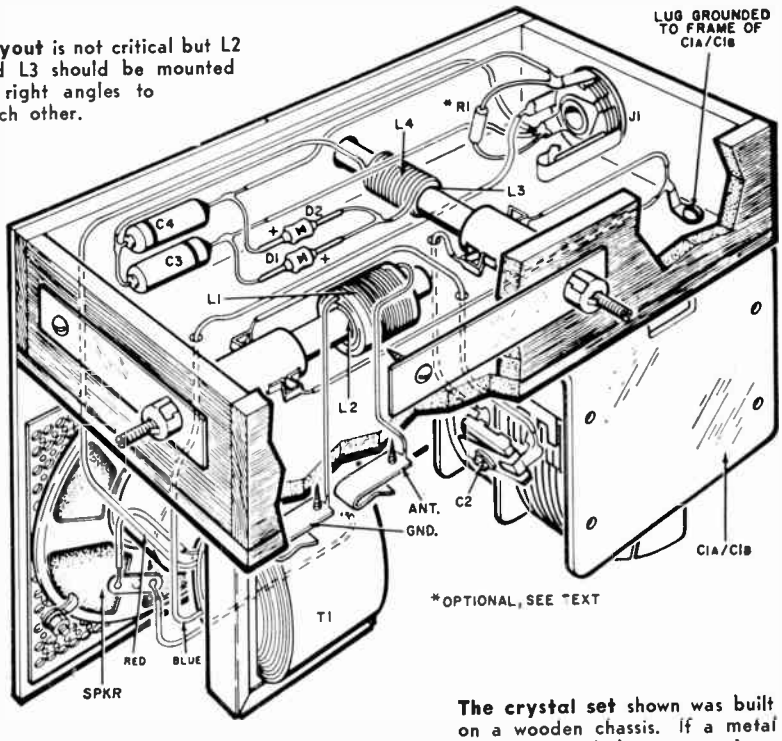
Construction. The model was built on a 2½" x 4½" wooden chassis with a 3½" x 4½" metal front panel. However, size is not critical, and other materials can be substituted if desired.

Two standard ferrite loopsticks, *L2* and *L3*, are used. Both must be modified by the addition of a second winding, *L1* and *L4*, respectively. Each of the added windings consists of 22 turns of No. 24 cotton-covered wire wound on a small cardboard tube as shown on the pictorial. (Actually, any wire size from No. 22 to No. 28 with cotton or enamel insulation will do the job.) The

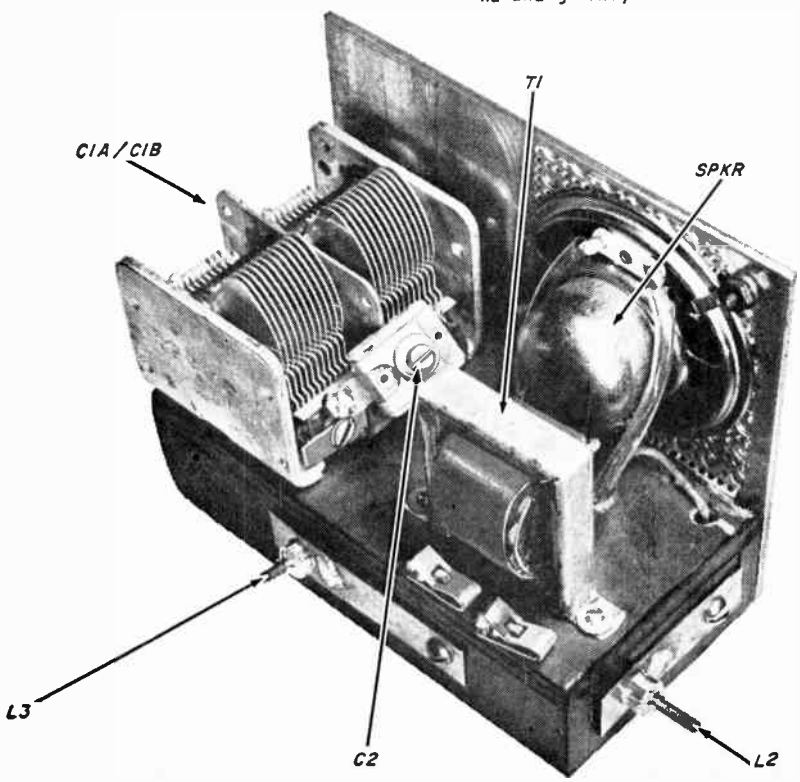


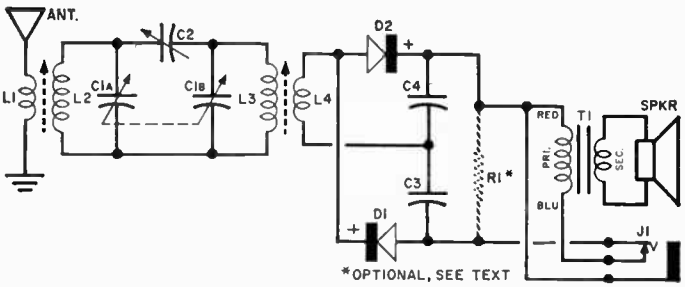


Layout is not critical but L2 and L3 should be mounted at right angles to each other.



The crystal set shown was built on a wooden chassis. If a metal chassis is used, be sure to insulate the Fahnestock clips (antenna and ground) from the chassis.





For phone operation only, the speaker, transformer, and resistor R1 can be omitted. In this case, connect high-impedance phones in place of R1.

diameter of the cardboard tube should be slightly larger than *L2* and *L3* so that *L1* and *L4* will slip over *L2* and *L3* easily.

Resistor *R1* is used only for feeding the set into an amplifier; it should be omitted for both earphone and loudspeaker operation. Trimmer capacitor *C2* should be soldered across the stator terminals of two-gang variable capacitor *C1a/C1b*, as shown. The speaker and output transformer can be mounted wherever convenient.

After all of the parts have been mounted on the chassis, wire them together following the schematic and pictorial diagrams. Be sure that diodes *D1* and *D2* and capacitors *C3* and *C4* are correctly polarized.

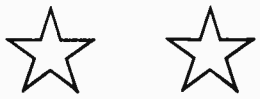
Alignment and Operation. To align the receiver, first connect it to an antenna and ground. (The optimum length of the antenna varies with location, but 50 feet will usually be suitable in areas serviced by several broadcast stations.) Next, plug in a high-impedance earphone at jack *J1*. Tune in a station near the high-frequency end of the broadcast band—say 1500 kc.—and adjust the trimmer capacitors on variable capacitor *C1a/C1b* for the loudest signal.

Trimmer capacitor *C2* should then be adjusted for the best selectivity and volume over the entire broadcast band. Finally, coils *L1* and *L4* can be optimumly positioned by sliding them back and forth over coils *L2* and *L3*. If a nearby station interferes with reception of a weaker one, tune the slug on *L2* for minimum interference.

For loudspeaker operation, simply unplug the earphone from *J1*—strong local stations should come in with fair volume. To operate the set as an AM tuner, wire *R1* in place and connect *J1* to the crystal-phono input of a preamplifier or integrated amplifier. The set should give excellent results with a quality hi-fi system. —30—

PARTS LIST

C1a/C1b—2-gang, 365-μμf. variable capacitor (Lafayette MS-142 or equivalent)
C2—180-μμf. compression-type trimmer capacitor
C3, C4—.005-μf. fixed capacitor
D1, D2—1N34A diode
J1—Closed-circuit phone jack
L1, L4—22 turns of No. 24 cotton-covered wire (see text)
L2, L3—Ferrite antenna coil (Miller 6300 or equivalent)
R1—47,000-ohm, ½-watt resistor (see text)
T1—Replacement-type output transformer; 3000- to 10,000-ohm primary; 4-ohm secondary
Spkr.—2½" speaker, 4-ohm voice coil
Misc.—Hardware, wood, aluminum sheet, Fahnestock clips, etc.



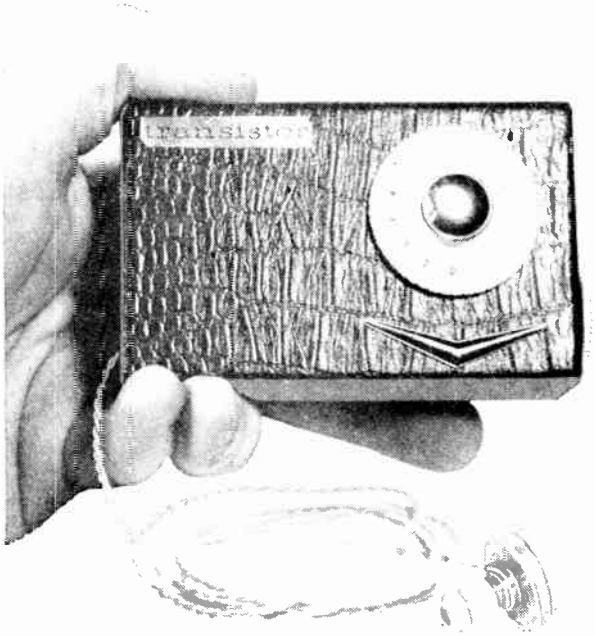
HOW IT WORKS

The receiver employs a double-tuned circuit feeding a crystal-diode voltage-doubler/detector which drives a small speaker. In operation, r.f. signals picked up by the antenna system are induced into coil *L2* from coil *L1*. The desired signal is selected by tuned circuit *C1a-L2* and coupled through capacitor *C2* to a second tuned circuit, *C1b-L3*, which improves the selectivity by narrowing the r.f. bandpass. The twice-tuned r.f. signal is then induced into coil *L4* from coil *L3*.

The positive half of the r.f. signal appearing across *L4* passes through diode *D2* to charge capacitor *C4*; the negative half of the signal passes through diode *D1* to charge capacitor *C3*. Polarities of the charges on *C3* and *C4* are such that the effective voltage is doubled. This voltage appears across the primary of output transformer *T1*, which changes the high impedance at the output of diodes *D1* and *D2* to the low impedance required by the speaker.

When high-impedance earphones are plugged into closed-circuit jack *J1*, the speaker is disconnected and the output from the diodes feeds directly into the earphones. Optional load resistor *R1* is placed across the output of the diodes when the receiver is used with an amplifier.

Reflex and regenerative circuits are combined in this sensitive and stable . . .



ONE TRANSISTOR POCKET RADIO

By
ALVIN MASON

DESIGNING and constructing a one-transistor pocket receiver is a challenge to any experimenter. A good many "pocket" receivers are either too large or too bulky for true "pocket" operation. Or they simply don't possess enough sensitivity and gain to pull in stations without an external antenna.

The little receiver described here gets around both of these weaknesses. It uses a combination of reflex and regenerative action to cut size and components to a minimum and increase sensitivity to striking proportions. The complete unit measures only 4" x 2½" x ¾". And it's powerful enough to pull in every local station on the dial with no external antenna at all!

Reflex Circuit. Because of the "reflex" action of the circuit, a single transistor is made to amplify the signal twice—once at radio frequencies and again, after detection, at audio frequencies (see "How It Works"). To simplify the circuit, a diode is used as a detector, leaving

the transistor free to do nothing but amplify.

Also acting to increase the circuit's simplicity and stability is the regeneration hookup. The circuit is designed so that the amount of positive feedback or regeneration doesn't control the overall sensitivity as is usually the case with regenerative detectors. What's more, there is no regeneration control or annoying oscillation to contend with.

Since the remarkable efficiency of this little set doesn't depend on regeneration alone, only a limited amount of regeneration is used. Its stability is evidenced by the fact that, once adjusted, the set is as stable as most non-regenerative detectors.

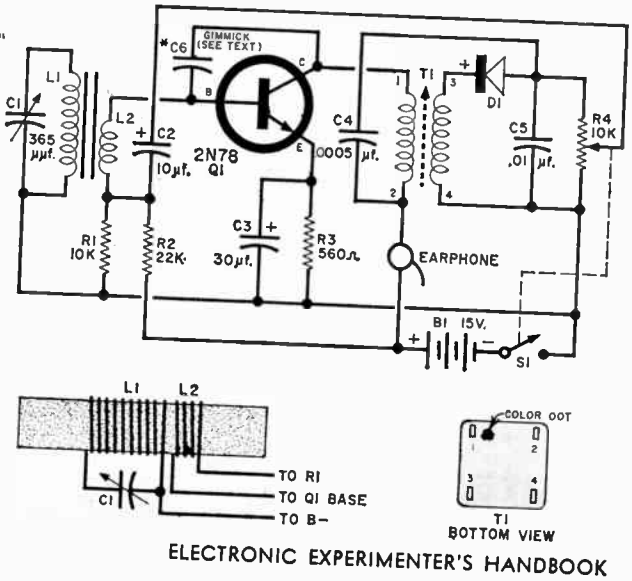
Although a Philco r.f. transformer was used as *T1* in the model, this particular transformer is available only from authorized Philco distributors and may prove hard to get. However, *T1* is in no way critical—a number of transformers were substituted for the Philco unit, and most of them worked satisfactorily.

The Argonne AR-162 (available from Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y., for $2.95) seems to be a good substitution. A miniature output transformer measuring only 1" x ¾" x ¾", the AR-162 has identical center-tapped primary and secondary winding of 500 ohms with a d.c. resistance of 18 ohms. You'll have to remove the transformer's strap and laminations to fit the unit in the small plastic box specified in the parts list. But you'll find that this bit of disassembling proves no problem (see illustration on next page). The windings are light enough to be held in place with a strip of transparent tape. The center-taps are not used.

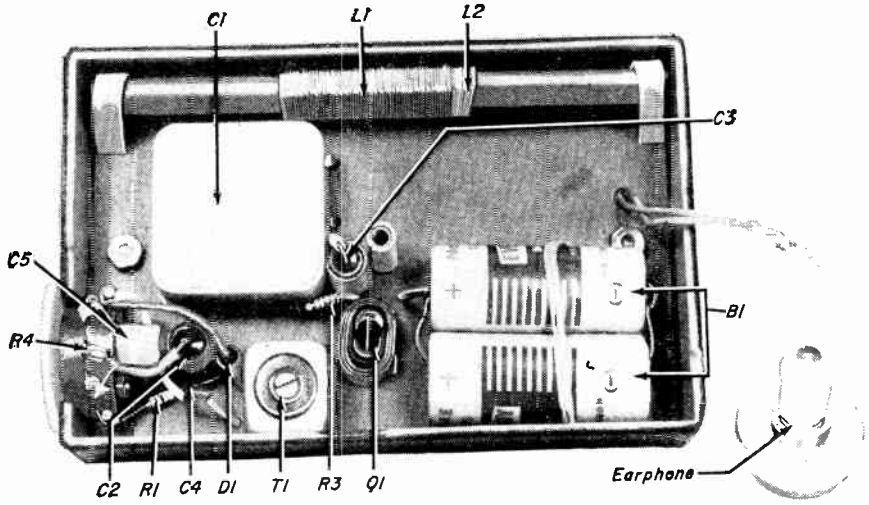
Construction. The chassis is a piece of Formica or phenolic board about 4" x 2½" x 1/16". Depending on the size of the components, the chassis should fit into a small plastic box measuring about 4" x 2½" x ¾". Homemade printed circuitry was used on the model, but standard wiring will do just as well. Most of the component leads are long enough to permit point-to-point

PARTS LIST

B1—15-volt battery (two Eveready 504's or equivalent in parallel)
C1—365-μμf. variable capacitor
C2—10-μf., 25-volt miniature electrolytic capacitor
C3—30-μf., 25-volt miniature electrolytic capacitor
C4—.0005-μf. ceramic capacitor
C5—.01-μf. ceramic capacitor
C6—Gimmick capacitor (see text)
D1—1N60 diode
L1—Antenna coil for C1 (Miller 2004 or equivalent)
L2—Six turns of #26 insulated wire wound on L1 (see text)
Q1—2N78 transistor
R1—10,000 ohms (All resistors ¼ watt)
R2—22,000 ohms
R3—560 ohms
R4—10,000-ohm volume control with s.p.s.t. switch S1
S1—S.p.s.t. switch (on R4)
T1—Coupling transformer (Philco 32-4763-2 or equivalent—see text)
1—2000-ohm impedance earphone
1—Transistor socket
1—4" x 2½" x ¾" plastic box
1—4" x 2½" x 1/16" phenolic board
Misc.—Tuning dial, knob for volume control, wire, solder, etc.



One transistor does the work of two in this highly efficient circuit. The signal is amplified twice—once at radio frequencies and, after detection, at audio frequencies.



Parts are mounted on a phenolic board; R2 and C6 are on reverse side.

wiring, but a transistor socket was used to prevent possible damage to the transistor when soldering.

Coil *L2* consists of six to nine turns of No. 26 insulated hookup wire wound on the "ground" end of *L1* and spaced 1/16" from it. "Gimmick" capacitor *C6* is made up of two ½" lengths of insulated hookup wire twisted together several times to form a small capacitor.

It's a good idea to lay out all parts and drill most of the holes in the chassis before starting assembly. Since the wiring is relatively simple, you should be able to take your time and do a good job. As with any construction project, time spent in careful wiring will pay off in the long run.

Operation. After all parts have been mounted and soldered in place, double-check all connections. Now, with the switch off and battery *B1* in place, plug in the transistor. Turn on the set and rotate the volume control to full on. Select a station, preferably the strongest one on the dial. Listen for distortion. If necessary, either loosen the coupling in capacitor *C6* by untwisting the leads slightly or by snipping off the leads bit by bit until the distortion disappears.

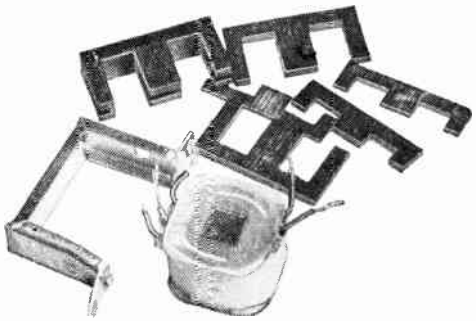
Once adjusted, the set should be nearly as stable as the superhet in your living room. And it's a safe bet that in sensitivity and portability this little unit will have few equals. —30—

HOW IT WORKS

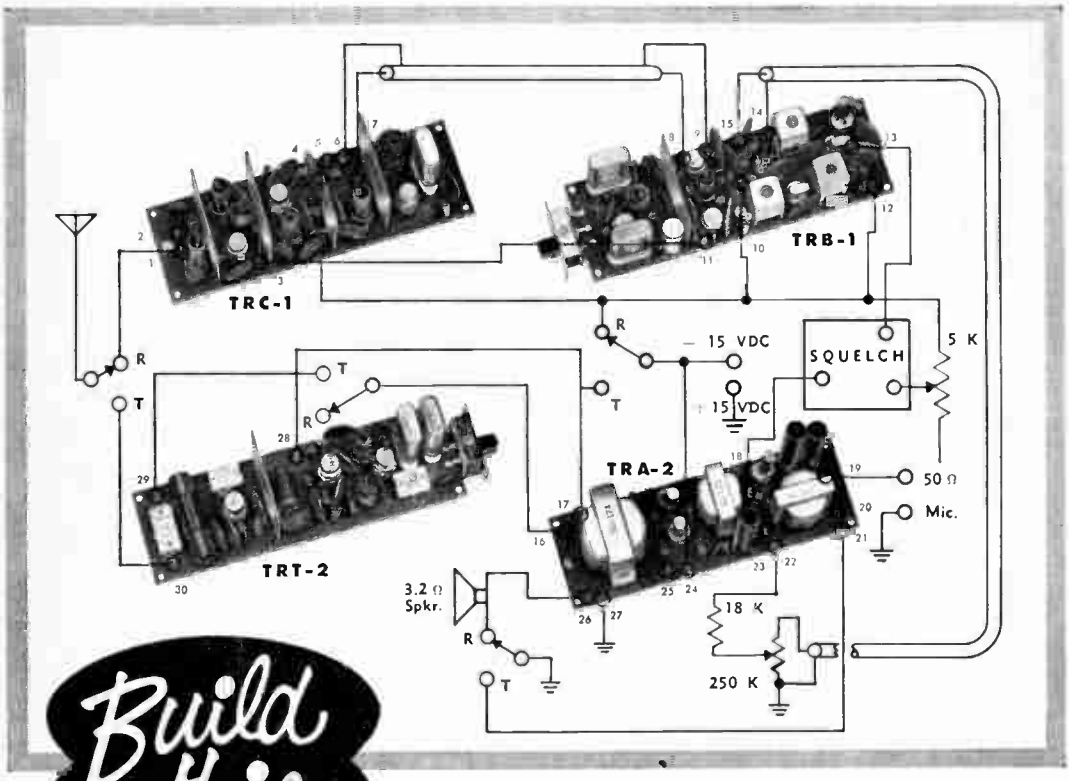
One transistor and one diode are employed in a circuit that combines the advantages of both reflex and regenerative action. Because the signal passes through transistor *Q1* twice—once as r.f. and once as a.f.—the transistor is properly described as operating in a "reflex" circuit. Adding to the already high efficiency of this circuit is the regeneration furnished by gimmick capacitor *C6*.

In operation, the r.f. signal picked up by antenna coil *L1* is tuned by coil-capacitor combination *L1-C1* and induced into secondary coil *L2*. Fed directly into the base of transistor *Q1*, the r.f. signal is amplified and passed to transformer *T1*. A portion of the signal from *Q1's* collector is returned to *Q1's* base by capacitor *C6* to provide additional gain through regeneration. The signal induced in *T1's* secondary is detected by diode *D1*, smoothed by capacitor *C5*, and returned to the base of *Q1* through volume-control *R4* and coupling capacitor *C2*.

Transistor *Q1* again amplifies the signal, this time at audio frequencies. The audio signal from *Q1's* collector is fed through the primary of *T1* to the earphone.



Coupling transformer T1 must be a miniature unit. If Argonne Type AR-162 is used, it can be reduced in size by removing the strap and laminations.



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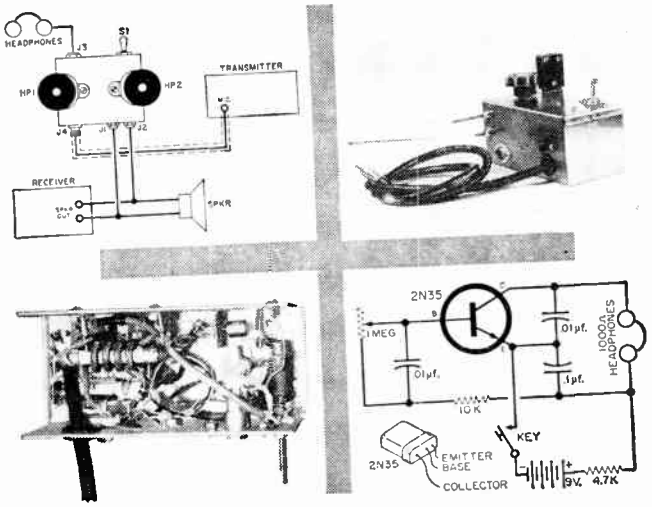
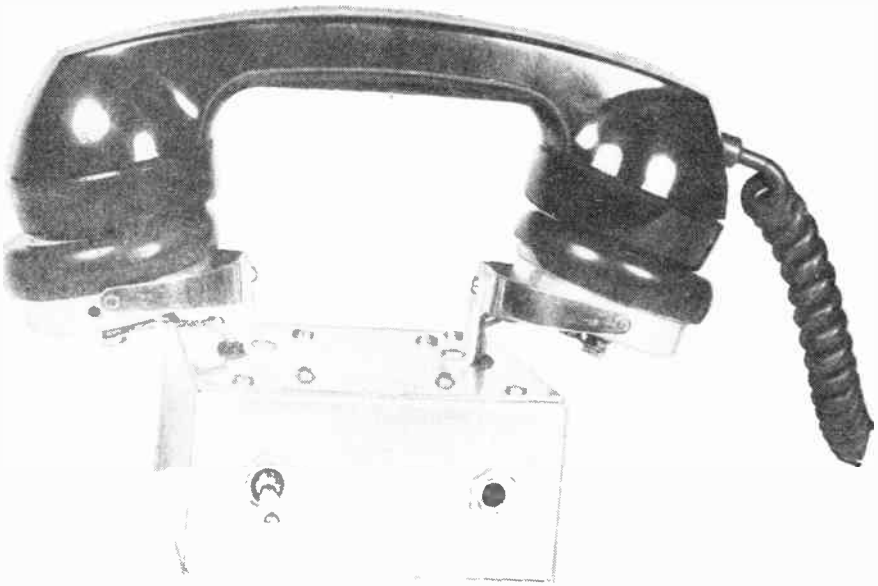




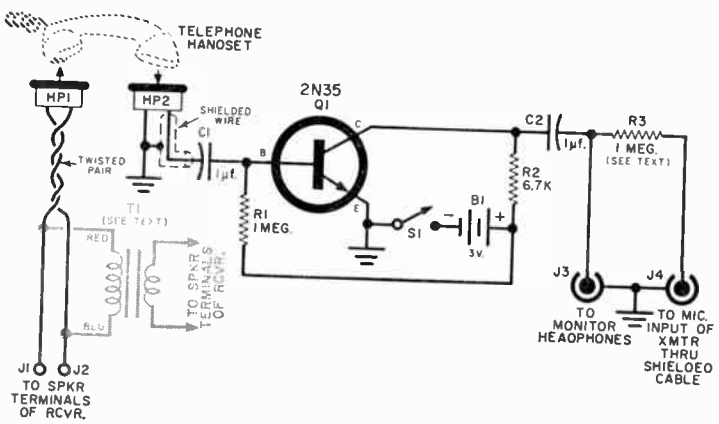
ACOUSTIC PHONE PATCH

Build this third-party link between your ham contact and telephone.

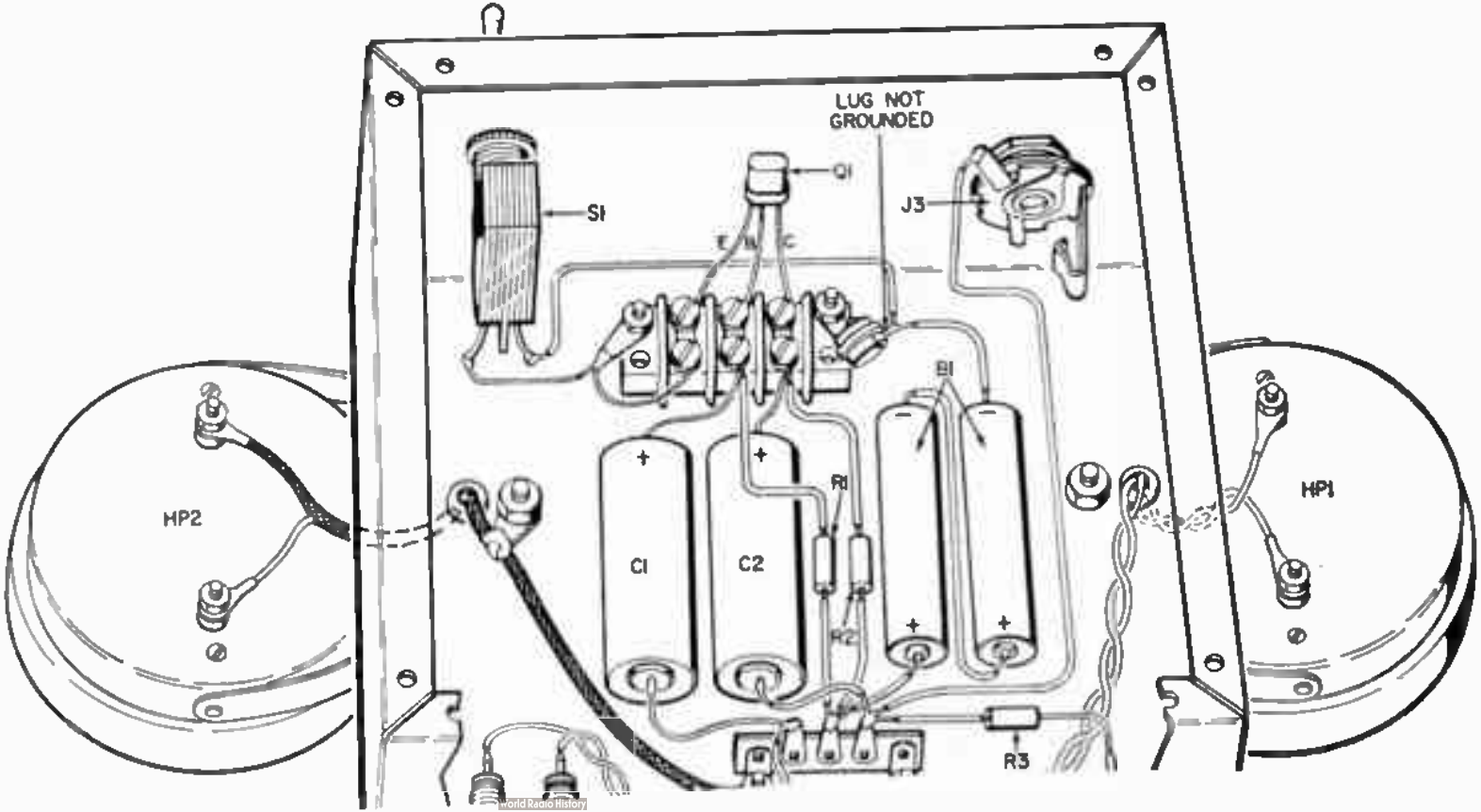
By J. C. FISCHESSER, W4FMW

EVERY HAM realizes that a phone patch can add to the fun and usefulness of his station. A phone patch allows an operator to make a telephone connection between fellow operators and their friends who are in the vicinity. Here is one which is easy to build and needs no connections to telephone wires, thus avoiding possible trouble with the telephone company.

Construction. Basically, this phone patch is a pair of magnetic headphone units mounted so that a telephone handset can rest on them. One headphone unit acts as a microphone and feeds the acoustical



Transformer T1's use is optional. With it, you can increase volume in the headphone unit (HP1) feeding the telephone mouthpiece. Note that the voice of the telephoned party is picked up by headphone unit HP2.


LUG NOT
GROUNDED
S1
Q1
J3
B1
HP2
HP1
C1
C2
R1
R2
R3

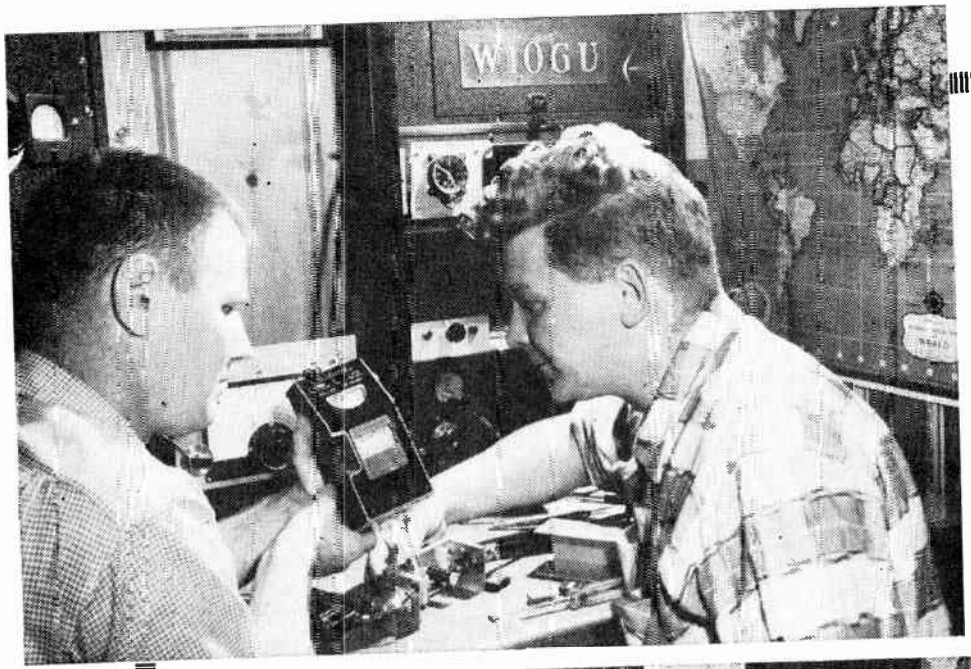
speaker terminals and *HP 1* to improve the impedance match. The transformer's voice-coil winding should be connected to the speaker terminals and the plate winding to jacks *J1* and *J2*.

Output from the transistor amplifier is fed from output jack *J4* to the microphone input jack of the transmitter via a cable with suitable connectors. This input to the transmitter can be monitored at jack *J3* with a pair of high-impedance headphones.

Operation. Place the telephone handset on the phone patch with the mouthpiece against *HP1*. Don't worry if the telephone doesn't fit perfectly against the phone patch headphone units. Quality is actually better if there is a small air gap.

When you close switch *S1*, you should hear the party on the telephone in your monitoring earphones. Adjust the transmitter speech amplifier gain control for the best modulation. Then turn up the receiver volume until the party on the telephone can hear your radio contact at normal telephone volume.

Make a note of the positions of your receiver volume control and the speech amplifier gain control, and you will be able to hook up the phone patch in a jiffy next time.



The authors tune up the tiny transistorized transmitter with grid-dip meter prior to going on air. (Right) Gus Fallgren keys the transmitter whose power source is 6 v. battery.

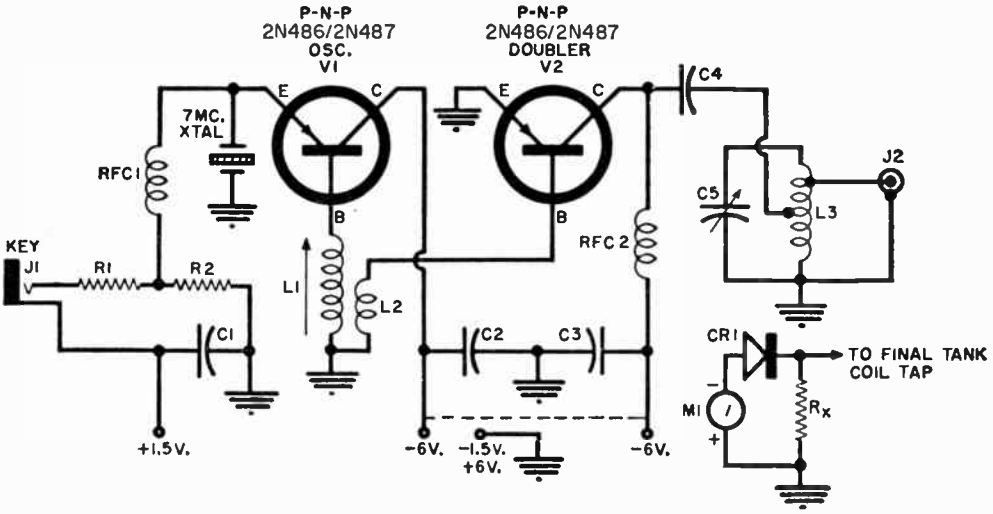
"Tiny-Mite" Transmitter for DX-ing

By **GUS FALLGREN,** Raytheon Company
&
AL HANKINSON, Federal Aviation Agency

Bored with your big ham rig? Try this transistorized unit for new operating fun and thrills.

IF YOU are bored with your big rig and want a new and exciting experience, how about building this tiny .08-watt transmitter for your DX-ing. It is both transistorized and compact.

The entire unit can be constructed in a standard 5" x 2¼" x 2¼" chassis box or case. The under-chassis view shows, from right to left, the key jack, the crystal socket, a transistor socket for the oscillator section, the slug adjustment for the oscillator coil, another transistor socket for the doubler-final stage, the tuning knob for the output tank capacitor, and the antenna coax connector. The battery leads are brought out below the coax fitting in the lower left-hand corner. No further comments on component placement are needed,



Complete schematic and parts list for the .08-watt transistorized ham transmitter.

PARTS LIST

Rx—Non-inductive resistor equal to line impedance (see text)
R1—160 ohm, ½ w. res.
R2—1 megohm, ½ w. res.
C1, C2—.01 μf. disc ceramic capacitor
C3—.005 μf. disc ceramic capacitor
C4—.001 μf. disc ceramic capacitor
C5—50μμf. variable capacitor (National HF50)
L1—38 t. #22 en. closewound, ½" dia. (CTC slug-tuned form)
L2—8 t. #22 en. wound over ground end of L1
L3—17 t. B & W "Miniductor" #3011, tapped 5¼ t. from ground
J1—Miniature open-circuit jack
J2—Coaxial cable connector
M1—1 ma. d.c. meter
CR1—CK705 or equiv.
RFC1, RFC2—2.5 mh. r.f. choke (Grayburne M25)
Xtal.—7 mc. crystal
V1, V2—"p-n-p" transistor (Raytheon 2N486, 2N487, or for more power, 2N417)

as nothing seems to be critical; you can adapt the layout to fit the components.

For matching the antenna to the transmitter the authors used a 52-ohm coax.

The oscillator coil should be wound as indicated in the schematic. Don't attempt to build the oscillator separately and then check it out as you may run into trouble from individual transistor variations. Build the entire transmitter, plug in the transistors, and you are ready to tune.

Tuning is a little different than with a regular tube transmitter, but if you follow directions you should find it simple. You will need a grid-dip meter or your receiver's "S" meter, a 0-25 milliammeter, and the simple r.f. indicator shown on the schematic. The r.f. indicator is easily constructed and is very handy for working with transistorized transmitters. *Rx* is a carbon resistor which matches the line impedance—51 ohms for a 52-ohm coax, etc.

Here is the tuning procedure:

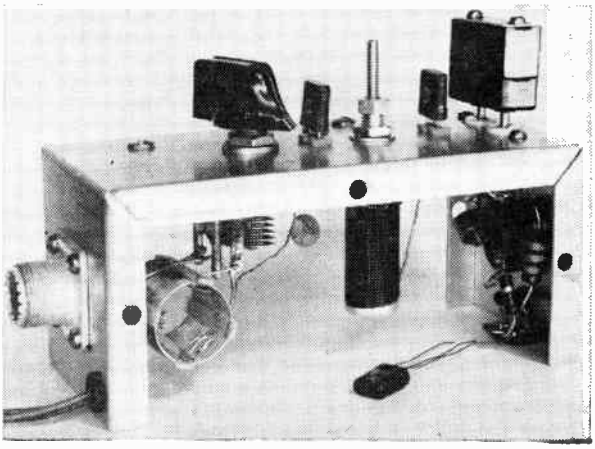
1. Using either the grid-dip meter or the "S" meter, adjust the slug-tuned coil *L1* for maximum 7-mc. output. This step should give you no trouble, as transistor oscillators seem to oscillate easily.

2. With the milliammeter inserted in the final stage collector lead, adjust link *L2* for maximum current (12 to 15 ma.).

3. Again using either the grid-dip meter or the "S" meter, adjust the final tuning capacitor for maximum 14-mc. output.

4. You are now ready to select the tap for the collector. Using the grid-dip meter as

Complete transmitter fits into a 5" x 2¼" x 2¼" box. Transistors shown in this photo were later changed to the newer 2N417's noted above.



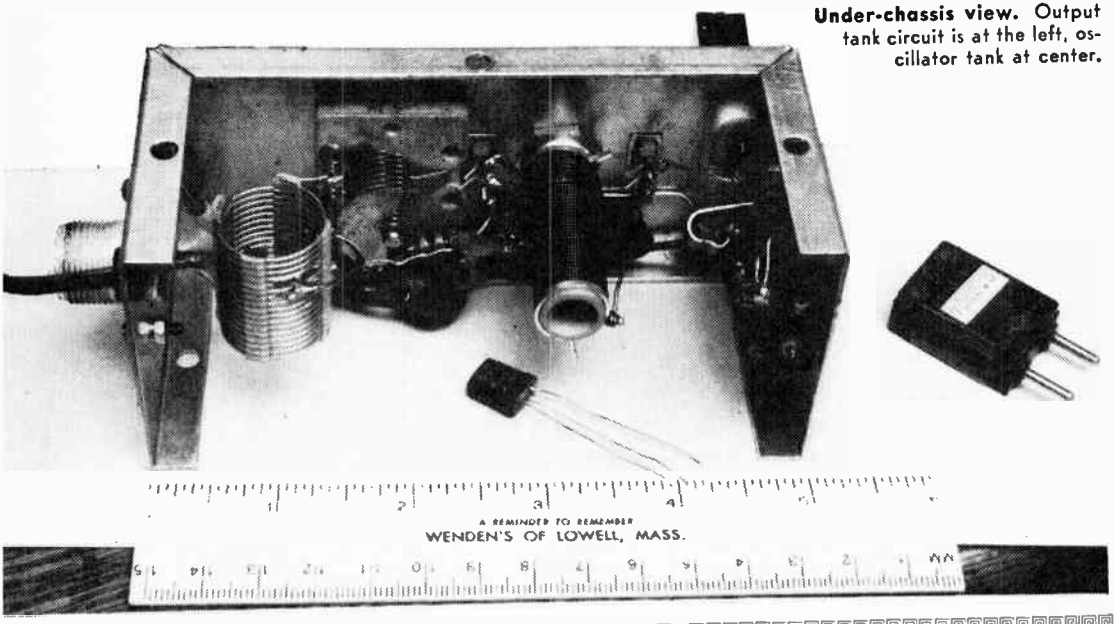
an absorption wavemeter tuned to 14 mc. record the meter reading, then change the tap and hunt for a point where the output is maximum. Simple but effective! The best tap will be quite far down on the tank coil because of the low collector impedance.

5. Using the r.f. indicator, move up and down the final coil until the point of maximum output is found, and connect the antenna tap at this point.

Now you have a working rig, any variations are up to you. One that was tried and discarded in the interests of simplicity was the use of a 1-megohm potentiometer in place of *R1* and *R2*. With a pot in this location, you will have control over your drive and also your keying characteristics. The authors experienced no keying trouble whatsoever, so the pot was eliminated.

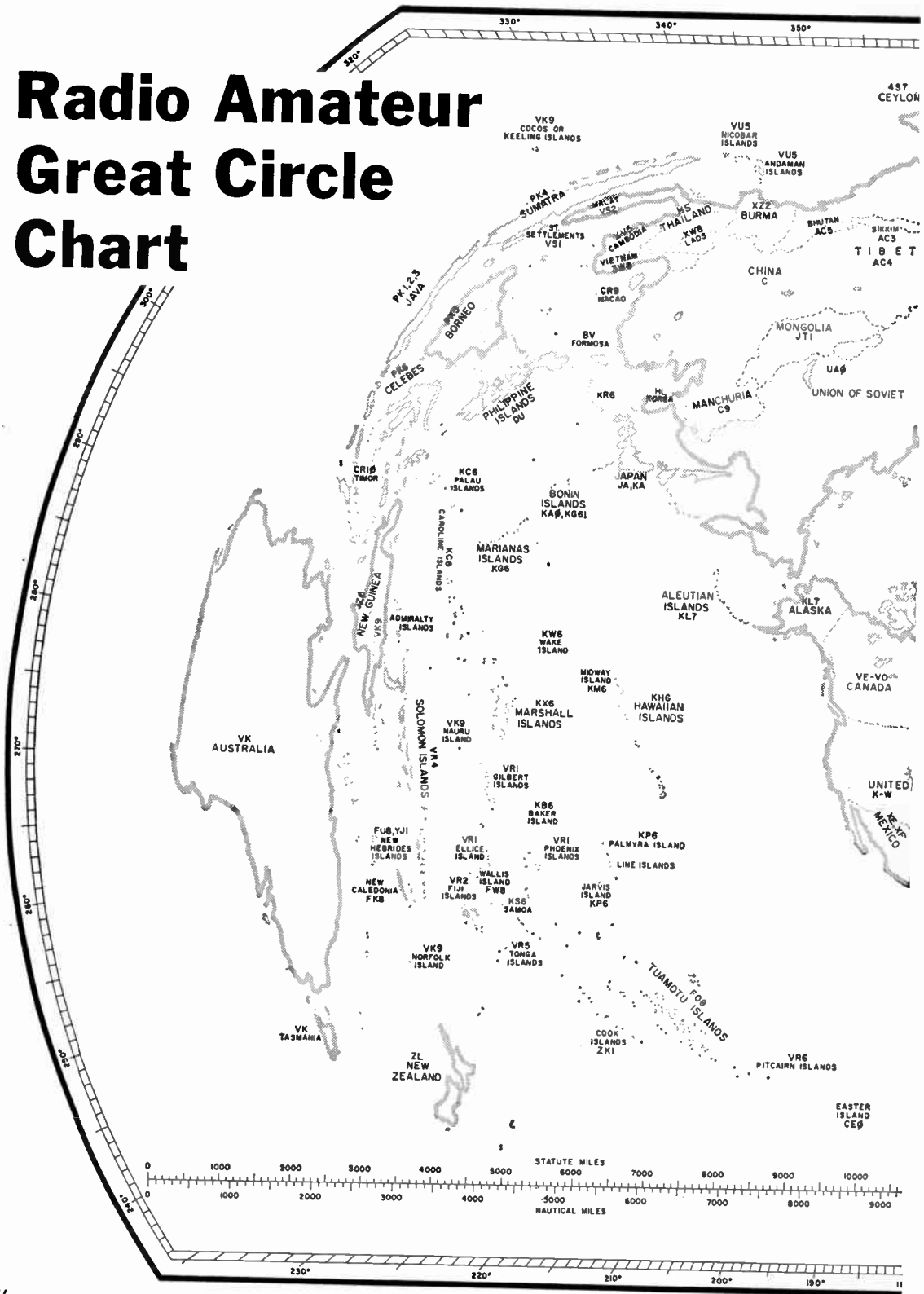
Another possible refinement is to include a closed-circuit jack in the "high-voltage" lead to the final. Then all you have to do to go on 20-meter phone is plug in a carbon mike of the F1 variety.

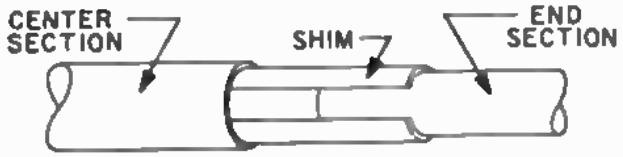
Connected to a 20-meter, three-element beam, this little rig has worked Denmark—which by simple math shows that 3600 miles (approximate distance to Denmark) divided by .08 watt is equal to 45,000 miles per watt! Not a bad record for a project that had its origins in boredom with our big ham rigs! —30—



Under-chassis view. Output tank circuit is at the left, oscillator tank at center.

Radio Amateur Great Circle Chart





SHIM IS MADE FROM A PIECE OF 1" DIA. TUBING 6" IN LENGTH WITH A 3/8" WIDE SLOT CUT DOWN ITS LENGTH. SHIM IS THEN SQUEEZED TOGETHER IN VISE. (4 REQ'D)

DRIVEN ELEMENT END SECTIONS TELESCOPE 9" INTO CENTER SECTION.

DIRECTOR END SECTIONS TELESCOPE 15" INTO CENTER SECTION.

Fig. 2. Beam dimen

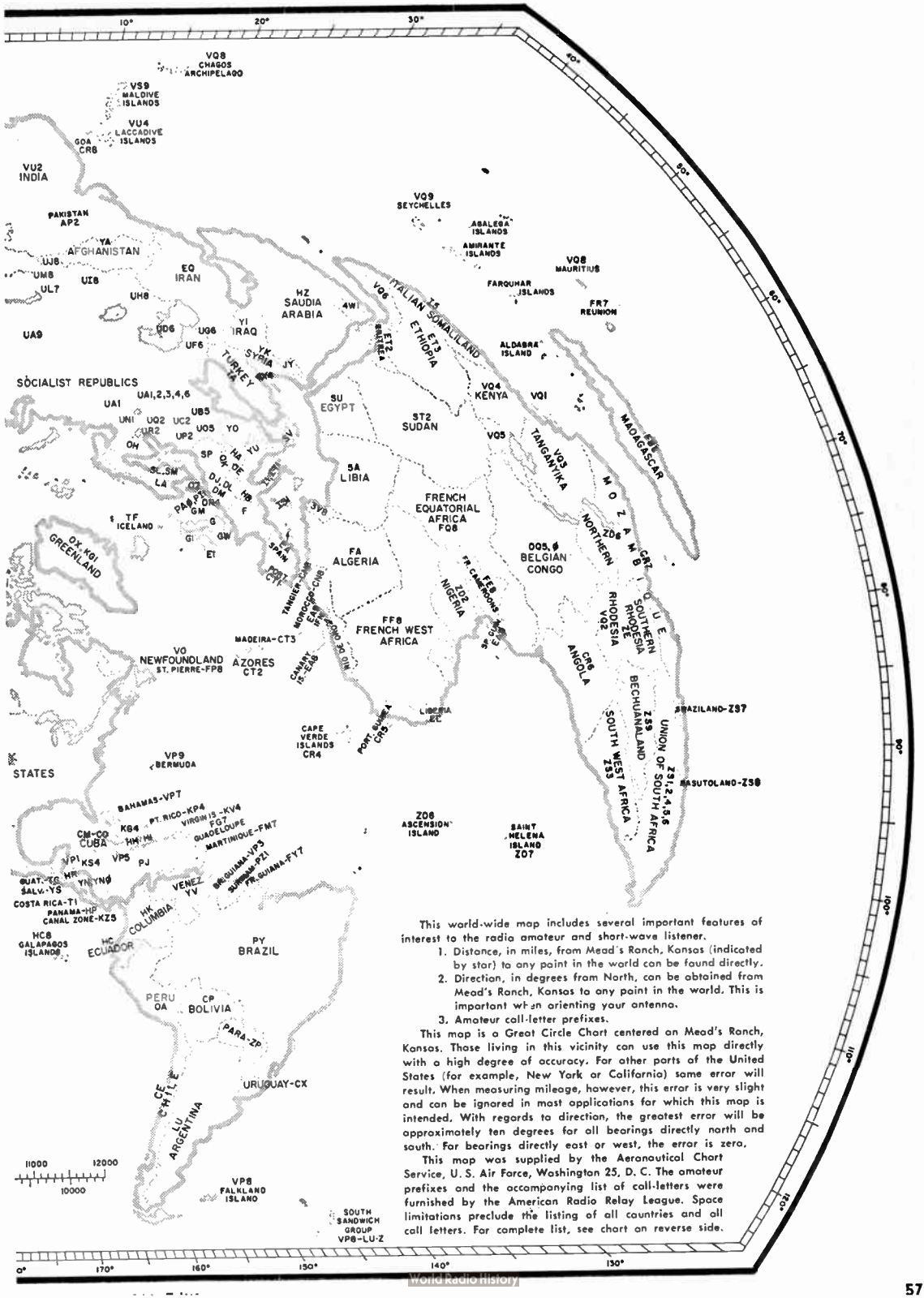
may be used with a 1¼" pipe strap to hold the boom. By connecting this "mast" to another 2" x 3" with heavy hinges, the array can be rotated almost 180° at minimum cost. The beam and its aluminum mast are so light that they can be supported in a fixed position using a small vise to hold the mast to some permanent part of the house or other structure.

Adjustment. The *gamma* matching section presents the correct impedance for standard five-cent-per-foot 52-ohm coaxial cable (RG-58/U). In adjusting the dimensions of the *gamma* matching section, there is no substitute for a standing-wave-ratio bridge or reflected power indicator. Both the matching section and the value of the capacitor should be adjusted to minimize SWR.

You'll find that the gain of the antenna will theoretically be only unity, but signals arriving at the ends will definitely be weaker than those arriving broadside. Later, if you wish, you can add a third element—a reflector—for increased gain.

Aside from adding to the signal strength of a station, a beam adds to the morale and courage of its user. The rare ones become more common. Disappointments in multiple layer pile-ups are rare, and 100% QSO's are the rule rather than the exception.

—30—



This world-wide map includes several important features of interest to the radio amateur and short-wave listener.

1. Distance, in miles, from Mead's Ranch, Kansas (indicated by star) to any point in the world can be found directly.
2. Direction, in degrees from North, can be obtained from Mead's Ranch, Kansas to any point in the world. This is important when orienting your antenna.
3. Amateur call-letter prefixes.

This map is a Great Circle Chart centered on Mead's Ranch, Kansas. Those living in this vicinity can use this map directly with a high degree of accuracy. For other ports of the United States (for example, New York or California) some error will result. When measuring mileage, however, this error is very slight and can be ignored in most applications for which this map is intended. With regards to direction, the greatest error will be approximately ten degrees for all bearings directly north and south. For bearings directly east or west, the error is zero.

This map was supplied by the Aeronautical Chart Service, U. S. Air Force, Washington 25, D. C. The amateur prefixes and the accompanying list of call-letters were furnished by the American Radio Relay League. Space limitations preclude the listing of all countries and all call letters. For complete list, see chart on reverse side.

POPULAR ELECTRONICS CITIZENS BAND "11" CODE

OVER the past few months, many Class D Citizens Band operators have "adopted" the "10" code devised by the Associated Police Communication Officers, Inc. ("APCO"). CB'ers using this code find that their messages are easily, rapidly, and effectively transmitted over some pretty busy channels. Obviously, on a crowded channel, it's easier to understand someone speaking one or two numbers than a whole sentence.

But the APCO code is a hand-me-down: it's excellent for police departments, but it leaves much to be desired for CB work. While CB'ers can put many of the numbers to good use, signals such as "10-32"—which means "Is drunkometer available?—are of no value at all to CB'ers.

In response to a considerable number of reader requests, POPULAR ELECTRONICS contacted CB manufacturers, clubs, and individual operators to find out just what they would like to have included in a CB code. We sifted, sorted, reworded, and re-worked hundreds upon hundreds of suggestions, combining many and junking many. The result is the POPULAR ELECTRONICS Citizens Band "11" Code (given below). We hope that you will use it and help cut down on interference caused by long transmissions.

You'll notice that some of the numbers between 11-1 and 11-100 have not been utilized. These omissions are deliberate on our part and allow for additions to the series. —30—

GENERAL STATION OPERATION

11-1 Receiving poorly.
11-2 Receiving well.
11-3 Stop transmitting.
11-4 Okay—acknowledged.
11-5 Identify your station by FCC-assigned call sign.
11-6 Cease operation—signal indicates malfunctioning transmitter.
11-7 Out of service—leaving the air.
11-8 This station is standing by on _____ *(channel number)*.
11-9 On which other channels can you transmit and receive?
11-10 Switch to _____ *(channel number)* for transmitting and receiving.
11-11 Unable to copy you because of _____.
11-12 Please repeat your last message.
11-13 Trouble at station because of _____.
11-14 Request licensed radio technician be sent to this station.
11-15 Conducting test—please count to ten slowly.
11-16 Conducting test—please transmit unmodulated carrier for ten seconds.
11-20 What is your location? (My location is _____.)

MESSAGES AND TRAFFIC-HANDLING

11-30 Does not conform to operating rules and regulations.
11-31 Stand by! *(order)*
11-32 Please speak slower.
11-33 Please relay message.
11-34 Busy.
11-35 Confidential information.
11-36 Correct local time.
11-37 Please call this station by telephone.
11-38 Visitors present.
11-39 Is telephone patch possible?
11-40 Advise if _____ is available for radio contact.
11-41 Do you have any messages for this station?
11-42 Any answer on my message regarding _____?
11-43 Is _____ at your station?
11-44 What channel is _____ operating on?
11-45 Your reply is satisfactory.
11-46 I have an urgent message for _____.
11-47 Please clarify your message.
11-48 What is next message?
11-49 Please confirm.
11-50 Telephone _____! *(order)*
11-51 Can you contact _____?
11-52 I have an urgent message for _____. *(NOT for emergency use)*

MOBILE AND EN ROUTE

11-60 Reserve hotel room with bath for _____.
11-61 Can you recommend a good local restaurant?
11-62 Can you recommend a good local hotel or motel?
11-63 Please advise weather/road conditions.
11-64 What is highway or best route to _____?
11-65 What is location of nearest service station?
11-66 Will arrive _____ *(time and/or place)*.

COMMERCIAL

11-70 Rush—quick action desired.
11-71 Return to base.

11-72 Assignment completed.

11-73 Report in person to _____.

11-74 I will be at your station in _____ *(hours/minutes).*

11-75 Pick up _____ at _____.

11-76 I have _____ with me.

MARINE

11-80 Please advise sea conditions at _____.

11-81 Do you have dockside moorings available for _____ *(boat type)?*

11-82 Do you have dockside fuel available?

11-83 I will monitor marine channel _____ *(9 or 13)* while under way.

EMERGENCY

11-90 Send police to _____.

11-91 Send ambulance to _____.

11-92 Send fire department to _____.

11-93 Send auto wrecker to _____.

11-94 Send Coast Guard to _____.

11-95 Personal injury due to accident a _____.

11-96 Please summon doctor to your station to give emergency first aid advice by radio.

11-99 Emergency conditions no longer exist.

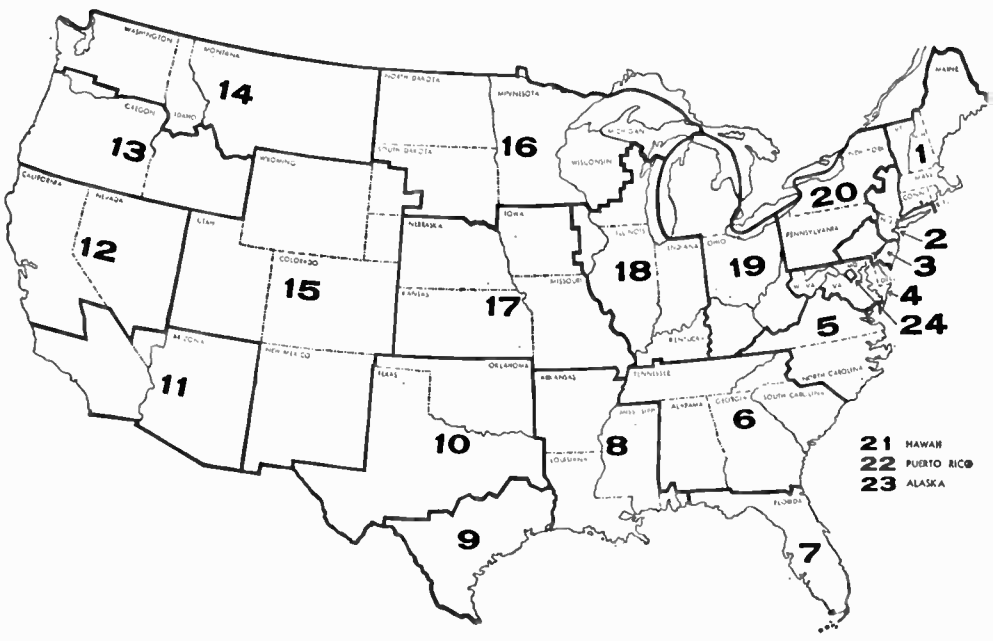
11-100 I have emergency traffic regarding the safety of life and property. Will all stations please give me priority use of this channel until the emergency traffic is completed.

Citizens Band Call Signs

WHEN your CB license arrives from the FCC, you will notice that it bears a number in the upper right-hand corner. This is your station's call sign, or serial number. Call signs are assigned with different prefix numbers for each radio district of the country. For instance, all stations in the metropolitan New York-New Jersey area, which is the Second Radio District, will have a "2" before the letter in the call sign (2W833, 2W4970, etc.). There are 24 radio districts in the CB service, so when you hear a distant station you will know where the operator is from, by noting his prefix number. The map below identifies each district.

Your call sign must be given regularly at specified times during your transmissions namely at the beginning and end of all communications. However, if you are exchanging brief communications (less than 3 minutes per transmission) with another station, you may give your call every 10 minutes (don't forget the 2-minute "break" every 5 minutes if you're talking with another licensee). Violation of these rules means loss of license.

Although anyone can listen in on CB frequencies, don't use your transmitter unless you have received your license and call letters from the FCC—it is a federal offense to do so. It is also an offense for you to use a call sign which has not been issued to your station by the FCC. —30—



Easy-to-Build Beam Antenna

Pull in the DX and cut down noise and interference.

By JIM FAHNESTOCK, W2RQA

BEAM ANTENNAS are becoming increasingly popular among users of frequencies above 14 megacycles. While once considered a luxury in amateur radio circles, the beam is rapidly joining the list of necessities as the spectrum becomes more crowded and competition more severe.

Thanks to "do-it-yourself" aluminum, which can be found in almost any hardware store, a ham or short-wave listener can start on a beam for a small investment of tubing and brackets. To squeeze out every possible ounce of performance, let's sacrifice multi-band operation and pick 15 meters, meeting place for veterans and Novices alike.

The dimensions shown in Fig. 1 were chosen for approximately the middle of the c.w. portion of the 15-meter band (21.2 mc.). These dimensions are not extremely critical. For other frequencies, the proper lengths can be calculated using the simple formulas:

$$\text{Driven element (in feet)} = \frac{475}{\text{freq. (mc.)}}$$

$$\text{Director (in feet)} = \frac{455}{\text{freq. (mc.)}}$$

The *gamma* matching bar is a proportionate length.

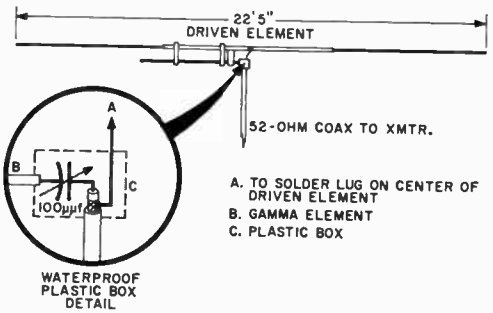
Construction. The boom is a 6' length of 1¼" tubing. (See Fig. 2.) The two center element sections are 8' lengths of 1" tubing and the four end element sections are 8' lengths of ¾" tubing telescoped into the center elements. A 1¼" x 6' length of tubing serves as a mast. You can substitute a length of 2" x 3" lumber for the mast in the initial installation if you wish.

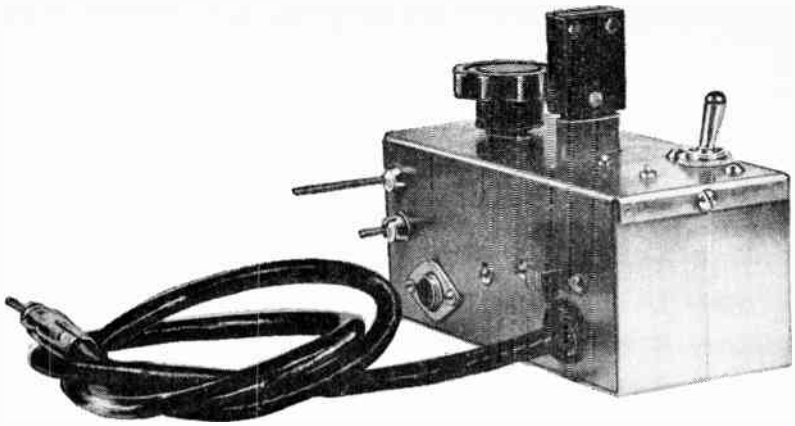
To create a snug fit at the telescope joints, the following procedure is recommended. Take a 6" length of 1" tubing and, with a hacksaw, cut a ⅜" slice along the length of the tube. Then, squeezing the slotted section in a vise, reform the tube by closing the slot. This will create a new piece whose outside diameter corresponds roughly to the inside diameter of the 1" tubing, and whose inside diameter approximates the ¾" tubing's outside diameter.

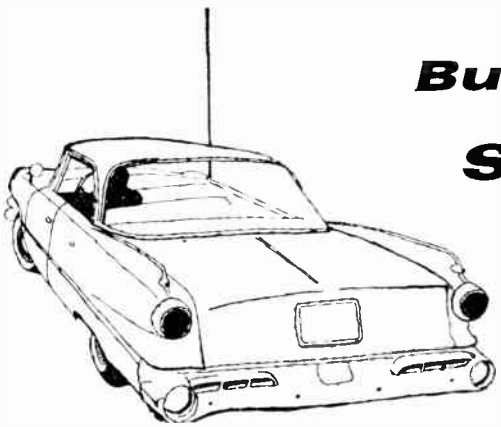
After you prepare four such shims, and insert them into the ends of the 8' sections of 1" tubing, then insert the 8' sections of ¾" tubing into the shims. For the radiator, or driven element, the overlap will be 9", and for the shorter director, the overlap will be 15". The ¾" end sections can be held firmly in place by several sheet metal screws which are long enough to pass through both pieces of tubing and the shim as well.

When the driven element has been assembled, the *gamma* matching section is attached to it. To form the *gamma* matching section mounting straps, bend the ends of a 6" strip around the 1" tubing and the *gamma* matching bar, and drill holes for screws and nuts to clamp the tubing. You can make the *gamma* matching bar from five feet of ¼" or ⅜" tubing. The strap on the inner end must be insulated from the driven element, and the insulation must be strong enough to withstand anticipated

Fig. 1. Shield of 52-ohm line is connected to driven element and inner conductor to gamma element via the variable capacitor. To eliminate the box, use a weatherproofed fixed capacitor of optimum value.







Build a MOBILE SHORT-WAVE CONVERTER

By J. A. STANLEY

Self-powered unit pulls in short-wave and ham broadcasts while you drive.

TUNING IN short-wave or ham stations on your auto radio is easy with this crystal-controlled converter. A small, self-powered unit, it can be quickly connected to any auto radio by simply inserting it between the radio and the antenna. Although the converter uses only one transistor, it will pull in foreign short-wave broadcasts easily. You'll be able to tune all frequencies between 30 and 49 meters (about 5 to 10 mc.), using only five different crystals.

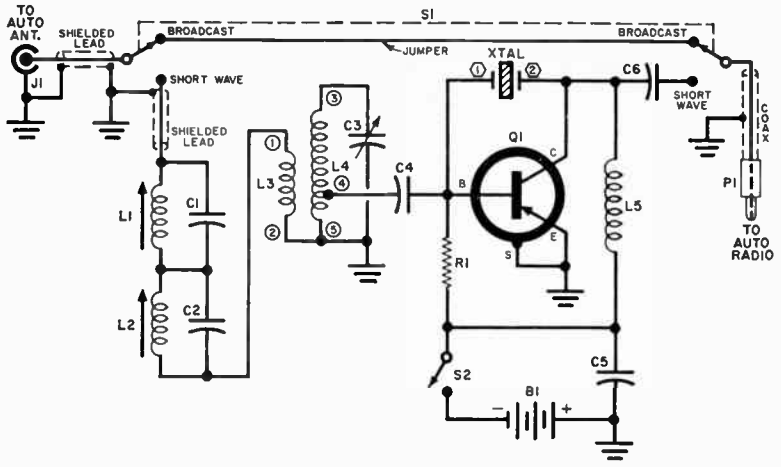
Since the converter runs on its own battery, you won't have to break into your car's electrical system. Parts will cost around $10, and you should be able to complete the unit in a couple of evenings.

Construction. The complete converter is built into a 5" x 2¼" x 2¼" aluminum box as shown. Using a slightly larger box will make assembly easier, but take care to keep tuned-circuit leads short.

Of the five coils (*L1* through *L5*) in the converter, only two (*L3* and *L4*) are hand-wound. Coil *L4* consists of 22 turns cut from a section of Barker & Williamson 3016 coil stock. Any similar coil stock can be used as long as it has a spacing ratio of 32 turns to the inch and a 1" diameter. Note that *L4* is tapped 2½ turns from the ground end, as shown in the pictorial detail.

Antenna coil *L3* consists of nine turns of No. 22 solid insulated hookup wire wound directly over *L4*. A turn or two of plastic tape around *L4* separates the two coils.

Coils *L1* and *L2* are the "garden" variety of broadcast-band antenna loopsticks. If you have a couple of these in your junk box, so much the better, but keep in mind that they have to be short enough to fit into the box you select for the converter. The r.f. choke (*L5*) should have a value of about 2.5 mh., as shown in the parts list;



Schematic diagram of converter shows a p-n-p transistor for Q1. Battery polarity should be reversed if an n-p-n transistor is used.

PARTS LIST

B1—3-volt battery (two penlight cells in series, Burgess Type Z or equivalent)
C1—500-μμf. ceramic capacitor
C2, C4—100-μμf. mica or ceramic capacitor
C3—100-μμf. midget variable capacitor (Hammarlund APC-100B or equivalent)
C5, C6—.001-μf. ceramic capacitor
J1—Auto antenna jack (Motorola 1207 or equivalent)
L1, L2—Ferrite broadcast-band loopstick (Lafayette MS-11 or equivalent)
L3—Antenna coil (see text)
L4—Tuning coil (see text)
L5—2.5-mh. r.f. choke (National R-100 or equivalent)
P1—Auto antenna plug (Motorola 1200 or equivalent)
Q1—2N247 transistor (see text)
R1—390,000-ohm, ½-watt resistor
S1—D.p.d.t. slide switch
S2—S.p.s.t. slide switch
Xtal—5- to 8-mc. crystal (James Knight H-73 or equivalent—see text)
1—5" x 2¼" x 2¼" aluminum box (Bud CU3004A or equivalent)
Misc.—Hardware, battery holder, sockets

current rating isn't really important, but the d.c. resistance should be as low as possible.

Any number of transistors will work in the converter; a 2N247 (RCA) was used in the model, but the AO-1 and 2N344/SB101 (Philco) will serve as well. The converter will even work with the low-cost 2N170 (G.E.), if you reverse the battery polarity shown on the schematic. With the 2N170, though, the converter's tuning range may be limited from 5.5 to 6 or 7 mc., depending on how well your 2N170 transistor oscillates.

Frequency Coverage. Select a crystal with a fundamental frequency between 5 and 8 mc. Any 40-meter ham-band crystal will do, as will the surplus FT-243 units.

The converter will tune from 550 to 1600 kc. *higher* than the frequency of the crystal you select. For example, if you select a 6450-kc. crystal, you will be able to tune from 7000 to 8050 kc. on your auto radio dial. This range takes in the 40-meter ham band and the 39-meter international shortwave band.

If you want to pick up other frequencies in the converter's 5- to 10-mc. range, simply select a crystal *near* the frequencies shown in the following table.

Crystal Frequency (kc.)	*Frequency-Covered by Auto Radio (kc.)*
5000	5550 to 6600
6000	6550 to 7600
7000	7550 to 8600
8000	8550 to 9600

Operation. Once the crystal has been selected, it's an easy matter to fire up the converter. Simply unplug the antenna lead from the auto radio and plug it into jack *J1* on the converter. Then insert plug *P1* from the converter into the auto radio's antenna jack.

Now switch on the converter and the auto radio. Set bandswitch *S1* on the converter to "short wave," and tune the car radio. Instead of the usual broadcast sta-

tuning capacitor, the only control on the converter. Input and output connections are made through phono-type connectors and power is fed in through an octal plug, arranged to mate with an octal socket on the matching power supply. If desired, a cable could be substituted for the power plug.

Parts layout is not especially critical. Since only one tube is used, the parts may be grouped around the socket with as short leads as practical, following the layout shown in the photographs.

An old TV booster or u.h.f. converter might be used to supply the cabinet, chassis, dial, and power supply at a considerable saving in parts cost.

The power supply is built in the same size box as the converter and has an octal socket mounted on one end to match the plug on the converter. A 1:1 ratio transformer is used for power. A selenium rectifier, simple *RC* filter, and line switch complete this assembly. The suggested circuit is shown in Fig. 2. The use of a regulator tube is not mandatory but it does improve stability. If the 0B2 is not used, remove *R7* and increase the value of *R6* to 4700 ohms at 2 watts. Output voltage will then be about +100 volts.

Connecting the Converter

If the receiver to be used with the converter is transformer-operated and does not use a loop antenna for its input coil, connection of the converter is relatively simple. A piece of 50- or 75-ohm coaxial cable not more than 2 feet long (up to 6 feet of low-capacity auto radio lead-in cable may be used) should be employed to con-

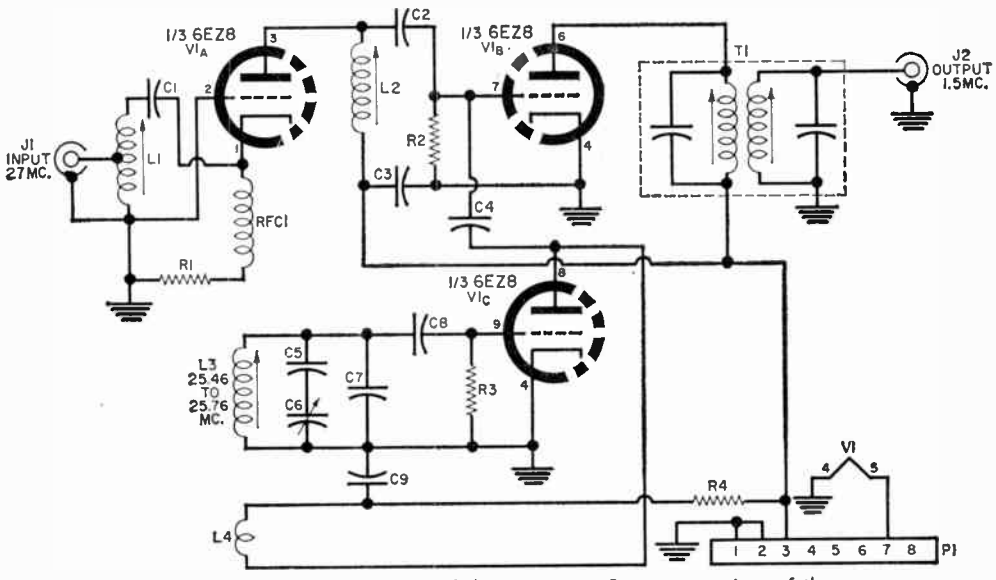
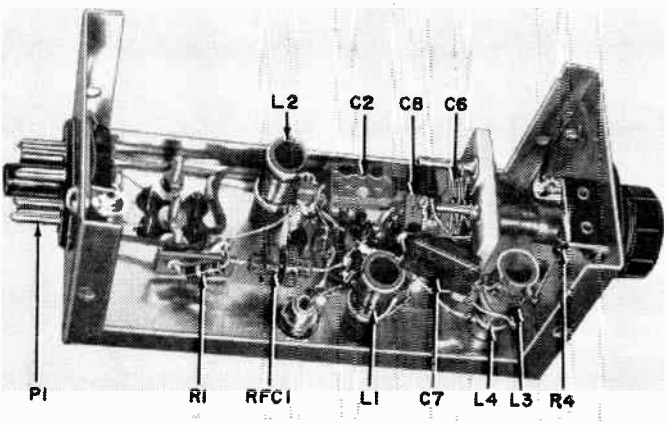


Fig. 1. Schematic diagram of the converter. Separate sections of the triple-triode 6EZ8 tube are used as r.f., mixer, and oscillator stages.

PARTS LIST

R1—270 ohm, ½ w. res.
R2—1 megohm, ½ w. res.
R3—10,000 ohm, ½ w. res.
R4—2700 ohm, ½ w. res.
C1—470 μμf. ceramic capacitor
C2, C8—100 μμf. mica capacitor ± 10%
C3, C9—.001 μf. ceramic capacitor
C4—1 μμf. ceramic capacitor
C5—10 μμf. silver mica capacitor
C6—2.8-17.5 μμf. var. capacitor (Hammarlund Type HF-15)
C7—150 μμf. silver mica capacitor
J1, J2—Coax or phono jack
RFC1—750 μhy. r.f. choke
L1—20 t. #26 en. closewound, tapped 6 t. from ground end (CTC Type LS3, 3/8" form, 20063-B slug)
L2—18 t. #26 en. closewound (CTC Type LS3 form, 20063-B slug)
L3—4 t. #24 en. spaced to ¼" (CTC Type LS3 form, 20063-B slug)
L4—10½ t. #28 en. closewound at distance of ¼" from ground end of L3
T1—1400-1600 kc. i.f. output transformer (J. W. Miller Type 12-W2)
P1—Octal plug
V1—6EZ8 triple-triode tube (General Electric)



Bottom view with shielding cover removed. Oscillator tuning capacitor, C6, is fastened to top of box with small angle bracket. Some capacitors have this bracket attached. Tie points were used to anchor the small parts.

nect the converter output to the antenna and ground binding posts of the receiver.

Use of an a.c.-d.c. receiver will require blocking capacitors in both leads from the converter in order to keep the converter chassis from being "hot". These capacitors may be any value from 0.01 to 0.1 μf.

A receiver with a loop antenna may give trouble with pickup of broadcast stations which will ride in with the signals from the converter. The best solution to this problem is to remove the loop and substitute a shielded antenna coil. If the slug-tuned variety is used, no difficulty should be encountered in obtaining tracking of the receiver throughout the broadcast band.

Alignment for Citizens Band

The converter may be aligned with a signal generator or by using on-the-air signals. If an on-the-air signal is used, it will be necessary to know the channel frequency, as the oscillator dial must be set to place the signal in its proper position on the dial.

After the converter is hooked up to the receiver and power supply, turn it on and allow approximately ten minutes' warm-up time before starting alignment. Tune the broadcast receiver to a relatively clear channel near 1500 kc. and feed in a signal of knowr frequency in the Citizens Band, either from a signal generator directly connected or from an antenna and a local station. Set the dial at a position which will place the signal at the proper part of the dial and adjust the slug in *L3* until the signal is heard. Now adjust the slugs in *L1*, *L2*, and tune *T1* for maximum signal, keeping the signal tuned in with *C6*. —30—

PARTS LIST

R5—47 ohm, ½ w. res.

R6, R7—680 ohm, 2 w. res.

C10-C11—40/40 μf., 150 v. elec. capacitor

S1—S.p.s.t. toggle switch

SO1—Octal socket

SR1—35 ma., 130 v. selenium rectifier (Tarzian Model 35 or equiv.)

T2—Power trans. 117 volts @ 20 ma.; 6.3 volts @ 1 amp.

V2—0B2 tube (see text)

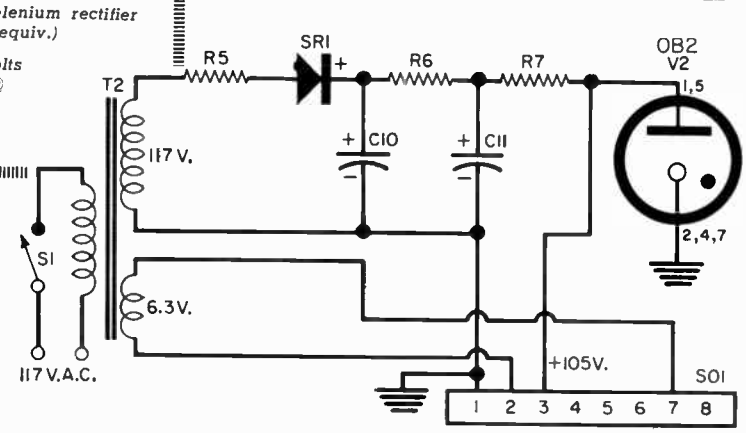


Fig. 2. Suggested circuit for 105-volt d.c. power supply. The 0B2 regulator tube is helpful in stabilizing oscillator plate voltage, thus eliminating frequency shifts caused by power-line voltage changes.

Antennas for Citizens Band

By LEO G. SANDS
Author, "Class D Citizens Radio"

Increase the operating range of your CB equipment by using the right antenna and transmission line in a proper installation.

THE range of a class D Citizens Band radiotelephone depends, primarily, on its antenna system. While it will work using a plug-in indoor antenna, its signal will reach farther when connected to a proper outdoor antenna mounted up in the open where its signal is unobstructed.

The FCC stipulates that the height of the antenna shall be no greater than 20 feet above ground or the structure which supports the antenna mast. If only 20 feet above ground in flat country, the range would be limited to about five miles or less. If placed 20 feet above the ground on a hilltop, with the antenna clear of surrounding trees, the range could be considerable since it is the *effective antenna elevation,* not *height,* that is the important thing.

The 20-foot limitation isn't as restrictive as it sounds. You can put your base station antenna on a TV antenna mast to project its tip 20 feet above the roof or, if you live in a tall apartment building, you can hoist the tip of your antenna 20 feet above the roof and talk for many miles.

Omnidirectional Antennas

For general, all-around use, the antenna should transmit and receive equally well in all horizontal directions. Fortunately, you have a wide choice of such antennas for base stations or you can make your own simple doublet antenna from a piece of 72-ohm twin-lead, as shown in Fig. 1. When installed vertically, it is omnidirectional but you can often get better results by using a ground-plane antenna or a coaxial antenna. Ground-plane antennas are available from radio parts stores, mail-order houses, and mobile radio manufacturers for $19.95 or less, including a 50-foot length of coaxial cable. Some ground-plane antennas can cost as much as $100 or more.

A full-size ground-plane antenna for the 27-mc. band consists of a vertical whip about 9 feet long. See Fig. 2. At the bottom are three or four horizontal or drooping rods (which protrude from the hub where the vertical radiating element is attached) which are connected together but insulated from the vertical radiating element. Some of these antennas have telescoping rods which are extended when placed in operation. There are also antennas, developed especially for class D Citizens Band stations, which have three drooping ground rods and one vertical rod which are about a third of the usual length. Loading coils at the base of the vertical elements and at the hub end of each of the three ground radials provide the electrical effect of a longer rod. While not quite as efficient as a full-size ground-plane antenna, the smaller antenna can be installed where space is limited.

A coaxial antenna has no horizontal or drooping elements. It looks like two pieces of vertical pipe, of which the upper section is generally of smaller diameter than the lower section. For the class D band, a coaxial antenna is about 18 feet long.

Directional Antennas

When communication in all directions is not required, a directional antenna may be used. It will transmit and receive better in one (unidirectional) or two (bidirectional)

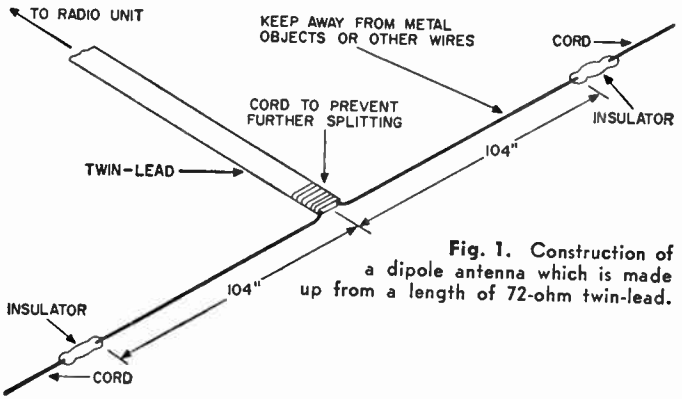
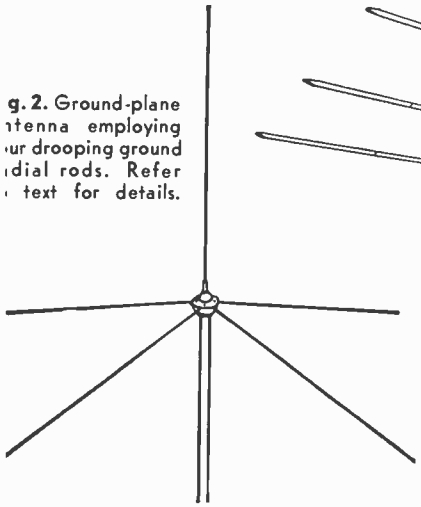


Fig. 1. Construction of a dipole antenna which is made up from a length of 72-ohm twin-lead.

g. 2. Ground-plane ıtenna employing ·ur drooping ground ıdial rods. Refer · text for details.



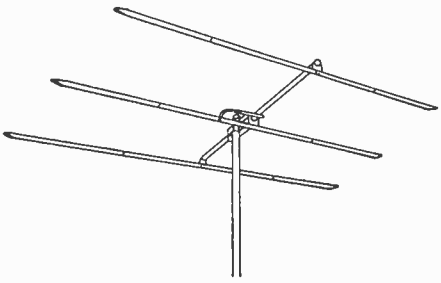


Fig. 3. Three-element yagi antenna. While shown here horizontally polarized, the elements may be oriented vertically in order to produce vertical polarization.

rections than in all other directions. Not ıly does a directional antenna increase the rength of the signal and the range in the :vored direction, but it also reduces radia- on and reception in other directions.

A modified form of the ground-plane an- nna, using two spaced antenna elements ıd known as a cardioid, transmits best in heart-shaped pattern from the base sta- on. In the most favored direction, the r.p. (effective radiated power) of the ansmitter is doubled (3 db). A figure-8 ıttern (bidirectional) can be obtained ith a special type of antenna which con- sts of two coaxial, dipole, or ground-plane ıtennas separated by a critical distance. ain in the two favored, opposing (forward ıd backward) directions is 3 db.

For concentrating most of the energy in :e direction, a yagi antenna can be used. 3-element yagi, designed for class D use, n be obtained for as little as $29.95. See g. 3. More complex yagi arrays may have many as five elements. There are much ore expensive antennas with very high .ins which can be used by class D Citizens ınd stations. One such array, consisting two yagi antennas side-by-side, has a ted gain of 13 db in the forward direction. ıis means that the effective radiated pow- is 20 times as great as the power fed to by the transmitter. Thus, a class D trans- .tter, which puts out around two watts or 5 watts input), can be as effective as a -watt-output transmitter connected to a nventional antenna.

Mobile Antennas

The most commonly used mobile antenna is a quarter-wave vertical whip, about nine feet long, mounted by means of a spring assembly to the bumper, cowl, or fender of a vehicle. See Fig. 4. It forms an efficient radiator since it is approximately a quarter of a wavelength long at the operating frequency. The body of the vehicle serves as the ground plane and is part of the antenna system. But, because the body of the vehicle shields the antenna in some directions, it is more effective in some directions than in others. Ideally, the antenna should be mounted in the center of the metal roof of the vehicle but there it would be both cumbersome and unsightly, to say nothing of the damage it does to the top of the car.

More attractive, and easier to install, are the many special base-loaded whip antennas which are much shorter than a full-length, quarter-wave whip. At the base of the shorter whip is a coil, called a loading coil. The coil, which is a part of the antenna, makes it possible to use a shorter whip. The shorter whip, without the coil, has too little inductance at the operating frequency but the coil provides the requisite inductance, raising the inductive reactance of the antenna high enough to cancel out the capacitive reactance of the antenna, so that the antenna looks like a resistance at the operating frequency.

While a base-loaded antenna is not as efficient as an ideally located quarter-wave whip, it often works as well, if not better, when installed in the center of the metal roof of the vehicle. Since it is not always feasible or desirable to put the antenna in the center of the car top (it *does* jeopardize the trade-in value of the car), it is often installed on the cowl or a fender.

It is extremely important that the ground connection of the antenna-mounting device make good contact with the car body since the body is a vital part of the antenna system. While clip-on antennas will work, special attention should be given to making good electrical contact with the car body.

their instruction books, should be used only with a specified length (or multiple of that length) of transmission line. Most antennas for Citizens Band use, except dipoles, have a rated impedance of 50 ohms, requiring the use of a 50-ohm transmission line.

Kinks, sharp bends, and splices in a coaxial cable cause a change in the impedance of the line, resulting in a higher standing-wave-ratio and should be avoided. It is for this reason that suitable connectors must be used at each end of the coaxial cable for connecting to the antenna and the radio. Sometimes the antenna is designed so that a connector is not used at the antenna end and the cable is connected directly to the antenna. With a ground-plane type, the inside wire (center conductor) of the coaxial cable connects to the vertical radiating element; the shield braid connects to the ground-plane radials.

Connectors for use with RG-8/U, RG-11/U, RG-58/AU, and RG-59/U cable cost around 75 cents each. If both the antenna and radio are equipped with receptacles to mate with coaxial cable plugs, two will be required, one at each end of the cable. Some Citizens Band radios use other kinds of plugs at the set end, such as a phono plug or the type used for connecting an antenna to a regular auto radio. No matter what type of plug is used, it should be carefully soldered to the cable, taking care to keep strands of the shield from contacting the center or plug pin. —30—

This has an important effect on ignition noise as well as on the transmitting range of the equipment.

Antennas for Portable Operation

The plug-in antenna, which comes with many Citizens Band units, is equipped with a base loading coil. In some sets, the loading coil is a part of the set. With this kind of antenna, communicating range is only fair, for three reasons: first, the antenna is not a full quarter-wave long; second, it is not in the most advantageous location; and third, and quite important, the metal case of the set which functions as the antenna system's ground plane is too small.

By placing the set on top of a metal filing cabinet, the roof of a car, or other large metal surface the signal strength can be increased noticeably. But, for short-range communication the combination of the plug-in antenna and the set's cabinet form a fairly satisfactory antenna system.

Transmission Lines

Irrespective of the type of antenna used, the transmitting antenna should be connected to the CB unit through coaxial cable, not microphone cable, twin-lead, or twisted-pair wire. Coax costs from about 7 cents per foot for small diameter cable to around $1.00 per foot for heavy, low-loss cable. The kind you should use depends on how long a cable is required. Always get a cable in one piece; don't attempt to splice coaxial cable. If two pieces *must* be used, extra-heavy RG-17U cable or what is known as hollow transmission line. Here the cost runs about 80 cents per foot or more, plus several dollars apiece for connectors. By using such low-loss cable (0.42 db attenuation per 100 feet), around 90% of the transmitter power gets through to the antenna. The quoted losses are applicable only if the impedance is matched at both ends of the cable. It is obvious that length of the coaxial cable should be kept at a minimum because of the power losses in the cable. No matter what type of cable is used, it is often advantageous to get the antenna up high and in the clear since the added height will often more than offset cable loss effects.

Most Citizens Band transmitters can be used with any length of antenna transmission line. Some, however, according to

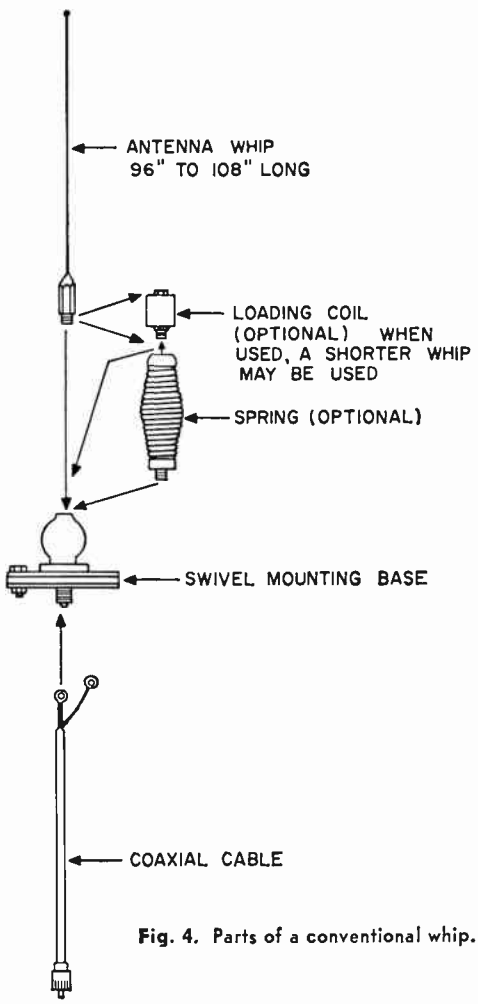


Fig. 4. Parts of a conventional whip.

A Tubeless Transistorless Code Practice Oscillator

By LEON A. WORTMAN

HERE'S a simple CPO that uses a neon tube relaxation oscillator. It operates without tubes or transistors and has enough output to drive a built-in loudspeaker. And if extra power is needed to serve a code class of a dozen or more people, output to an amplifier can be tapped off across the speaker voice coil leads.

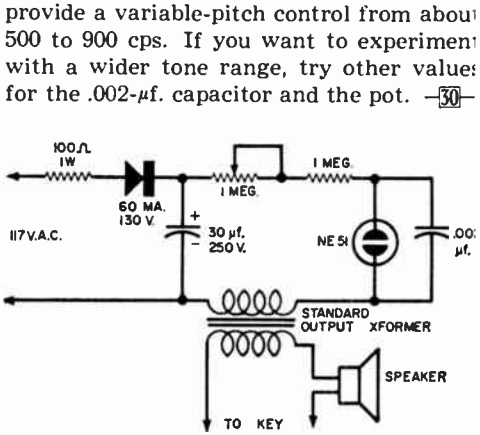
A case intended for use with a 3" meter movement serves as a housing for the unit. Such cases are obtainable with the meter holes already cut out, thus saving you considerable time and labor. A small square of perforated metal or metal window-screening can be placed behind the cutout to serve as a loudspeaker grille.

It is convenient to use one of the so-called "Postlite" neon indicators (manufactured by the Drake Company) for the neon lamp oscillator; this is a plastic unit, threaded for panel mounting, with the neon lamp molded in. Or, you may prefer to use a standard NE-51 along with a socket assembly.

Keying is accomplished by putting a key in series with the secondary winding of the output transformer. The circuit shown works nicely on 105 to 125 volts a.c. If it is used with d.c. power lines, or with a 90-volt battery, the selenium rectifier and the 30-μf. capacitor should be eliminated. For power line operation, make sure that no part of the circuit is connected to the cabinet.

No warm-up time is necessary—just plug in the line cord and press the key.

The potentiometer varies the pitch of the generated tone. Parts values given provide a variable-pitch control from about 500 to 900 cps. If you want to experiment with a wider tone range, try other values for the .002-μf. capacitor and the pot. —30—

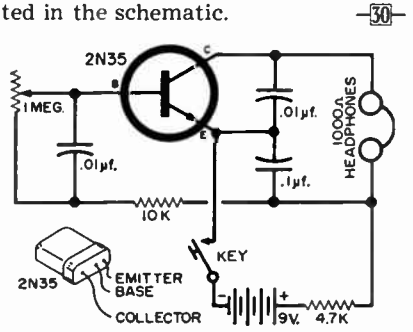


Code Practice Oscillator

A TRANSISTORIZED version of a Colpitts oscillator can be used as a code practice oscillator, as indicated in the diagram. The one-megohm tone control shown at the upper left of the drawing, may be adjusted for a tone most pleasing to the user.

Ordinary 1000-ohm magnetic headphones are used and serve not only to monitor the signal but as an inductance in the oscillator circuit.

The transistor, an inexpensive *n-p-n* general-purpose 2N35, can either be wired directly into the circuit or plugged into a transistor socket. The leads for the transistor are indicated in the small drawing at the lower left-hand side of the diagram. The capacitors may be any low-voltage units you have in the capacitances indicated in the schematic. —30—



Calling Frequencies in the CB Service

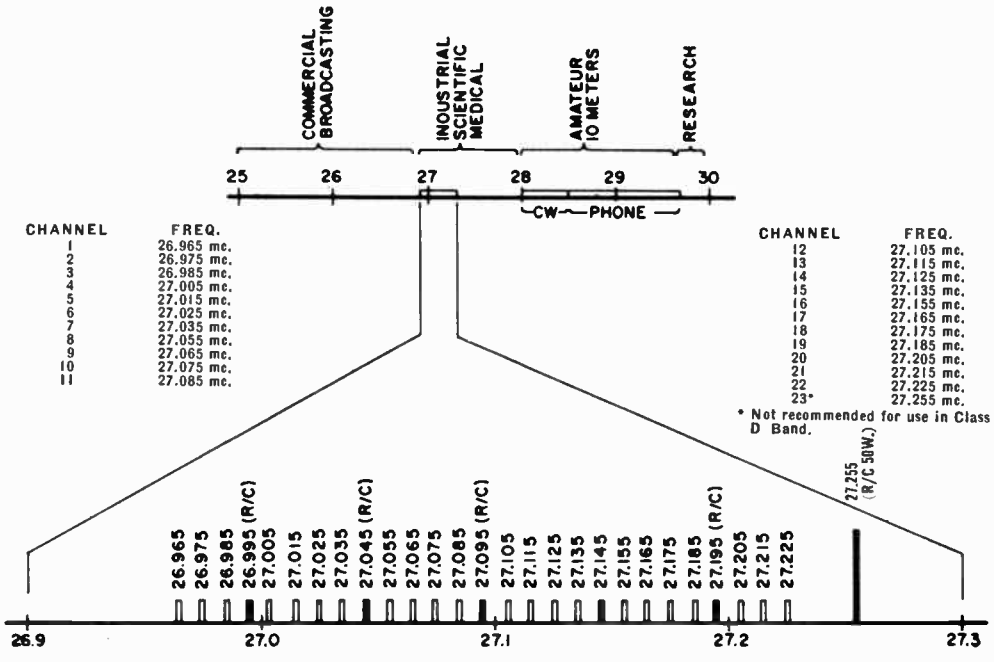
THROUGH the efforts of manufacturers of Citizens Band equipment, CB users, and with the editorial support of leading electronic publications, "calling" frequencies have been informally established to provide service and assistance to boating enthusiasts and those traveling on the nation's highways.

For boatmen, it has been recommended that CB Channel 13 (27.155 mc.) be used for pleasure-craft contacts along with Channel 9 (27.065 mc.) to be shared by operators of both pleasure and commercial craft. A number of marina operators have already agreed to monitor these CB channels in order to be of maximum service to the boatsman in matters of docking facilities, reprovisioning, along with other similar services.

The national travel service frequency, established as a result of the enthusiastic acceptance of the marine monitoring provision, was selected as Channel 15 (27.135 mc.). In order to avoid infringement of FCC regulations governing operation in the Citizens Band, the Commission emphasizes that the procedure must clearly indicate that it is not a general call to any or all stations hearing the transmission but that the transmission must be adequately specific to indicate the station or stations desired even though the names and call signs of the stations involved are not known. An appropriate form for such a message would be "This is 1W000 calling any motel in the (specified) area. I am located at . . . . . and require accommodations for the night. Can you advise if you have an opening and, if so, the best route to follow."

While use of any of these "calling" channels is not compulsory, their acceptance by the majority of those operating in the Citizens Band will enhance not only the service as a whole but extend the usefulness of this person-to-person communications network which has been established by the federal government for the convenience of all U. S. citizens. —30—

CB Frequency Allocation Chart



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- **TUBES AND FUNCTIONS**: 6DQ5 power output; 6CX8 crystal oscillator and driver; 12AX7 speech amplifier; 6DE7 modulator; silicon high voltage rectifiers.
- **FRONT PANEL**: Function (AC off, tune, standby, AM, CW); Band Selector (80, 40, 20, 15, 10, 6); Drive control; Plate tuning, plate loading, Crystal-V.F.O.; Grid Current; Meter; AC indicator light; RF output.
- **REAR CHASSIS**: Microphone gain; antenna co-ax connector; remote control terminals; AC power cord.

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- **CONTROLS**: Tuning; Antenna Trimmer; Cal. Reset; Function (AC off, standby, AM, CW-SSB); Band Selector; Cal. on/off; RF Gain; Auto. Noise Limiter on/off; Selectivity /BFO; Audio Gain; phone jack; S-meter Adj.
- **TUBES AND FUNCTIONS**: 6AZ8 tuned RF amplifier and crystal calibrator; 6U8 oscillator and mixer; 6BA6 1650 kc. IF amplifier and BFO; 6T8A 2nd detector, A.V.C., ANL and 1st audio; 6AW8A audio power amplifier and S-meter amplifier; (2) silicon high voltage rectifiers.

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PART 3

Hi-Fi and Audio

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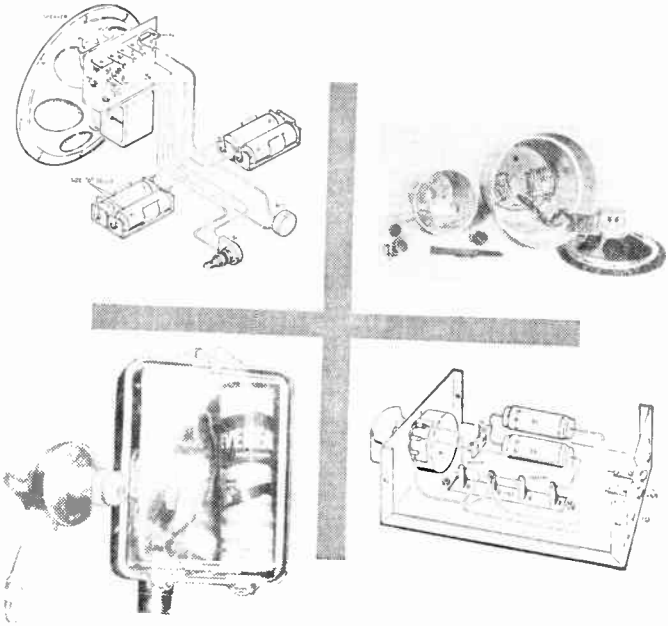


Build this

Unusual AMPLIFIER

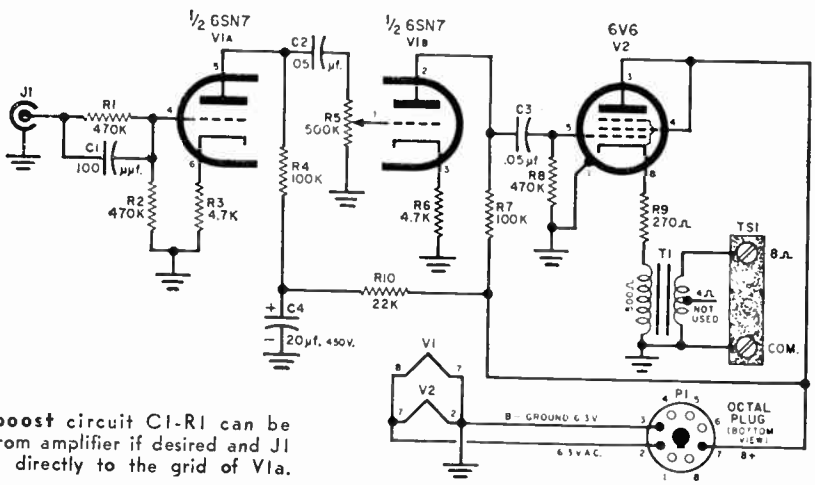
Low-distortion cathode-follower output stage has surprising hi-fi quality.

By JAMES ROMELFANGER

HERE'S an unusual amplifier that should appeal to the hi-fi experimenter. It's unusual because the output is taken from the cathode and not from the plate of the output tube as you would expect. A similar circuit appears quite often in hi-fi preamplifiers where you probably know it as the cathode follower.

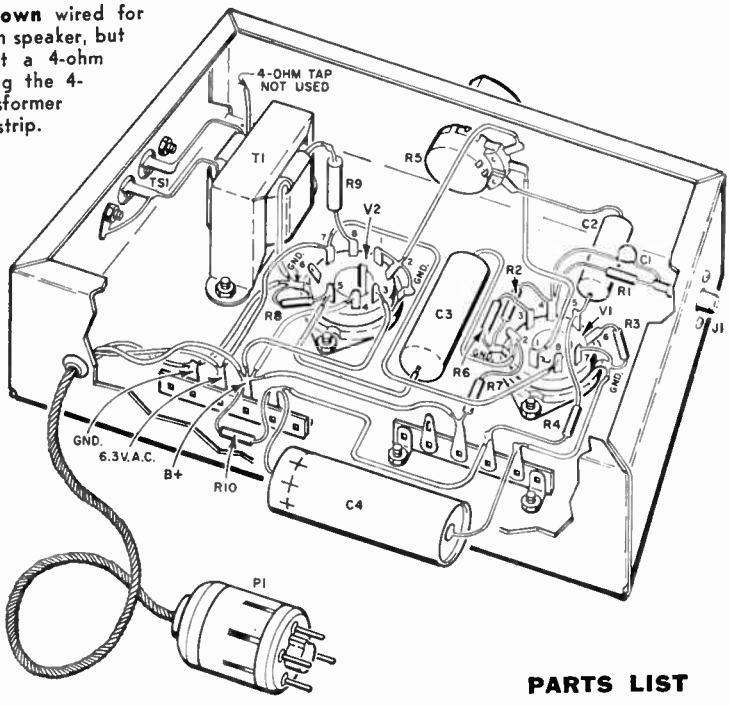
This amplifier was designed to work from a high output cartridge or tuner. You'll need about .1 volt or more to drive the unit to its full output which is in the region of 1 watt. For a simple stereo system, two of these units would be ideal.

The author built his model on a 5" x 7" x 2" chassis he had on hand, and the power supply was built on a separate chassis of the same size. (If you wish, you can build both on a single larger chassis with no ill effects.) Although the circuitry is noncritical, all grid leads should



Treble boost circuit C1-R1 can be omitted from amplifier if desired and J1 connected directly to the grid of V1a.

Amplifier is shown wired for use with an 8-ohm speaker, but you can connect a 4-ohm speaker by wiring the 4-ohm tap on transformer T1 to terminal strip.



HOW IT WORKS

Audio signals from a crystal or ceramic phono cartridge are applied to triode *V1a* through simple treble-boost circuit *C1-R1*. Amplified signals are taken from the plate of this triode and fed to volume control *R5*. The desired portion of the audio is tapped off *R5* and applied to the grid of triode *V1b* where it is again amplified, and finally applied to *V2's* control grid. The signal is then taken from the cathode of *V2* and coupled to the speaker through output transformer *T1*. Resistor *R9* biases *V2* in normal fashion.

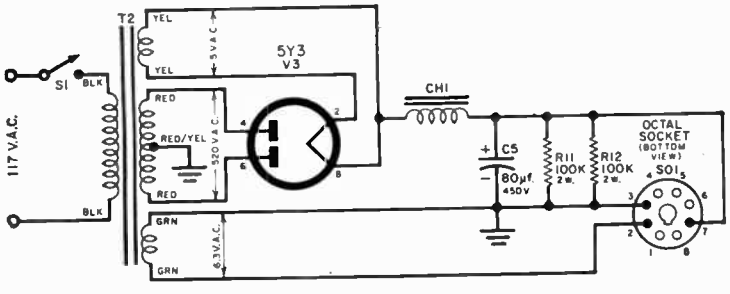
The power supply is a standard full-wave rectifier with a choke-input filter consisting of *CH1* and *C5*. Paralleled resistors *R11* and *R12* operate as a bleeder and as a discharge path for capacitor *C5*.

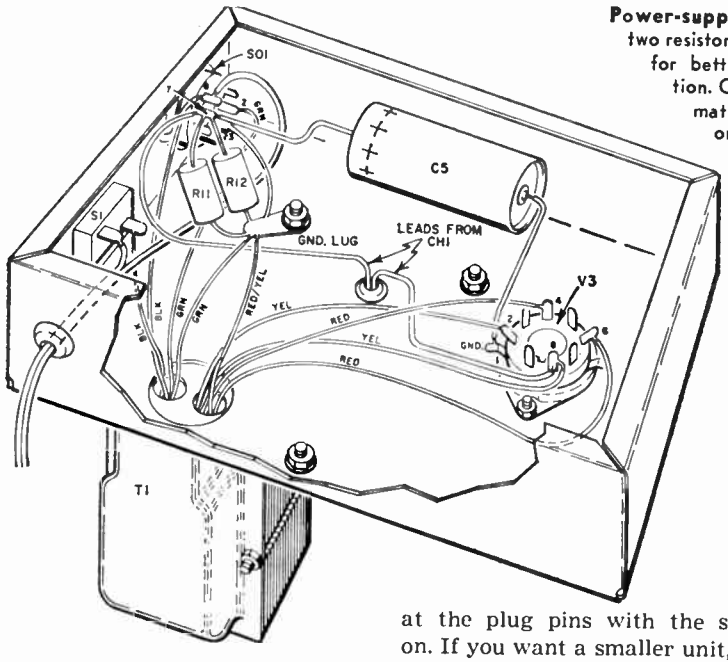
Choke-input filter in power supply lowers B+ to proper voltage for V2. Capacitor C5 must be large since it filters output of supply and also serves as audio bypass for V2.

PARTS LIST

C1—100-μμf. disc ceramic capacitor
C2, C3—.05-μf., 600-volt capacitor
C4—20 μf., 450-volt electrolytic capacitor
C5—80-μf., 450-volt electrolytic capacitor
CH1—15-henry, 75-ma. filter choke (Stancor C1002 or equivalent)
J1—RCA-type phono jack
P1—Octal plug
R1, R2, R8—470,000 ohms
R3, R6—4700 ohms
R4, R7—100,000 ohms
R5—500,000-ohm potentiometer
R9—270 ohms, 2 watts
R10—22,000 ohms
R11, R12—100,000 ohms, 2 watts
S1—S.p.s.t. toggle switch
S01—Octal socket
T1—Line-to-voice-coil transformer, 500-ohm primary to 4- and 8-ohm secondary (Stancor A8101 or equivalent)
T2—Power transformer, 117-volt primary, secondaries 520 volts CT at 90 ma., 5.0 volts at 2 amps, and 6.3 volts at 3.0 amps (Knight 61G444 or equivalent)
TS1—Two-terminal screw-type terminal strip
V1—6SN7 tube (see text)
V2—6V6 tube (see text)
Misc. hardware, chassis, tube sockets, tie points, wire, etc.

All resistors ½ watt unless otherwise noted





Power-supply bleeder uses two resistors (R11 and R12) for better heat dissipation. Octal socket SO1 mates with plug P1 on the interconnecting cable.

be kept short and away from leads carrying a.c. power and heater current. It's generally best to wire the heater and power leads first, and then proceed with the rest of the wiring.

A cable is used to interconnect the two chassis, with an octal plug and socket serving as cable connectors. Mount the socket—but not the plug—on the power supply chassis. If the plug were on the power supply, you would be liable to get a bad shock at the plug pins with the supply turned on. If you want a smaller unit, you can substitute a 12AU7 for the 6SN7 tube (*V1*) and a 6AQ5 for the 6V6 tube (*V2*). No circuit changes would be necessary.

Transformer *T1* is not a standard output transformer. It is a line-to-voice-coil unit with a primary impedance of 500 ohms and a 4- and 8-ohm secondary.

A simple boost circuit, *C1-R1*, equalizes the phono cartridge output. These parts can be eliminated if no boost is required and *J1* can be connected directly to the grid of *V1a*. —30—

Chip Chasing

By JOSEPH L. REIFFIN, W5CWP

THE problem of drilling a hole in a completed chassis is one that faces every ham and experimenter at one time or another. Clearing away existing wiring and small components is difficult enough, but the real "fly in the ointment" is the "shavings in the circuitry."

Solutions to this problem, ranging all the way from the application of a constant stream of air under pressure to the use of magnets to catch the troublesome metal chips, have been offered by the ingenious among us. However, compressed air is available only to a fortunate few. The less fortunate majority of us can develop air pressure by lung power but this is difficult, if not downright impossible, to sustain at high enough levels to do any good. The magnet idea is helpful if the chassis is made of steel but absolutely useless if the chassis happens to be made of aluminum—which is often the case.

A method currently being employed to eliminate this problem when modifying sections of the huge Burroughs Corporation computers used in the Air Force SAGE system, is both easy and effective.

A small blob of ordinary soft modeling clay, such as is used in children's modeling sets, is stuck against the back side of the chassis over the spot where the hole is to be drilled. Another blob is stuck on the top side of the chassis, doughnut fashion, around the marking for the hole. The hole is then drilled and the metal chips are automatically caught up in the clay. It then becomes a simple matter to remove the blobs of clay and the danger of the metal shavings falling into the circuitry is eliminated.

The clay can be used over and over again until it becomes so full of metal shavings that it should be discarded. —30—

Design Your Own Speaker Cabinets

Complete construction details for both bass reflex and ducted-port types of enclosures.

THE matched bass-reflex enclosure is a very effective means of loading a cone-type loudspeaker so that the speaker and enclosure combination reproduce smooth low-frequency response well below the original free-air resonance of the speaker, with excellent damping, and with approximately twice the acoustic output of that of a closed box for the same speaker.

By means of a resonance condition set up by the volume of the box and the front opening (the port), the backwave from the speaker is reversed in phase, and radiates from the port in-phase with the front wave. The close coupling of the enclosure to the speaker, where both are tuned to the same resonant frequency, sharply attenuates the excessive original resonant peak of the speaker and substitutes for it two damped resonant peaks on either side of the original resonance. By this method, low frequencies are obtained below the original free-air resonance of the speaker.

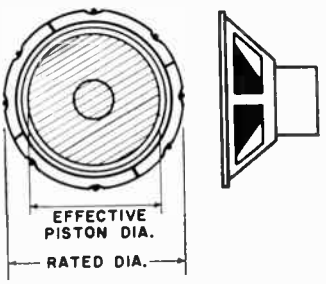
In designing the bass-reflex enclosure, an enclosure volume and port opening are chosen so that the enclosure resonates at the same frequency as the speaker alone in free air. The enclosure consists of an internal box volume with a port or vent on the panel side of the enclosure which holds the speaker. Since this opening will radiate low frequencies comparable to those radiated directly from the speaker piston, port area should approximate the effective size of the piston. The effective piston area of a speaker is always less than that determined by its rated diameter. (See Fig. 1.)

Fig. 2 gives the necessary internal volume of an enclosure to resonate at a given frequency for popular-sized speakers. Curves are based on a port opening equivalent to the effective piston area of the speaker being used. When the actual volume of the cabinet is chosen to be less than that given by the curves by a factor of "k", then the port area must be reduced by a factor of "k^2" in order to maintain the original resonance condition. For example, if volume is reduced to .866V, then the port must be reduced to .75A, or if the volume is reduced to .707V, then the port must be reduced to .5A. As the port area is reduced, however, it may impede effective bass radiation due to viscous losses and there may be a rise in low-frequency distortion. Rather than use a very small port then, a somewhat larger area in conjunction with a duct may be preferred.

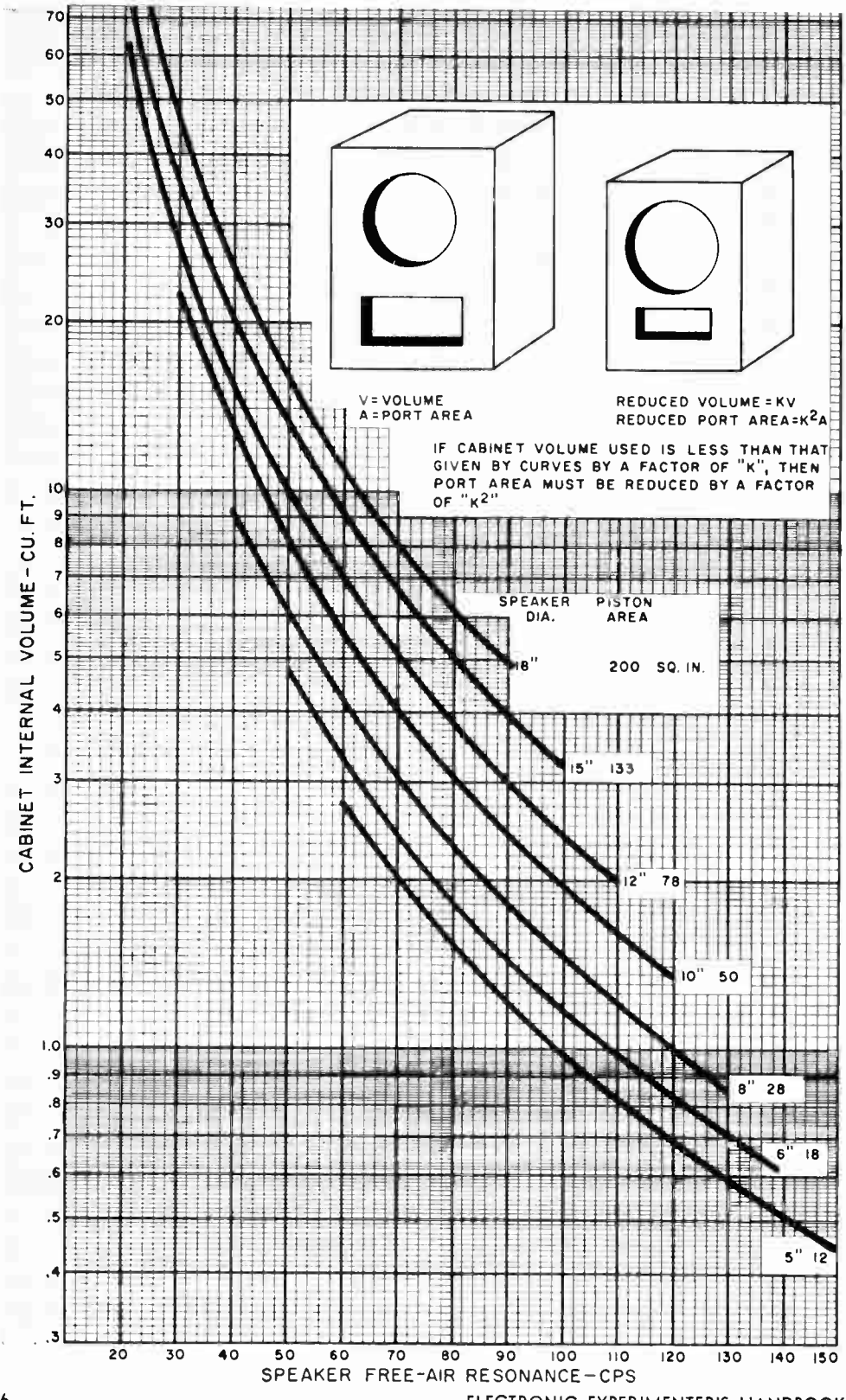
Enclosure volume may be reduced by the use of a ducted port. Fig. 3 shows a family of curves correlating cabinet volume as it is affected by introducing a length of duct for various resonances of the popular-sized speakers. For a given speaker size and resonance, a duct length may be chosen so that the volume of the cabinet is reduced to the desired size. These curves are based on a duct cross-sectional area equivalent to the effective piston area.

Where it is necessary to use a cabinet of

Fig. 1. Effective piston area and speaker volume displacements for typical speakers.



RATED DIA.	EFFECTIVE PISTON AREA	SPEAKER VOLUME DISPLACEMENT
5"	12 SQ. IN.	.05 CU. FT.
4" x 6"	12 "	.05 "
6"	18 "	.10 "
5" x 7"	18 "	.10 "
8"	28 "	.15 "
7" x 9"	28 "	.15 "
10"	50 "	.25 "
12"	78 "	.40 "
15"	133 "	.75 "
18"	200 "	1.50 "



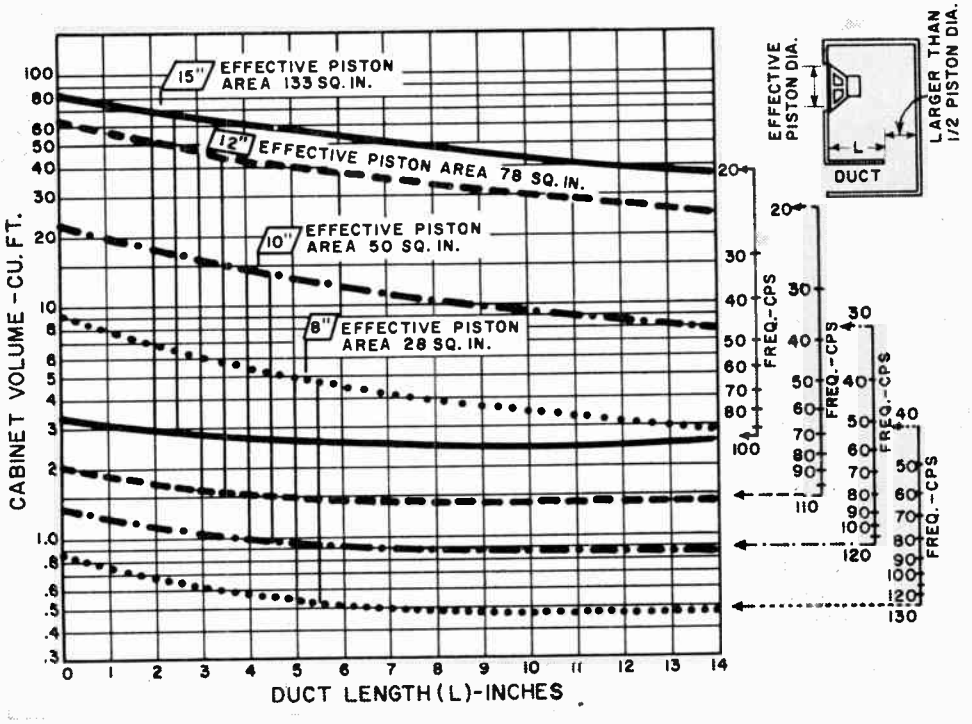


Fig. 3. Internal cabinet volume necessary for a given resonance for a ducted-port area equal to full equivalent piston area of speaker. Volume includes space used up by duct. If smaller size is desired, choose set of curves for smaller piston area, maintaining original resonance frequency of larger speaker. Refer to text.

smaller dimensions than given by these standard curves, it is possible to lay out an alternate arrangement. The piston areas of Fig. 3 may also be considered to be the duct cross-sectional area irrespective of speaker size. Even if the speaker being used is a 15" type, the curves for the 8" effective piston area (in this case, duct area) may be used to choose a duct length and cabinet volume to resonate at the original 15" speaker resonance. The internal end of the duct should not be closer to the rear wall of the cabinet than one-half the effective speaker piston diameter. These values for cabinet volume include the volume occupied by the duct.

The curves give the free internal volume of the structure. The actual physical dimensions will be larger by a factor determined by the amount and density of sound-absorbing material used to line the internal faces of the structure. (It is desirable to line all faces, but if at least two-thirds of the surfaces are lined, satisfactory results will be obtained.) A rule of thumb to determine volume of the sound-absorbing material is to multiply the area of the material by its hand-compressed thickness. This total volume should be added to the free volume figure. Also, the volume displaced by the speaker itself, from Fig. 1, should be added to the free volume figure. From the total internal volume thus obtained, Fig. 4 will give the final internal dimensions of the panels. The constructor will add to these dimensions sufficient overlap areas of these panels depending on their thickness and the method of assembly. Fig. 4 also provides a very close figure for the total area of lumber (and sound-absorbent material) required to construct the enclosure for the size chosen. The construction should be of a good grade ¾-inch plywood or solid wood, with all wood mating surfaces, except for the back panel, thoroughly glued. The panels should be

◀ **Fig. 2.** Internal cabinet volume necessary for a given resonance for a port area equal to full equivalent piston area of a speaker. If smaller volume is used, the port size is reduced, as indicated in this illustration.

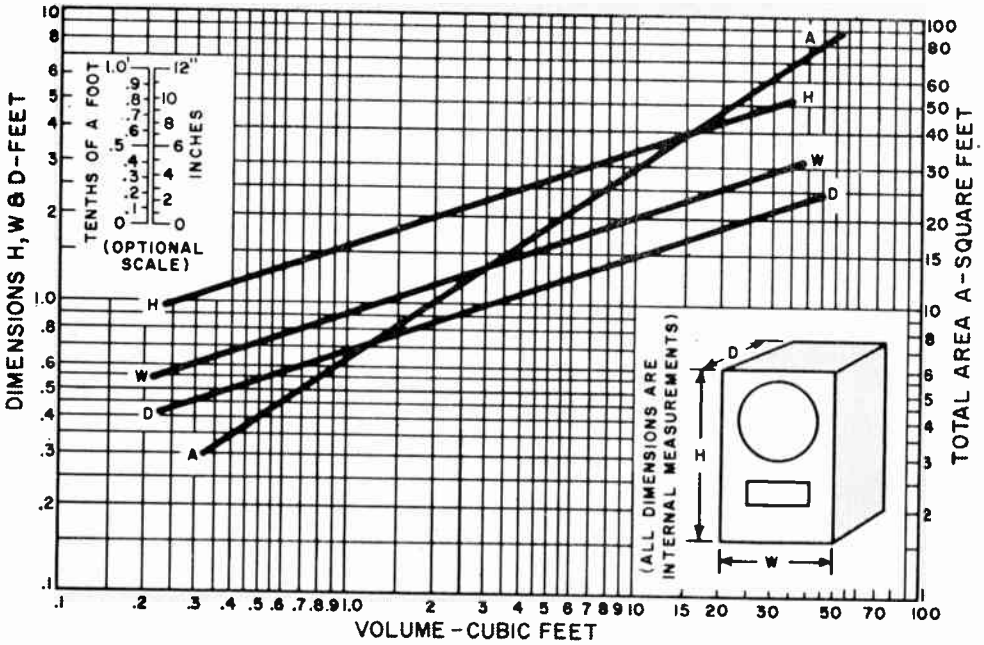


Fig. 4. Internal dimensions and total internal area of the panelling required for total volume of enclosure as determined from the previous curves, Fig. 3.

screwed together after the glue is applied, to insure maximum rigidity of the completed enclosure.

If these suggestions are followed and the dimensions are picked properly, the results will be very worthwhile. —30—

TV Lead-in Serves as S.W. or B.C. Band Antenna

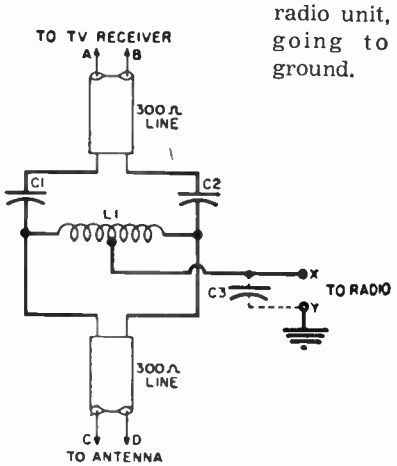
By **PAUL FALK**

WITH the circuit shown, a TV lead-in can double as antenna for a radio or s.w. converter without a loss of efficiency on TV.

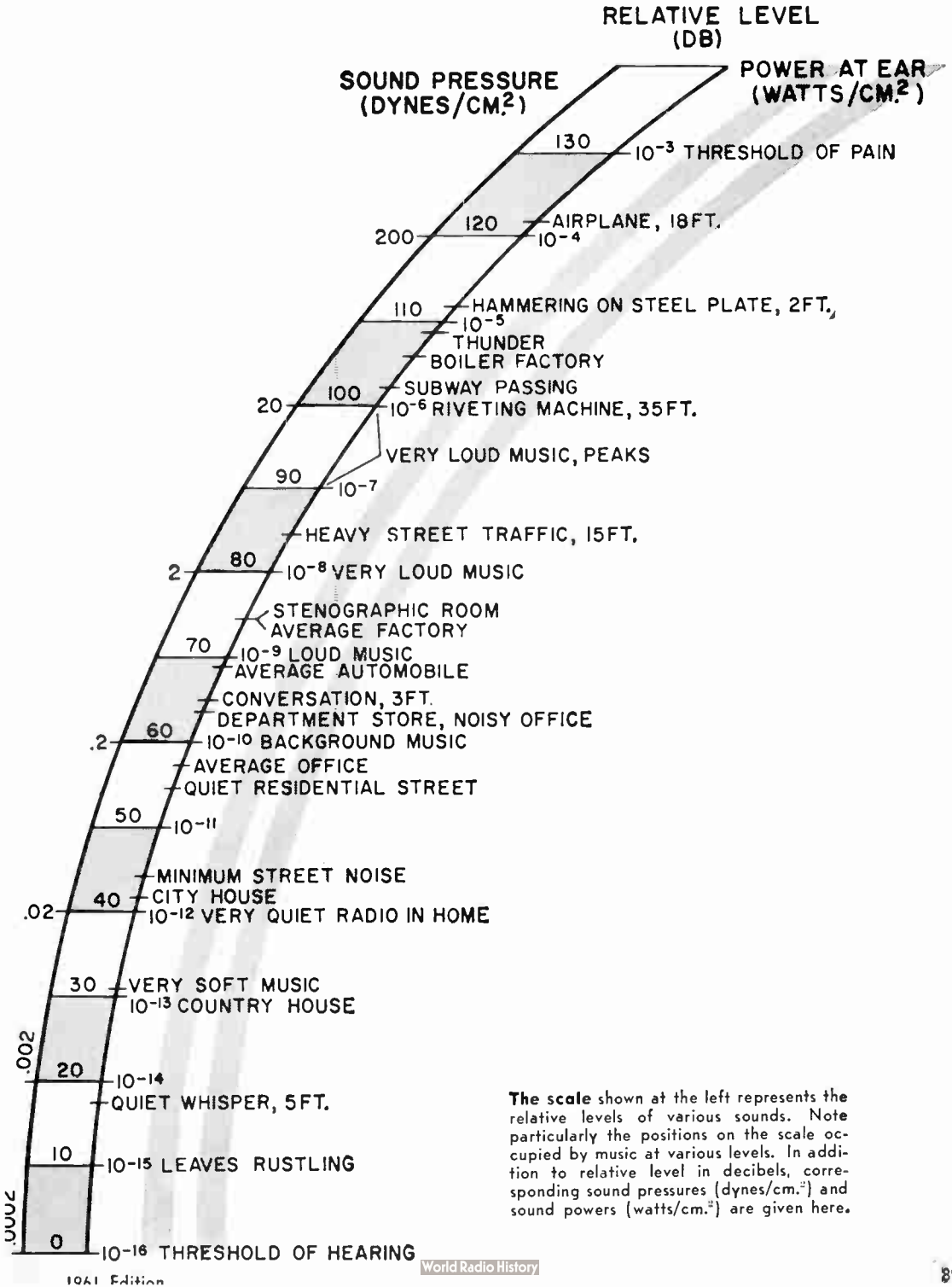
Make L_1 by wrapping 20 turns of #22 wire on a ½" form; bring out a loop for center tap X, and continue with 20 turns more. Remove the coil from the form and mount on a piece of fiber 2" x 3" in which suitable mounting holes have been drilled.

C_1 and C_2 should be 20 to 50 $\mu\mu$f. each, but not over 50. They provide the path for v.h.f. and u.h.f. energy to reach the TV set. The inductance of L_1 will tend to block these frequencies from reaching point X, but will permit longer waves to pass; while the capacitors block the longer waves from the TV set. In effect, desired filtering action is being provided for both units.

The addition of C_3 (which can often be achieved simply by twisting together the leads at X and Y) will act to improve rejection of many types of TVI. Points X and Y are connecting points for the radio unit, with Y going to earth ground. —30—



SOUND LEVELS



The scale shown at the left represents the relative levels of various sounds. Note particularly the positions on the scale occupied by music at various levels. In addition to relative level in decibels, corresponding sound pressures (dynes/cm.²) and sound powers (watts/cm.²) are given here.

power megaphone

By LOUIS E. GARNER, JR.

Fun to build—but practical too—at home, out camping, at the beach, or for boating.

YOU CAN USE a power megaphone at many outdoor events. It's handy when boating, for example, or for calling the gang to chow at picnics and beach parties. And it's just the ticket for announcing umpires' decisions and scores at outdoor games or for gathering in lost souls who have wandered off in the woods.

The low-cost unit shown here can be built for under $15. Its megaphone-like housing consists of two plastic flower pots bolted together. Choose pots so that the top of the smaller rear unit fits within the bottom of the pot in front; the larger pot must be big enough to accommodate the speaker used.

Construction. Mount the microphone cartridge (*Mic.*) and press-to-talk switch *S1* in the smaller pot. All other components—the single-stage transistor amplifier, loudspeaker, and batteries—are mounted in the larger pot. Any standard carbon microphone cartridge will do, but it's best to choose a sensitive unit. The author's megaphone uses a mike picked up at a local surplus store for about three dollars. If you prefer a standard commercial unit, obtain a Shure Type R10 cartridge.

Use plastic foam rings or washers to bolt the microphone to the bottom of the smaller pot. After mounting the switch and the rear-handle mounting stud, stuff the smaller pot with plastic foam or similar material to cut down acoustic feedback and rattle. Run the microphone and switch leads through the hole in the bottom of the larger pot.

Choose a quality loudspeaker with as heavy a magnet as you can afford and attach it to a circular piece of perforated Masonite with plastic foam rings or washers. Cut the Masonite to fit the larger flower pot; the holes in the Masonite should be large enough to serve as sound ports. Transistor *Q1* and bias resistor *R1* are mounted on a small aluminum chassis attached to the rear of the speaker; machine screws secure the battery holders to the rear of the larger flower pot.

Two different microphone connections are possible, depending on the individual characteristics of the cartridge. In either case, one microphone lead connects to the

transistor's base electrode and the other to either the −3- or −6-volt battery terminal as shown on the schematic. Try both, and use the connection delivering maximum output at minimum distortion. If you decide upon −3 volts, be sure to disconnect the lead between the microphone and the −6-volt terminal.

Operation. With wiring completed and checked, install the batteries, being certain to use fresh ones (a high-resistance cell can cut power output drastically). Take care to observe polarities: positive terminals on the battery holders can be identified with dabs of red fingernail polish.

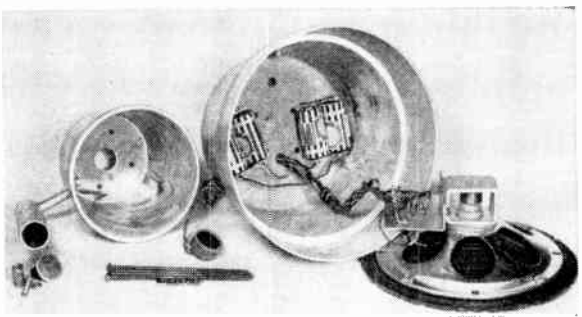
Hold the microphone close to your mouth, pointing the unit in the direction you wish to project your voice. Depress the push button and speak in a slightly-louder-than-normal voice. Release the button to turn the unit off. —30—

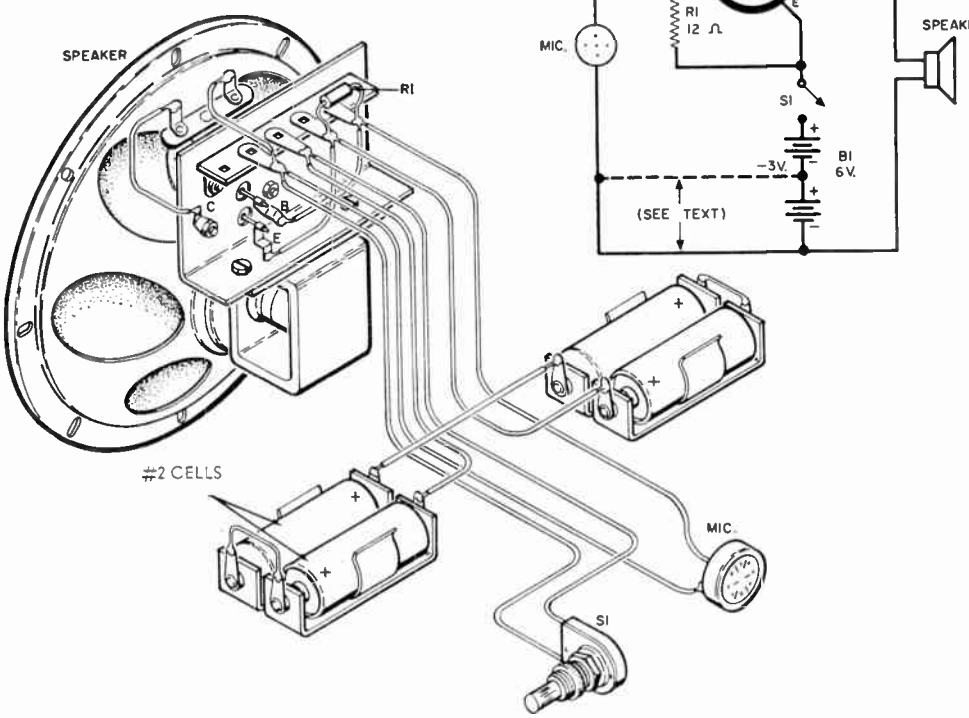
HOW IT WORKS

The megaphone is a single-stage common-emitter amplifier using a *p-n-p* power transistor. Audio input is supplied by the carbon microphone; the PM loudspeaker serving as a collector load is coupled directly to the transistor. Resistor *R1* stabilizes base bias; power is supplied by a 6-volt battery. The microphone is connected to either the —3- or —6-volt battery terminal, depending on the sensitivity of the mike used.

PARTS LIST

B1—6-volt battery (Four Burgess #2 cells in series)
Q1—2N255 transistor (CBS)
R1—12-ohm, ½-watt carbon resistor
S1—S.p.s.t. momentary-contact push-button switch
Mic.—Carbon microphone cartridge (see text)
2—Plastic flower pots (see text)
1—Small aluminum chassis (see text)
Spkr.—PM loudspeaker (see text)
Misc. perforated Masonite, handle, battery holders, terminal strip, etc.





battery-powered intercom

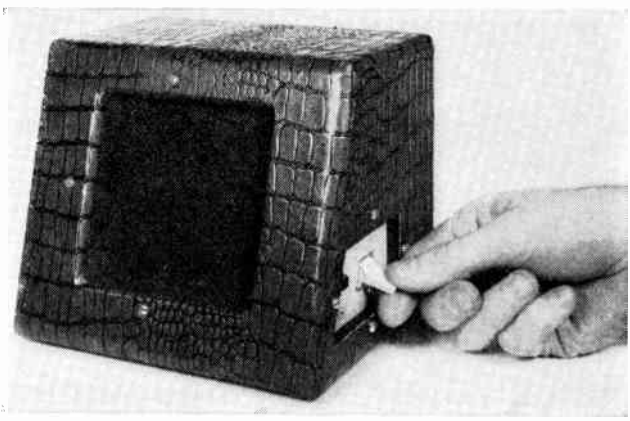
By LOUIS E. GARNER, JR.

An inexpensive unit which functions away from power lines—at camps, summer homes, on boats, or in planes.

CHANCES ARE you'll find dozens of uses for a two-station intercommunication system at your summer vacation spot. An intercom could be installed between the main lodge and the boathouse at a fishing camp, for example. At a hunting camp, it might provide communication between the lodge and the dog kennels. Or, in a simpler setup, it could be installed between any two cabins or tents. Now, while you have time, get it ready!

Lack of a power line often restricts use of electronic equipment. But the intercom described here has no such limitations. Because it's fully transistorized, the unit needs only standard flashlight cells to operate.

The complete system consists of two stations connected together with two-conductor "zip-type" line cord. The remote station is simply a small PM loudspeaker mounted in a metal or wooden baffle. The master station



contains a similar loudspeaker, plus the system's amplifier, power supply, and operating controls.

Construction. Assemble the master unit in a small wall-type loudspeaker baffle equipped with button-type "bumper" feet. The PM loudspeaker and pair of dual-battery holders are attached to the baffle with machine screws and nuts.

Assemble the transistorized amplifier on a small "chassis" made up of aluminum and perforated Masonite. An all-aluminum chassis can be used if the transistor cases are insulated with mica washers. Chassis size, circuit

layout, and wiring are not critical, but care must be taken to observe all d.c. polarities. The model uses Lafayette SP-147 transistors, low-cost equivalents of the CBS 2N255 specified in the parts list on the next page.

Once assembled and checked, the amplifier chassis can be attached to the baffle with long sheet-metal screws. Cut out a piece of the baffle's side wall to permit access to on-off switch *S2* and talk-listen switch *S1*.

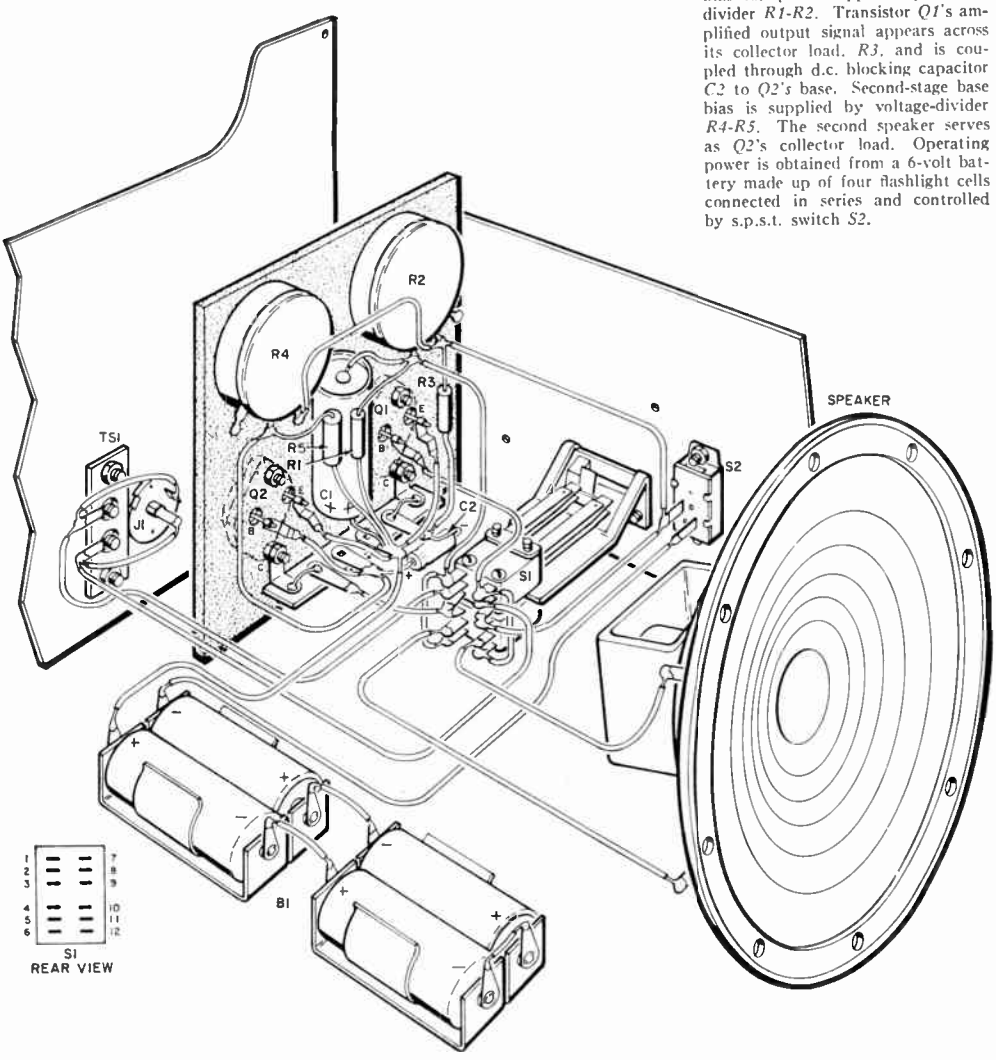
For connection to the remote station, dual outlets are provided—a conventional two-terminal screw-type strip, and a regular phono jack *(J1)*. These dual outlets are hooked up in parallel and permit use of the master station in both permanent and temporary installations. For temporary setups, the line from the remote station can be terminated in a plug matching the master station's jack.

Operation. After the wiring has been completed and checked for errors, install the four flashlight cells. You can use dabs of red fingernail polish to identify battery

HOW IT WORKS

The intercom is a two-stage resistance-coupled amplifier using *p-n-p* power transistors in the common-emitter arrangement. When *S1* is in its "talk" position, the master unit's built-in speaker serves as a microphone, with the amplifier driving the external remote speaker. Turning *S1* to "listen" reverses the speaker roles.

In operation, the input signal obtained from the speaker serving as a microphone is applied to *Q1;* base bias for *Q1* is supplied by voltage divider *R1-R2*. Transistor *Q1*'s amplified output signal appears across its collector load, *R3*, and is coupled through d.c. blocking capacitor *C2* to *Q2*'s base. Second-stage base bias is supplied by voltage-divider *R4-R5*. The second speaker serves as *Q2*'s collector load. Operating power is obtained from a 6-volt battery made up of four flashlight cells connected in series and controlled by s.p.s.t. switch *S2*.

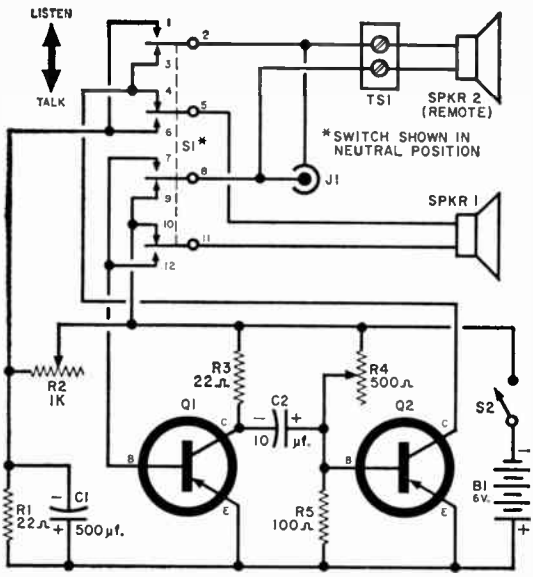


polarity in the holders. Connect the remote station with a length of line cord.

Next, turn *R2* and *R4* full on. Turn the unit on by closing *S2*, and turn *S1* to its "listen" position. Have a friend talk into the remote station speaker while you adjust *R2* and *R4* for maximum sensitivity and power output, respectively. Once these adjustments have been made, *R2* and *R4* can be left untouched unless one or both transistors are replaced.

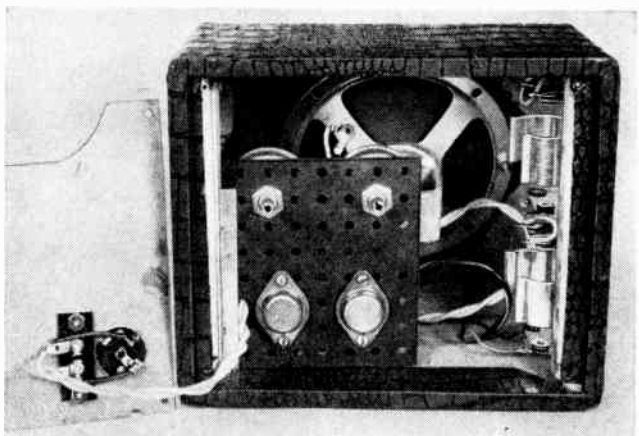
In normal use, *S1* is left in its "listen" position. This enables the person at the remote unit to answer without having to operate a switch or control.

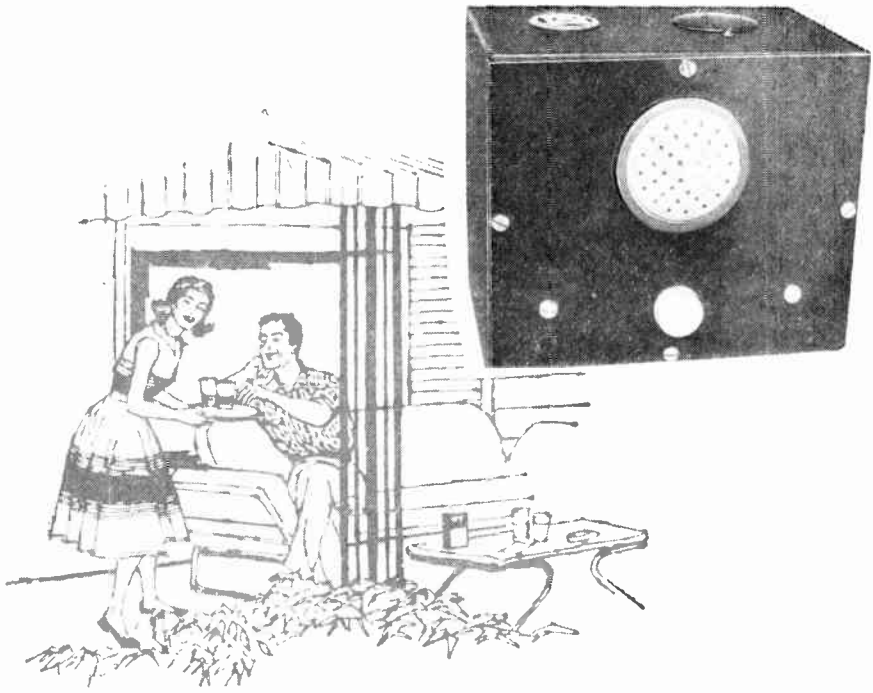
You'll find that this simplified circuit has less sensitivity and power than most commercial intercoms. But the unit's performance will be satisfactory as long as background noise levels are not high. —30—



PARTS LIST

B1—6-volt battery (four Burgess #2 cells in series)
C1—500-µf., 15-volt electrolytic capacitor
C2—10-µf., 15-volt electrolytic capacitor
J1—RCA-type phono jack
Q1, Q2—2N255 transistor (CBS or equivalent)
R1, R3—22-ohm, 1-watt resistor
R2—1000-ohm wire-wound potentiometer
R4—500-ohm wire-wound potentiometer
S1—4-p.d.t. spring-return lever switch
S2—S.p.s.t. switch
TS1—Two-terminal screw-type terminal strip
Spkr. 1, Spkr. 2—5" PM loudspeaker, 3-4 ohm voice coil
1—Wall-type speaker baffle
1—Desk-type speaker baffle
1—Aluminum chassis (see text)
Misc. dual-cell battery holders, terminal strip, bumper tacks, wire, etc.





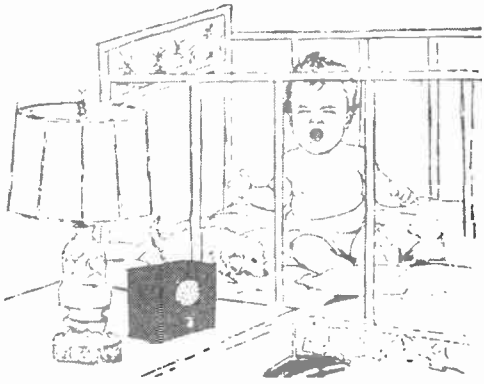
Electronic House-Sitter

Easy-to-build unit lets you monitor household activities at a distance.

By LOUIS E. GARNER, Jr.

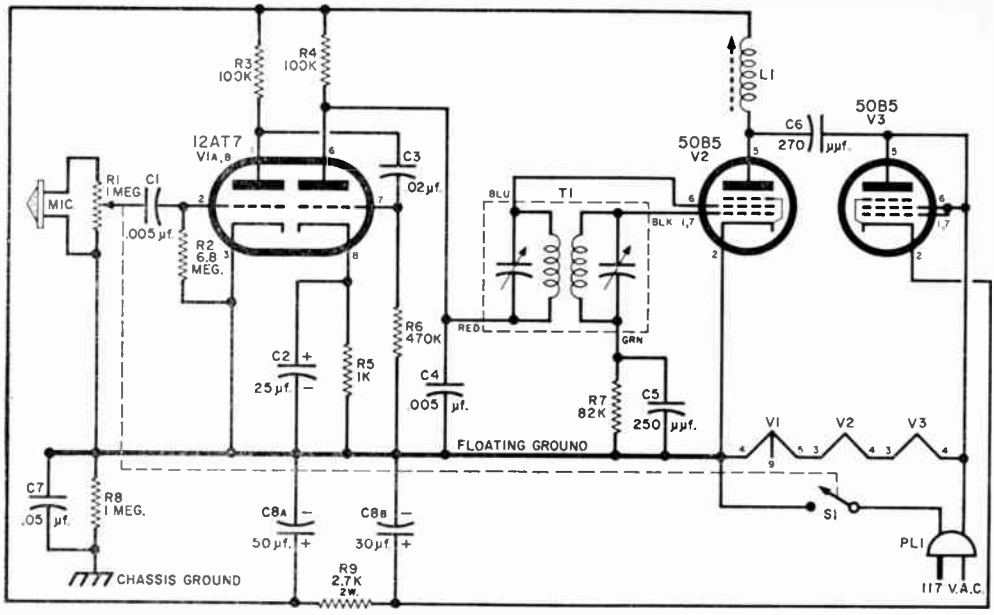
FOR a few dollars' worth of parts and several evenings' work, you can own an "Electronic House-Sitter," a useful little gadget that will:

- Let you know immediately if someone knocks on your front door, even though you are visiting a neighbor.
- Serve as a remote baby-sitter while you're out-of-doors, telling you the moment the baby wakes and starts to cry for his bottle.
- Allow you to listen to your favorite records or radio programs while you're working, yet call you immediately if the telephone rings.



The Electronic House-Sitter is a low-power transmitter operating in the AM broadcast band. It can be used in conjunction with any radio, though transistorized models are usually preferable because they are self-powered and small enough to be slipped into a spare pocket. With the transmitter broadcasting any sounds occurring in its vicinity, and a transistorized receiver in your pocket, you can wander all over the neighborhood and still know what's going on at home.

No separate antenna is required; the unit employs the house wiring as an antenna. A



Wireless house-sitter uses "floating" ground to keep power line clear of chassis and eliminate possibility of dangerous shocks.

PARTS LIST

C1, C4—0.005-µf., 600-volt paper capacitor
C2—25-µf., 25-volt electrolytic capacitor
C3—0.02-µf. disc capacitor
C5—250-µµf. ceramic capacitor
C6—270-µµf., 600-volt capacitor
C7—0.05-µf., 600-volt paper capacitor
C8a, C8b—30-50-µf., 150-volt electrolytic capacitor
L1—Ferrite-core loopstick antenna coil (Meissner No. 14-9015)
PL1—Polarized line cord plug (see text)
R1—1-megohm potentiometer
R2—6.8 megohms
R3, R4—100,000 ohms (all resistors ½ watt unless otherwise noted)
R5—1000 ohms
R6—470,000 ohms
R7—82,000 ohms
R8—1 megohm
R9—2700-ohm, 2-watt resistor
S1—S.p.s.t. switch ganged with R1
T1—455-kc. i.f. transformer (Meissner No. 16-6658)
V1—12AT7 tube
V2, V3—50B5 tube
MIC.—Crystal microphone cartridge (Lafayette PA-27)
1—4⅞" x 3⅞" x 1¼" aluminum chassis
1—4" x 5" x 6" metal utility box (Bud CU-729B)
2—Seven-pin miniature tube sockets
1—Nine-pin miniature tube socket

special circuit keeps the output power within the limits stipulated by the FCC.

Assembly. Made from standard, readily available components, the gadget can be wired in two or three evenings, even by a builder with limited experience. It is a.c.-operated and measures only 4" x 5" x 6" over-all.

When drilling the case and panels, you should make provisions for reaching the oscillator transformer (*T1*) adjustments *after* assembly. This can be done by punching an appropriate hole in the case and covering it with a snap hole plug. Be sure to include ample ventilation holes to allow tube heat to escape.

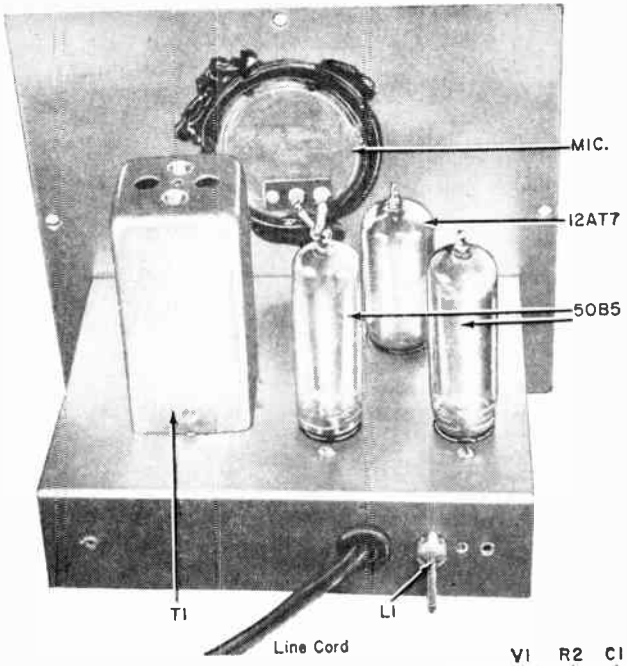
All major parts except the microphone and output coil are mounted with standard

HOW IT WORKS

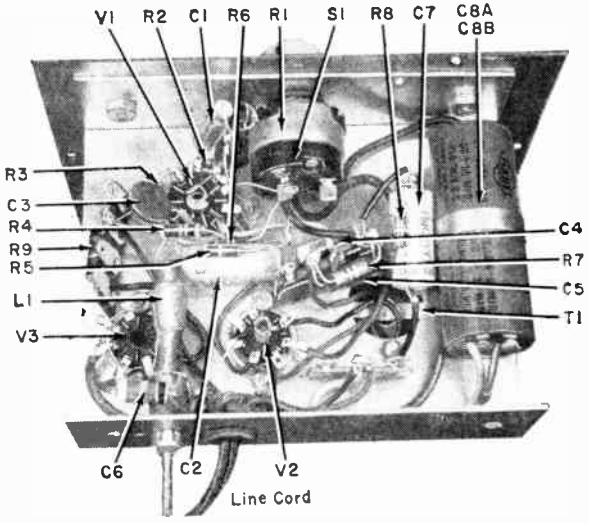
Sound is picked up by the crystal microphone and fed to a conventional two-stage resistance-coupled amplifier (*V1*). The amplified audio frequency signal appears across *R4* and is superimposed on the voltage applied to the screen grid of oscillator *V2*. This modulates the r.f. signal. The r.f. oscillator (*V2*) is unique in that it operates as a combination oscillator and frequency doubler. Oscillator transformer *T1* is tuned to one-half the frequency of output tank coil *L1* which resonates in the broadcast band. Thus, the r.f. output is kept at a low level.

The screen grid of *V2* serves as the "plate" of a triode oscillator. Transformer *T1* furnishes the feedback path between screen and control grids necessary to obtain oscillation. The r.f. developed in the "triode" is doubled in *V2*'s plate circuit by tank coil *L1*, which is tuned to the broadcast band by its ferrite core and distributed wiring capacities. Resistor *R7*, bypassed by *C5*, serves as the oscillator's grid-leak resistor and shunt capacitor. The modulated output signal appears across *L1* and is coupled through *C6* to the "hot" side of the 117-volt a.c. line.

The power supply is a conventional half-wave rectifier using a 50B5 (*V3*) with its screen and control grids connected to its plate. The "ground" side of the power line connects to a "floating" ground circuit through *S1*, and the "floating" ground in turn is connected to the chassis through *C7*, shunted by *R8*. Combined with the use of a polarized plug (*PL1*), this "floating" ground insures a shock-free chassis, although a transformerless supply is used.



Parts layout is not critical. Only R8 and C7 should be connected directly to chassis. All other components which are grounded are connected to floating ground tie points or bus bar.



machine screws, nuts, and lockwashers. The microphone is furnished by the manufacturer with a rubber gasket which is cemented to the instrument's front panel. Coil *L1* is fitted with a familiar spring snap mounting and is simply slipped into an appropriate hole.

If you're unable to locate a commercial polarized plug for *PL1*, you can make your own by soldering a small piece of wire around the edge of one prong of a conventional line plug. This makes one wider prong which serves as the "ground" side of the line where a correspondingly polarized wall socket is used.

Adjustment and Test. With assembly completed, you are ready for preliminary tests. But double-check all wiring *before* installing the tubes or connecting to line power. If everything checks out, install the tubes and plug in the unit.

Turn the instrument on and allow a minute or two for warm-up. Use a 5000 ohms/volt (or better) voltmeter set for its 50-volt d.c. scale (or a VTVM) to check for d.c. voltage across *R7* (grid "end" is negative). Switch to a lower scale if necessary. If there is no d.c. voltage across this resistor, the oscillator is not working. Try adjusting *T1*'s trimmer capacitors, checking again for a d.c. voltage. Also check for about 125 volts d.c. between pin 5 of the 50B5 oscillator (*V2*) and the "floating" ground. If you are still unable to obtain oscillation, try reversing *T1*'s secondary connections.

Once you are sure the oscillator is working, mount the instrument in its cabinet, and remove the snap plug covering *T1*'s adjustments.

Since the Electronic House-Sitter is used with a standard receiver, you'll need a radio

to make further adjustments. Place the receiver near the transmitter. Turn both instruments on and tune the receiver to a "dead" spot on its dial between 800 and 900 kc.

Now close *T1*'s trimmers *fully*. Turn up the set's volume control and set *R1* about two-thirds up. Then adjust *T1*'s trimmers slowly, backing each out an equal amount until a signal is picked up on the radio. This signal may be heard as a slight hum, as a "hiss," or as a squeal, depending on the relative adjustments of the volume and gain controls. That takes care of one step.

For closer adjustment, move the receiver across the room, and re-adjust *T1*'s trimmers. Then adjust *L1* for maximum pickup by the receiver.

Operation. To use the instrument, simply plug it into a wall receptacle in the room where you would like to have maximum audio pickup. Turn the unit on and adjust gain control *R1* for desired pickup level as heard on your pocket receiver. Good results are also obtained when an earphone is used with the receiver. —30—

TRANSISTOR ALARM GENERATOR

By DAVE STONE

HERE is a useful and interesting circuit which produces pulses of audio tones at intervals of less than one-per-second to about eight-per-second. When it is connected to an audio amplifier the resulting output sounds like a series of "beeps" much like the busy signal on the telephone, or "whoops" similar to the emergency call which summons crews to combat stations aboard a battleship.

The self-quenched superregenerator is an old standby in the radio-frequency range. Feedback for regeneration is obtained from the split primary winding of the audio output transformer (Triad A-65J) and the circuit produces a normal audio tone at a frequency determined by *C2*'s capacity and the primary inductance of *T1*. It is approximately 600 cps with the values indicated on the schematic.

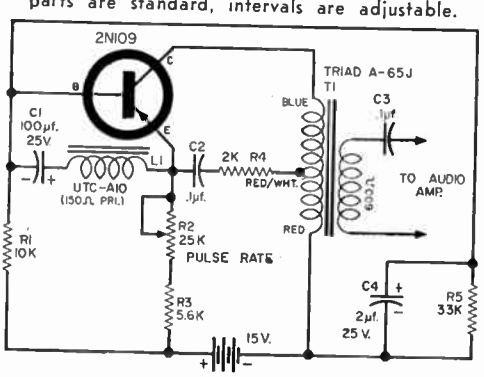
C1 is connected so as to provide cut-off bias to the base-emitter circuit when it has sufficient charge. During oscillation it charges high enough to "quench" the oscillator and when no oscillator current is flowing, discharges until the cut-off bias is reduced and the circuit begins to oscillate again. The "tone-on," "tone-off" action is repeated at a rate determined by the values of *C1* and *L1*. The "Pulse Rate" control, *R2*, changes the bias and charging conditions which, in turn, affect the repetition rate.

The values of *C1* or *L1* can be altered to obtain faster cycling—up to a rate of about fifteen-per-second, if desired. The optimum values for *L1* were found to lie between 500 and 700 millihenrys. The 50-200 ohm winding of a low-to-high impedance transformer—such as mike-to-grid or line types—will fill the bill. Several transformers of this type were measured and the low-impedance windings were within the desired inductance range. The UTC A-10 audio transformer provides several low-impedance combinations.

The tone of the audio frequency can be varied by changing the value of *C2*—the larger the capacitor, the lower the tone, while a smaller capacitor will produce a higher frequency output. *C3* and the 600-ohm secondary of the A-65J transformer will work well into a moderate- to high-impedance p.a. system input.

Use this stage to generate an alarm or warning signal with the higher pulsing rates. A burglar alarm relay can be connected to apply power to the alarm generator when it is activated. The resulting noise is guaranteed to attract attention! Use it as an audible "count-down" signal over the p.a. system by adjusting pulses to exactly one-per-second. —30—

Complete schematic of alarm generator. All parts are standard, intervals are adjustable.



Portable Utility Amplifier

Battery-powered transistorized amplifier has many useful workbench applications.

WHETHER your interest in electronics lies in servicing, in project construction, in circuit experimentation and testing, or in a combination of all these, you'll find that a self-contained audio amplifier is one of the most valuable instruments you can add to your home workshop. Here is a unit you can have fun building, and then use to trouble-shoot or debug other projects.

For maximum utility, this audio amplifier was designed to deliver from 500 to 750 milliwatts with a frequency response and distortion level adequate for checking high-fidelity components. Both high and low input impedances are available, with a variety of input jacks for versatility. Over-all gain is high enough to permit its use with a magnetic phono cartridge, and battery operation minimizes hum and reduces the possibility of ground loops in checking other equipment.

Easy to build, using readily available components and

There is no power cord in this transistorized unit. Just connect your source of audio, switch it on, and you have an amplified output—instantly.

By
LUIS VICENS

standard hand tools, this unit compares favorably with high-quality factory-built equipment in both appearance and performance. The circuit consists of a three-stage amplifier using *p-n-p* transistors. Resistance-capacity coupling is used in the first two stages, with the second stage transformer-coupled to a class AB push-pull power amplifier.

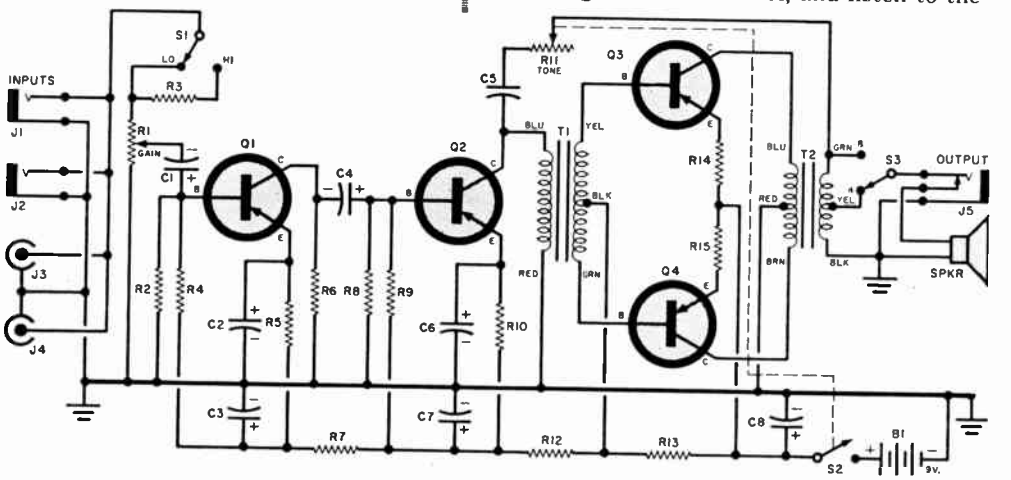
Construction. You can build the three-stage transistorized amplifier on a 3½"-square Bakelite board (or use conventional wiring, if you wish). A wall baffle for an 8" loudspeaker provides the amplifier housing. The chassis is bracket mounted on the rear fiberboard panel of the baffle with leads to the speaker of sufficient length to permit testing and repair. The mounting technique is shown at right.

Before final assembly, install the transistors, connect the battery and give the instrument an over-all operational test by applying a test signal to one of the input jacks. Use an audio oscillator, radio tuner, record player, or even a small crystal receiver for the test. Turn the unit "on" by rotating the *Tone* control, and listen to the speaker's output. Adjust the *Gain* and *Tone* controls throughout their ranges to check them.

PARTS LIST

B1—9-volt battery (Burgess 2N6 or equivalent)
C1, C4—30-μf., 6-volt electrolytic capacitor
C2, C6—30-μf., 15-volt electrolytic capacitor
C3, C7, C8—50-μf., 12-volt electrolytic capacitor
C5—.02-μf., 50-volt capacitor
J1—Miniature open-circuit phone jack
J2—Open-circuit phone jack
J3—Panel-mounting coaxial microphone connector
J4—RCA-type phono jack
J5—Closed-circuit phone jack
Q1, Q2—2N323 transistor
Q3, Q4—2N321 transistor
R1—5000-ohm potentiometer (audio taper)
R2—150,000 ohms
R3—470,000 ohms
R4—10,000 ohms
R5, R7, R10—1000 ohms
R6, R9—4700 ohms
R8—47,000 ohms
R11—25,000-ohm potentiometer (linear taper) with s.p.s.t. switch (S2) mounted on rear
R12—220 ohms
R13—47 ohms
R14, R15—10 ohms
S1, S3—S.p.d.t. toggle switch
S2—S.p.s.t. switch on R11
T1—Driver transformer; 10,000-ohm primary; 2000-ohm center-tapped secondary (Argonne AR-109 or equivalent)
T2—Output transformer; 160-ohm center-tapped primary; 3.2- 8-ohm secondary (Argonne AR-170 or equivalent)
SPKR—8" PM loudspeaker, 3.2- 8-ohm voice coil
1—Loudspeaker wall baffle
1—3½" x 3½" Bakelite board (see text)
Misc. fiberboard, hardware, transistor sockets, brackets, etc.

All resistors ½ watt composition unless otherwise indicated

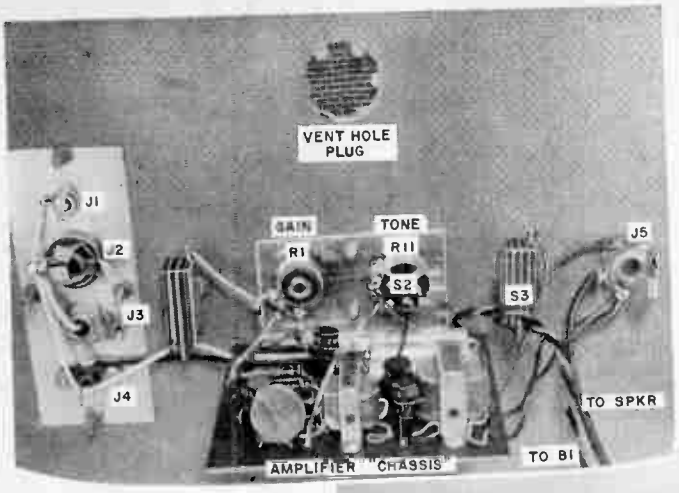


Four input jacks are provided in the utility amplifier for versatility. Low and high input impedances can be selected by switch S1 and both 4- and 8-ohm outputs are available for the self-contained speaker or at output jack J5.

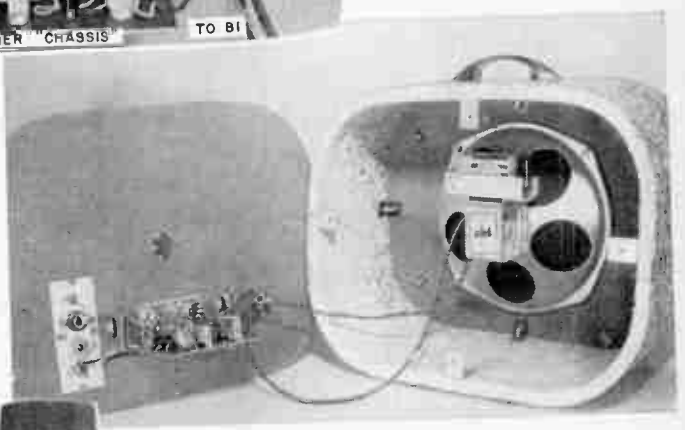
Operation. To test a phono cartridge or microphone, connect it to any of the four input jacks. Set gain control *R1* for the desired volume level and switch *S1* to the high or low impedance settings depending on the unit being tested. If in doubt, try *S1* in both positions.

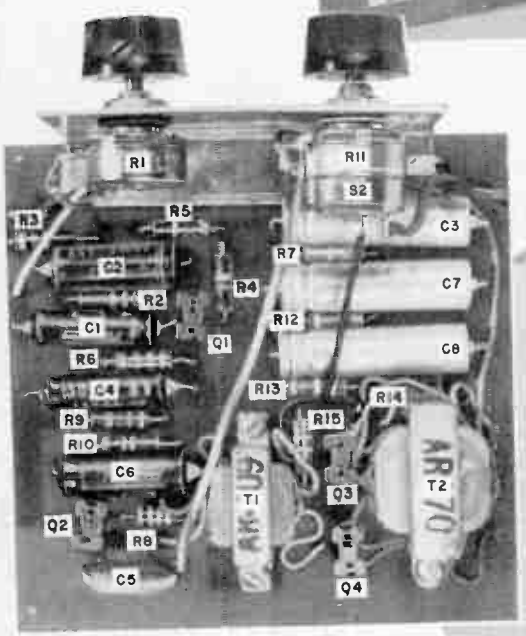
To test speakers or low-impedance headphones, simply plug them into jack *J5* and flip output impedance switch *S3* to 4 or 8 ohms. High-impedance headphones can be tested but will give low volume.

Many other applications are possible for this versatile instrument. For example, it

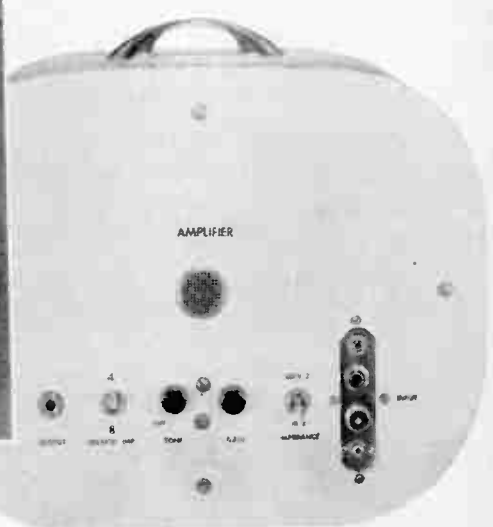


Mount amplifier chassis, controls, input and output jacks on rear panel of speaker baffle. Allow sufficient lead length between speaker, battery, and rear panel so that the unit can be opened for test and repair.





Compact chassis is achieved by using printed-circuit board. Similar layout can be made on perforated phenolic board.



will serve as a low-power p.a. amplifier, a guitar amplifier, or as a booster for low-volume transistor portables. And it won't be hard to find dozens of other uses. —30—

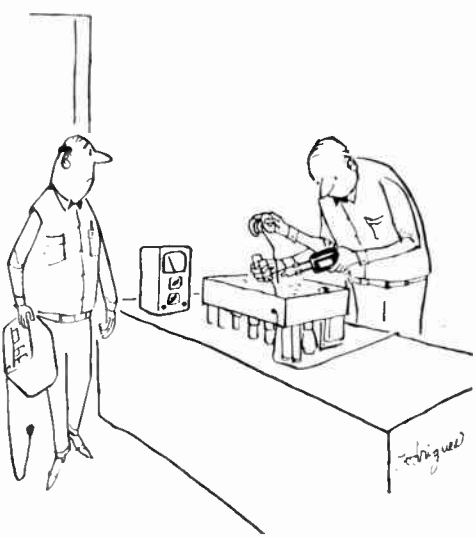
HOW IT WORKS

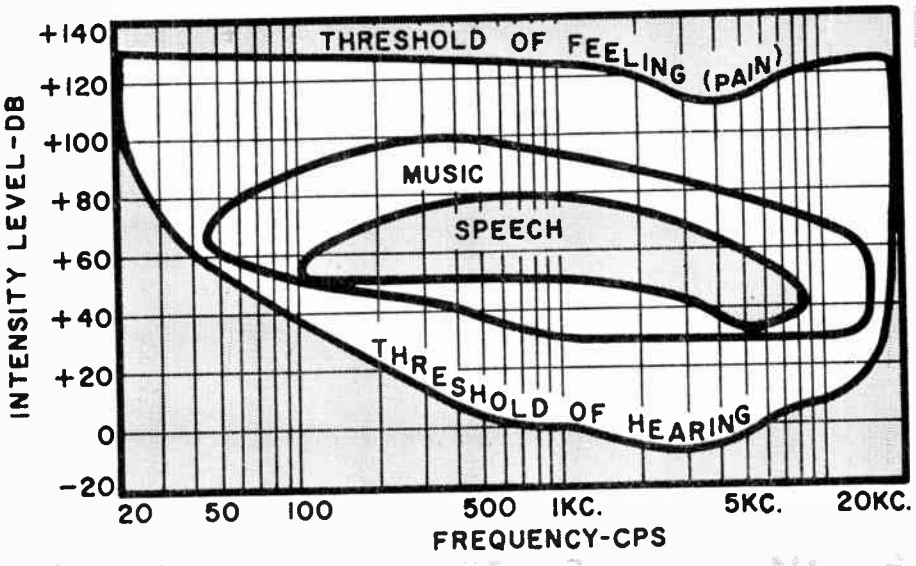
Audio signals applied to one of the four input jacks (*J1 to J4*) are coupled through input switch *S1* to *Gain* control *R1*. The input circuit normally has a low impedance, but it can be changed to a high input impedance by switching resistor *R3* in series with the *Gain* control. Input signals are applied to the base of preamp stage *Q1*. Stabilized base bias is furnished *Q1* by voltage-divider *R2-R4* in conjunction with emitter resistor *R5*, bypassed by *C2*. Resistor *R6* serves as the collector load, with stage decoupling provided by *R7* and *C3*.

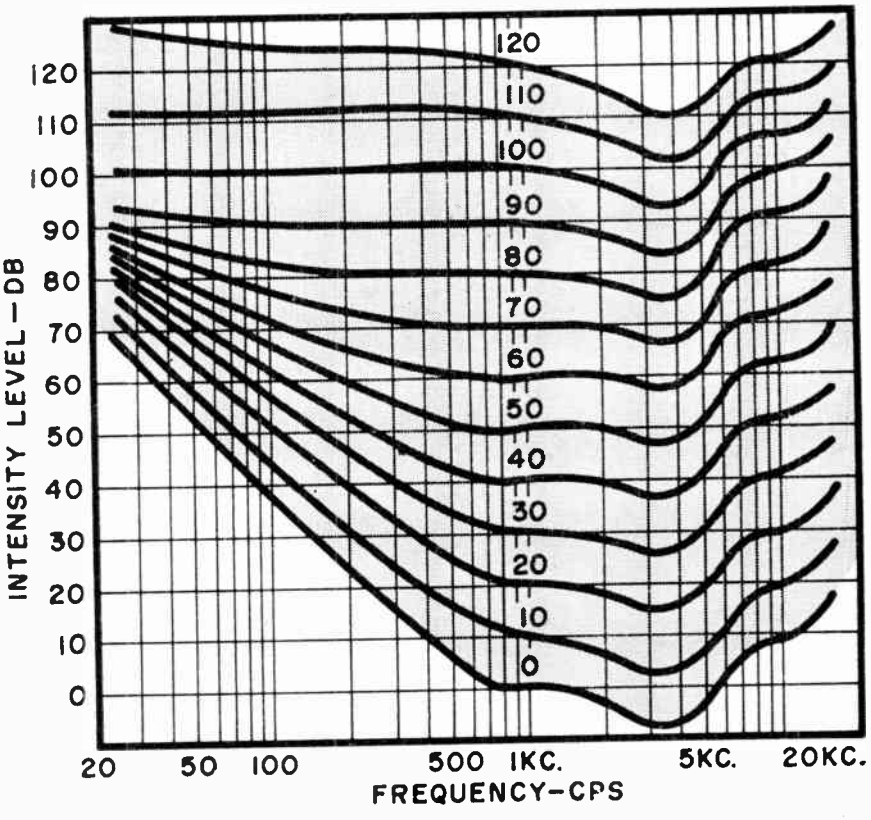
The amplified signal developed across *R6* is coupled through *C4* to the driver stage, *Q2*, with the primary winding of driver transformer *T1* serving as *Q2's* collector load. Transformer *T1* has a dual job: it matches *Q2's* moderate output impedance to the relatively low input impedance of the push-pull stage and supplies the out-of-phase signals needed to drive the push-pull power amplifier, *Q3-Q4*.

The small base bias required by the output stage for class AB operation is furnished by the d.c. drop across *R13*, stabilized by unbypassed emitter resistors *R14* and *R15*. The power amplifier stage is coupled to its load through impedance-matching transformer *T2*. A negative feedback signal is obtained from *T2's* secondary and coupled back through blocking capacitor *C5* and *Tone* control *R11* to *Q2's* collector.

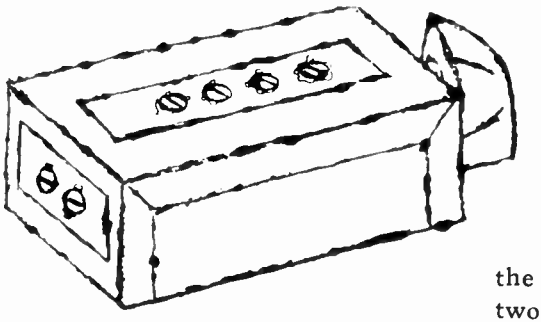
Output transformer *T2* has a tapped secondary to provide a choice of output impedance values. The signal delivered here is coupled through the speaker impedance switch *S3* and closed-circuit output jack *J5* to the loudspeaker's voice coil. When a plug is inserted in *J5*, the speaker circuit is opened and the output signal can be delivered to an external load.







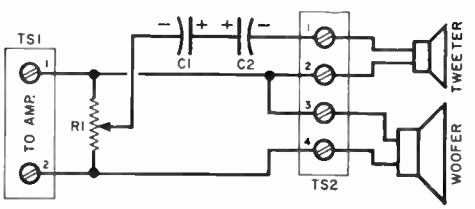
Hi-Fi Speaker Crossover



As a general rule, small loudspeakers do a better job of reproducing high-frequency sounds than do large units. By the same token, a large loudspeaker is best suited to handling low-frequency or "bass" sounds. Professionally designed high-fidelity installations utilize this fact by providing two or more loudspeakers: a small "tweeter" for high frequencies and a large "woofer" for low frequencies, with, often, a medium-sized unit for medium-range frequencies.

You, too, can take advantage of this fact by adding another loudspeaker to your present radio or phonograph if you do not now have a hi-fi system. All you'll need is another speaker plus a "crossover" to divide the high and low audio frequencies between the two units as shown.

Wire the crossover unit according to the pictorial diagram. Note that the two electrolytic capacitors *(C1, C2)* are connected "back-to-back," i.e., positive terminal to positive terminal. Check the wiring after you have completed it.



SPKR	3–4Ω	6–8Ω	16Ω
R1	15Ω	30Ω	75Ω
C1,C2	50μf.	20μf.	10μf.

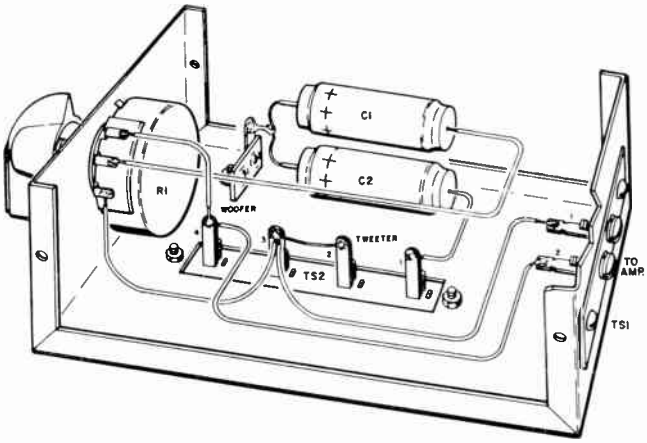
Adding a Speaker. If your set now uses a large loudspeaker, one with a diameter of from 8″ to 12″, you'll want to add a small "tweeter." This can be a 3″ to 5″ loudspeaker or a commercial tweeter, as offered by most distributors. An 8-ohm unit will work well with any impedance woofer.

If your set now uses a 3″-5″ loudspeaker, you'll want to use it as a tweeter and add a "woofer." Obtain a 10″ to 12″ PM loudspeaker of the best quality you can afford.

Mount the new speaker in a suitable enclosure; ask your audio dealer for his recommendations.

Disconnect the leads now connected to the voice coil terminals of your present loudspeaker and connect them to the *Amplifier* terminals of the crossover. Connect your small loudspeaker to the *Tweeter* terminals (1 and 2) and your large speaker to the *Woofer* terminals (3 and 4). Listening to music with a good balance between high and low frequency notes, adjust the crossover's control *(R1)* for the preferred balance between the two loudspeakers.

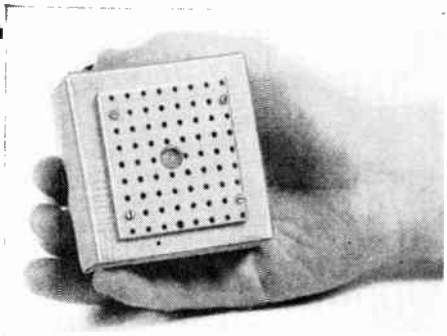
How It Works. In operation, the two electrolytic capacitors in series form a non-polarized "a.c." capacitor offering a relatively high impedance to low-frequency signals but permitting high-frequency signals to be applied to the tweeter with minimum loss. The 4-watt potentiometer *(R1)* serves as a variable voltage divider, controlling the voltage input to the tweeter. —30—

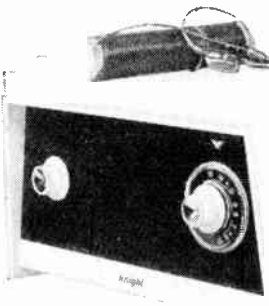


PARTS LIST

C1, C2—25-volt electrolytic capacitor (see diagram for values)
R1—4-watt wire-wound potentiometer (see diagram for values)
TS1—Two-terminal screw-type terminal strip
TS2—Four-terminal screw-type terminal strip
1—3¼" x 2⅛" x 1⅝" aluminum box
Misc. control knob, screws, nuts, wire, solder, etc.

Carrier—Current Sentinel





The Sentinel (above) feeds signal through power line to the pickup unit (coil on top of radio at left).

By
MARTIN H. PATRICK

Low-cost pager uses a. c. power line for inter-station wiring.

HERE'S a monitoring unit that can keep you in direct contact with other members of your family in various parts of your home. Plug the "Carrier-Current Sentinel" into a receptacle in one room, tune in a small radio in another, and you can keep tabs on calls from the nursery, garage, attic, basement, workshop, or anywhere else nearby.

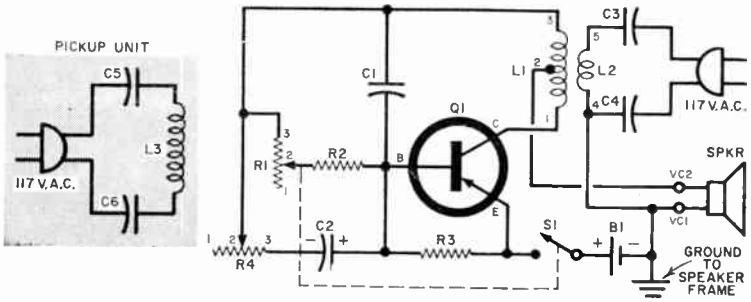
The Sentinel uses a small PM speaker as a microphone and feeds a modulated r.f. carrier into the a.c. wiring. The signal is passed along the wiring to a pickup unit which plugs into an a.c. receptacle and couples the r.f. signal from the power line to an ordinary AM radio.

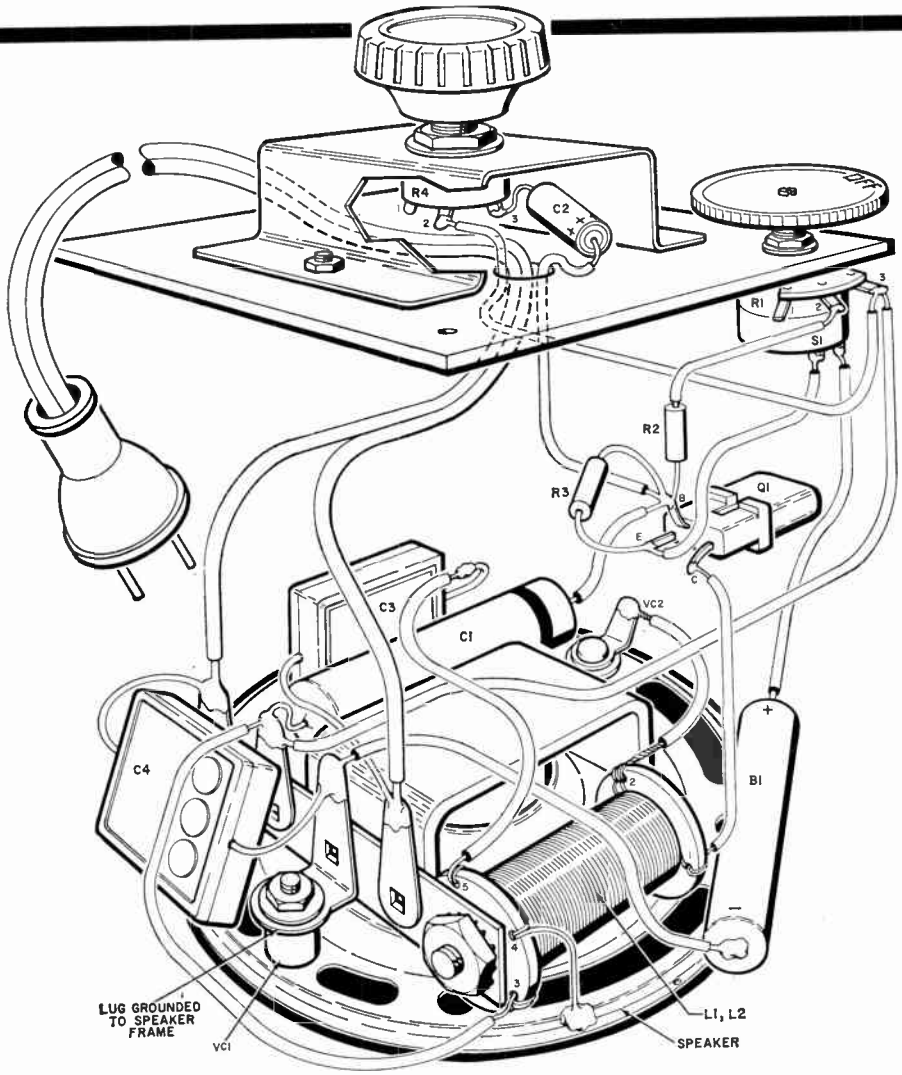
Despite the low power output of the Sentinel, the pickup unit enables even an inexpensive a.c.-d.c. radio to detect any signal the Sentinel will put out. Parts for both the Sentinel and the pickup unit should cost less than $10.00.

Construction. Coils *L1* and *L2* for the Sentinel are close-wound on a No. 8 brass bolt 1¾" long; ¾" fiber washers limit the winding space to ¾".

Start *L1* by winding 300 turns of No. 25 enameled wire on the bolt, tagging the beginning of the winding terminal *1*. When 300 turns have been wound, make a loop in the wire, label it terminal *2*, and wind an additional 300 turns in the same direction. Label the end of the second 300-turn winding terminal *3*, and you have completed *L1*. To hold the windings in place, pass the leads through holes in the fiber washers.

Schematic diagrams for Sentinel and pickup unit. Switch S1 can be on either R1 or R4.





Speaker frame serves as a support for most of Sentinel's components. In the model, voice-coil lug VC1 was removed and replaced with a machine screw and spacer to hold a four-terminal mounting strip.

PARTS LIST

B1—1.5-volt penlight cell
C1—0.1-μf., 50-volt capacitor
C2—50-μf., 10-volt electrolytic capacitor
C3, C4—.0015-μf., 500-volt mica capacitor
C5, C6—0.003-μf., 500-volt mica capacitor (for pickup unit)
L1—600 turns of #25 enamel-covered wire, center-tapped; scrambled-wound on 3/16" brass bolt, 1 1/4" long; length of coil, 3/4"
L2—20 turns of #25 enamel-covered wire wound over L1
L3—70 turns of #20 enamel-covered wire wound on broomstick handle (for pickup unit)
Q1—2N1265 transistor (Sylvania) or equivalent
R1—5000-ohm miniature potentiometer with switch S1 (Lafayette VC-27 or equivalent)
R2—470-ohm, 1/2-watt resistor
R3—10,000-ohm, 1/2-watt resistor
R4—500,000-ohm miniature potentiometer (Lafayette VC-37 or equivalent)
S1—S.p.s.t. switch (part of R1)
Spkr.—Miniature permanent-magnet speaker
Misc.—Line cords and plugs, fiber washers, wire, solder, etc.

Coil *L2* consists of 20 turns of No. 25 enameled wire wound on top of *L1*. Label its terminals *4* and *5* respectively, and pass them through additional holes in one of the fiber washers as shown above.

Wire the Sentinel as shown in the pictorial diagram, and be sure to use leads long enough so that the cover of the completed unit can be removed from time to time for battery replacement. When wired, the assembly can be placed inside a 3" x 3" x 1 1/2" plastic or wooden box and the cover

screwed in place; if size isn't too important, a small cigar box or similar wooden container will do.

The coil for the pickup unit (*L3*) is wound on a dowel stick ⅞" to 1" in diameter and approximately 5" long; an old broomstick was used in the model. Wind 70 turns of No. 20 plastic-covered hookup wire on the form, and pass the ends of the winding through two holes drilled through the ends of the dowel. Connect capacitors *C5* and *C6* in series with the leads, and solder the free ends of the capacitors to a line cord. House the pickup unit in a suitable wooden box.

Operation. Place the pickup unit on top of a broadcast radio in the listening room; to insure maximum pickup, make certain that the coil of the pickup unit is parallel to the loop antenna in the radio. Turn on the radio and tune it to the lowest unused frequency on the dial.

Now plug the Sentinel's line cord into an adjacent receptacle and turn the unit on. Set the modulation control about midway, whistle into the loudspeaker "mike," and turn the frequency control until you hear yourself on the radio. Talk into the Sentinel and adjust the modulation control for best sound. Next, unplug the Sentinel and plug it into a receptacle in the room you want to monitor, taking care not to upset the control settings.

Your Carrier-Current Sentinel is now set for receiving calls. Just talk into its miniature "mike," and the Sentinel will do the rest. -30-

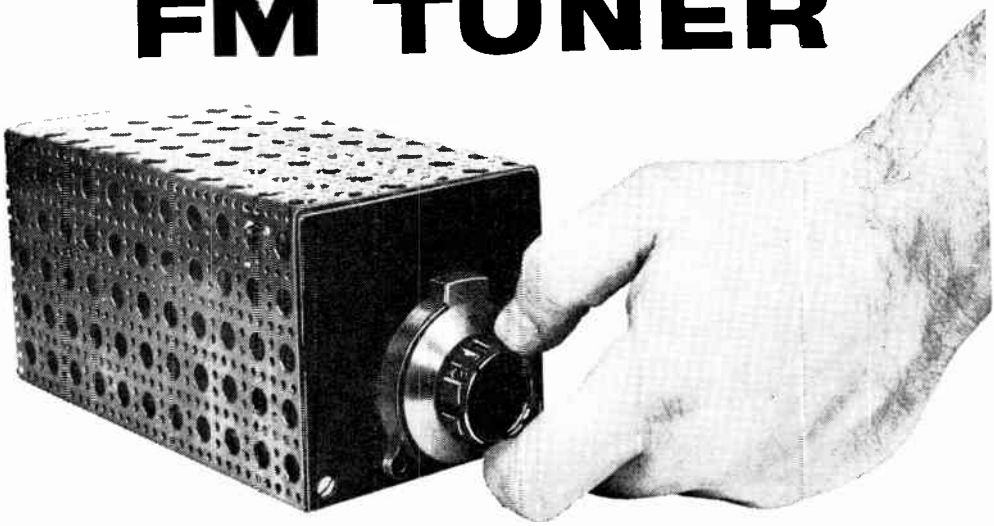
HOW IT WORKS

The heart of the Sentinel is a Hartley oscillator circuit (coil *L1*, capacitor *C1*, and transistor *Q1*) which develops an r.f. carrier. The center-tap of coil *L1* would ordinarily be connected directly to ground, but in this case the ground connection is made via the speaker voice coil. As a result, the output from the speaker collector-modulates (i.e., plate-modulates) the r.f. carrier.

Potentiometer *R1* adjusts the feedback to the transistor base and thus controls the carrier frequency; potentiometer *R4* controls the modulation level in the circuit. The oscillations in *L1* are induced in *L2* and coupled to the a.c. line through blocking capacitors *C3* and *C4*.

Coil *L3* in the pickup unit concentrates the signal on the line near the radio's antenna. The radio in turn detects the signal and broadcasts it over its speaker.

ONE-TUBE FM TUNER



This superregen circuit provides FM reception at low cost, yet combines features of more elaborate sets.

By ROBERT E. DEVINE, W6AVW

HERE'S a one-tube FM tuner that's inexpensive, easy-to-build, and remarkably good-sounding to boot. Naturally, the set's sensitivity doesn't compare with that of commercially available tuners, but it will pull in most stations within a range of approximately 10 miles. Parts for the tuner, including power supply, will cost approximately $11.

Because it's built around a superregenerative detector, the set is comparatively insensitive to pulse interference—auto ignition noise, for example. Another inherent characteristic of a superregenerative detector is its tendency to hang on to a signal; this gives the set a sort of automatic frequency control action.

Although the tuner circuit isn't much more complicated than some fancy crystal sets, bear in mind that its operating frequency is measured in *mega*cycles, not *kilo*cycles. A good many sets will get by with long, sloppy leads at broadcast frequencies, but things just won't perk at 100 mc. unless the wiring is as short and direct as possible. For this reason, it's best to follow closely the pictorial layout.

Construction. The tuner and power supply were assembled on a 3½" x 6½" x ½" piece of plywood. End pieces are 3½" x 3½" x ¼" plywood; the cover is a 10½" x 7" piece of perforated metal bent into a "U" shape. If you have trouble with body-capacity effects, try mounting a 3½" x 2½" piece of sheet metal on the back of the front panel to isolate tuning capacitor *C2;* ground the metal plate.

Since pins 2 and 5 on socket *SO1* were not needed in wiring, they were removed. The metal grounding post in the center of the socket was also removed and replaced with a wood screw to mount the socket on the board. A 4-40 nut placed under *SO1* acts as a spacer to keep the remaining pins from being pushed out flat as the socket is tightened down.

Choke *RFC1* was wound on a ¼" dowel, then coated with polystyrene dope to make it easier to handle. If you don't have No. 23 enameled wire on hand, but do have No. 22 or 24, use it instead. Choke *RFC2* isn't overly critical, either—any 7- to 10-mh. r.f. choke should be satisfactory.

The B+, ground, and heater leads are

terminated on a three-terminal mounting strip; *RFC2* and *L1* are soldered to brass screws driven into the plywood. The a.c. cord, the shielded audio output cable, and the 300-ohm twin-lead can be passed through holes in the rear panel; make these holes slightly undersized to grip the leads firmly.

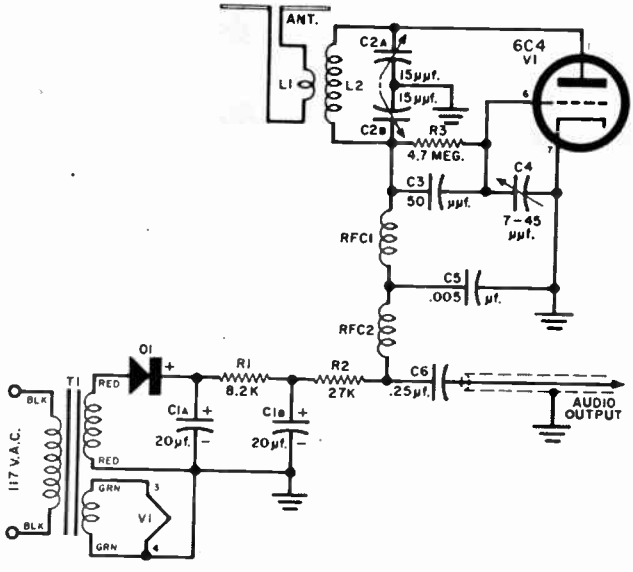
Note that transformer *T1's* mounting strap is grounded. One red lead from *T1* is soldered to a lug under one of *T1's* mounting screws; another lug is used under the other mounting screw. Be sure to scrape off the paint around *T1's* mounting holes to insure good electrical contact.

One last construction tip—don't fudge on the values of resistor *R3* and capacitors *C3* and *C4*. The total cost of these three parts is relatively small, and their values are quite critical. Capacitor *C3* must be a silver mica unit as specified.

Operation. With the a.c. power cord plugged in, an outside antenna attached (a TV antenna will work well), and the audio output lead plugged into an amplifier, you should hear either a hiss or a station. Now all you have to do is adjust *C4* or *L1* for best performance, and expand or compress *L2* so that the tuning capacitor covers the 88- to 108-mc. range.

Capacitor *C4* is properly set when its capacitance has been increased as much as possible with the detector still oscillating over the entire frequency range. With *C4* at maximum, the receiver will be dead over part or all of the FM band. Too tight a coupling between *L1* and *L2* will also stop the oscillation, but the coupling here should be as close as possible to bring in stations strongly and eliminate hiss. You can also try grounding one side of *L1;* make the connection permanent if it results in a stronger signal.

If you can't get stations on the high end of the band, unsolder *L2*, expand it slightly, re-solder it in place, and see if the high end of the band comes in. If it does not, repeat



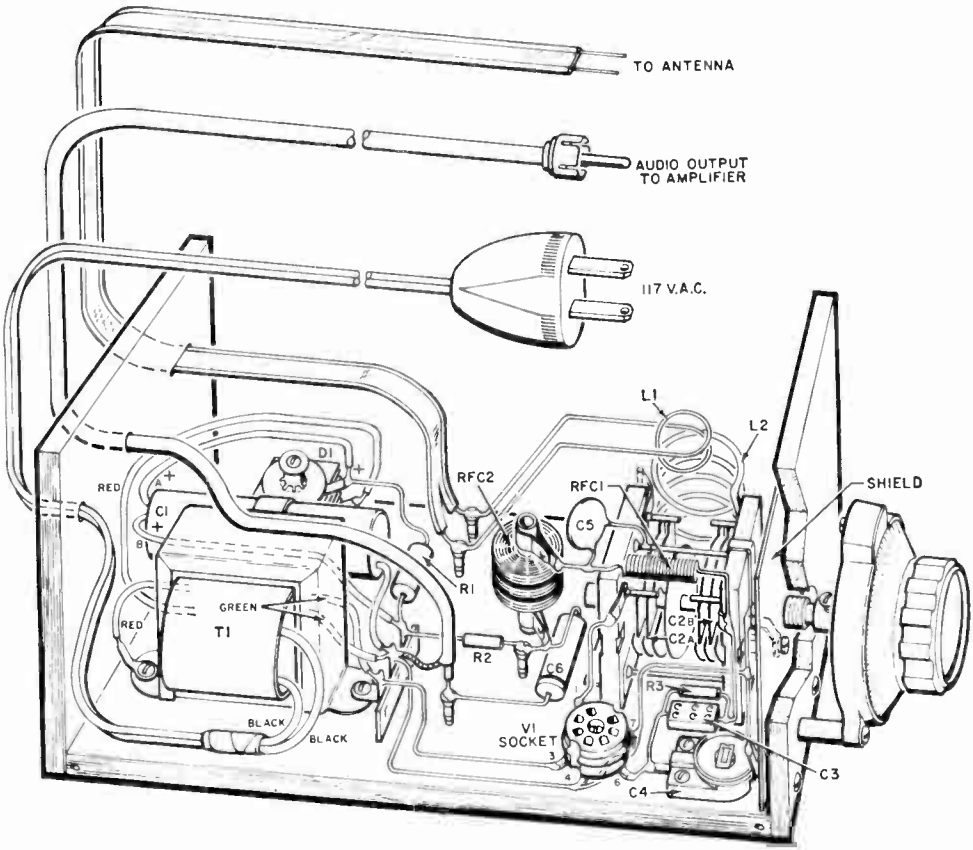
Circuitry of the FM tuner is extremely simple, as the schematic diagram shows. A single triode (V1) is connected in a superregenerative hookup; power for the tube is furnished by rectifier D1.

HOW IT WORKS

A single triode is used as a superregenerative detector in the familiar Colpitts circuit. Incoming signals from the TV or FM antenna pass through the 300-ohm twin-lead to *L1*. Since coils *L1-L2* act as a transformer, voltage is induced into *L2* with specific stations selected by tuned circuit *L2-C2*. The signal passes to the grid of *V1* through grid leak resistor-capacitor combination *R3-C3*. Since both grid and plate circuits of *V1* are tuned to the same frequency by *L2-C2*, oscillation takes place at that frequency.

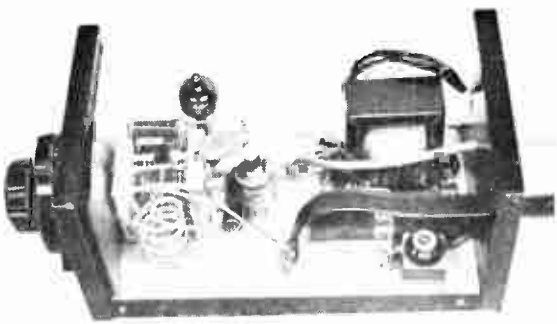
Because of the presence of *R3-C3*, oscillations occur simultaneously at another and lower frequency. This second or "quenching" frequency throws the detector in and out of oscillation at its main frequency some 20 to 30 thousand times a second. Since sensitivity in a regenerative detector is maximum when the detector is about to go into oscillation, throwing the detector in and out of oscillation at a ultrasonic rate results in sensitivity so great that thermal noise can be heard as a hiss between stations.

The a.f. component in the output from the detector is filtered by the r.f. chokes and capacitor *C5*, then fed to an external amplifier through d.c. blocking capacitor *C6*. Power for the detector is furnished by transformer *T1* working in conjunction with half-wave rectifier *D1* and filter *C1-R1*.

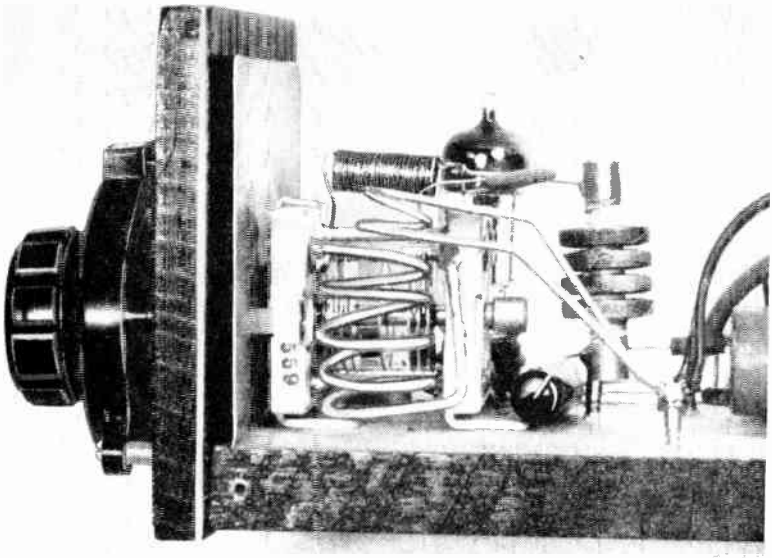


PARTS LIST

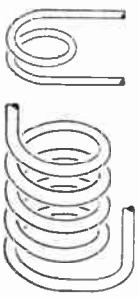
C1a/C1b—20-20 μf., 150-volt electrolytic capacitor
C2a/C2b—15-μμf. dual variable capacitor (Bud LC 1660 or equivalent)
C3—50-μμf. silver mica capacitor
C4—7-45 μμf. trimmer capacitor (Centralab Type 833 or equivalent)
C5—.005-μf. disc capacitor
C6—.25-μf., 400-volt capacitor
D1—50-ma., 130-volt selenium rectifier
L1—1½ turns of #14 enameled wire, ¼" long, ⅜" in diameter
L2—4½ turns of #12 enameled wire, ¾" long, ½" in diameter
R1—8200-ohm, 1-watt resistor
R2—27,000-ohm, ½-watt resistor
R3—4.7-megohm, ½-watt resistor
RFC1—30" length of #23 enameled wire wound on ¼" form
RFC2—8 mh. r.f. choke
S01—7-pin miniature socket
T1—Power transformer; primary, 117 volts a.c.; secondaries, 125 volts at 15 ma., 6.3 volts at 0.6 amp. (Stancor PS-8415 or equivalent)
V1—6C4 tube
1—3½" x 6½" x ½" sheet of plywood
2—3½" x 3½" x ¼" sheets of plywood
1—10½" x 7" piece of perforated metal
Misc.—Tuning knob, a.c. cord and plug, shielded wire and phono pin plug, 300-ohm twin-lead, three terminal mounting strip, wire, solder, etc.



Parts are assembled in breadboard fashion on a 3½" x 6½" plywood base; slightly undersized holes in rear panel hold 300-ohm twin-lead, line cord, and audio output cable securely. Shield behind front panel is optional.



Coils L1 and L2 are hand-wound from No. 14 and No. 12 wire respectively and held in place by their own leads. Although the coils should be as close together as possible, they should not touch each other. Spacing of L2 can be varied until the tuner covers the entire 88-108 mc. FM band.



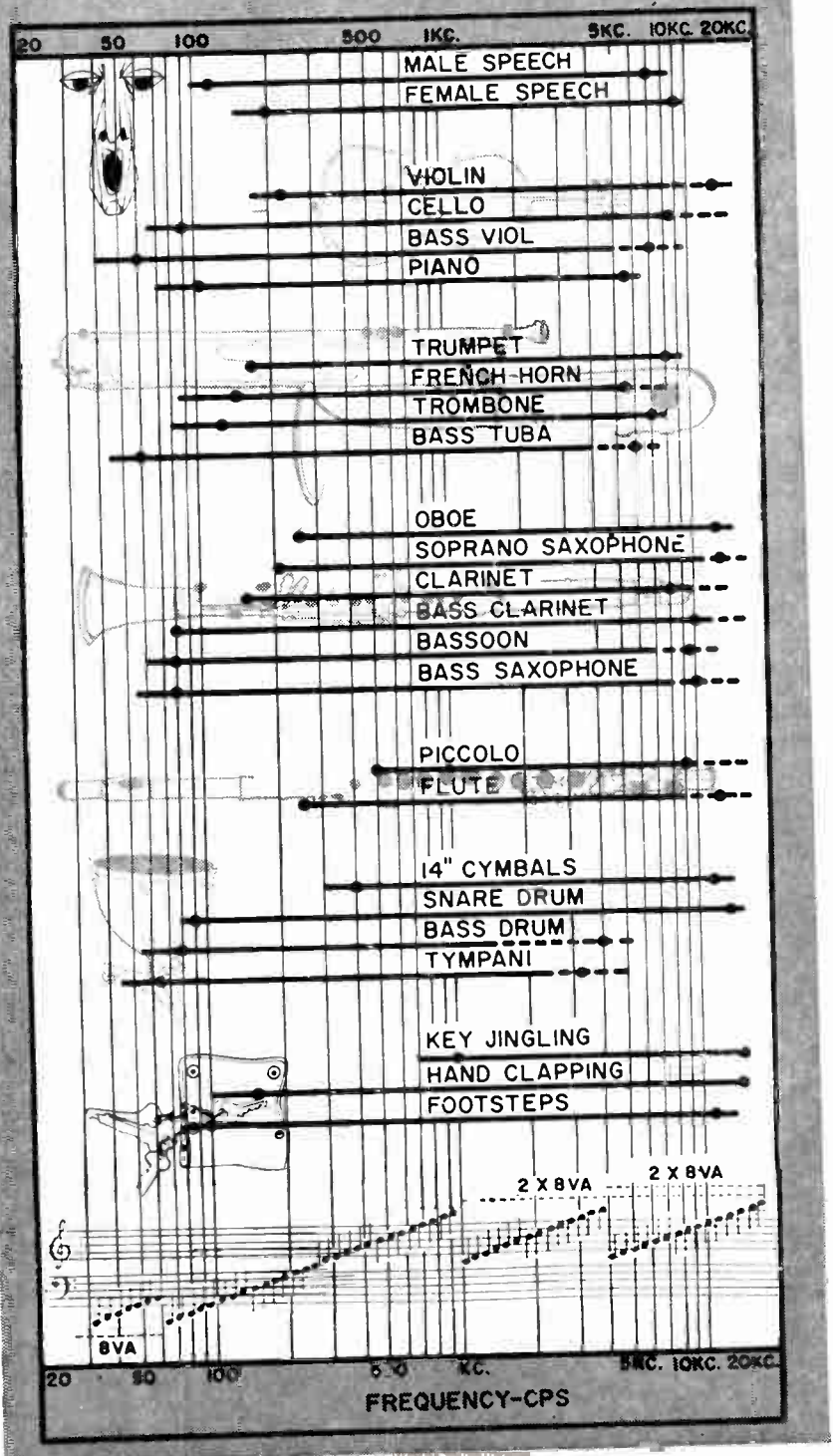
this procedure until it does. On the other hand, if the tuning capacitor becomes fully enmeshed before you get to the lower-frequency stations, unsolder *L2* as above, but compress it before replacing it. If this doesn't work, add one turn to the coil—you'll have to make a new coil to do so, but this should take only a few minutes.

Remember that you are not working on the AM broadcast band with this little tuner, but you are trying to receive 100 mc. signals. Therefore, you must use short, direct leads on everything but the power supply circuits. It is best to follow the layout shown in the photographs and in the drawing just as closely as you possibly can so you will not be troubled with any parasitic oscillations.

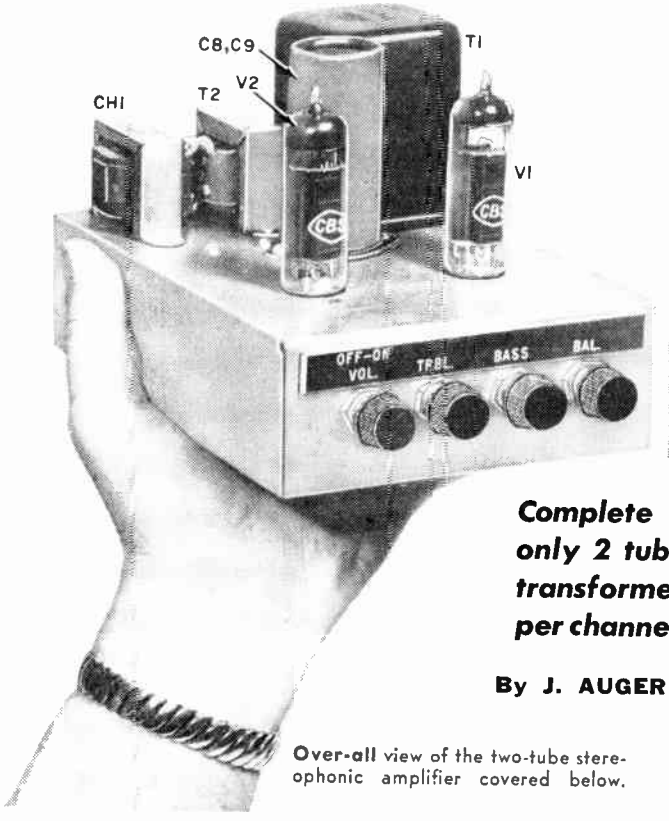
Prepare to be pleasantly surprised if you have a hi-fi rig to feed the tuner into. Many people are astounded at the quality of sound that emanates from this ultra-simple unit. In fact, you're likely to be swamped with friends by the bushel who want you to whip up one for them. —30—

Audible Frequency Ranges

The chart below shows the audible frequency ranges for common musical instruments, speech, and noise. Actual tonal ranges are shown by the solid lines, while accompanying noise range is shown dashed. Points indicated are cut-off frequencies detectable in most tests. Corresponding musical scales are below.



Compact Two-Tube Stereo Amplifier



Over-all view of the two-tube stereophonic amplifier covered below.

Complete stereo amplifier uses only 2 tubes, requires no power transformer. Delivers 3.5 watts per channel, and includes controls.

By J. AUGERI and D. CHRISTIANSEN,
CBS Electronics

THIS compact, lightweight (less than four pounds) stereo amplifier uses just two tubes and is built on a chassis measuring only 5" x 7" x 2". With the proper choice of stereo cartridge it provides on the order of 3.5 watts per channel. Although the unit should not be compared with higher power, hi-fi amplifiers, it does do a good job where simplicity and compactness are required. Versatile controls include "on-off" and master volume, balance, bass, and treble controls.

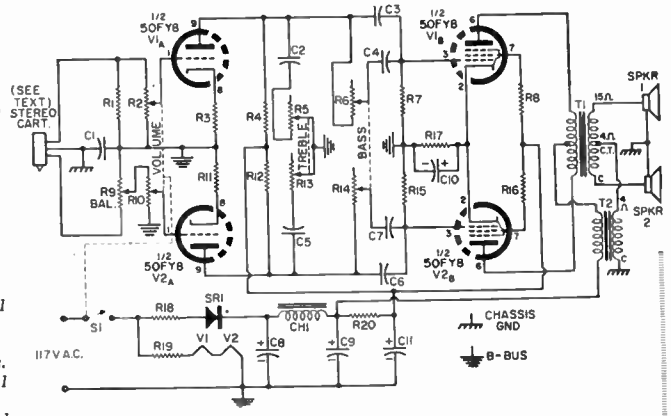
The key to the unit's compactness is in the use of the CBS-Simplex circuit developed by CBS Laboratories of Stamford, Conn. This circuit saves money as well as space. Thus, in addition to the two tubes already mentioned, the builder needs only a pair of inexpensive output transformers and a handful of resistors, capacitors, and miscellaneous parts.

Although the CBS-Simplex circuit has been adequately described elsewhere,[1, 2] the reader may find the following review of its operation interesting and helpful. The schematic diagram shows the basic push-pull circuit with an additional output transformer (*T2*) connected in series with the "B+" centertap of the push-pull transformer (*T1*). This second transformer, plus the symmetrical connection of the speakers with respect to the *transformer combination*, are the important features of the circuit.

What the circuit accomplishes, in effect, is the selective amplification of two separate components of the total stereo signal —the "major" component by push-pull action and the "minor" component by single-ended action. Beyond the stylus itself, the total signal does not exist as a single measurable entity. It does exist, however, at the grids of *V1* and *V2*, as two separate signals proportional to the right- and left-channel information picked up by the stylus and, as we shall see, at the output transformers in somewhat different form.

If the instantaneous values of the signals at the input grids are R (right) and −L (left), respectively, then a signal proportional to R *plus* L is amplified *via* the push-pull action of the circuit and a signal proportional to R *minus* L is amplified by its single-ended action. Herein lies the se-

Complete schematic diagram and parts listing for the two-tube stereo amplifier.



PARTS LIST

R1—2 megohm, ½ w. res.
R2, R10—2 megohm, ½ w. dual audio-taper pot
R3, R11—1800 ohm, ½ w. res.
R4, R12—220,000 ohm, ½ w. res.
R5, R13—500,000 ohm, ½ w. dual linear-taper pot
R6, R14—1 megohm, ½ w. dual audio-taper pot
R7, R15—470,000 ohm, ½ w. res.
R8, R16—1200 ohm, ½ w. res.
R9—2 megohm, ½ w. audio-taper pot
R17—75 ohm, 2 w. res.
R18—22 ohm, 2 w. res.
R19—120 ohm, 4 w. res.
R20—200 ohm, 1 w. res.
C1—.1 μf. paper capacitor
C2, C5—.005 μf. paper capacitor
C3, C6—.0005 μf. paper capacitor
C4, C7—.1 μf. paper capacitor
C8—100 μf., 150 v. elec. capacitor
C9—80 μf., 150 v. elec. capacitor
C10—100 μf., 25 v. elec. capacitor
C11—60 μf., 150 v. elec. capacitor
CH1—1.5 hy., 200 ma. filter choke
S1—S.p.s.t. switch (ganged to R2, R10)
SR1—Silicon diode (1N1081)
Stereo Cart.—Columbia SC-2 stereo cartridge or equiv. (see text)
Spkr. 1, Spkr. 2—High-efficiency type speaker, 4-ohm v.c.
T1—Output trans. 5000 ohms to 15, 8, 4 ohms @ 18 w. (Stancor A-3872 or equiv.)
T2—Output trans. 2000 ohms to 4 ohms @ 5 w. (Stancor A-3876 or equiv.)
V1, V2—50FY8 tube (CBS)
4—Phono input jacks (RCA type)
1—5" x 7" x 2" chassis

cret of the circuit. With proper phasing of the cartridge terminal voltages, the "R plus L" signal is directly related to the lateral component of stylus motion. Because this lateral component determines the main qualities and power of both channels, it is logically the component we want to amplify *via* push-pull action.

The other ("R minus L") component, although important, is less critical by virtue of its being related to the vertical component of stylus motion and it is amplified "single-endedly." This selective amplification of the two portions of the stereo signal, incidentally, enables the builder to use a parallel or single-ended transformer (*T2*) that is even smaller and less expensive than the push-pull transformer (*T1*).

The individual channel information is recovered at the speakers by connecting them as shown. Thus, if the voltages at the secondaries of *T1* and *T2* are, for example, 10 (R+L) and 5 (R−L), respectively, the actual outputs can be computed by tracing the connections to each speaker. They would be, for the right channel: 5 (R−L) + ½ × 10 (R+L) or 10R and for the left channel: 5 (R−L) − ½ × 10 (R+L) or −10L.

Thus we note that the right and left channels are completely symmetrical with respect to both quality and power. The minus sign at the left channel output simply indicates opposite phase, as did the minus sign at the left channel input. It means that the leads to one speaker must be reversed in order to get the two speakers to operate in-phase.

The cartridge used by the authors is the Columbia SC-2. This commercially available cartridge is manufactured specifically for use with the CBS-Simplex circuit. It is identical to the Columbia SC-1 except for phasing of terminal voltages. Although other 3-terminal cartridges *cannot be used* with this circuit, 4-terminal cartridges having a sufficiently high output can be used by properly phasing their output voltages externally (reversing leads to one side).

Construction Details. The amplifier is built around a pair of newly introduced audio tubes (CBS 50FY8's). Each combines a high-mu triode and a power pentode in a single envelope. Plate and screen voltage required is only about 125 volts and thus a single silicon rectifier can be used for the d.c. supply.

The builder will find it convenient to first mount all the components with the ex-

ception of the controls. The 1N1081 silicon diode is mounted in a diode holder which is screwed to the side of the chassis. The heaters should be wired first, with the d.c. supply next. For low hum, care should be taken to wire the heaters so that pin 4 of each tube is toward the ground side and the heaters are on the ground side of *R19*, the 120-ohm, 4-watt resistor. Incidentally, *C8*, *C9*, *C10*, and *C11* can be a multiple-section electrolytic, but in the amplifier shown in the photographs, *C10* and *C11* are actually separate capacitors.

Other connections are then completed and finally the controls are mounted and wired. Shielded wire is used between the input jacks and the controls. The shielded wire should be grounded to the chassis at the input jack end only to minimize hum pickup.

The balance control, *R9*, is a single 2-megohm audio-taper pot on one side of the amplifier only. This was done in order not to sacrifice any gain and means that the tubes may have to be swapped, initially, so that the stronger tube is on the same side as the balance control. Master volume, bass, and treble controls are dual half-watt pots and the "on-off" switch is ganged to the master volume control.

The builder will probably want to experiment with various speakers. Of course, they should be of the conventional high-efficiency type. For best results they should be identical and should have a voice-coil impedance of 3-4 ohms. The authors used a pair of Columbia AX130's, each having a 12-inch woofer and two 4-inch tweeters in a 4.5 cubic foot cabinet.

One speaker is connected to the common (black) lead and the other to the 15-ohm tap (green lead) of the push-pull transformer secondary. One side of the parallel transformer secondary is grounded to the chassis and the other is connected to the center tap (brown lead) of the push-pull transformer.

Speakers must be connected to operate in-phase. Phasing can be checked just as it is with conventional separate-channel stereo amplifiers. Note that this check should be made with signals applied to the input of the amplifier. If the speaker phasing is checked at the loudspeakers themselves, connections should be made in such a way that they are oppositely phased. This is required since the polarity of the signals applied to the speakers in normal operation is of opposite phase rather than being in-phase.

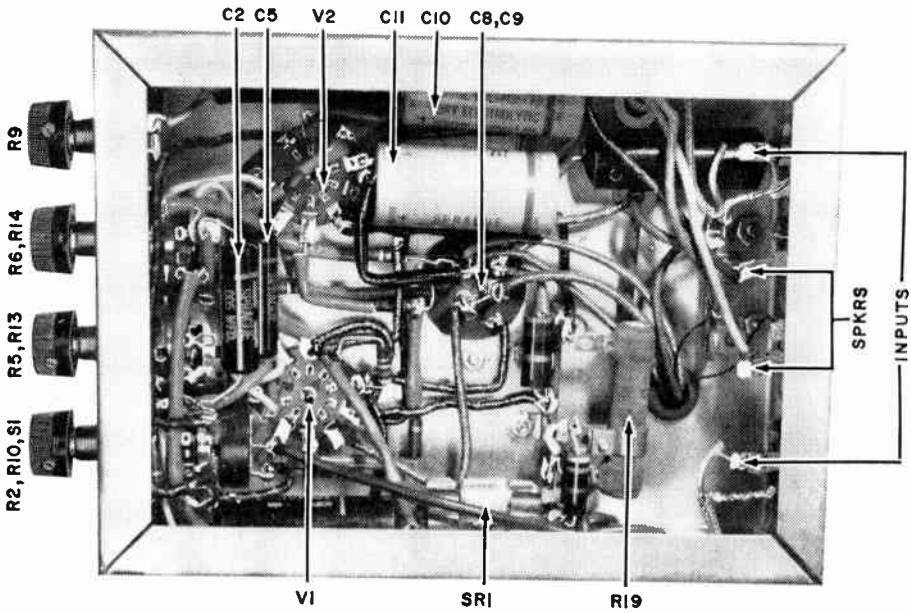
The system will provide amazingly good quality stereophonic sound at power levels entirely adequate for the average-size living room or den.

REFERENCES

1. Crowhurst, N. H.: "Single Push-Pull Stage for Both Stereo Channels," Radio & TV News, January, 1959.

2. Bauer, Hollywood & Maerkle: "A Two-Way Stereophonic Amplifier," Audio, October 1958.

Under-chassis view of the amplifier showing components.



PART 4

Test Equipment

Direct Reading Frequency Meter 118
Modulate Your Grid-Dip Meter 120
Build a Dual-Meter Transistor Tester 122
Citizens Radio Tune-Up Meter Probe 126
Build an R.F. Power Meter 128
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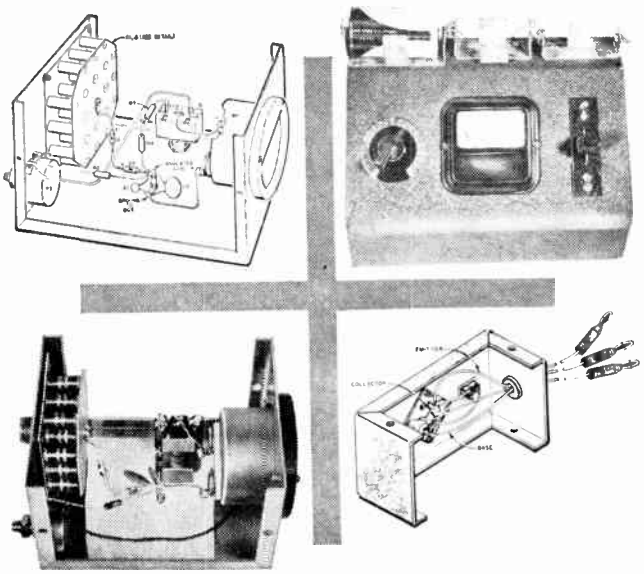
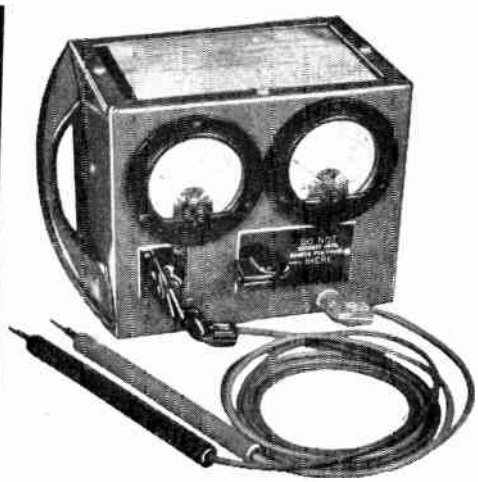
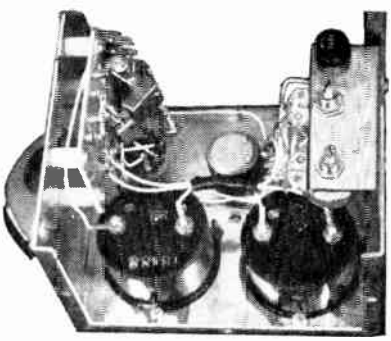


Direct Reading Frequency Meter





This handy gadget measures frequencies from 20 to 5000 cps.

By ROBERT J. D'ENTREMONT

HERE IS a direct-reading frequency meter that requires no tubes or batteries. A handy gadget for the workbench, it will measure frequencies between 20 and 5000 cps at any voltage between 15 and 200 volts, and will indicate the frequency directly on a meter scale which, once calibrated, needs no further adjustment.

You can build the unit in a 6"x5"x4" aluminum utility case and arrange the components to your own liking. Calibration potentiometers *R3* and *R4* should be recessed behind the panel to prevent them from being turned after the instrument has been calibrated.

Calibration. An audio generator having an accurate range of at least 20 to 5000 cps and an output of 15 volts or more will be needed for the initial calibration of the frequency meter.

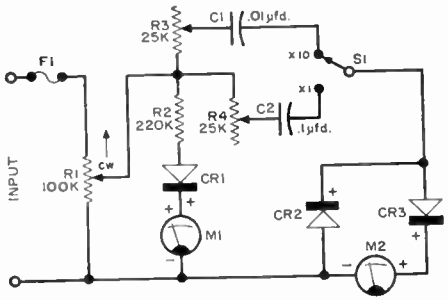
First, turn potentiometer *R1* fully counterclockwise and set selector switch *S1* to the "X1" position. Now connect the audio generator output to the frequency meter input. The generator should be set for 15 or more volts output at 500 cps. Adjust *R1* until meter *M1* reads half-scale, or 25 microamperes. (As frequencies or voltages are shifted, *M1* may go off its center scale reading. If it does, use *R1* to reset *M1* to a center scale reading.)

Next, adjust *R4* until meter *M2* reads full scale (1 ma.). Progressively decrease the frequency as follows: 500, 400, 350, 300, 250, 200, 170, 150, and in steps of 10 cps down to 20 cps. Keep a record of *M2*'s reading at each frequency.

Repeat the above procedure with *S1* in the "X10" position. Set the generator to 5000 cps and set *R3* for a full-scale (1-ma.) reading of *M2*. Decrease the frequency as follows: 5000, 4000, 3500, etc., as was done for the lower scale. Keep *M1* at center scale at all times.

Now the scales should line up for all frequencies in the ratio of 1 to 10; for example, 400 cps and 4000 cps should be at the same point on the meter scale. If they do not line up, it means that *C1* does not

Polarity of the meters and diodes must be observed. For reasons of economy, a 1-ma. meter could be used for M1, instead of the 0-50 μamp. meter specified in the parts list, and an 11,000-ohm resistor for R2. In this case, R1 would have to be adjusted for an input level reading of .5 ma. on M1 for all measurements.



have exactly one-tenth the capacity of *C2*. To correct this situation, either add or remove capacitance to change *C1* slightly until the scales agree.

After recording the relationship of ma. to frequency, a new meter scale can be lettered, or a record of current vs. frequency may be pasted on the instrument case. Letter the scale from "0" to "500" and mark switch *S1* showing the "X1" and "X10" positions. If you wish, you can also attach operating instructions to the case.

Operation. Set switch *S1* to "X10." Be sure to rotate potentiometer *R1* fully counterclockwise. Connect the leads from the input terminals to the unknown voltage and frequency source, and rotate *R1* slowly clockwise until *M1* reads 25 microamperes. If the meter needle of *M2* is above 50 on the scale, that reading multiplied by 10 equals the frequency in cps.

If the meter reads below 50, the frequency under test is less than 500 cps and you can use the "X1" scale. In this case, set *S1* to "X1," readjust *M1* to 25 μamp., and then read the frequency directly on meter *M2*. —30—

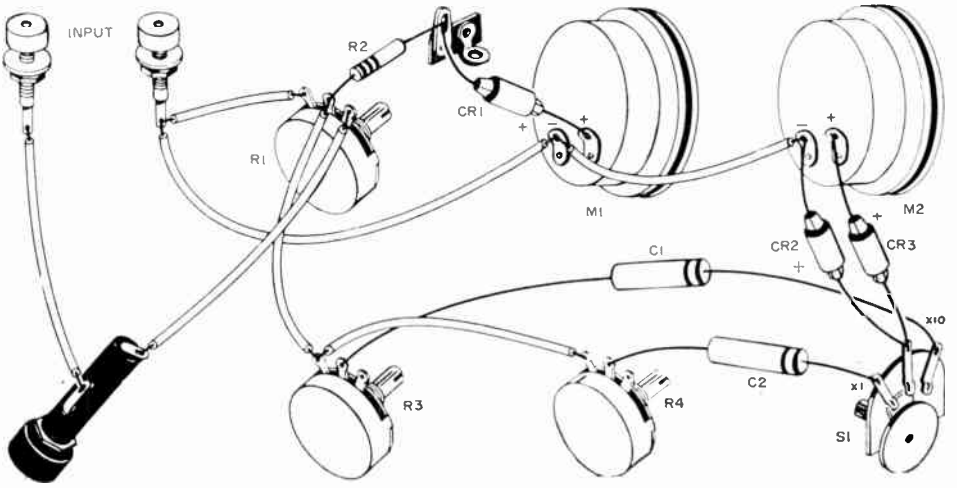
PARTS LIST

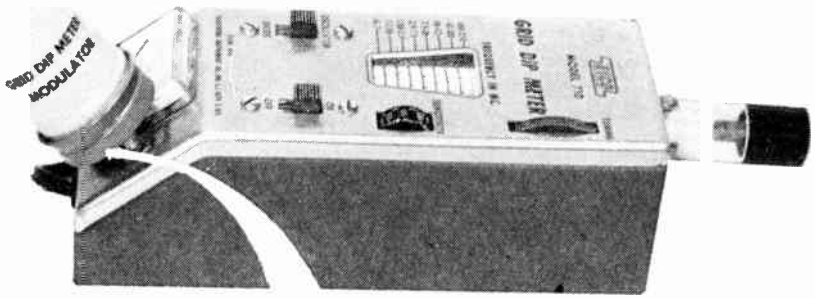
C1—.01-μf., 400-volt capacitor
C2—.1-μf., 400-volt capacitor
CR1, CR2, CR3—1N34A diode
F1—⅛-amp. 3AG fuse, and holder
M1—0-50 μamp. d.c. meter
M2—0-1 ma. d.c. meter
R1—100,000-ohm, 2-watt wire-wound potentiometer
R2—220,000-ohm, ½-watt resistor
R3, R4—25,000 ohm potentiometer
S1—S.p.d.t. rotary switch
1—6" x 5" x 4" aluminum utility case
Misc. test lead wire, tip jacks, knobs, hardware

HOW IT WORKS

Input level indicator meter *M1*, in conjunction with *R1, R2 and CR1*, serves to set a standard reference level. The actual reading of *M1* is not critical provided the same setting is used for the initial calibration and all subsequent readings.

When an alternating voltage of constant amplitude and waveform is impressed upon capacitor *C1* or *C2* (depending upon the scale being used), the current through the capacitor is directly proportional to the input frequency. If the frequency is increased, the current through the capacitor to diodes *CR2* and *CR3* increases proportionately. The d.c. output of the diodes is read by meter *M2*, which indicates the frequency.

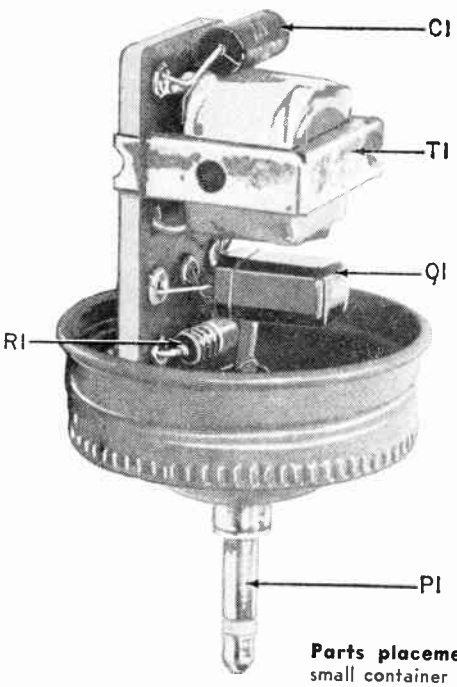




MODULATE YOUR GRID-DIP METER

. . . with this easy-to-build plug-in accessory.

By R. L. WINKLEPLECK

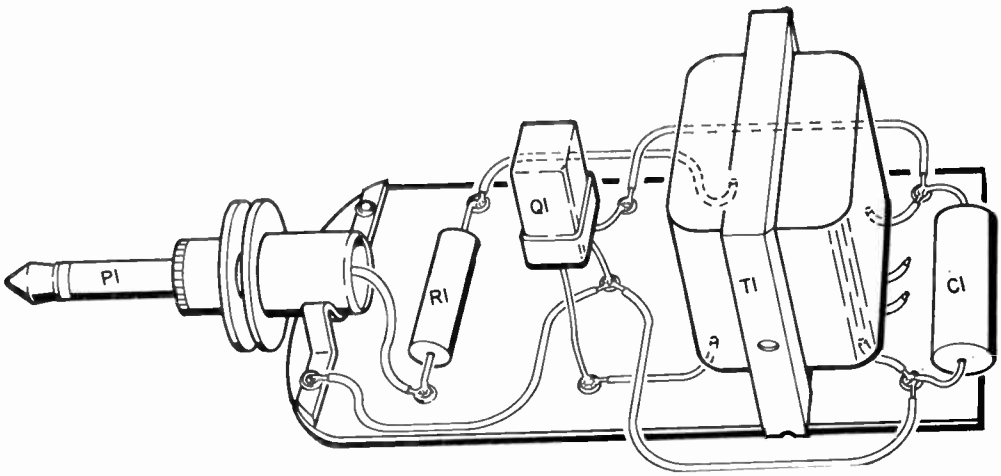


MOST EXPERIMENTERS who have used a grid-dip meter (GDM) as a signal generator know that it suffers from one major weakness in this application: the r.f. signals produced are unmodulated. It's difficult to use a GDM to check a receiver by ear, since no modulation of the r.f. signal from the GDM means no audio from the speaker of the receiver under test. Lack of a modulated output makes it virtually useless for alignment purposes, too.

But modulating your grid-dip meter is easy with the handy accessory shown here. It plugs into the phone jack on the GDM and requires no changes in the meter's circuitry. Plug it in, and your GDM is instantly modulated. Unplug it, and your GDM is precisely as it was before.

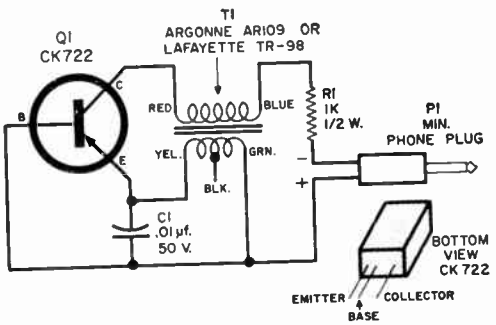
The modulator draws all its power from the meter, and its modulation frequency can be varied by adjusting the GDM's sensitivity control. This plug-in accessory

Parts placement is not critical. Any small container can be used to house the modulator. The phone plug should match the phone jack on the grid-dip meter.



HOW IT WORKS

The modulator is a one-transistor feedback oscillator which operates without a battery and is driven by current in the grid circuit of the GDM. Transformer *T1* provides audio feedback between the collector and emitter circuits of the transistor. Capacitor *C1* tunes the emitter circuit to the frequency of oscillation, and resistor *R1* limits current surges. The unit acts as a grid modulator by varying the GDM grid current at an audio rate.



Various transistors and transformers can be substituted in the GDM modulator circuit. Changing the value of the capacitor will vary frequency of oscillation.

will work with almost every grid-dip meter on the market that has a phone jack. And you can build it in one evening for less than three dollars.

Construction. The author's model was built in a 35-mm. film can. Any small container will do, but choose one small enough to clear the controls and switches on the grid-dip meter. Cement the miniature phone plug to the lid of the can. If your GDM has a standard-size phone jack, use a mating plug and mount it on the container with a nut.

All other components of the modulator are mounted on a ¾" x 1½" piece of perforated phenolic board attached to the underside of the lid. Component arrangement is not critical. Complete all wiring before the circuit board is attached to the lid of the can. Check the schematic or instruction manual of the grid-dip meter before wiring the phone plug. Polarity at the GDM phone jack must be observed or the modulator will not oscillate.

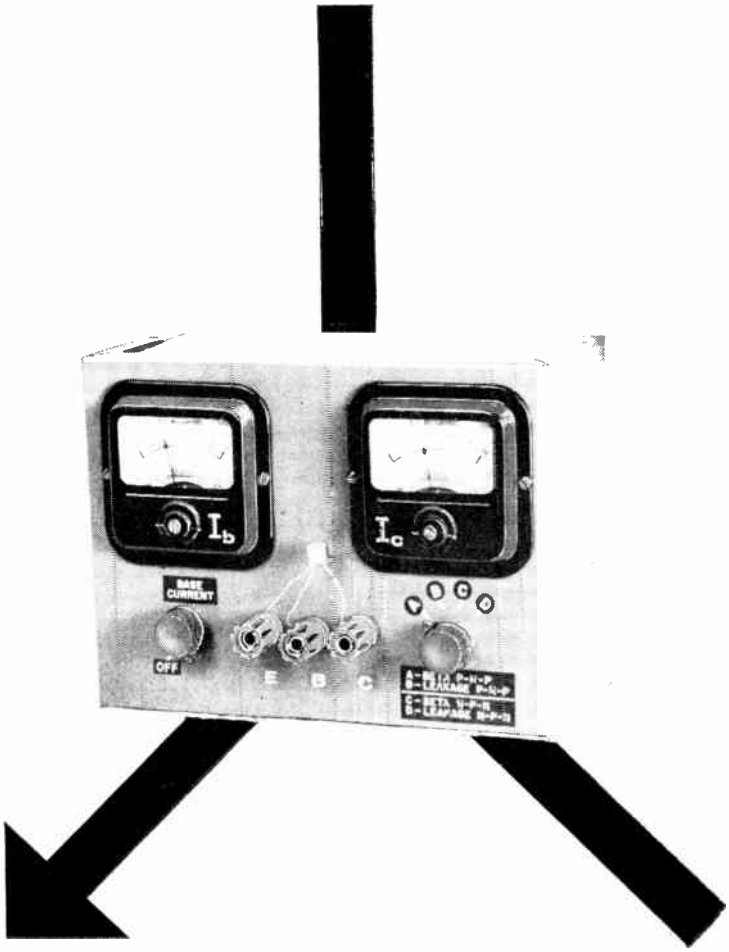
Another transistor can be substituted for the CK722 used here, but the frequency of oscillation may vary. The value of capacitor *C1* will also affect the frequency. If you use a transformer other than one of those indicated on the schematic diagram, the circuit may refuse to oscillate; in this case, try reversing the leads to either the primary or secondary of the transformer.

Operation. Plug the modulator into the phone jack of the grid-dip meter, and place the GDM near the receiver antenna or i.f. circuit. Adjust the meter to the frequency of the circuit under test.

Now position the GDM sensitivity control for the desired audio tone and modulation level. You'll find that the frequency of oscillation varies with the voltage at the phone jack. The author's model oscillates in the range from 100 to 1000 cps.

When you want to go back to normal grid-dip meter operation, simply unplug the modulator.

—30—



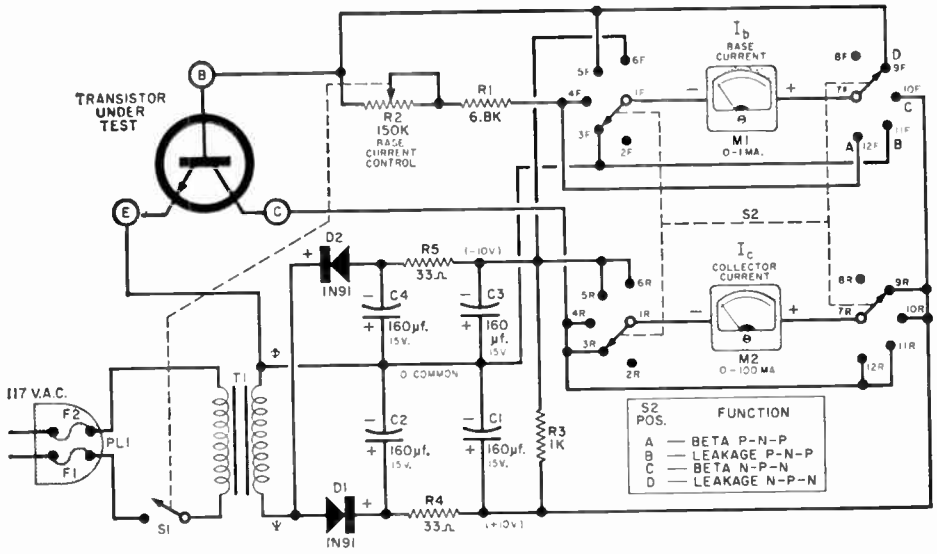
Build a Dual-Meter Transistor Tester

You can check both audio and power transistors with one easy-to-operate unit.

By
R. J. SHAUGHNESSY

SOMETIMES you'll finish building a transistorized project and find that it doesn't work. It's easy enough to recheck your wiring, but if you do and the unit still doesn't work, then what? Were the transistors good before you put them in the circuit? Were they burned out accidentally? It's obvious that you need a transistor tester to check the transistors before you wire them into the circuit and to check them again if the circuit stops working.

This tester measures the two important characteristics of almost all audio and power transistors: current gain (*Beta*) and collector-to-base leakage (I_{co}). Only transistors which have a 5-ma. maxi-



Transistor tester base current control R2 should be wired so that maximum resistance is obtained when ganged switch S1 is open.

mum collector current cannot be tested with this unit; see the manufacturer's data for special testing techniques for these low-current jobs.

Two meters are built into the tester to allow the base current and the collector current to be monitored simultaneously under various bias settings. This monitoring feature enables a transistor to be tested under actual circuit load conditions.

For maximum flexibility, no sockets were incorporated in the tester proper. The transistor under test is simply connected by its leads to the tester terminals. An adapter which plugs into the tester's binding posts can be built which will accommodate the various types of power and audio transistor sockets.

Parts used in the tester and optional adapter are not critical. With all new components, cost of the tester is about $15.

Construction of the tester is begun by mounting all the components directly on the cabinet. Before mounting function switch *S2*, crimp all jumper leads to the switch terminals. After the switch is mounted, connect and solder the remaining leads to it.

The transistor tester adapter can be built into the smallest Minibox that will accommodate a standard three-lead transistor socket (in-line or circular type) and a power transistor socket. When a transistor

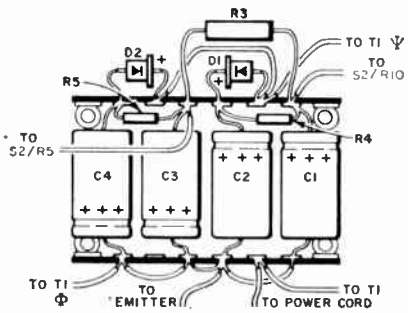
TESTER PARTS LIST

C1, C2, C3, C4—160-μf., 15-volt capacitor
D1, D2—1N91 germanium diode (Sylvania)
F1, F2—½-amp. 3AG fuse (to fit PL1)
M1—0-1 ma. meter (Shurite 950-9300Z)
M2—0-100 ma. meter (Shurite 950-9307)
PL1—Fuse plug (El-Menco EL-32)
R1—6800-ohm, ½-watt resistor
R2—150,000-ohm potentiometer (IRC Q13-328)
R3—1000-ohm, 1-watt resistor
R4, R5—33-ohm, ½-watt resistor
S1—On-off switch mounted on rear of R2 (IRC 76-1)
S2—Four-pole, four-position rotary switch (Centralab PA-1013)
T1—6.3-volt filament transformer (Triad F-13X)
1—7" x 5" x 3" Minibox (Bud CU-2108A)
3—Five-way binding posts
2—Pointer knobs
2—Six-lug terminal strips

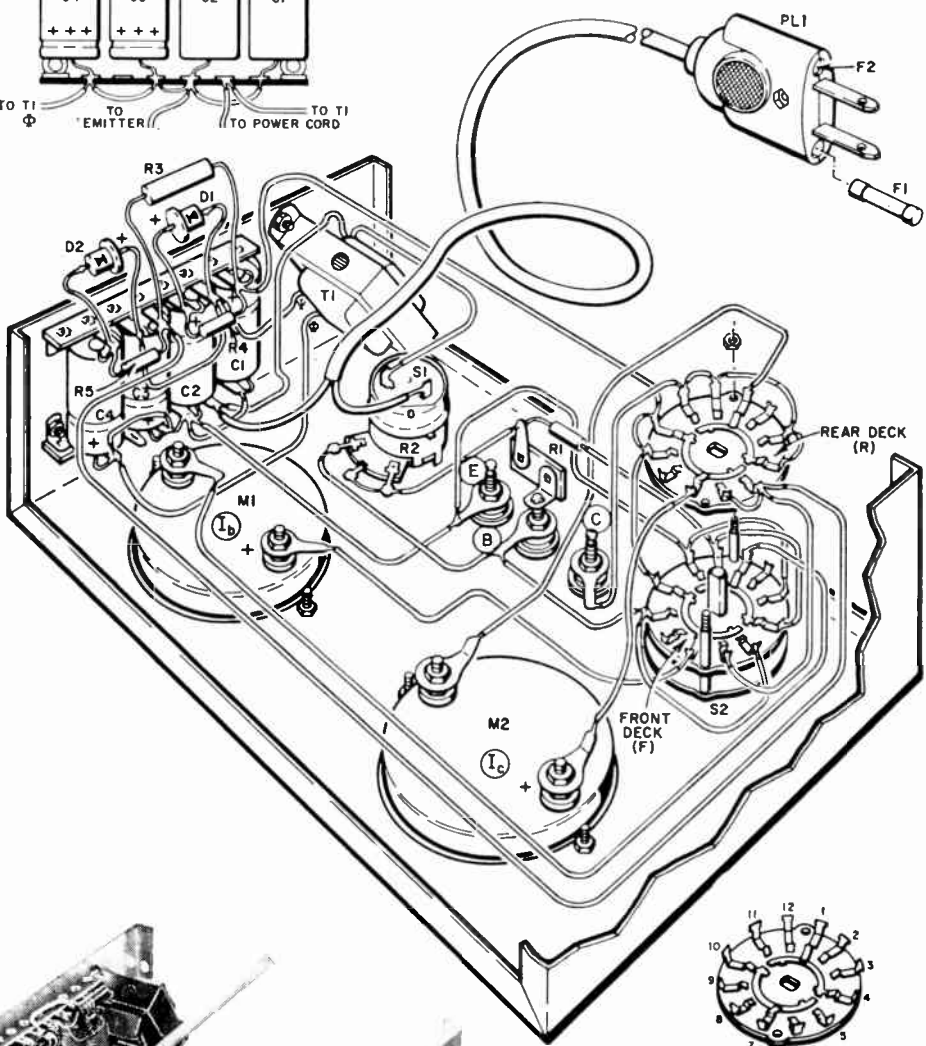
is being tested, the adapter's banana plugs (which are connected to the appropriate pins on the transistor sockets) plug into the tester's universal binding posts.

Testing for leakage is simple. Rotate function switch *S2* to *Leakage N-P-N* or *Leakage P-N-P*, depending on the transistor in question. Connect the transistor base lead to the tester's emitter binding post. Then connect the transistor collector to the collector binding post. Leave the transistor emitter lead unconnected. (The transistor emitter is left unconnected for all leakage measurements.) Now turn on the tester by advancing the *Base Current* potentiometer (*R2*). If the 0-100 ma. collector current meter (*M2*) is not deflected, the leakage current is within acceptable limits.

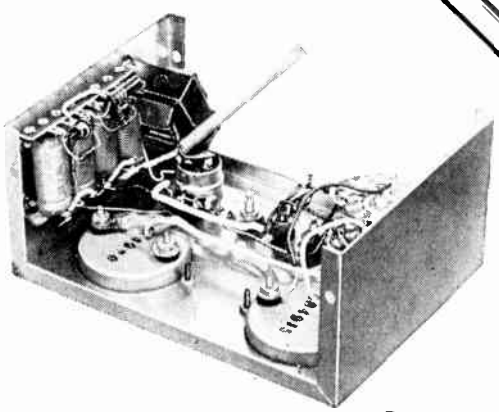
You can safely measure the exact leak-



Observe polarity of diodes and capacitors in tester power supply detail (left).

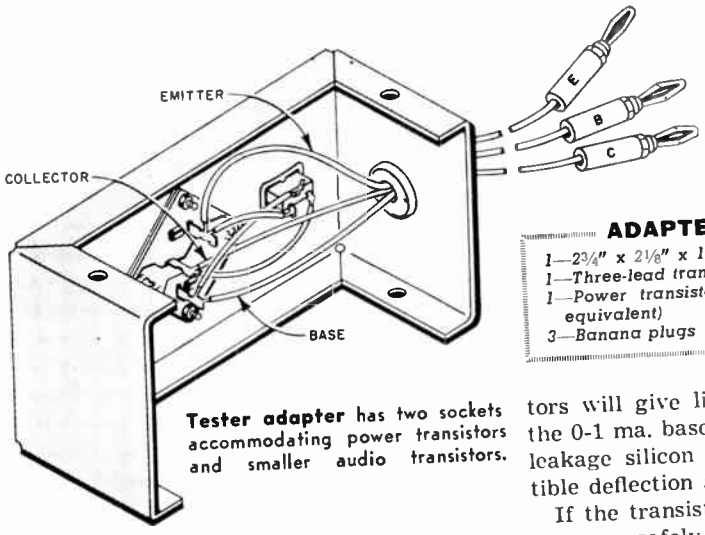


S2 FRONT AND REAR DECK DETAIL



Two-wafer ganged function switch is used in tester as shown in pictorial diagram above. Both wafers are identical. Note that pins two and eight are not used.

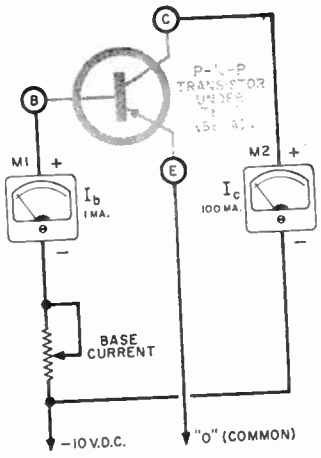
Power cord of tester is led through grommet in mating half of Minibox before soldering it in place.



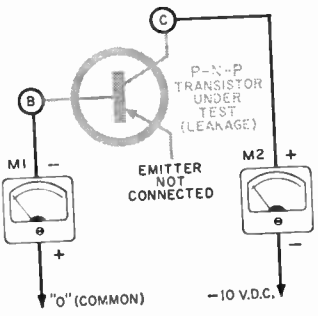
Tester adapter has two sockets accommodating power transistors and smaller audio transistors.

ADAPTER PARTS LIST

1—2¾" x 2⅛" x 1⅝" Minibox (Bud CU 2100A)
1—Three-lead transistor socket
1—Power transistor socket (Motorola MK-10 or equivalent)
3—Banana plugs



Current gain (Beta) test for n-p-n transistors is identical to p-n-p test shown in simplified schematic but polarities of meters and power source are reversed by switching S2.



Leakage test effectively puts two meters in series with transistor as shown in simplified schematic. Polarities for n-p-n transistors are reversed as in Beta test.

age current on the more sensitive 0-1 ma. base current meter (*M1*). Turn off the tester and reconnect the transistor base and collector leads to the corresponding tester binding posts. Do *not* connect the emitter lead; keep the function switch in the "leakage" position. When you turn on the power, you'll find that most transistors will give little—if any—deflection of the 0-1 ma. base current meter. Some low-leakage silicon units will give no perceptible deflection at all.

If the transistor passes the leakage test, you can safely perform the current gain (*Beta*) test. Current gain cannot be read directly on the tester, but *Beta* is very easily found by dividing the collector current reading by the base current reading.

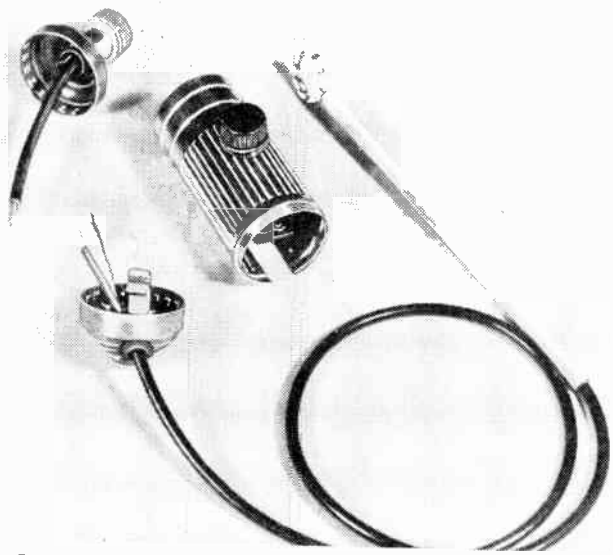
The Beta test is made by setting *S1* to *Beta N-P-N* or *Beta P-N-P*. Make sure the power is off. Connect the transistor base, emitter, and collector leads to the corresponding binding posts. Check the manufacturer's specifications for the maximum collector current for the transistor under test and *never* exceed this value as read on the 0-100 ma. collector current meter. Now switch on the tester, but leave the *Base Current* pot full counterclockwise. Record the base current and collector current meter readings. Dividing the collector current by the base current will give you one value for the *Beta* (current gain) of the transistor under test.

Now increase the base bias current with the *Base Current* potentiometer. This will cause an increase in the collector current. Once more, record the meter readings and compute the current gain. Continue this process until you have several values for current gain.

Note that *Beta* is constant except at the higher collector currents; this is a normal transistor characteristic. Check your computed values for the current gain against the manufacturer's specs to see if the transistor is up to snuff.

You'll soon find that you'll have more confidence in the circuits you build and troubleshoot. Using the tester, you'll be able to give transistors a rapid checkout and use them to best advantage. —30—

Citizens Radio Tune-Up Meter Probe



Probe ready for final assembly. Coax cable is wired in last.

By HAROLD REED

Construct this simple VTVM probe for transmitter tuning and for monitoring the audio quality of your CB station rig.

WHEN tuning-up and adjusting any radio transmitter the job is done most quickly and efficiently by picking up a small r.f. voltage at any particular stage and tuning for maximum, as indicated by a suitable meter.

The r.f. voltage may be rectified by a diode and applied to a d.c. meter for indication. In this unit, output is applied to the high-impedance input circuit of a VTVM set to one of its low d.c. ranges. The crystal-rectified current flows through the VTVM input circuit and produces a low voltage that is easily read on the meter.

Circuit Analysis

The tune-up meter circuit consists of an untuned r.f. pickup coil made up of two turns of wire coupled through coax to a germanium crystal diode. The r.f. signal is converted to d.c. by the diode and this output is applied to the connector of the VTVM which is normally used for d.c. measurements. An r.f. bypass capacitor is connected across the diode output, as shown in the schematic diagram. The meter sensitivity is adjusted by means of a variable control while a phone jack is provided for the aural monitoring of the audio signal from the transmitter.

Construction Details

The few component parts required for this device are assembled in a metal container. A metal, rather than a plastic, housing is preferable because of its shielding properties. Although any metallic enclosure will be satisfactory, the one shown in the photograph is made of parts salvaged from the junk box. These are an old split-type tube shield and two caps from an electric pull-chain lamp socket which fits snugly over the ends of the tube shield.

A mating connector for the VTVM is soldered into one of the end pieces and the monitor phone jack is mounted in the other end piece. A hole was also drilled in this latter cap and fitted with a ¼-inch rubber grommet for passage of the input coax cable.

The miniature meter-sensitivity control is mounted in the shield housing as shown and a 3-terminal stand-off is soldered to the inside of the shield for tie-point connections, including the leads of the diode and capacitor.

After wiring, the end pieces are slipped over the shield and soldered in place. A bead of solder is also run down the tiny slit where the shield butts together. There was no concern about soldering up the container in this manner since it is unlikely that anything inside will ever have to be replaced. Of course, the meter probe should not be coupled tightly to higher powered transmitters, as this may burn out the crystal diode that is used to detect the radio-frequency signals that are indicated on the vacuum-tube voltmeter.

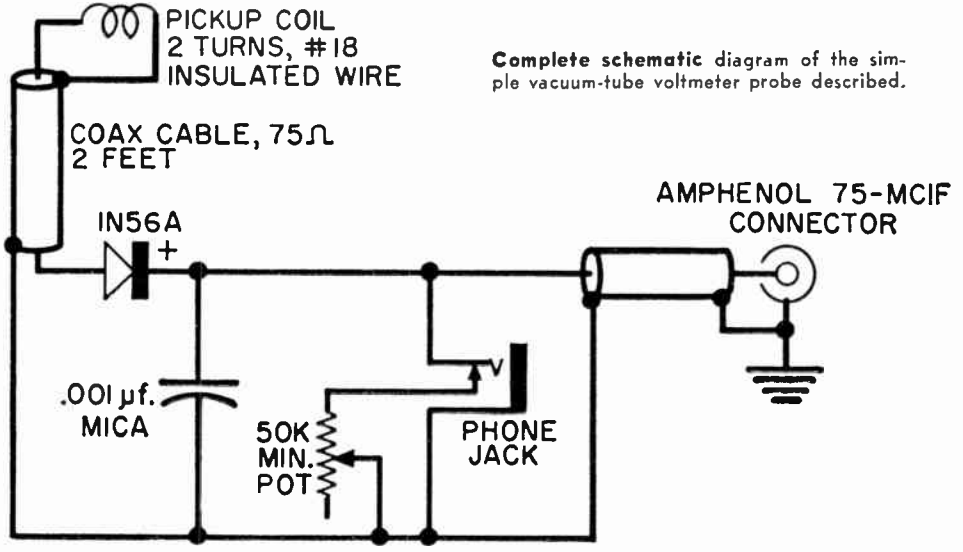
The r.f. probe consists of the pickup coil which is two turns of No. 18 insulated wire, ⅝-inch in diameter. The coil is connected to the end of a 2-foot length of small-size, 75-ohm coax cable. The coax cable fits nicely into a 6-inch length of ¼-inch plastic tubing which serves as the probe body or handle. A dab of cement at each end of the tubing will hold the coax in place. The completed device is small and easily manipulated.

Using the Device

The pickup coil of the r.f. probe is loosely coupled to any r.f. coil of any stage of the transmitter or antenna. (*Note: The holder of a commercial radio operator's license may check and adjust the oscillator coil, but the unlicensed operator must confine his adjustments to the final r.f. amplifier or antenna circuits.*) The VTVM voltage range-switch should be set to one of the two lowest voltage ranges. The author found the 1.5- and 5-volt settings both satisfactory. The meter-sensitivity control of the tune-up adapter is then set for suitable VTVM meter deflection. The r.f. stage being checked is now tuned for maximum indication on the VTVM.

Using a "VoltOhmyst," meter deflection to center scale was obtained with the voltage range-switch set to 5 volts and off-scale deflection resulted with the range-switch in the 1.5-volt position when checking the various stages of the Citizens Band transmitter.

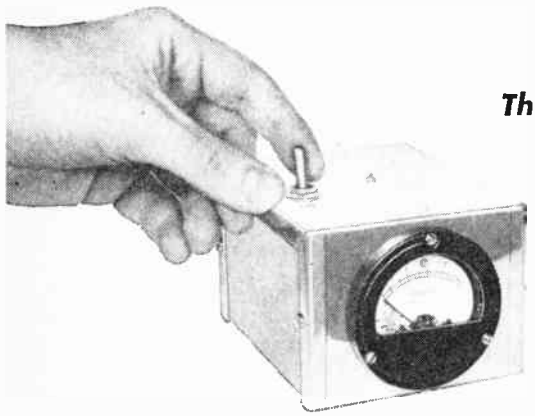
To aurally check audio modulation of the transmitter it is only necessary to plug a pair of magnetic headphones into the phone jack of the device. The audio quality is then directly monitored. —30—



Complete schematic diagram of the simple vacuum-tube voltmeter probe described.

Build an R. F.

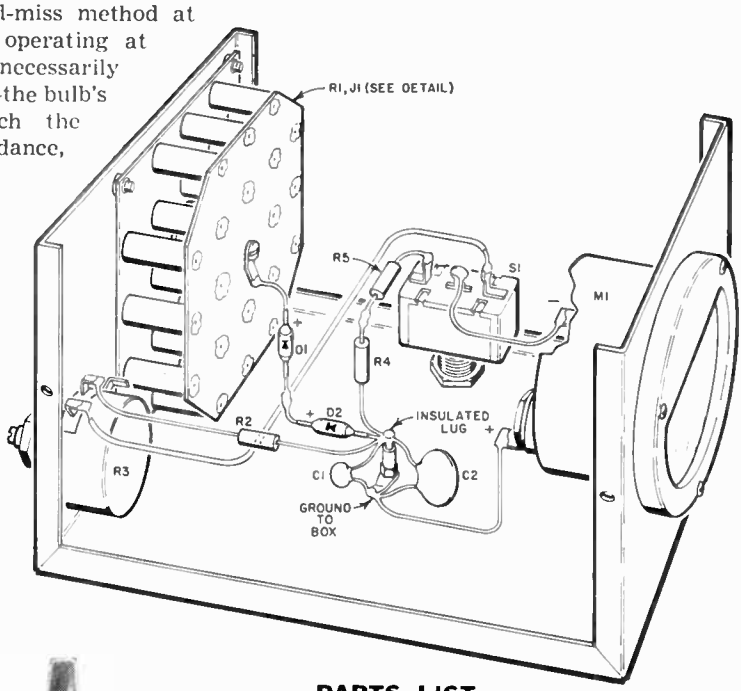
This inexpensive instrument doubles as a



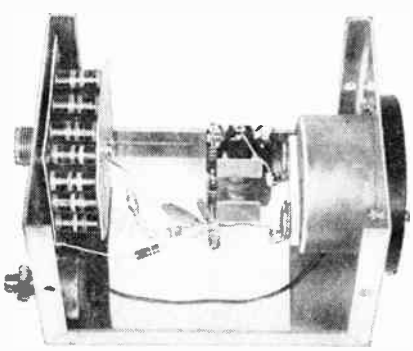
ALTHOUGH many amateurs use an ordinary light bulb to "measure" r.f. power output, this is a hit-and-miss method at best. A 150-watt bulb operating at "half-brilliancy" doesn't necessarily indicate 75 watts output—the bulb's impedance doesn't match the transmitter output impedance, and "half-brilliancy" is little more than a crude guess. The only accurate method of measuring r.f. power output is to use a calibrated r.f. power meter.

Here's a two-in-one unit that's both an r.f. power meter and a dummy load in one compact aluminum case. It's capable of handling 40 watts continuously and up to 100 watts for very short intervals. It can also be used to test a transmitter's low-pass harmonic filter.

This little unit has an effective input impedance of about 50 ohms to match the out-



Standard Minibox serves as chassis for power meter. For best results, use a single insulated tie-point and ground lug when wiring, as shown in pictorial diagram.



PARTS LIST

C1—.001-μf., 600-volt ceramic disc capacitor
C2—.01-μf., 600-volt ceramic disc capacitor
D1, D2—1N38B diode
J1—Coax connector
M1—200-μa. d.c. meter (Triplett 221T, or equivalent)
R1—50-ohm, 40-watt resistor (see text)
R2—330,000-ohm, ½-watt, 5% resistor
R3—250,000-ohm, 2-watt potentiometer, linear taper (Ohmite CLU2541 or equivalent)
R4—33,000-ohm, ½-watt, 5% resistor
R5—100,000-ohm, ½-watt, 5% resistor
S1—S.p.d.t. toggle switch
1—3" x 4" x 5" Minibox
Misc.—Hardware, brass plates, etc.

Power Meter

dummy load in your ham shack.

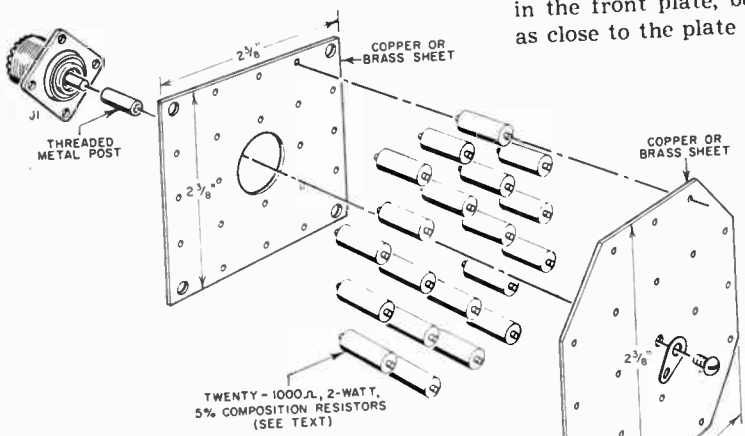
By **JOSEPH TARTAS,** W2YKT

put impedance of most transmitters. It operates on frequencies up to 200 mc. with a voltage-standing-wave-ratio (VSWR) of only 2:1 on the upper limit. Using standard components, you can build it for $20 or less, depending on the meter used.

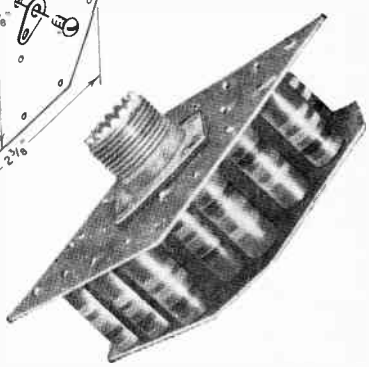
Construction. The 3" x 4" x 5" Minibox which serves as a cabinet also acts as a heat sink for load resistor *R1*. Drill the mounting holes for input jack *J1* and potentiometer *R3* at one end of the box; you'll need a hole for the meter on the opposite end. Switch *S1* mounts on top.

Load resistor *R1* consists of twenty 1000-ohm, 2-watt, 5% composition resistors soldered in parallel to a pair of brass or copper plates as shown in the pictorial detail. Cut the two load-resistor plates at the same time from two copper or brass sheets. Each plate should be 2⅜" square; the thickness isn't important. When the plates are cut, mark one for drilling, clamp them together, and drill both at the same time. This will insure alignment of holes and make assembly easier. Cut off the corners of the back plate to allow access to the nuts on the mounting screws.

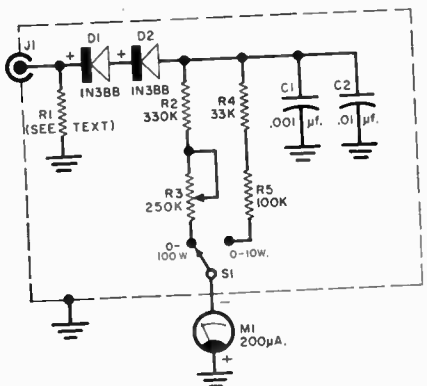
To assemble the load resistor, pass a lead from each 1000-ohm resistor through a hole in the front plate, bending over each lead as close to the plate as possible. Stand the

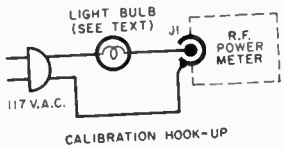


Metal plates for load resistor R1 should be clamped together and drilled at the same time to insure proper alignment of holes.



Setting of potentiometer R3 controls full-scale reading of 100-watt range. No control is provided for 10-watt range, but a potentiometer can replace resistor R5.





CALIBRATION HOOK-UP

plate on edge and insert the remaining leads in the back plate, bending over only the leads of the "corner" resistors. Squeeze the plates gently against the resistors and solder the leads from the "corner" resistors to each plate. Finally, solder the remaining leads and clip them off next to the plates. File down any leads that prevent the assembly from being mounted flush against the rear of the box.

Calibration. Since meter *M1* is calibrated in microamperes, it must be recalibrated to read in watts. To do this, switch *S1* to the 100-watt range, and connect electric light bulbs to *J1* as shown on the calibration schematic. Start with any combination of light bulbs totaling 400 watts—for example, two 150-watt bulbs and one 100-watt bulb; then decrease the wattage of the lamps to 300, 200, 150, 75, and 40 watts. The three higher wattage combinations should be left connected only momentarily. In each case, measure the voltage across *R1*.

Using 117 volts a.c. in the calibration setup, calculate the power for a given meter reading as follows:

$$\text{Power (watts)} = \frac{\text{Voltage}^2 \text{ (across } R1)}{50}$$

This formula is valid only if the voltage scale on the VTVM is calibrated in r.m.s. Use *extreme caution* when calibrating, since one side of the 117-volt line is connected directly to the power meter case.

The full-scale reading on the 100-watt range can be changed to read approximately 20% higher or lower by adjusting pot *R3*. The 10-watt range need not be calibrated and should read 10 watts full-scale with the values of *R4* and *R5* shown. If desired the 100,000-ohm resistor used for *R5* can be changed to a 2-watt potentiometer of the same value. This would allow you to vary the full-scale reading with switch *S1* in its "10-watt" position.

Operation. To operate the unit as a power meter, connect *J1* to the output jack of the transmitter under test. Set the range switch to the 100-watt position to start. If the meter reads 10 watts or less, you can safely switch *S1* to the 10-watt range for a more accurate reading.

To test a transmitter's low-pass harmonic filter, connect *J1* to the output of the filter with the transmitter output connected to the filter input. Record the wattage at the filter output jack. Next, remove the filter and connect *J1* directly to the transmitter output. A much higher reading without the filter indicates that the filter elements need re-adjustment or that the transmitter has a high harmonic output.

As a dummy load, the r.f. power meter can be operated continuously at 40 watts or less. Higher transmitter outputs should be applied only momentarily to prevent damage to load resistor *R1*. —30—

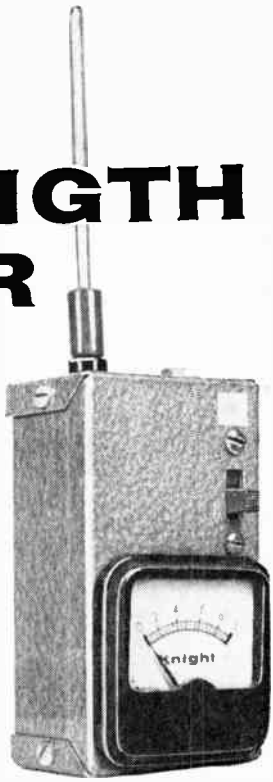
HOW IT WORKS

The r.f. power meter determines the power output of a transmitter by measuring the voltage across fixed load resistor *R1*, which is connected to the transmitter output. Meter *M1* is calibrated in watts according to Ohm's law.

In operation, diodes *D1* and *D2* rectify the r.f. voltage across *R1*. The rectified voltage appears across resistors *R2*, *R3*, and meter *M1* in the 100-watt range, and across resistors *R4*, *R5*, and meter *M1* in the 10-watt range. In each range (selected by *S1*), a current flows through the meter in proportion to the rectified voltage present.

Two bypass capacitors (*C1* and *C2*) are used to maintain the linearity of the meter. At self-resonance, each capacitor becomes ineffective as a bypass device. But since the two capacitors are self-resonant at different frequencies, one always functions as an r.f. bypass.

Build a FIELD STRENGTH METER



Inexpensive device checks radiation pattern of your CB or ham antenna system.

By RUSSELL KELLER, K9CZO

ARE you curious about the radiation pattern of your CB or ham antenna? Here's a simple field strength meter (FSM) that will give you an indication of relative field strength on either the 6- or 10-meter ham bands or the 11-meter Citizens Band.

This little instrument is nothing more than a tiny receiver which drives a meter instead of headphones. The meter lets you read the relative signal strength of your signal at various points near your transmitting antenna. Parts should cost less than $10, and total construction time shouldn't exceed a few hours.

Construction. The unit should be housed in a 4¼" x 2¼" x 1½" (or larger) *metal* box; unshielded plastic boxes are not suitable since inductive pickup by the FSM's coil will give a false meter reading. Mount the r.f. portion of the FSM (capacitors *C1* and *C2*, coil *L1*, jack *J1*, and diode *D1*) in the upper half of the box as shown. Insulate antenna jack *J1* from the box with a fiber

washer. Keep all leads in the r.f. portion short, and use a heat sink when soldering diode *D1* and transistor *Q1*.

A one- or three-band version of the FSM is possible, the only difference being in the choice of tuning capacitor *C1*. For a three-band model (the 6- and 10-meter ham bands and the Citizens Band), use a 75-$\mu\mu$f. unit (Hammarlund APC-75 or equivalent) for *C1*. If you want only a six-meter FSM, use a 25-$\mu\mu$f. unit (Hammarlund APC-25 or equivalent).

Coil *L1* consists of six turns of No. 18 enameled wire, ½" in diameter. Solder *L1* directly across the terminals of capacitor *C1* and solder the negative lead of diode *D1* to a tap 1½ turns from the ground end of *L1*. Be sure to scrape the enamel from *L1* in the area of the tap before soldering *D1* in place. All other components except meter *M1* are also soldered in place by their leads.

A battery holder is not used since zero-signal current drain is only a few micro-amperes and penlight cell *B1* should last indefinitely. On-off switch *S1* can also be dispensed with if desired, but the antenna should be unplugged when the FSM is not in use.

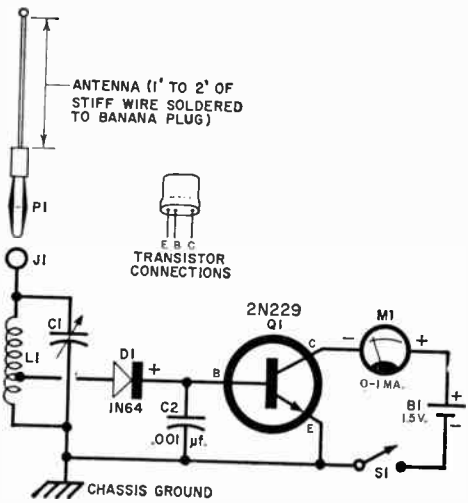
Mount meter *M1* in the lower half of the box. For a more sensitive instrument, use a 500-μa. or 100-μa. meter instead of the 1-ma. unit specified; no circuit changes are needed for either of these meters. With one of the more sensitive meters in the circuit, you can operate the FSM with a shorter antenna and measure r.f. field strength at a greater distance from the transmitter.

Make a short whip antenna, as shown, by soldering a 1' or 2' length of No. 12 or No. 14 bus bar to a banana plug. Jack *J1* on the FSM is a banana jack and permits the antenna to be unplugged when the FSM is not in use.

Operation. You can use the FSM to check the radiation pattern around your antenna or to see if your transmitter is improperly shielded and radiating r.f. Before these checks can be made, however, the FSM must be tuned to the transmitter. Do this by inserting the FSM's whip antenna into *J1* and placing it near the transmitter. Then rig a temporary short-wire antenna to the transmitter, and tune up the transmitter. If yours is a CB rig, just switch to "transmit" and use a clear channel. In any case, keep all experiments down to a minimum so that already burdened Citizens Band and ham frequencies are free of unnecessary interference.

Switch on the FSM and adjust capacitor *C1* to the transmitter frequency. The meter will show a sharp rise from the zero mark at the transmitter's frequency. Adjust *C1* for a maximum reading on the FSM. If the meter goes off scale, move the FSM farther away from the transmitting antenna. At this point, you'll notice that the FSM pickup depends on its polarization with the transmitting antenna: maximum pickup results when the FSM antenna and the transmitting antenna are parallel to each other.

Once the FSM is tuned to the trans-



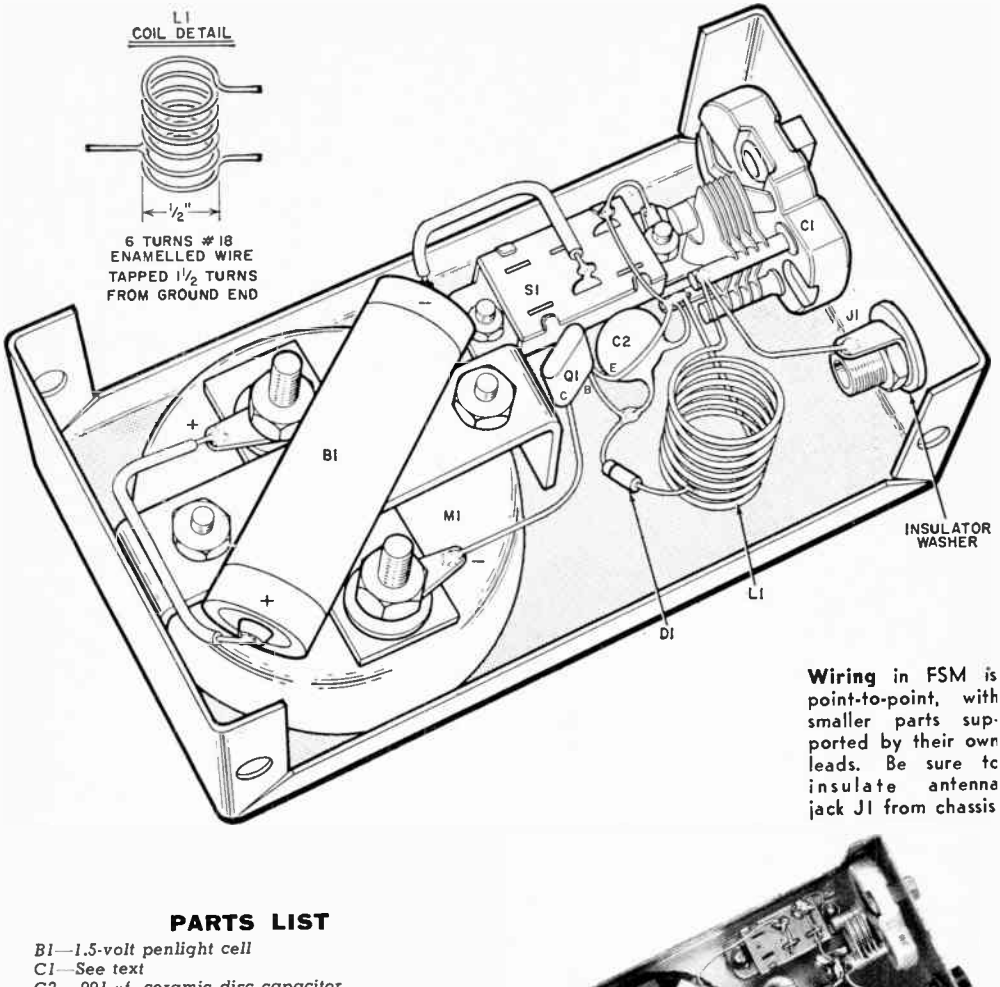
Schematic diagram of field strength meter. Exact values of C1 and M1 will depend on desired range and sensitivity of unit; switch S1 can be omitted if antenna is unplugged whenever meter is not in use.

HOW IT WORKS

Operation of the FSM is similar to that of a receiver using a diode detector followed by a one-transistor amplifier. In this case, the transistor feeds a milliammeter rather than headphones.

When r.f. is picked up by the antenna, it is tuned by coil *L1* and variable capacitor *C1*. Diode *D1*, connected to a low-impedance tap on *L1*, rectifies the r.f. appearing across the *L1-C1* tuned circuit. The rectified signal is filtered by capacitor *C2* and fed to the base of transistor *Q1*, where it is amplified and fed to meter *M1*.

Serving as a visual indicator, *M1* measures the amplitude of the rectified signal, which is proportional to the r.f. field strength. Battery *B1* powers *Q1* through on-off switch *S1*.



Wiring in FSM is point-to-point, with smaller parts supported by their own leads. Be sure to insulate antenna jack J1 from chassis

PARTS LIST

B1—1.5-volt penlight cell
C1—See text
C2—.001-μf. ceramic disc capacitor
D1—1N64 diode
J1—Banana jack
L1—Six turns of #18 enameled wire, ½" in diameter (see text)
M1—0-1 ma. meter
P1—Banana plug
Q1—2N229 transistor
S1—S.p.s.t. slide switch
1—4¼" x 2¼" x 1½" box (Bud CU-2116 or equivalent)
Misc.—Hardware, wire, solder, etc.

mitter, disconnect the temporary antenna and connect your regular transmitting antenna. If your transmitter and coaxial transmission line are properly shielded and grounded, you should get no reading on the FSM no matter how close to the transmitter or coax the FSM antenna is placed.

When this check has been made, go outside to your transmitting antenna and turn the FSM until its antenna parallels the transmitter's. Walk around the transmitting antenna with the FSM, taking care to stay at least several wavelengths away from the antenna.

The r.f. field you detect should correspond with the type of antenna you have. If your antenna is directional, the r.f. field will be stronger in one location than in another; this is true of horizontal antennas. Vertical antennas, on the other hand, should exhibit a perfectly uniform field in a 360° sweep. Antennas with reflectors should be most effective on the side away from the reflector. -30-

Capacitor Leakage Tester

By R. L. WINKLEPLECK

Easy-to-build unit checks coupling capacitors quick as a blink

WHAT do the drip, drip, drip of a faucet and the flip, flip, flip of your TV picture have in common? They are both caused by leakage—one by leaky pipes, the other by leaky capacitors.

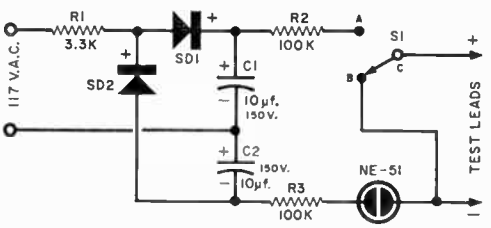
Leaky capacitors are bad in any circuit but in TV sync circuits they're pure poison. And trouble-shooting is complicated by the fact that capacitors leaky enough to cause trouble are frequently detectable only by specialized test equipment. For instance, a capacitor with as little as 20 megohms leakage can completely upset the horizontal stability of a TV receiver and yet be immune to detection by a standard ohmmeter.

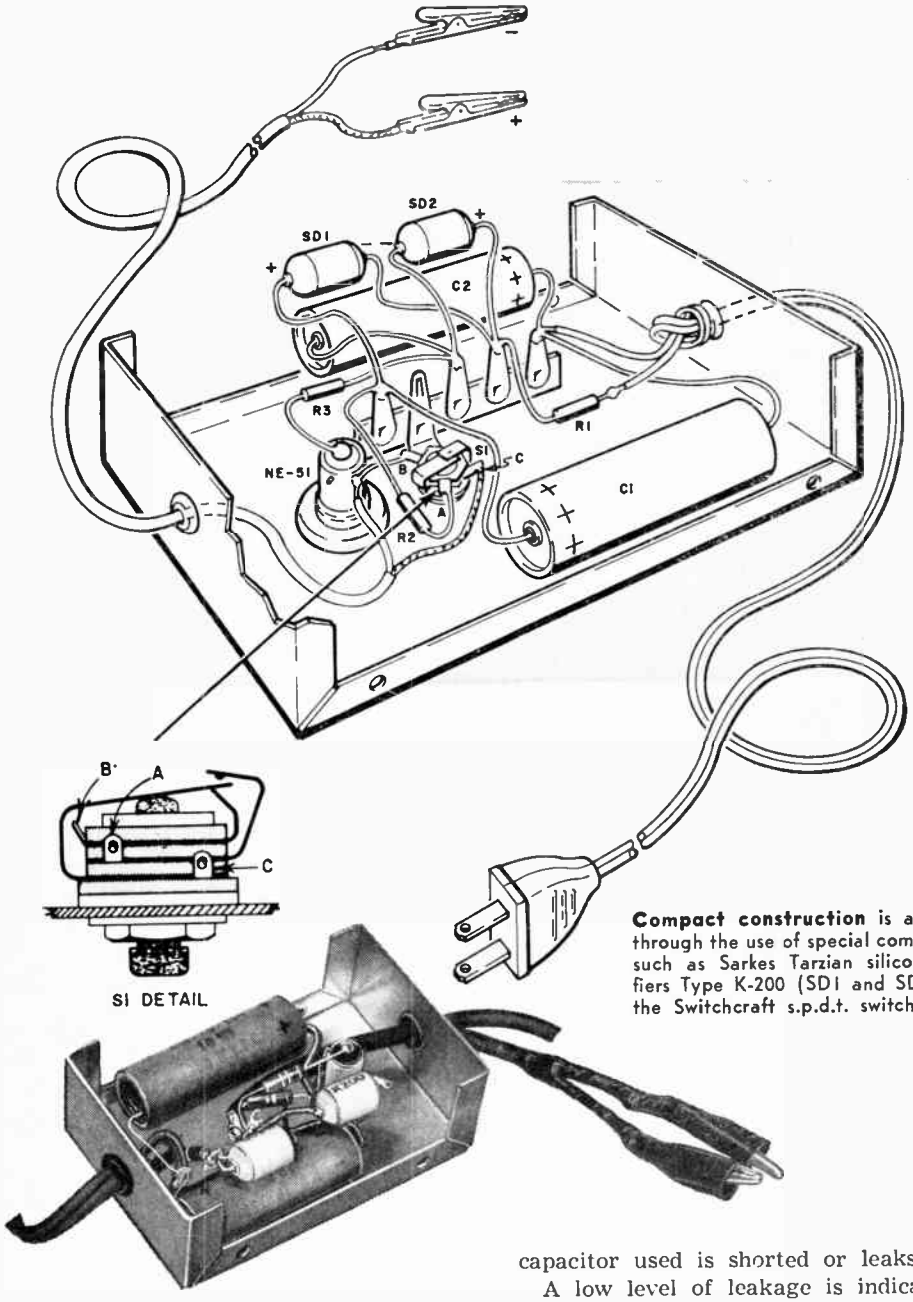
You can assemble this extremely sensitive, inexpensive leakage tester in about an hour. Since component values are not especially critical, the junk box should be able to provide its share of parts. The tester's simplicity is belied by its performance, for it will expose leaky capacitors as dependably as your ohmmeter finds off-value resistors—and you'll probably use it as often.

Essentially a voltage doubler which applies 250-300 volts to the capacitor under test through a neon lamp, the circuit is well enough isolated from the power line to make an isolation transformer unnecessary. Just make sure not to connect any part of the circuit to the aluminum box.

There's little possibility of accidental shock since the s.p.d.t. push-button switch (*S1*) shorts the test leads, except during

Push-button switch S1 is shown here in its normal position; when it is depressed, S1 unshorts the leads and applies the test voltage.





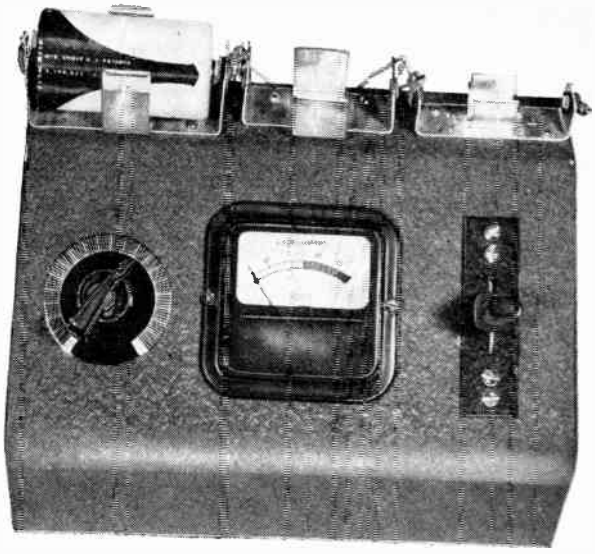
Compact construction is achieved through the use of special components such as Sarkes Tarzian silicon rectifiers Type K-200 (SD1 and SD2) and the Switchcraft s.p.d.t. switch #953.

the actual leakage test. Keep in mind, however, that when *S1* is depressed there's nearly 300 volts across the test leads.

In testing a capacitor, one end of it should be disconnected from its associated circuit, and the radio or TV set must be disconnected from the power line. Attach the test leads and depress the push button. The neon lamp will blink only once if the capacitor is good. It will stay on if the capacitor used is shorted or leaks badly.

A low level of leakage is indicated by repeated blinking of the lamp as the push button is held down steadily. The blinking rate indicates the degree of leakage. Exact calibration is not necessary.

If a capacitor in a sensitive circuit shows any significant leakage, discard it. For if it's not causing trouble now—it will later. Potential trouble-makers can be eliminated in double-quick time with this handy test unit. -30-



Dry Cell Tester and Rejuvenator

Simple circuit functions as Fountain of Youth for run-down 1½-volt dry cells.

By JAMES E. MURPHY

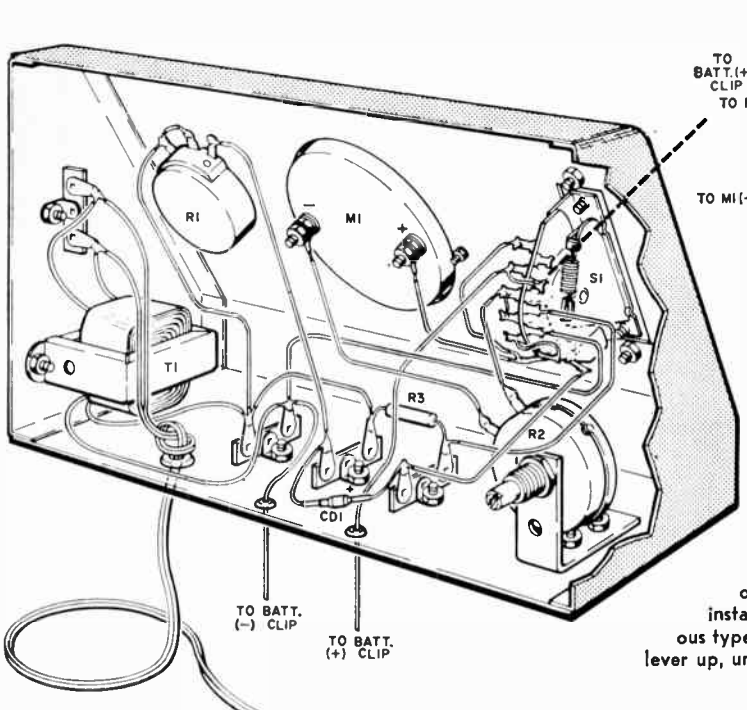
SMALL 1½-volt dry cells, originally developed for flashlight service, are finding increasing use in children's toys, transistor radios, and all sorts of electronic gadgets. Since the life of these units is limited, a simple recharging or rejuvenating method can result in real savings.

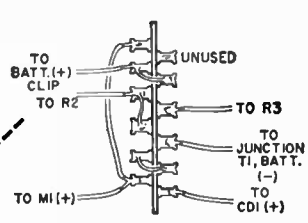
Rejuvenation circuits of the simpler variety include a small transformer, a rectifier, and a fixed resistor. More complicated circuits have a means of varying the charging rate, and a meter to read the charging current. In some cases, a small amount of unrectified a.c. is passed through the cell, since this appears to improve performance, probably by providing a sort of mixing or stirring action within the cell during charging. The unit described here includes all of these features.

One problem immediately presents itself to anyone who tries to rejuvenate dry cells: there is no way to determine how weak a cell may be, other than by trying it out in a flashlight or other apparatus. During the rejuvenation period, the same problem arises: there is no simple method for determining just when the cell has been brought back to its original condition.

With this rejuvenator, a flick of the switch indicates on the meter the exact condition of the cell. If the cell is below par, but not too far gone, the switch can be flicked to another position, and the rejuvenation process started. The charging rate, which is adjustable, is read from the same meter. The condition of the cell during the rejuvenation can be checked at any time by merely moving the switch to the test position. If more charging is needed, the switch is moved back to the charge position. All this can be done without removing the cell from the holder.

Construction is quite simple. Almost any type of cabinet, even a cigar box, can be used. Holes for the meter (*M1*) and function switch (*S1*) are drilled and all parts mounted except *S1* and the calibrating control (*R2*). Switch *S1* is wired before





DETAILED REAR VIEW OF S1 WIRING

Cabinet is shown as viewed from below. Note that bottom is left open. Battery brackets are installed to accommodate various types of 1½-volt cells. With *S1* lever up, unit is set for battery "test."

mounting, leaving long leads where necessary to connect to other parts; *R2* is left till the last to allow room for mounting *S1*.

Wiring should present no difficulties, but be sure to observe the correct polarity of the meter and the diode (*CD1*). The three cell holders are wired in parallel with the wires brought through holes in the back of the case.

Testing and calibration of the completed unit must be done with a fresh size D cell in the appropriate holder. Plug in the line cord, and set *S1* to the charge position. The meter should read upscale. If it reads downscale, reverse the diode. Set the charging rate for about 20 ma., as read on the meter, and then reverse the cell in the holder. The meter will now read either higher or lower.

The position which gives the *lowest* reading is the correct position. Mark the terminal contacted by the positive pole of the cell with red fingernail polish and use the same polarity with all cells for both charging and testing.

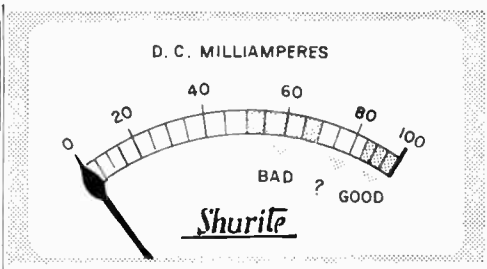
Move *S1* to the test position. The meter should read upscale. If it reads downscale, check *S1*'s wiring. With the meter reading correctly in the test position, adjust calibration control *R2* for full-scale deflection (100 ma.). This takes care of the electrical calibration, but the calibration of the meter scale to read *Good-Weak-Reject* requires a bit of calculation.

Since the current, as read on the meter, is 100 ma. (0.1 ampere), and the cell voltage is 1.5 volts, Ohm's law indicates that the combined resistance of the meter and *R2* is 15 ohms. (The internal resistance of a fresh cell is too small to take into consideration.) From this information, it is possible to calculate the power furnished by the fresh cell to the 15-ohm load using $P=I^2R$. The answer (P) is found to be 0.15 watt.

Let's say that a cell which can deliver 75% or better of full power to a 15-ohm load is okay; one which delivers 50% to 75% is weak; and one which delivers less than 50% is no longer usable. With a little algebra, the formula for watts can be converted into a form which allows the watts to be converted into milliamperes.

% Power	*Watts*	*Ma.*
100	0.150	100
75	0.113	87
50	0.075	71

If we now carefully remove the cover from the meter, and color the region be-



Meter movement face should be color-coded for direct reading of battery's condition. Charging current is read on 100-ma. scale.

tween 87 and 100 on the scale with green ink, the region from 71 to 87 with yellow ink, and from 50 to 71 with red ink, the relation of these colored regions to the *Good-Weak-Reject* condition of a cell under test becomes obvious.

Operation of the instrument is simple. Just place a cell in the proper holder, observing the correct polarity. If the meter reads full scale with the selector switch in the test position, the cell is okay. If the reading is less than full scale, but in the *Good* or *Weak* region, move *S1* to the charge position; this will automatically start the

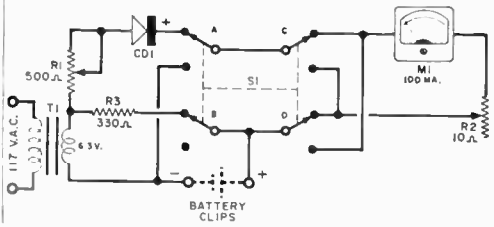
HOW IT WORKS

In the charge position, the a.c. which has been rectified by diode *CD1* to d.c. is passed through the cell (via sections *a* and *b* of *S1*, and meter *M1*) in a direction opposite to the cell's normal current flow. This current causes a reversal of some of the chemical reactions which are responsible for the normal activity of the cell, and thus serves to extend the life of the cell.

In the test position, *CD1* is disconnected from the cell and the meter, and the cell is reconnected to the meter so that the normal current from the cell flows through the meter and calibrating control *R2*. Since the direction of this current is opposite to the direction of the charging current, sections *c* and *d* of *S1* reverse the meter connections.

Control *R2* is used to calibrate *M1* for full-scale deflection with a fresh cell. Potentiometer *R1* adjusts the charging current through the cell.

Function switch *S1* is shown in the charge position. Any small 6.3-volt filament transformer will be suitable for use as T1.



charging cycle, and the charging rate can be adjusted by *R1* and read from the original 0-100 meter scale.

The charging rate is a matter of considerable controversy, but is limited in this case to 50 ma. by the maximum rating of *CD1*. Within reason, the charging rate is limited by the amount of heating of the cell being charged, and a high rate can be used as long as the cell does not get too warm. A charging rate of 100 ma. can be obtained by installing two diodes in parallel. Some writers, however, recommend only 10 to 20 ma. There is a considerable range here for individual experimentation. In any case, do not expect quick results; a charging time of several hours will be required for most cells.

Substitution of parts other than those indicated may be made. For example, almost any of the low-voltage germanium or silicon diodes can be used. The 100-ma. meter specified represents about the best load for testing size D cells, but any meter with a full-scale reading of 50 to 200 ma. will be satisfactory. Some of the low-priced meters may have too high an internal resistance to give full-scale deflection with 1.5 volts; such a meter can be employed but the maximum power point will have to be calculated from the maximum deflection obtained with a fresh cell. The more expensive moving-coil meters have very low resistance, and calibrating control *R2* will have to be increased to 20 to 25 ohms if a meter of this type is used.

Charging several cells at once, in series or parallel, is practical if the cells are similar in age and condition, and are all the same size. The circuit given here is suitable for parallel charging, but remember that the current read on the meter will divide among the cells in parallel, so that charging two cells in parallel at 50 ma. is the same as charging one at 25 ma. —30—

PARTS LIST

CD1—1N56 or 1N34A crystal diode (see text)
M1—100-ma. meter (Shurite Model 950)
R1—500-ohm, 2-watt wire-wound potentiometer (Mallory Type R500L or equivalent)
R2—10-ohm, 2-watt wire-wound calibrating control (Mallory Type M10RK or equivalent)
R3—330-ohm, ½-watt resistor
S1—4-p.d.t. lever switch (Centralab #1458 or equivalent)
T1—6.3-volt filament transformer
1—4" x 4½" x 7" sloping front cabinet (Bud C1609)
Misc. dry cell holders, terminal strips, pointer knob, hardware

2752. HIGH QUALITY SOUND REPRODUCTION, Moir

A perfect manual for both the professional engineer and the serious amateur in high fidelity. Complete coverage of sound reproduction in 591 pages. $15.00

2002. ELECTRONIC KITS DIRECTORY, Ziff-Davis Publishing Company

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40 projects for home and shop, 20 of which are transistorized. Special section on understanding transistor circuits. $1.00; 2009. cloth, $1.95

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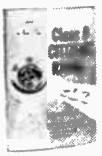
1960 edition. Prepared by the editors of Electronics World. An excellent advanced guide to theory, construction and circuitry. $1.00.



2008. CLASS D CITIZENS RADIO, Sands

First complete book on Citizens Radio operation. Covers Class D history, rules, applications, how it works. Many illustrations. $4.95

2901. HAM RADIO, Hertzberg

Tells exactly how to become a "ham"—how to obtain a ham "ticket," how to learn code, how to select receivers and transmitters—everything you need to know is between the covers of this handy guidebook. $2.50

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A fact-filled guidebook to electronic computers. Explains the working of every major computer system. Must reading for all who want a more complete knowledge of this important field. $4.95

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Resistors in Series And Parallel

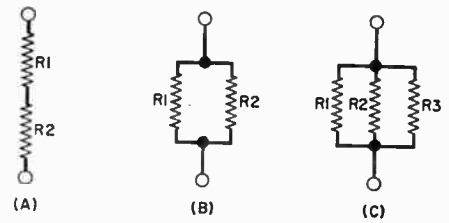
SOME of the projects described in these pages may use resistance values that you may not have on hand. It is an easy matter, however, to obtain these values by combining a number of resistors from your junk box in series or in parallel.

First consider what happens when you wire two or more resistors in series. The circuit current must flow through each resistance in turn. Hence, the total resistance in the circuit is the *sum* of the individual resistances. (See part (A) of the figure below.) For example, suppose you need a 1500-ohm resistor, but you only have a number of 500-ohm and 1000-ohm units. By simply connecting a 1000-ohm resistor in series with a 500-ohm resistor, you produce a total circuit resistance of 1500 ohms.

When two or more resistors are wired in parallel, the current in the circuit is able to divide into the parallel paths. Under these conditions, the total circuit resistance is lower than the smallest resistor value. With two resistors, the total resistance equals the product of the two resistance values divided by the sum of these values, as shown in part (B) below. For example, assume we need a total resistance of 1500 ohms as in the previous case. By using two paralleled resistors of 3000 ohms each, or by using a 2000-ohm resistor in parallel with a 6000-ohm unit, the required total resistance is produced. Other resistors can be used just so long as they result in the desired total resistance value.

When three resistors are connected in parallel, the calculations for total resistance get a little harder. The formula that is used is shown in part (C) below. —30—

$$R_{TOT} = R1 + R2 \qquad R_{TOT} = \frac{R1 \times R2}{R1 + R2} \qquad R_{TOT} = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}}$$



Low-Distortion Sine-Wave Generator

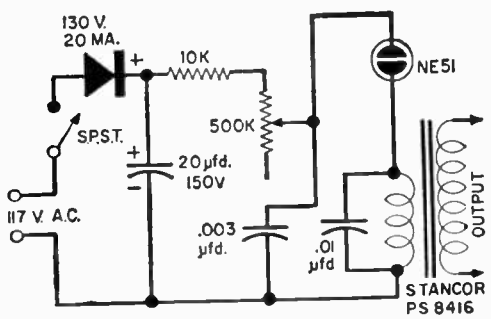
By HERBERT COHEN
General Transistor Corp.

THE author has been considering the problem of extracting the fundamental frequency from a conventional neon-tube saw-tooth generator. The slow charge time and the extremely rapid discharge time produces a saw-tooth waveform whose usefulness is limited but which contains the fundamental and many harmonics.

However, by parallel tuning the capacitor discharge circuit, a low-distortion sine wave can be obtained. The primary of a Stancor PS-8416 power transformer, paralleled by a .01-μf. capacitor, is used as a high-"Q" tank circuit. The tuned circuit appears as an exceedingly high impedance to the fundamental frequency but practically a short circuit to its harmonics.

With an oscilloscope across the transformer primary, the pot is adjusted to set the oscillator at the LC frequency of transformer and capacitor. As the fundamental approaches the tuned LC frequency, the waveform becomes more and more sinusoidal with an increasing amplitude on approaching resonance.

At resonance, the waveform shows less than 3% harmonic distortion as measured with a distortion analyzer. The secondary of the transformer supplies many outputs for low- and high-impedance matching. One problem in this construction is that ground is also a.c. ground. An isolation transformer can be used to eliminate this problem. The stability of this unit is basically determined by the stability of the a.c. line. A 1000-cycle oscillator shown in the diagram puts out a waveform comparable to the Hartley type. —30—



Transistorized Tachometer Pickup

By PAUL S. LEDERER

Construction of simple photoelectric tach that produces indication proportional to shaft speed.

THE tachometer, a device which measures the speed of a rotating shaft, is a very important industrial and laboratory tool. When it is necessary to monitor the rotational speed of a shaft continuously, a tachometer in the form of a generator is usually permanently attached to the end of the shaft. There are many cases, however, where it is desirable to check speed only occasionally. Using a permanently attached tachometer under these conditions would become prohibitively expensive.

Portable, mechanical revolution counters are available commercially. They require direct contact with the rotating shaft, which at times may be dangerous. When applied to low-power devices, such a mechanical tachometer can seriously affect the speed of the shaft. It is possible to devise a tachometer which does not need any mechanical linkage to the shaft whose speed it measures. A magnet radially embedded in the shaft will induce a voltage whenever it passes a coil placed in proximity and radially to the shaft. Another method uses a light shining through a hole drilled in the diameter of the shaft. It impinges on a photocell and generates a pulse whenever all three are in line, thus producing a number of pulses proportional to the speed of shaft rotation.

Another technique, employing a light and photocell, uses light reflected from alternately dark and light colored areas along the shaft's circumference. If half of the shaft's circumference is painted black and the other half white and a light is shining on it, whenever the white area is lighted, most of the light will be reflected. Whenever the light shines on the black area, most of the light will be absorbed and very little reflected. If the photocell is mounted next to the lamp, but shielded from its direct light and facing the painted areas on the shaft, the current flowing will depend on the amount of light reflected from the painted areas to the cell. One complete revolution of this shaft would generate *one* cycle of a (probably squared-off) sine wave at the photocell output. The speed of a slowly turning object can be determined by dividing the circumference into *many* dark and light areas so that one revolution will generate many cycles.

In practice, it is seldom necessary to actually paint adjacent areas black and white. Clean, bright metal reflects sufficient light; a piece of black electrical tape can serve as the non-reflecting (black) area.

A number of commercial tachometers operate on this principle. Most are designed to operate with electronic frequency counters from which they derive their power. They are fairly big and expensive.

The transistorized tachometer pickup to be described is self-contained in a 2¼" x 2¼" x 4" aluminum box. It employs a cadmium selenide photocell operating as a reflected-light pickup. A pre-focused flashlight bulb supplies the light and a grounded-emitter amplifier completes the device, which is powered by two small batteries.

The photocell used in this circuit is a photoresistive device. Its resistance decreases when light impinges on the face of the photocell. The unit used by the author is the Clairex CL-3 which has a diameter of approximately ¼" and is about ½" long. It nets for $3.50. The cell is mounted in a piece of copper tubing about one inch long and with an i.d. of about ¼", sufficient for the photocell to slide in. The front face of the photocell is recessed about ⅝" inside the tube. The tube, besides keeping the photocell aligned, also serves as a light shield. This makes it possible to operate the ta-

chometer pickup under adverse ambient light conditions.

The copper tube is attached to a bracket fastened to and protruding through the 2¼" x 2¼" surface of the box. The other end of the bracket carries the socket for the light bulb. This light bulb is a pre-focused "penlite" bulb (G. E. #112) designed to operate from a 1.2-volt battery. The copper tube and the light bulb socket are inclined toward each other and to the box surface at about a 60-degree angle. Their axes intersect about 1½" in front of the box surface. This means that for optimum operation, the portable tachometer pickup should be held so that its front surface is about 1½" away from the surface of the rotating object whose speed is being measured.

The circuit of the transistorized tach is shown in Fig. 1. The switch turns on both the lamp battery and the battery-energizing photocell and transistor amplifier. When light strikes the front of the cell, its resistance decreases and the battery pushes more current through it and the 82,000-ohm resistor, *R1*, into the base circuit of the transistor. The amplified signal generates a voltage across the 47,000-ohm load resistor, *R2*, which is picked off at the collector of the grounded-emitter transistor amplifier. It is fed to the output cable through a 0.1 μf. paper capacitor, *C1*. It is not possible to give much information on the output voltage obtained because it will depend on such factors as distance from the rotating object, frequency of light variation, ambient light, and light reflecting qualities of the rotating surface.

In the case of a rotating anodized aluminum disc, half of which was covered with black electrical tape, the output was 1 volt peak-to-peak at about 110 cps (corresponding to a rotational speed of 6600 rpm) at a distance of 1½ inch. The output increases at lower frequencies. This is a characteristic of many of the crystal-type photocells. The output is adequate for frequency measurement by Lissajous figures on an oscilloscope (using a calibrated audio oscillator to feed the scope's horizontal amplifier). For industrial use, the output appears sufficient to drive the electronic counters of many frequency meters.

This tachometer can be used to measure rotational speed of electric fans if it is recalled that there will be as many cycles put out per revolution as there are fan blades.

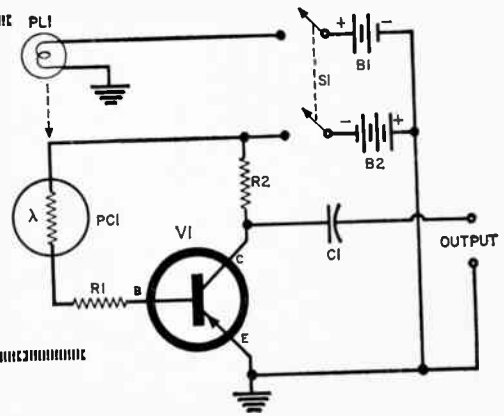
Total construction cost of this unit is less than $10.00. The batteries are held against the inside of the box by means of a home-made bracket. The switch serves to hold the 15-volt battery by pushing it against a spring-loaded screw in the end of the box which serves as ground terminal for the battery. A small plastic block holds the 1.5-volt cell against a similar spring-loaded screw. The d.p.s.t. switch, *S1*, is the only control.

No problems should be encountered in wiring the electronics portion of the pickup because of the simplicity of the circuit that is employed. With only a handful of components needed, the circuit should be a worthwhile project for the experimenter interested in a simple device that will indicate shaft speeds. -30-

Fig. 1. Single transistor amplifies output of photocell. This output may be applied to an oscilloscope, to a sensitive a.c. voltmeter, or to a frequency-meter circuit.

PARTS LIST

R1—82,000 ohm, ½ w. res.
R2—47,000 ohm, ½ w. res.
C1—0.1 μf., 100 v. paper capacitor
S1—D.p.s.t. switch
B1—1.5-volt "C" cell
B2—15-volt hearing-aid battery (Burgess V-10 or equiv.)
PC1—Cadmium selenide crystal photocell (Clairex CL-3)
PL1—1.2-volt pre-focused screw-base bulb (G-E #112)
V1—"p-n-p" germanium transistor (Raytheon CK722)



Transistor Tone Generator

By R. L. WINKLEPLECK

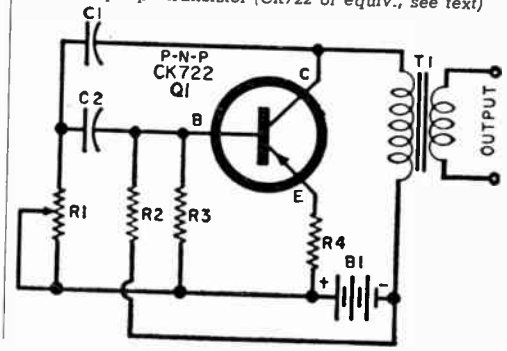
THE phase-shift oscillator is a familiar vacuum-tube circuit noted for its simplicity and low distortion. The phase-shift principle isn't often used for transistor oscillators but it is equally suitable.

The one suggested here has a two-leg *RC* feedback network for phase shifting. Resistor *R3* acts with frequency network resistor *R2* to form a voltage divider for base bias stabilization. An interstage transformer is used in the transistor's collector circuit rather than a resistor. This provides better voltage gain plus a low-impedance output completely isolated from the oscillator circuit. A tapped winding is not needed for this type of oscillator. Output of this circuit with six volts power is about two volts peak-to-peak into a scope. A stage of transistor amplification can be added to increase the output, if desired. Waveshape is quite good.

The extremely small size and low power requirement of this oscillator permits it to be used for many purposes. It is a convenient source of sine waves for the oscilloscope. It can be used as an audio signal injector in radio and amplifier servicing or it can be used with headphones or speaker and a key for code practice. Many other possibilities will occur to the experimenter.

—30—

R1—25,000 ohm pot
R2—47,000 ohm, ½ w. res.
R3—10,000 ohm, ½ w. res.
R4—100 ohm, ½ w. res.
C1—.01 μf., 200 v. capacitor
C2—.02 μf., 200 v. capacitor
T1—Transistor interstage trans. 20,000/30,000 ohms to 800/1200 ohms (UTC SSO-7 or equiv.)
B1—1-25 volts (see text)
Q1—"p-n-p" transistor (CK722 or equiv., see text)



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___	0Z4M	.79	___	4BQ7	.96	___	6AR5	.55	___	6CG7	.60	___	6SA7GT	.76	___	8E88	.94	___	12B4	.63	___	12EL6	50	___	19BG6	1.39
___	1AX2	.62	___	4BS8	.98	___	6AS5	.60	___	6CG8	.77	___	6SK7	.74	___	100A7	.71	___	12BA6	.50	___	12EG6	.54	___	19T8	.80
___	1B3GT	.79	___	4BU8	.71	___	6AT6	.43	___	6CM7	.66	___	6SL7	.80	___	11CY7	.75	___	12BD6	.50	___	12EZ6	.53	___	21EX6	1.49
___	1DN5	.55	___	4BZ6	.58	___	EAT8	.79	___	6CN7	.65	___	6SN7	.65	___	12A4	.60	___	12BE6	.53	___	12F5	.66	___	25BQ6	1.11
___	1G3	.73	___	4BZ7	.96	___	6AU4	.82	___	6CN7	.65	___	6SQ7	.73	___	12AB5	.55	___	12BF6	.44	___	12F8	.66	___	25C5	.53
___	1J3	.73	___	4CS6	.61	___	6AU6	.50	___	6CR6	.51	___	6T4	.99	___	12AC6	.49	___	12BH7	.73	___	12FM6	.45	___	25CA5	.59
___	1K3	.73	___	4DE6	.62	___	EAU7	.61	___	6CS6	.57	___	6U8	.78	___	12AD6	.57	___	12BL6	.56	___	12K5	.65	___	25C06	1.44
___	1L6	1.05	___	4DK6	.60	___	6AU8	.87	___	6CU5	.58	___	6V6GT	.54	___	12AE6	.43	___	12BQ6	1.06	___	12SA7M	.86	___	25CU6	1.11
___	1LN5	.59	___	4DT6	.55	___	6AV6	.40	___	6CU6	1.08	___	6W4	.75	___	12AF3	.73	___	12BY7	.74	___	12SK7GT	.74	___	25DN6	1.42
___	1R5	.62	___	5AM8	.79	___	6AW8	.89	___	6CY5	.70	___	6W6	.69	___	12AF6	.49	___	12BZ7	.75	___	12SN7	.67	___	25EH5	.55
___	1S5	.51	___	5AN8	.86	___	EAX4	.65	___	6CY7	.71	___	6X4	.39	___	12AJ6	.46	___	12C5	.56	___	12SQ7M	.73	___	25L6	.57
___	1T4	.58	___	5AQ5	.52	___	EAX7	.64	___	6DA4	.68	___	6X5GT	.53	___	12AL5	.45	___	12CA5	.59	___	12U7	.62	___	25W4	.68
___	1U4	.57	___	5AT8	.80	___	EBA5	.49	___	6DB5	.69	___	6X8	.77	___	12AL8	.95	___	12CN5	.56	___	12V6GT	.53	___	25Z6	.66
___	1U5	.50	___	5BK7A	.82	___	EBC5	.54	___	6DE6	.58	___	7AU7	.61	___	12AQ5	.52	___	12CR6	.54	___	12W6	.69	___	35C5	.51
___	1X2B	.82	___	5BQ7	.97	___	EBC7	.94	___	6DQ6	1.10	___	7A8	.58	___	12AT6	.43	___	12CU5	.58	___	12X4	.38	___	35L6	.57
___	2AF4	.96	___	5BR8	.79	___	EBC8	.97	___	6DT5	.76	___	7B6	.69	___	12AT7	.76	___	12CU6	1.06	___	17AX4	.67	___	35W4	.52
___	3AL5	.42	___	5CG8	.76	___	EBD6	.51	___	6DT6	.53	___	7Y4	.69	___	12AU6	.50	___	12CX6	.54	___	17BQ6	1.09	___	35Z5GT	.60
___	3AU6	.51	___	5CL8	.76	___	EBE6	.55	___	6EU8	.79	___	8AU8	.83	___	12AU7	.60	___	12D85	.69	___	17C5	.58	___	50B5	.60
___	3AV6	.41	___	5EA8	.80	___	EBF6	.44	___	6EA8	.79	___	8AW8	.93	___	12AV5	.97	___	12DE8	.75	___	17CA5	.62	___	50C5	.53
___	3BA6	.51	___	5EU8	.80	___	EBG6	1.66	___	6H6GT	.58	___	8BQ5	.60	___	12AV6	.41	___	12DL8	.85	___	1704	.69	___	50C6	.37
___	3BC5	.54	___	5J6	.68	___	EBH6	.65	___	6H6GT	.51	___	8CG7	.62	___	12AV7	.75	___	12DM7	.67	___	17DQ6	1.06	___	50EH5	.55
___	3BE6	.52	___	5T8	.81	___	EBH8	.87	___	6J6	.67	___	8CM7	.68	___	12AX4	.67	___	12DQ6	1.04	___	17L6	.58	___	50L6	.61
___	3BN6	.76	___	5U4	.60	___	EBJ6	.62	___	6K6	.79	___	8CN7	.97	___	12AX7	.63	___	12DS7	.79	___	17W6	.70	___	117Z3	.61
___	3BU8	.78	___	5U8	.81	___	EBK7	.85	___	6S4	.48	___	8CX8	.93	___	12AZ7	.86	___	12DZ6	.56	___	19AU4	.83				
___	3BY6	.55	___	5V6	.56	___	EBL7	1.00																		
___	3BZ6	.55	___	5X8	.78	___	EBN4	.57																		
___	3CB6	.54	___	5Y3	.46	___	EBN6	.74																		
___	3CF6	.60	___	6A84	.46	___	EBQ5	.65																		
___	3CS6	.52	___	6AC7	.96	___	6BQ6G	1.05																		
___	3CY5	.71	___	6AF3	.73	___	EBQ7	.95																		
___	3DK6	.60	___	6AF4	.97	___	6BR8	.78																		
___	3DT6	.50	___	6AG5	.65	___	EBU8	.70																		
___	3Q5	.80	___	6AH6	.99	___	EBY6	.54																		
___	3S4	.61	___	6AK5	.95	___	EBZ6	.54																		
___	3V4	.58	___	6AL5	.47	___	EBZ7	.97																		
___	4BC5	.56	___	6AM8	.78	___	EC4	.43																		
___	4BC8	.96	___	6AN4	.95	___	6CB6	.54																		
___	4BN6	.75	___	6AN8	.85	___	6CD6	1.42																		
			___	6AQ5	.50	___	6CF6	.64																		

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USING THE DECIBEL

IN ANY listening situation, the smallest increase in the volume of any sound that can be detected by the human ear is one-fourth, or 25 per-cent, over a previous sound. In other words, if any two sounds have a power ratio of at least 1.25 to 1, we will detect that the former is louder.

This ratio holds true for a wide range of power regardless of the absolute power of a particular sound. If we hear two sounds whose powers are respectively 12.5 and 10 watts, we would still hear the same difference in their loudness as we heard between the sounds at 1.25 and 1 watt, since the ratio is still the same (1.25).

This is because we hear approximately in proportion to the logarithm of the intensity, rather than in direct linear response to it. The decibel has been developed as a convenient unit for expressing and measuring intensity logarithmically. Mathematically, "1 decibel" is approximately 10 multiplied by the common logarithm of the ratio, 1.25 to 1.

The factor of 10 enters the picture because the original unit used was the "bel" (named for Alexander Graham Bell), which is the logarithm of 10 to the base 10. The decibel is actually one-tenth of a "bel" and is used in preference to the bel inasmuch as a change of sound intensity of 1 decibel approximates very closely the ratio of 1.25 to 1, which is the minimum change in sound intensity human ears can detect.

The decibel is used widely in audio work because it represents accurately the response of the ear to different intensities and because it can be used over a wide range of intensities. Decibels are used for expressing power ratios, voltage ratios, current ratios, amplifier gain, hum level, loss due to negative feedback, network loss, and loss in attenuator circuits and in transmission lines.

Gain is expressed as plus db; loss as minus db. Ratios between currents and voltages across the same or equal resistors

DECIBEL TABLE

Voltage or Current Ratio (Equal Impedance)	Power Ratio	← − db + →	Voltage or Current Ratio (Equal Impedance)	Power Ratio
1.000	1.000	0	1.000	1.000
0.989	0.977	0.1	1.012	1.023
0.977	0.955	0.2	1.023	1.047
0.966	0.933	0.3	1.035	1.072
0.955	0.912	0.4	1.047	1.096
0.944	0.891	0.5	1.059	1.122
0.933	0.871	0.6	1.072	1.148
0.923	0.851	0.7	1.084	1.175
0.912	0.832	0.8	1.096	1.202
0.902	0.813	0.9	1.109	1.230
0.891	0.794	1.0	1.122	1.259
0.841	0.708	1.5	1.189	1.413
0.794	0.631	2.0	1.259	1.585
0.750	0.562	2.5	1.334	1.778
0.708	0.501	3.0	1.413	1.995
0.668	0.447	3.5	1.496	2.239
0.631	0.398	4.0	1.585	2.512
0.596	0.355	4.5	1.679	2.818
0.562	0.316	5.0	1.778	3.162
0.531	0.282	5.5	1.884	3.548
0.501	0.251	6.0	1.995	3.981
0.473	0.224	6.5	2.113	4.467
0.447	0.200	7.0	2.239	5.012
0.422	0.178	7.5	2.371	5.623
0.398	0.159	8.0	2.512	6.310
0.376	0.141	8.5	2.661	7.079
0.355	0.126	9.0	2.818	7.943
0.335	0.112	9.5	2.985	8.913
0.316	0.100	10	3.162	10.00
0.282	0.0794	11	3.55	12.6
0.251	0.0631	12	3.98	15.9
0.224	0.0501	13	4.47	20.0
0.200	0.0398	14	5.01	25.1
0.178	0.0316	15	5.62	31.6
0.159	0.0251	16	6.31	39.8
0.141	0.0200	17	7.08	50.1
0.126	0.0159	18	7.94	63.1
0.112	0.0126	19	8.91	79.4
0.100	0.0100	20	10.00	100.0
3.16×10^{-2}	10^{-3}	30	3.16×10	10^{3}
10^{-2}	10^{-4}	40	10^{2}	10^{4}
3.16×10^{-3}	10^{-5}	50	3.16×10^{2}	10^{5}
10^{-3}	10^{-6}	60	10^{3}	10^{6}
3.16×10^{-4}	10^{-7}	70	3.16×10^{3}	10^{7}
10^{-4}	10^{-8}	80	10^{4}	10^{8}
3.16×10^{-5}	10^{-9}	90	3.16×10^{4}	10^{9}
10^{-5}	10^{-10}	100	10^{5}	10^{10}
3.16×10^{-6}	10^{-11}	110	3.16×10^{5}	10^{11}
10^{-6}	10^{-12}	120	10^{6}	10^{12}

are also expressed in decibels. In the case of voltages or currents, the logarithm of the ratio must be multiplied by 20. This is because the decibel is basically an expression of power (wattage) which is always a function of the square of either current or voltage. To square a number, you double its logarithm. Thus, in the case of values already expressed as powers (wattage), we multiplied the logarithms of the ratio by 10. But in the case of values not yet expressed as powers, such as voltage or current, we multiply the logarithm of their ratio by 10 doubled, or 20.

We now can state all the above in terms of these simple formulas:

$$db = 10 \log \frac{P_2}{P_1}$$ when P is known in watts.

$$db = 20 \log \frac{E_1}{E_2}$$ when E is known in volts.

$$db = 20 \log \frac{I_1}{I_2}$$ when I is known in amps.

The value of the "common logarithm" (sometimes written as $\log_{10}$) is easily obtained from standard tables that are included in most mathematics and technical textbooks. From then on it's a case of simple arithmetic.

The table on the opposite page is a shortcut aid in determining db gain or loss. It has, in effect, already computed the logarithms of the power (and voltage and current) ratios for you. Notice that the right-hand side (4th and 5th columns) expresses ratios in which there is a gain (1 or higher). The left-hand side (1st and 2nd columns) expresses ratios in which there is a loss (1 or lower). The center column gives you the number of decibels of either gain or loss for a given ratio.

Let us now work a few problems using both the formulas and the table.

Example: What will be the gain in db of an amplifier whose output power rises to 5 times its input?

The formula tells us that for power (in wattage),

$$db = 10 \log_{10} \frac{P_2}{P_1}$$

In this case, P_2 over P_1 is given; it is known to be 5. (In other words, the input might be 2, the output 10, resulting in a ratio of 5 to 1). The log of 5 is approximately 0.7. Multiplying this by 10, we get 7, which is the solution. In other words, this amplifier has a gain of 7 decibels. In practical terms this means that the difference in sound intensity between

the input to the amplifier and the output from it would be heard by the ear as seven times the minimum change in loudness that we could detect.

Now, let us use the table to work this problem. Since there is a gain involved, we refer to the right-hand portion of the table. Since the values are in terms of power (watts), we use the 5th column. The nearest figure in this column to our power ratio of 5 happens to be 5.012. This corresponds to plus 7 in the db column. Again, our answer is plus 7 db.

Let us work a problem using voltages.

Example: What will be the gain in db of an amplifier whose output voltage rises to 9 times its input (across equal resistances)?

Here we must multiply the logarithm of the ratio by 20, since we are dealing with a voltage rather than a wattage value.

The common log of 9 is 0.95. Multiplying this by 20 we get 19 db.

Again, the same answer could be obtained directly from our table. Since a gain is involved we again confine ourselves to the right-hand side of the table. Since our ratio is expressed in voltage, we check down the 4th column. We find that the number of decibels that corresponds most closely to a voltage ratio of about 9 happens also to the 19 db.

As long as this table is available, there is no need for the formulas or for logarithmic values of the ratios. If the table is not handy, though, the formulas and a table of common logarithms will solve any problem.

Let us now take a situation in which there is a decibel loss to be calculated. For example, an amplifier has a negative voltage feedback loop which is intended to reduce distortion at the output. This feedback voltage also reduces the over-all gain of the amplifier. But by how much? Assume that we measure 1.2 volts at the output of the amplifier with its feedback loop in operation. Then we disconnect the feedback loop and find the output measures 12 volts.

Our ratio in this case is 1.2 over 12, or 0.1. We now consult the left-hand side of our table for decibel loss. Since these are voltages we check down the column so headed. We discover that a voltage ratio of 0.1 indicates a 20 db loss. Thus we express the feedback value in this amplifier as minus 20 db.

Conversely, if an amplifier's specifications claim that the circuit incorporates a

minus 20 db feedback loop (or "negative feedback, 20 db"), this means that the output of the amplifier should measure one-tenth the voltage with the loop than it does without the loop.

Another example of decibel loss: Assume that an amplifier has a rated output of 20 watts. We want to determine what its hum level is because in order not to hear the objectionable hum, its level should be very low—maybe 50 db below the rated output of 20 watts. Here's how this is done: We apply a signal to the input of the amplifier and connect a voltmeter across its output terminals, say the 8-ohm terminals. Next we turn up the gain of the amplifier to the point necessary to produce its rated 20 watts output. Since we are using a voltmeter at the output terminals, we must translate watts into volts. From Ohm's Law we know that power in watts is equal to the square of the voltage divided by the resistance. ($P = \frac{E^2}{R}$). Therefore, E equals the square root of $P \times R$. P is 20 and R is 8. Thus E equals the square root of 160 which is approximately 12.7 volts.

Consequently, when our voltmeter—connected across the 8-ohm output terminals—reads 12.7 volts, we have reached the amplifier's rated output of 20 watts. We now disconnect the input signal and short the input. Naturally, the voltage to be expected with no input signal should be quite small. But whatever is present will be noise and hum within the amplifier circuit itself. Again, consulting our voltmeter (still connected at the 8-ohm terminals) we discover that it reads 3 millivolts (0.003 volts).

To determine the number of "minus decibels" the hum level is with respect to the 20 watts output, we must first get our voltage ratio, which is 0.003 over 12.7. This comes to approximately 0.00024. Since we are dealing with a loss in voltage, we consult the 1st column of our table, and we find there is no figure like our 0.00024!

Therefore, we must interpolate. The nearest significant figure to our ratio of 0.00024 happens to be 0.251. This gives us minus 12 db. But our ratio is about one-thousandth, or 10^{-3}, of 0.251. We, therefore, consult the 10^{-3} value in the same column and discover we must add another minus 60 db to the minus 12 we already have. Thus our final answer is minus 72 db. This means the hum level of the amplifier is 72 decibels below its rated output, which puts it well below the level at which it could be heard.

Conversely, this means that if an amplifier is rated at 20 watts output with a hum level of minus 72 db, the actual voltage measured across its 8-ohm output terminals with no signal input should not exceed 0.003 volt.

Three main types of meters are used for measuring db directly, without the need for calculating values by the use of logarithms or the table. The simplest and possibly the most familiar type is the "output meter" or the decibel scale found on many multimeters. This is actually an a.c. voltmeter calibrated to read the number of db that expresses a ratio between the power being fed into the meter and some fixed reference level, usually 6 milliwatts. The meter calibration assumes that the voltage is measured across 500 ohms resistance. This type of meter is used in determining the relative outputs of various audio circuits and is also used in receiver alignment.

The "VU meter" is similar to the output meter, except the reference level is 1 milliwatt in 600 ohms resistance. In addition, the VU meter has time-constant characteristics which determine its response to voltage peaks, such as "sound bursts" or other short time interval peaks. It is widely used in broadcasting and recording studios to monitor the output levels of programs.

A third type of decibel meter is the sound level indicator. This is actually an assembly of a microphone, an amplifier, and an a.c. voltmeter calibrated to provide a db reading which corresponds to human hearing levels. On this meter, zero db represents the threshold of hearing. This meter is used by acoustics technicians to determine hearing conditions in auditoriums and theaters.

In summary, the decibel is used to express any ratio of power, voltage, current, acoustic energy, etc. whether it be a gain relationship or a loss. It can be used to express the range of a symphony orchestra and then to determine how much amplification is needed to carry the music across lines of certain distance in order to fill a hall of a certain size or cut a particular recording. Any type of gain or loss in any circuit may be expressed in decibels which provide a quick and accurate key to the operating conditions of the circuit. The advantage of using decibels is that it permits the simple addition of ratios to obtain complete gain and loss data whereas using *E*, *I*, or *P* ratios would involve multiplication and division. For example, it is easier to add 25 db and 36 db than it is to multiply the corresponding gain figures of 316.2 and 4000, to get the total gain of two amplifiers in cascade. —30—

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The following interesting and informative booklets have been prepared for the readers of the ELECTRONIC EXPERIMENTER'S HANDBOOK. They are offered without cost or obligation. Simply circle the identifying numbers of the specific booklets you desire on the coupon. Indicate your name and address clearly, and mail coupon to the address given.

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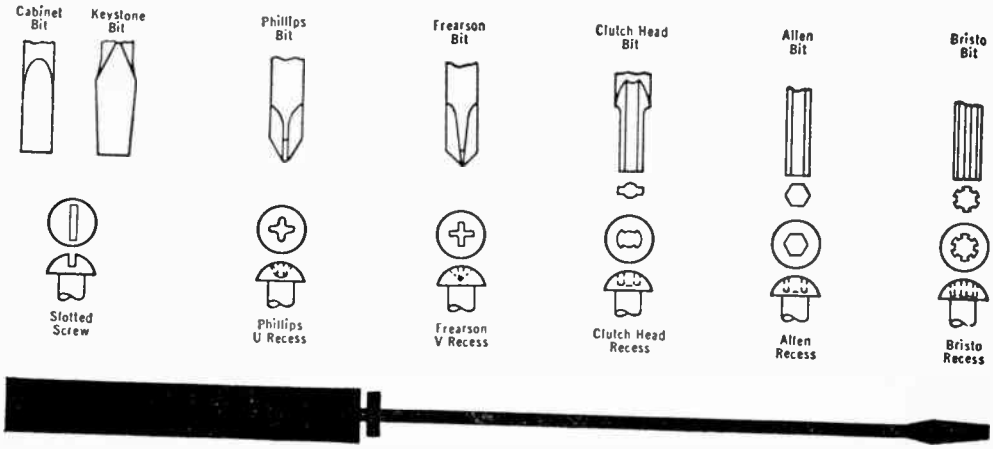

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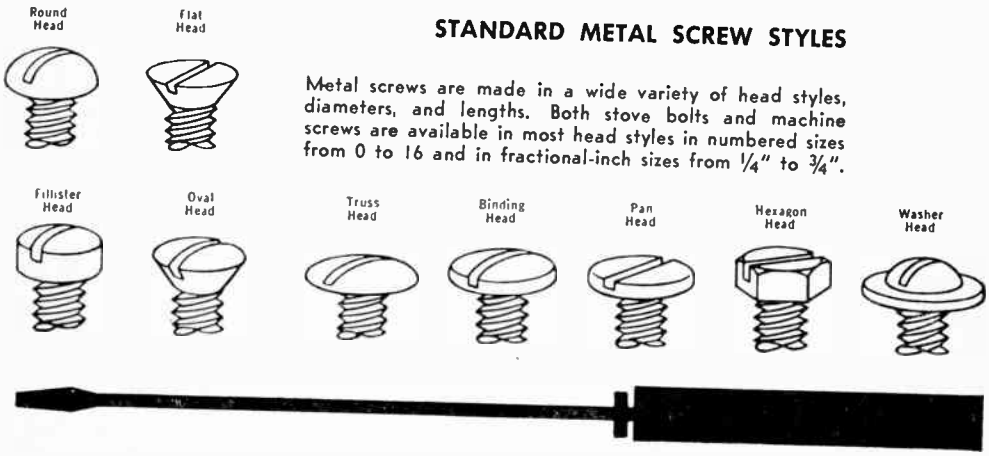
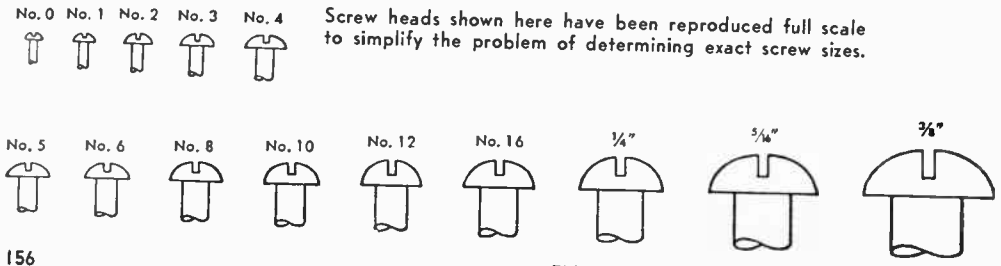


Metal screws are made in a wide variety of head styles, diameters, and lengths. Both stove bolts and machine screws are available in numbered sizes from 0 to 16 and in fractional-inch sizes from 1/4" to 3/4".

SIZE IDENTIFICATION CHART FOR METAL SCREWS



Screw heads shown here have been reproduced full scale to simplify the problem of determining exact screw sizes.

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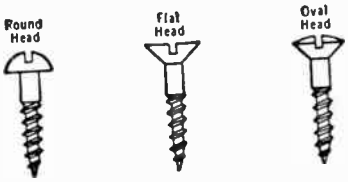

Wood screws are available in a wide variety of diameters—from No. 2 to No. 8—and lengths of from 1/4" to 4".

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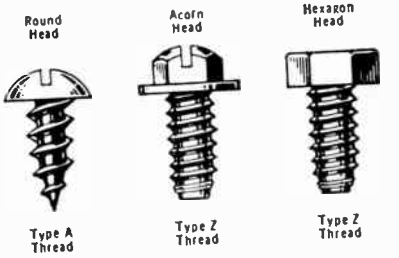

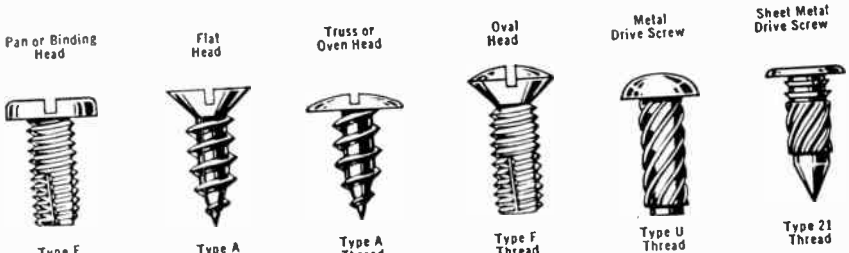

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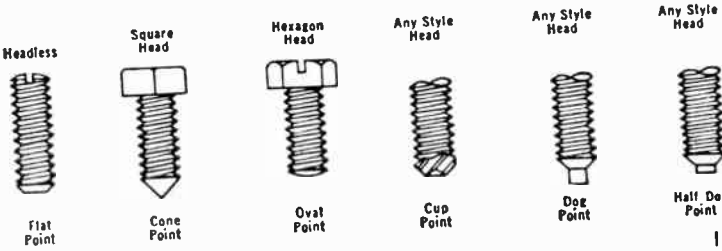


Courtesy of Vaco Products Company, Chicago, Ill.

Capacitors in Series And Parallel

IF YOU wire capacitors in series or in parallel, you will be able to get some odd values of capacitance or some values that you don't already have on hand.

For example, consider what happens when two or more capacitors are connected in parallel. This effectively increases the area of the plates used and hence increases the total capacitance. As a matter of fact, the total capacitance is equal to the sum of the individual capacitances as shown in (A) below. For example, if an 8-μf. capacitor is shunted by a 16-μf. unit, the total capacitance is 24 μf.

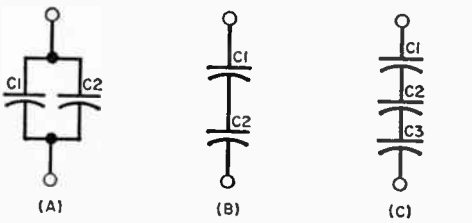
When capacitors are wired in series, the charge must be divided among the individual capacitors. Under these conditions the total capacitance is lower than the smallest series capacitor. See part (B) below. With only two capacitors, the total capacitance is equal to the product of the two values, divided by their sum. If the 8-μf. and 16-μf. units mentioned above were to be wired in series, for example, their total capacitance would be 5.3 μf.

With three capacitors in series, the formula shown in part (C) below is used. As an example, assume that a 4-μf., an 8-μf., and a 16-μf. capacitor are all wired in series. The total capacitance of these three units would then be 1, divided by $\frac{1}{4} + \frac{1}{8} + \frac{1}{16}$, or 2.3 μf.

Sometimes capacitors are wired in series, not to reduce the over-all capacitance so much as to increase the voltage rating of the combination. For example, assume that two 16-μf., 350-volt capacitors are connected in series. The total capacitance is now only 8 μf.; however, the combination will be able to handle 700 volts before breakdown occurs.

30

$$C_{TOT} = C1 + C2 \qquad C_{TOT} = \frac{C1 \times C2}{C1 + C2} \qquad C_{TOT} = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3}}$$



(A) (B) (C)

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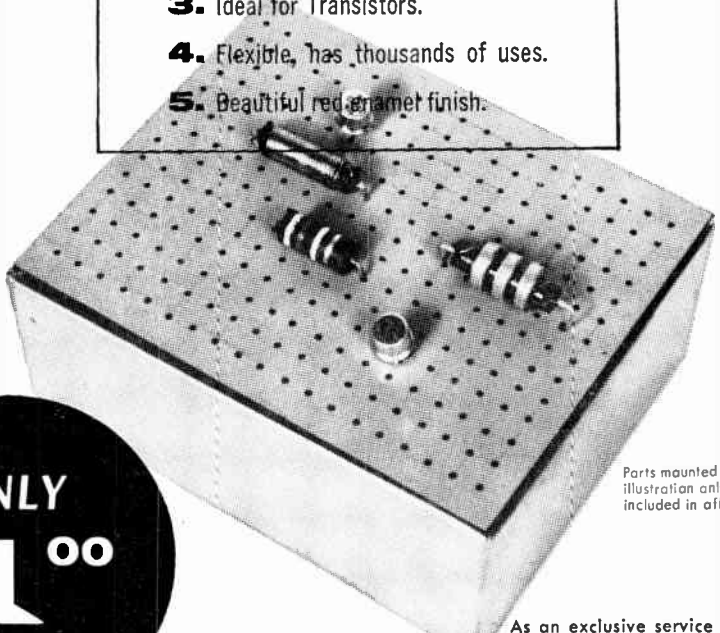

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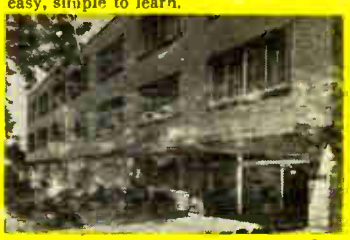

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