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POPULAR ELECTRONICS

MARCH
1956

25
CENTS

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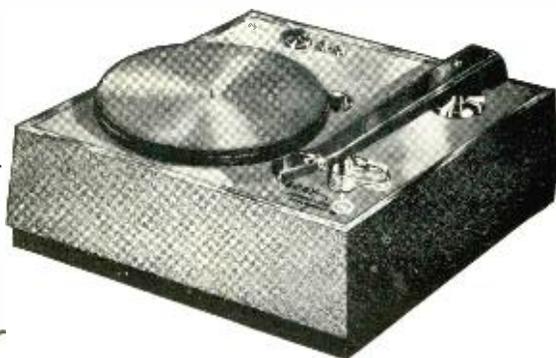
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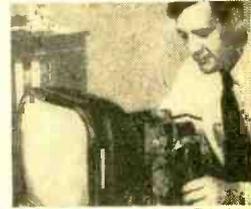
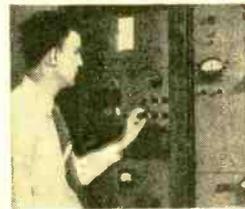
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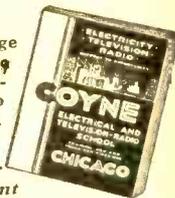
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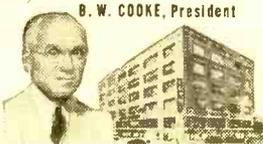


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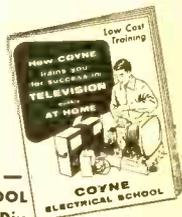
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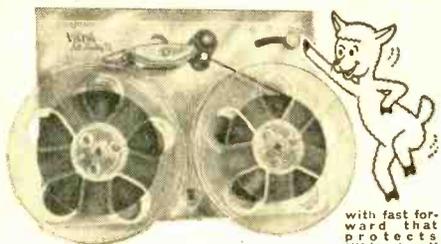
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Radar on the Highway

The facts on "radar speed traps"—how accurate they are and how they are handled.

Electronic Realism at Disneyland

Equipment used behind the scenes at Disneyland to produce realistic sound.

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■ Short-Wave Listening ■ What's New ■
How It Works ■ How to Make It ■ How to
Use It ■ Carl & Jerry ■ Tips & Techniques

IN THIS MONTH'S RADIO & TELEVISION NEWS

(March—Special Service Feature Issue)

Guided Missiles—Maintenance
Color TV Trouble in Black and White Sets
Transistor Servicing Precautions
The Art of Pulling a Chassis
Tube Inventory for Service Shops
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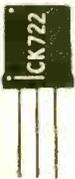
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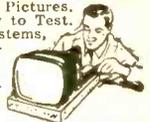
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*"Mylar" is a DuPont registered trademark.



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The term "SCOTCH" and the plaid design are registered trademarks for Magnetic Tape made in U.S.A. by MINNESOTA MINING AND MFG. CO., St. Paul 6, Minn. Export Sales Office: 99 Park Avenue, New York 16, N.Y.

LETTERS FROM OUR READERS

Metal Locator Sensitivity

■ I have been looking for a way to boost the penetrating power of your metal locator (June, 1955, issue, p. 47).

WILLIAM T. SHAW
Shreveport, La.

Sorry, Bill, but there's no really simple way of boosting the sensitivity of that particular model. If you want to search down to 10 or 15 feet, it will require a locator similar to the Type MA distributed by Fisher Research Laboratory, 1961 University Ave., Palo Alto, Calif.

Underwater Detector

■ I need to search for fishing and hunting equipment under water. Can I use your metal locator (June, 1955, issue)?

M. D. BURR
Centralia, Ill.

Possibly you could make use of this device, but the difficulties involved in waterproofing the oscillator housing, search coil, etc., would be tremendous. We would suggest contacting Bludworth Marine, 92 Gold St., New York 38, N. Y., for information on the Model UML-2 underwater metal locator which was mentioned several times in Life magazine.

12" Speaker in \$2 Baffle

■ I wonder if a 12" speaker will work in the \$2 speaker enclosure described in your November issue?

L. H. DWORETZKY
Valhalla, N. Y.

■ My speaker is a G.E. 1201A. Can I use it in the \$2 baffle?

JOHN B. KILLORAN
Flushing, N. Y.

■ Am interested in purchasing a G.E. 1203-A. Could I design the enclosure one-third larger?

PETER MOOD
Dallas, Texas

■ How do I calculate dimensions for a 12" speaker?

RICHARD YOUNGKIN
Meadville, Pa.

Please, fellows, we're sorry! Next time we'll get a "universal" design for all sizes of speakers. The \$2 baffle was designed to be cut from a single 4' x 4' piece of Celotex. It will not hold a 12" speaker. Probably it can be designed one-third larger, although we have no way of knowing how well it would perform. Look for a low-cost 12" baffle in our next issue. Believe it or not, it'll work better than the labyrinth baffle.

Protect Bandspread Capacitor

■ It might be a good idea to shield the variable capacitor used in WIFSN's article ("More Band-



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I would like complete facts including "89 Ways to Earn Money in Television-Radio-Electronics."

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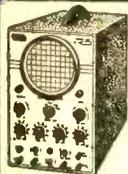
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Occupation

spread with the SW-54", Dec., 1955) with a Mini-
box. This would reduce the drift caused by hand
capacity.

AL KARP, WN1GIS
Chelsea, Mass.

Saturable Reactors

■ I think Mr. Katona ("Letters to the Editor,"
Oct., 1955) would be interested in reading the
book by Leonard R. Crow titled, "Saturable
Core Devices." It is published by Scientific Book
Publishing Co., 500-30 South 4th St., Vincennes,
Ind.

AE3 CHARLES NOLLE
NAS, Jacksonville, Fla.

Good Results with \$2 Baffle

■ This is a photo I snapped while my "assistant"
fitted together the \$2 baffle. I am pleased with



the results and would like to see more material
on this level.

WELDON W. SHOWS, JR.
Baylor University

*How come you built it as we said? Every-
body else wants to put in a 12" speaker (see
p. 10). Anyhow, we're glad you liked it. Look
for a great many more ideas on the how-to-do-it
level by our cost-conscious editors.*

Inquiries? ? ?

■ I have obtained a transformer with the manu-
facturer's number 52C204 on it. Please send me
specifications.

(Name withheld)

*Many thanks for your high opinion of our
perceptive powers, but honestly Mr. _____, did
you really think we could answer this one?*

Case of the Missing "R"

■ In your "Carl and Jerry" (January, 1956, page
103), that emergency call QRR should have been
QRRR. Tell Mr. Frye that QRR now has a differ-
ent meaning.

DAVE EDDLEMON, K5DIR
Dallas, Texas

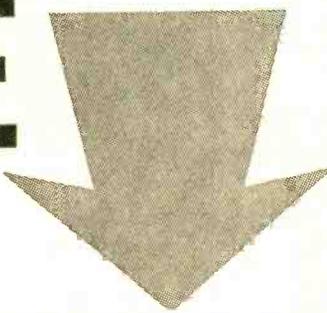
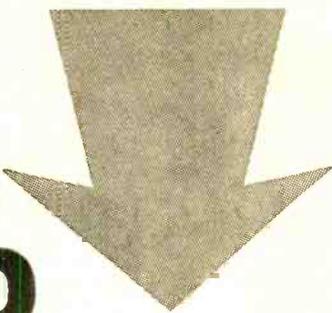
*You're right on the ball, Dave, for QRRR
would have been proper. It is the official ARRL
"land SOS" call.*

Increasing "Regenode" Sensitivity

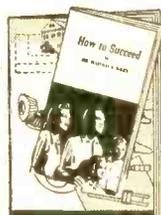
■ Readers may be interested in my further ex-
periments with the "Regenode" receiver (page 51

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of the January, 1956, issue). I have found in weak signal areas (broadcasting stations more than 25 miles away) that increasing the value of the screen resistor *R2* from 33,000 ohms to 270,000 ohms, and simultaneously decreasing *R5* from 470,000 ohms to 270,000 ohms, will double the sensitivity. Readers close to broadcasting stations should not attempt this modification as it may make the receiver unstable.

FRANK H. TOOKER
Lakehurst, N. J.

Photo Flash Guns

■ I am most interested in obtaining further information on electronic flash gun circuits.

MAX B. GRATZ
Santiago, Chile

■ I would like to combine my photography hobby with electronics, and am interested in building an electronic flash unit.

ALBERT DEINER
Baltimore, Md.

We have nothing scheduled for the immediate future on the topic of electronic flash guns. However, we strongly recommend that all readers interested in flash guns read the January, 1956, issue of our sister publication POPULAR PHOTOGRAPHY. Note especially the article by Bob Schwalberg on electronic flash guns.

Garage Door Opener

■ Can we see something new and unusual in a radio-controlled garage door opener?

CARL CONTI
Burlington, N. J.

The editors have never been too happy with the garage door opener article published a number of months ago. We are in contact with two designers that promise some very interesting and novel approaches to this problem and hope to publish full details within the next few months.

Wire to Tape? ? ?

■ Is there some way I can convert my console wire recorder to a tape recorder?

HENRY TOON
Cincinnati, Ohio

This conversion would appear to be a little too extensive for the average reader even to contemplate. It would mean revamping the mechanical arrangement, and adding new record and erase heads, as well as new bias supplies. Undoubtedly it can be done, and we would like to see an article on the subject. Any volunteers?

More "Phonogenic Music"

■ I have just finished reading the Fantel article, "Selecting Your 'Phonogenic Music'" (January, 1956, page 87), and find that it has really helped me in getting the right type of records. I called the record store to order the ones mentioned, and I sure would like to see a follow-up article.

GEORGE BONITO
New Bedford, Mass.

That's fine, George. We liked those recommendations ourselves. We'll take a look to see if there isn't a lot more to say on the subject. —30—

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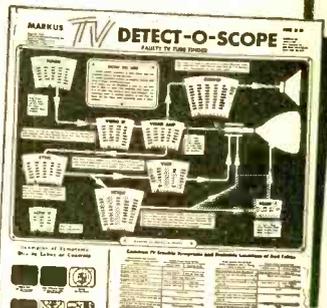
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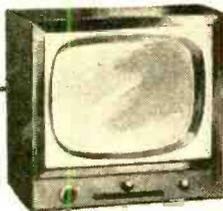
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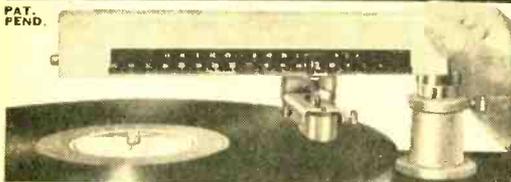
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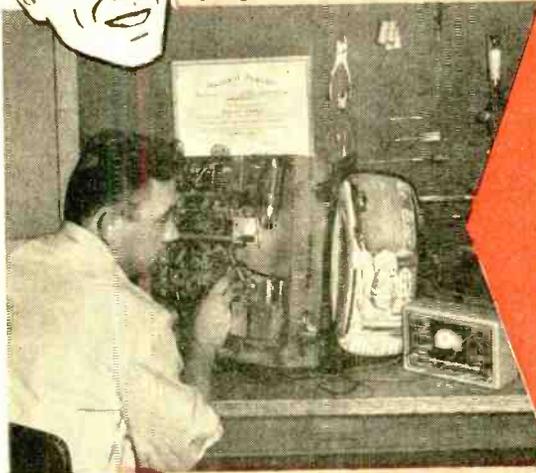
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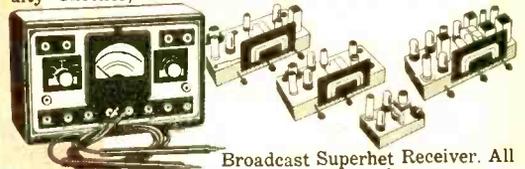
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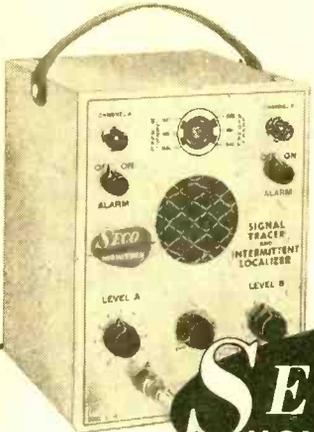
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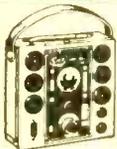
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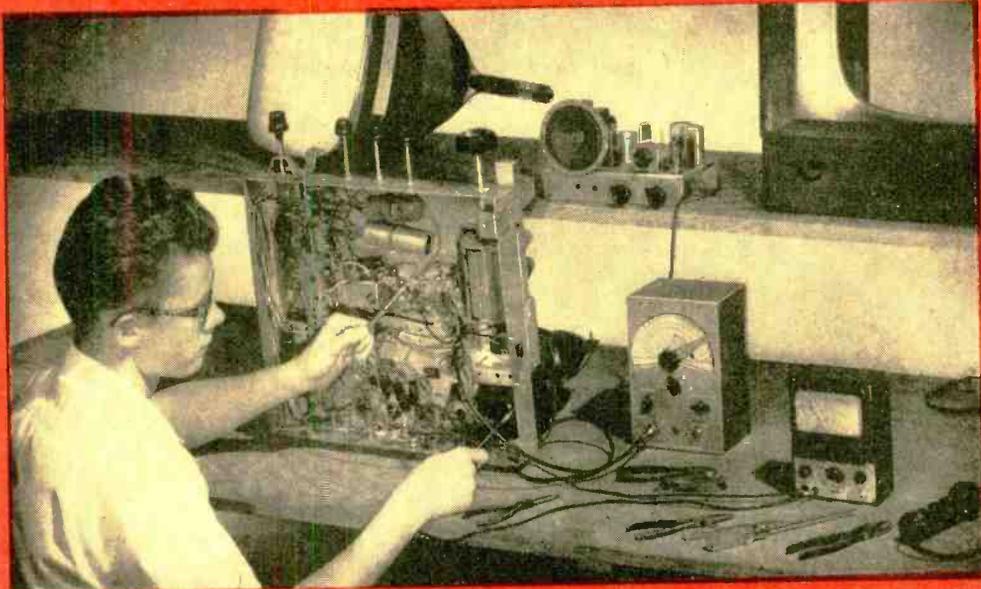
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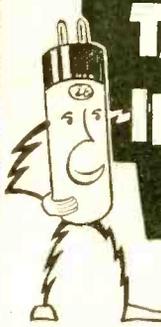


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REMEMBER "AUDREY?"

Some time ago I saw a newspaper item about a device called "Audrey." It was supposed to work with a telephone. What was it?
DON CAMPBELL
Utica, N. Y.

The name "Audrey" was coined by Bell Telephone Laboratories to identify its "automatic digit recognizer." This was a sensitive device



that determined which of ten numbers from 1 through 0 had been spoken into an ordinary telephone. It responded by flashing an appropriate light, as can be seen in the photo. At the time that the development of this device was announced, the Bell Labs people hoped to use it in conjunction with their telephone dialing operations.

THE LOWLY FUSE

A short time ago, I became involved in an argument with some engineers on the operation of the "lowly fuse." It all started over a 1/16-amp. fuse in a 250-volt d.c. circuit. I had asked if a fuse rated at 125 volts, 1/16 amp., would hold in this same circuit.

It is my contention that a fuse will pass a determined amount of power. When this limit is exceeded, the fuse element heats, melts, and opens the circuit. If the above is correct, would it not follow that a 250-volt, 1/16-amp. fuse would carry 1/8 amp. at 125 volts? Also, wouldn't a 125-volt, 1/16-amp. fuse carry 1/32 amp. at 250 volts?

A few of the engineers (university graduates) stated flatly that I was wrong, but could not definitely say why. One of them said that a fuse, for all intents and purposes, has no resistance,

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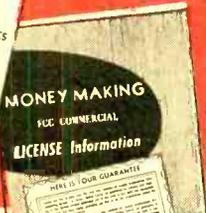
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and that the heating is caused by the mere "presence" of the current. But he could not explain how the "presence" of current in a very nearly perfect conductor could cause the conductor (fuse element) to melt. Apparently the resistance has nothing to do with it, and the voltage applied to the fuse is of no consequence (considering only the fuse itself and not the circuit), except in extreme cases where a high enough voltage would arc across the ends of the fuse case.

D. J. EARL
Montreal, Canada

Fuses are used in electrical circuits for protection against excessive current, not voltage. A fuse rated at 1/16 amp. will blow when more than 1/16 amp. flows through it, regardless of the voltage in the circuit. In general, the length of the fuse—or the length of the fusible element—is a function of the voltage. Greater length is required for higher voltages to prevent arcing across the fuse.

There is, of course, some power lost in the fuse in the form of heat. It is this heat which melts the fusible link when the fuse is overloaded. However, this power loss is a function of current only, and not of the circuit voltage. A fuse has a finite resistance, although very small, and the power consumed in it can be calculated by the formula:

$$\text{Power} = I^2R$$

where R is the resistance of the fuse in ohms and I is the circuit current in amperes. Thus,

circuit voltage does not enter into the picture.

To answer your questions specifically: a 1/16-amp. fuse will blow if 1/8 amp. of current flows through it; and a 1/16-amp. fuse would not properly protect a 1/32-amp. circuit.

MODULATING C. W. TRANSMITTERS

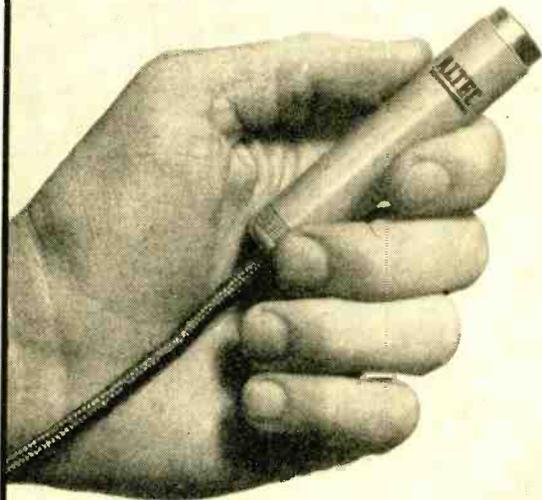
I would like to know if any c.w. transmitter can be turned into a voice transmitter by connecting a modulator into the key jack. If so, which ones may or may not be turned into voice transmitters? If not, could you run a series of articles which would tell how to build a different part of a General Class transmitter each month until one complete transmitter is built?

FRANK DUNN
Cleveland, Ohio

Very few transmitters designed for c.w. operation can be transformed into voice transmitters by connecting a modulator to the key jack. Transmitters which can be used in this fashion are then known as cathode-modulated transmitters. This is not a preferable form of modulation since it does not permit the operator to use the full power of his equipment. Plate modulation is probably the most desirable and widely used form of amplitude modulation.

We have had one of our staff members design a modulator for use with transmitters of from 15 to 40 watts. An article describing this modulator, and including a pictorial wiring diagram, will appear in an early issue. —30—

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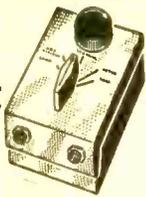
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R. F. Amplifier Pentode
6.3 Volts—3 Amps

STOCK NO. Z-223
EACH **5¢**

Sold Only in Factory Sealed Carton of 50...\$2.50

Brand new in original factory packing, one tube to a carton, 50 to a case. Stock up on this Regular \$2.80 1st tube at a nickel a piece. Manufactured by Tung-Sol, RCA and General Electric. Shpg. wt. carton 5 lbs.

NEW SENCO TUBE CHECKER

Stock No. **\$275**
TE-80



A must for servicing new series filament TV sets. Automatically checks all filaments including local and P I C T U R E tubes. Has built-in lamp and can be used as continuity and voltage tester too. Simple to use. Just plug tube into tester, if neon light glows, filament is good. In factory packed cartons. Shpg. wt. 2 lbs.

"GOLDEN GATE" 8" SPEAKER



With "Whizzer"
Sound Disperser

STOCK NO. S-229
List Price \$12.50
Olson's Price, Ea. **\$4.95**
2 for \$9.50

Finely finished in all gold lacquer. Dealers, order these speakers for installation where space is a factor. Will outperform many 12" units. Employs two concentrically mounted cones for extremely smooth reproduction at high or low volume. Small cone in center of large cone is called a "Whizzer" and provides extended treble response, good overall balance and wide dispersion angle. Equipped with heavy Alnico 5 magnetic core. Power handling capacity 8-10 watts. Response 40-12,500 cps. Speaker cone 8" diameter, voice coil 8 ohms. Shpg. wt. 3 lbs.

PANEL METERS

DC Ammeter—Records Charging Rates
Choice of 2 Movements

STOCK NO. 10-A-8
TE-8P

49¢ EA.

STOCK NO. 10-A-2
TE-82
20 AMP.

6 FOR \$2.00
MAY BE ASSORTED

Brand New! Now available at less than manufacturing cost. Sturdy meters with shock resistant movements. Screw terminals and solder lugs. 2" Diameter. Handsome enamel finish. Choice of 10 or 20 Amp movements. Comes in 4 colors, read OFF-CHARGING—DANGER. Shpg. wt. 1 lb.

NEW CRYSTAL SET KIT



STOCK NO. KB-1

\$150 KIT

New—Uses GE Germanium Diode

Easily assembled by even a child in minutes. Contains variable iron core tuned coil and knob, bypass condenser, variable padding condenser, 1N-64 General Electric Diode Detector, phone clips and transparent hinged case. Covers complete frequency range from 400 to 3000 KC which permits reception of local weather stations, aircraft beacons, standard broadcast, police calls, amateurs, aircraft and many others. Unique design still permits complete coverage of standard broadcast only, if desired. Supplied complete with all parts and detailed illustrated instructions, less only wire and solder. For best results use headphones listed right. Shpg. wt. 2 lbs.

COMPACT DRAWING SET



5-Piece Precision Construction

REG. LIST \$3.00
STOCK NO. X-579, **99¢** SET

Special—3 Sets for \$2.75

Pocket size drawing set for draftsmen, engineers, students and hobbyists. Contains large 4 1/2" bow compass with both ruling pen and pencil attachments. 4 1/2" ruling pen with sturdy black enameled handle, adjustment screw-driver and lead box. All parts except pen handle are bright nickel plated. Housed in felt lined two flap case. Shpg. wt. 1 lb.

5-in-1 STAG SCOUT KNIFE



STOCK NO. X-586 **99¢** EA.

REG. LIST \$1.95 • SPECIAL—3 FOR \$2.50
Standard size outdoor knife has can opener, reamer, 2 1/2" master blade, and combination cap lifter-screwdriver. Polished razor sharp steel master blade, scientifically heat treated and hand etched. All riveted construction with special Nuloy bolsters. Simulated stag handle for easy and positive grip. Size when closed 3 3/4 x 3 3/4 x 3/4". Shpg. wt. 1 lb.

TELEPHONE SET



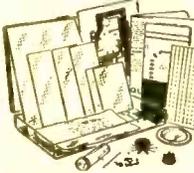
Sound Powered
Includes Headset
and Microphone

Stock No. **\$395**
M-98 SET

2 Sets for \$7.50

Brand New—original cost \$30.00. No batteries needed—self powered. Permits 2-way talking up to 25 miles over any two-wire circuit. Each set contains a pair of sound powered high impedance dynamic headsets with felt padded rubber cushions and leather covered head-band. Both microphone and earphones have cone diaphragms and are extremely rugged and sensitive. Units may be removed from headsets to make efficient high powered miniature speakers. Useful for Antenna Installations where beaming of antenna is critical. Shpg. wt. 5 lbs.

PRINTED CIRCUIT KIT



Stock No. KB-27

EACH

\$375 KIT

The latest marvel of electronics—now you can easily make your own printed circuits. Includes enough material to make several printed circuits of your own design. In addition, two circuit patterns are included to help you learn the techniques of printed circuitry. Kit consists of: 3 copper laminated boards, 2 1/2 x 3", 4 1/2 x 3" x 2 1/2"; one each of 7 and 9 printed circuit sockets, one packet etchant; etching tray; tape resin; eyelets for terminals; one 100, 52 drill; terminal holes; and complete illustrated instructions explaining theory use and construction. Shpg. wt. 3 lbs.

PHILMORE TRANSISTOR BATTERY RADIO KIT



STOCK NO. **\$585**
KB-12 KIT
Reg. \$9.75—3 for \$16.50

Germanium Diode crystal detector combined with transistor audio amplifier stage to provide loud, clear reception of your local radio stations. One single standard 1 1/2 Volt penic cell supplies all of the power and will last almost indefinitely. Perfect gift. Special high efficiency coil and variable condenser assure sharp tuning. Designed for use with double 2,000 ohm headphones (see below). Housed in an attractive plastic case—3 3/4" x 2 1/2" x 1 1/8". Weighs only 4 oz. with battery. Supplied with detailed, illustrated assembly instructions, from which anyone can build and complete this set within a few hours. Solder, hookup wire, headphones and battery not supplied. Shpg. wt. 2 lbs.

2000 OHMS HEADPHONES

STOCK NO. X-542.....Pr. \$1.95

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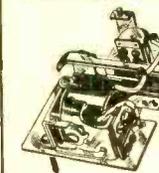


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\$1.99 3 FOR \$5.00 EA.

Signal Corps No. BC-709. Brand new in factory sealed cartons. Original cost \$12.00. Contains a wealth of valuable parts including 5 x 2 1/2 x 8" aluminum case, 354 tube, socket, condensers, resistors, 4 jacks, input and output transformers, battery holders, etc. For operation on 2 flashlight cells and one 67 1/2 Volt battery. Ready to operate or can be rewired for many other uses, such as: baby-sitter, amplifier, SW or BC receiver, transceiver, crystal set audio amplifier, etc. The polished aluminum case alone is worth more than the \$1.99. Get yours—while they last. Circuit diagram and instruction book included. Shpg. wt. 5 lbs.

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Brand New—Original Cost \$11.50
STOCK NO. SW-67

69¢ EA.
3 for \$2.00

Here's an unusual buy in a relay that will serve many useful purposes. Contains 2 relays. When current is applied to No. 1 relay a lever engages a brass piston which is driven along a precision track. After travelling 1/2" the piston automatically switches Relay No. 2 which returns piston to original starting position. Ideal for tripping lens shutters, operating micro switches, marking any light object 1 1/2" by remote control. Operates on 15 to 24 Volts DC. In transparent case. Size 4 x 4 x 3". Shpg. wt. 2 lbs.

Miniature Electric Motors



STOCK NO. **\$1.19**
X-403 EA.

3 for \$2.95

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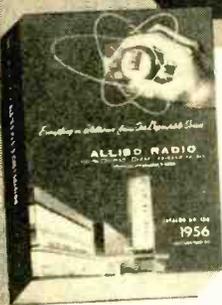
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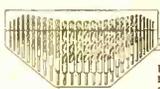
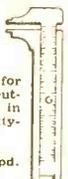
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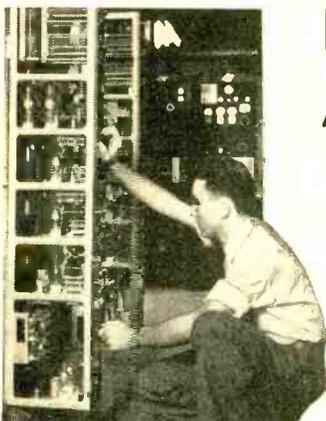
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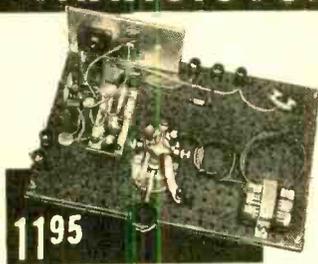
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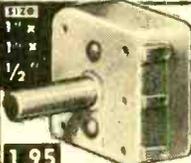
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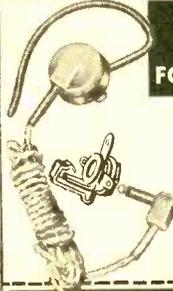


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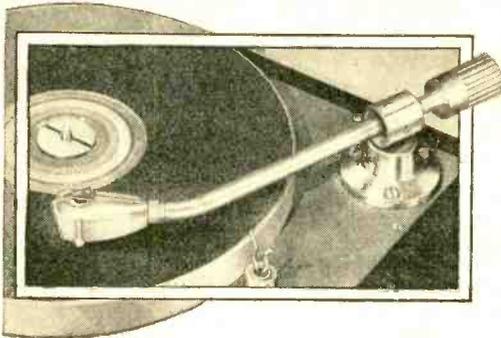
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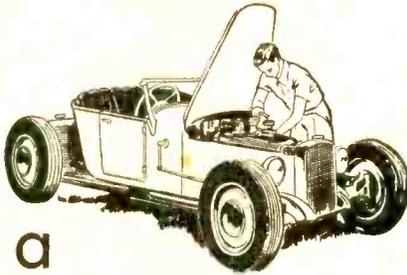
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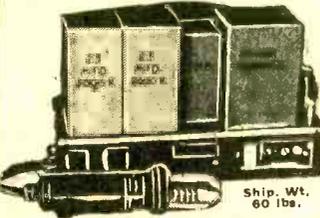
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\$165

2 MFD. 3000 VDC. Pyranol Oil w/ Mounting Brackets.
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Pri. 5000 ohms output SEC.
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#2 600 ohms sidetone 15 to 15,000 cy. flat. **\$1.95**

This Month's Cover

Ektachrome Photograph
by Maynard Frank Wolfe

THE portable device being tested by the gentleman in this photo is the new Sprague Electric Co. interference locator. Since it is completely self-contained, it can be used in a stationary or moving automobile, carried in field tests by a handle or shoulder strap, or mounted with other equipment in a truck designed for this work.

Interference location is rapidly becoming an important subsidiary operation of electric utility companies. Serious interference to broadcast and TV services can be created by faulty power lines. In an effort to help the utilities locate such interference rapidly, Sprague has developed its Model 400 receiver-locator.

The Model 400 can be tuned to any frequency between 500 kc. and 220 mc. This embraces practically all of the major AM, FM, and TV broadcasting channels, plus short-wave, police, taxi, industrial, and other channels.

To establish the source of incipient power line faults, the Model 400 can be used with a directional loop antenna. A special dipole is attached to the locator for v.h.f. coverage. The internal collapsible rod antenna is used for the broadcast and short-wave bands. In areas of extreme interference, the antennas are replaced by a probe carried in the hand and fed to the receiver by protective coaxial cable.

Audio frequency interference can also be located with the Model 400 by using a special probe. This unit is a search coil that responds to magnetic fields.

In all cases, the degree of interference may be measured on a built-in meter, monitored by a built-in speaker or with external headphones. Internal batteries can be recharged by simply plugging the receiver into the 117-volt power lines. Completely discharged batteries are fully recharged overnight.

Those of you who may be wondering why we have said so much about this piece of equipment will, we hope, find such information valuable—and will appreciate the fact that the unit was designed at the request of many power companies so that you might have better radio and TV reception.

HERSHEL RADIO CO. 5249 GRAND RIVER
Detroit 8, Michigan
Phone TR 8-9400

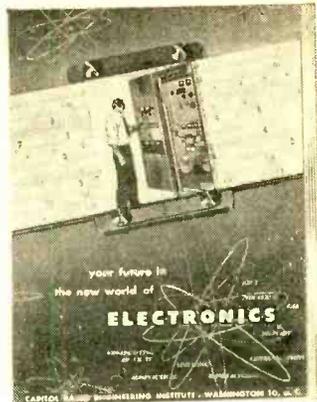
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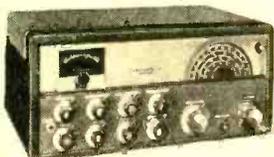
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**22 years experience
guarantees the best
in every price range**



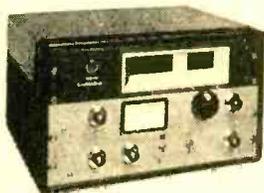
*model SX-100
AM-CW-SSB
receiver
\$295.00*

"Tee-Notch" Filter provides a stable non-regenerative system for the rejection of unwanted heterodyne in SSB. The "Tee-Notch" also produces an effective steepening of the already excellent 50 mc i-f pass band. Upper or lower side band selectable by front panel switch. Notch depth control for maximum null adjustment. Antenna trimmer. Plug-in laboratory type evacuated 100 kc quartz crystal calibrator—included in price. Second conversion oscillator crystal controlled—greater stability through crystal control and additional temperature compensation of high frequency oscillator circuits.



*model HT-30
AM-CW-SSB
transmitter/
exciter
\$495.00*

Built in V.F.O. reads directly in kilocycles. V.F.O. stability is equal to most crystals—.009%. There are also provisions for 1 crystal for fixed frequency operation. Selective filter system is same used by commercial communications companies for reliable sideband selection to assure continued suppression of unwanted side band energy (down 40 db or more) and distortion products. New 50 db range meter for constant monitoring of r-f output and carrier suppression. Voice control system built in with adjustable delay and anti-trip features. Front panel controls allow selection of AM, CW, and upper or lower side band.



*model HT-31
AM-CW-SSB
linear power
amplifier
\$395.00*

Continuous frequency coverage from 3.5 mc to 30 mc. Pi-network output for efficient harmonic and T.V.I. suppression. Major T.V.I. suppression built in. Does not require an antenna tuner as will feed loads from 50 to 600 ohms. Full metering of all important circuits, including input in watts. Employs two 811-A zero bias triodes in parallel. The input system is designed to be fed from a 50-70 ohm unbalanced line and requires a maximum of 10 watts drive on 80 meters. The grid tank circuit is balanced to provide all band neutralization.



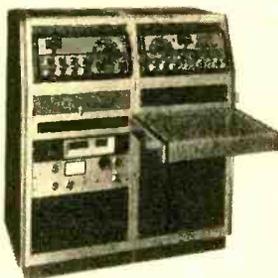
*model SX-96
AM-CW-SSB
double conversion
selectable
side band receiver
\$249.95*

Precision gear drives are used on both main tuning and band spread dials. Double conversion with selectable crystal controlled second oscillators. Selectable side band reception of both suppressed carrier and full carrier transmissions by front panel switch, delayed AVC, CW operation with AVC on or off. Has calibrated bandspread. Double conversion superheterodyne over the entire frequency range. Automatic noise limiter operated from front panel. Carrier level indicator calibrated in "S" units from 1 to 9, decibels to 90 db over S9, microvolts from 1 to 1000 K.



*model SX-99
AM-CW receiver
\$149.95*

Over 1000° of calibrated bandspread over the 10, 11, 15, 20, 40 and 80 meter amateur bands on easy-to-read dial. Separate bandspread tuning condenser, crystal filter, antenna trimmer, "S" meter, one r-f, two i-f stages and new styling. Complete front panel controls: antenna tuning, sensitivity, band selector, main tuning, bandspread tuning, volume, tone, standby, selectivity, crystal phasing, noise limiter.



*model SR-500
complete amateur
radio station
\$1495.00*

A complete radio station in a handsome console cabinet—transmitter/exciter, linear power amplifier, receiver—affording the finest in V.F.O. or crystal. SSB, AM and CW transmission and reception. You need supply only the antenna, microphone and AC power. All the wiring is complete, and external connections are provided for antenna and microphone. A special communications speaker is positioned above the operating shelf. Console is mounted on casters. Three blank panels provide for installation of additional equipment.

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Chicago 24, Illinois

TRANSISTOR PROJECTS FOR THE BEGINNER

You can put transistors to work with these five circuits



PART I

By Louis E. Garner, Jr.

IT'S only a few years since transistors were heralded as the electronic wonders of the future, but that future has moved in with a rush. These surprising crystals—popping up in new commercial applications every day—have started to compete with vacuum tubes in real earnest. Whether you are interested in electronics as a professional, an experimenter, or a casual hobbyist, the time has arrived to make friends with transistors.

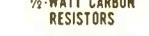
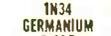
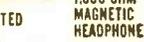
This series of easy-to-assemble projects is designed to demonstrate basic applications at minimum cost. The circuits are constructed from a handful of standard, inexpensive parts and because of the knock-down construction you can use most of them over and over. Whether you build one or all these projects, you will get a better feel for transistor circuitry and operation.

The projects, however, aren't just demonstration circuits; each one is a practical device that is interesting to assemble and fun to use.

Getting Ready. To simplify assembly, the projects are put together breadboard-fashion on a chassis of perforated Masonite. Parts are mounted with machine screws and nuts to eliminate the labor of chassis design and redesign.

Mount standard rubber feet in the corners of the 8" by 12" Masonite panel. The feet will provide clearance for the mount-

PARTS LIST

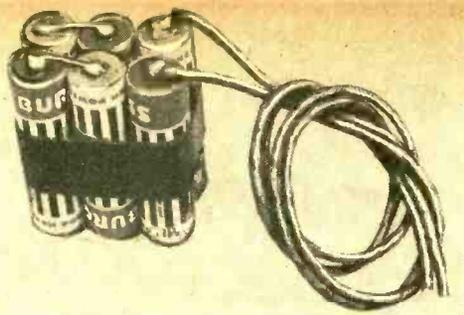
- | | | | |
|---|---|---|--|
|  | TR1
N-P-N
JUNCTION TRANSISTOR
TYPE 2N35 |  | 5-PIN
SUBMINIATURE
TUBE SOCKET |
|  | C1, C2
.01 μ F. |  | C4
50 μ F. |
|  | C6
.005 μ F. |  | R2 10,000 OHMS |
|  | R3 4,700 OHMS |  | R1 |
|  | 1/2-WATT CARBON
RESISTORS |  | 1N34
GERMANIUM
DIODE |
|  | S.P.S.T.
SLIDE SWITCH |  | SP1
TYPE
B2M
SELENIUM
PHOTOCELL
("SUN BATTERY") |
|  | R1
1-MEGOHM
POTENTIOMETER
(LINEAR TAPER) |  | C3
0.1 μ F.
PAPER
CAPACITOR |
|  | L1
TRANSISTOR ANTENNA COIL
(LAFAYETTE NO. MS-166) |  | C5
365- μ F.
MINIATURE VARIABLE
CAPACITOR (LAFAYETTE
NO. MS-215) |
|  | B1
9-VOLT BATTERY
(SEE TEXT) |  | 8" x 12" PERFORATED
MASONITE PANEL |
|  | STANDARD
KEY |  | 1,000-OHM
MAGNETIC
HEADPHONE |

ing screws and keep the chassis from slipping while you're wiring the parts.

Make up a 9-volt power supply by fitting six penlite cells into standard clips or taping them together as shown at the right. Connect the cells in series by soldering short leads from the cap, or positive terminal, of one cell to the negative outer shell of the next. Use 8" wire lengths for the two end connections so you can hook the power supply into the circuit. If you have taped up your power pack, you also have to bend an aluminum strap around it to serve as a chassis hold-down.

While you're about it, make another scrap-aluminum bracket as shown in the project photos and at the top of the next page. Drill it to take a 5-pin subminiature tube socket for the transistor and a 3-lug terminal strip. Wire the terminal lugs to the first, third, and fifth socket pins as shown. You can then make—and unmake—connections directly to the lugs without any risk of damaging the fragile socket or transistor leads.

Still another bent-aluminum bracket will come in handy as a "control panel." Drill $\frac{3}{8}$ " shaft-clearance holes so you can mount a tuning capacitor or potentiometer as necessary.

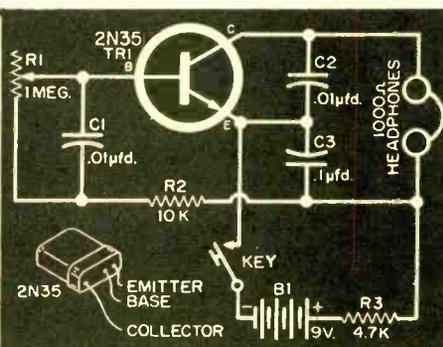
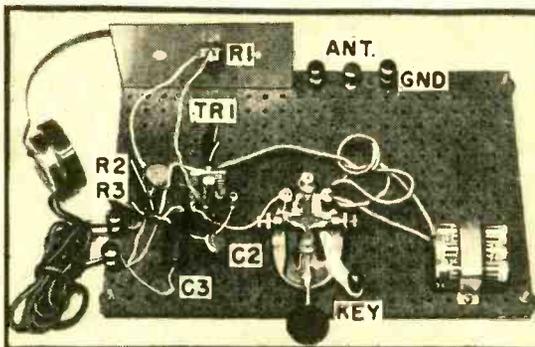


Power pack is a 9-volt battery made up of six series-connected penlite cells. You can tape the cells together as shown or fit them into standard clips.

Parts Substitution. A good set of working components is shown in the parts list, but you can make a number of substitutions without altering the circuitry in any important way. Note, for example, that in some photos tubular ceramic capacitors are shown while in others the same units appear as discs. The two types are, of course, interchangeable with each other as well as with paper or mica capacitors of equivalent value.

In place of the miniature variable capacitor, *C5*, you could use any standard 365- μ fd. broadcast-band tuning capacitor, or even a screwdriver-tuned padder. And for the 1000-ohm magnetic headphone, you

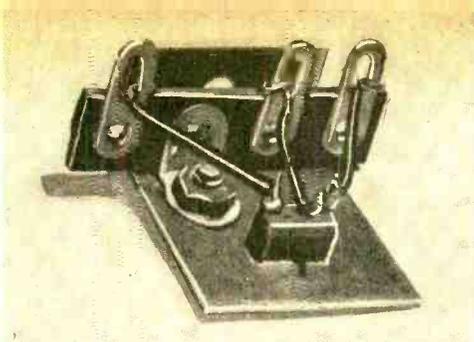
1 CODE-PRACTICE OSCILLATOR



For learning the sound and touch of a radio ham's second language, nothing takes the place of a code-practice oscillator. This simple job has as good a tone as any you'll find, and being transistorized, it can keep pouring out *dits* and *dahs* practically forever on its original power supply.

It takes fewer than a dozen connections to put the whole thing together, so invest a few extra minutes double-checking all connections before you fit the transistor into its socket and press the key. When you do get to it, close the key and adjust *R1* for the most pleasing tone.

This circuit is an adaptation of the familiar vacuum-tube Colpitts oscillator. Capacitors *C2* and *C3* in series are shunted across the inductance of the headphone. The combination forms both a tuned circuit and an impedance-matching network. The latter matches the high impedance of the collector-emitter output to the low impedance of the base-emitter input. The bias current is fixed by *R2* and the tone control, *R1*. Resistor *R3*, in series with the power supply, isolates the tuned circuit from the battery and serves also to limit the collector and base currents.



Transistor-mounting assembly can be made by bending a piece of scrap aluminum to hold 3-lug terminal strip and 5-pin subminiature tube socket.

could substitute any magnetic phone of high impedance.

Miscellaneous items, such as knobs, rubber feet, binding posts, machine screws, solder lugs scrap metal, and the like aren't listed and you can use whatever type you have on hand.

Wiring. In these experimental circuits the parts layout and lead dress aren't critical. You can follow the illustrations or rearrange the pieces in any way.

If you want to reuse the parts in several projects, it is best to leave the leads and pigtailed full length except on the transistor. These should be trimmed to about $\frac{1}{4}$ " so they'll fit the socket.

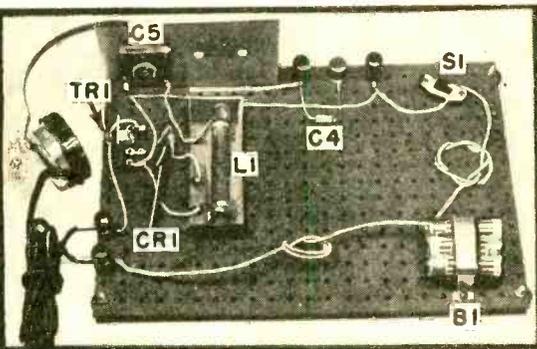
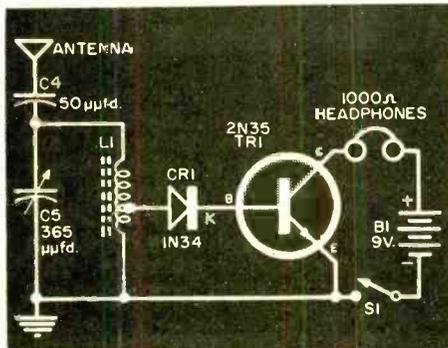
Each time you wire in the 1N34A diode, pinch the lead you are soldering with a pair of pliers. Holding pliers somewhere between the body of the diode and the wire tip being soldered serves to trap the heat and keep it from damaging the delicate crystal.

For safety, install the transistor last in all projects—after you've double-checked the wiring. Make sure, also, that battery polarity in every case follows that indicated in the diagrams.

An *n-p-n* junction transistor (type 2N35) is used in this first group of experiments. It requires battery polarity just opposite to that of the more familiar *p-n-p* units. Schematic symbols are similar for the two types except that in this one the arrow identifying the *emitter* electrode points *away* from the base line.

The *common-emitter* circuit—roughly similar to the *grounded-cathode* vacuum-tube circuit—is used in all these experiments. As you might imagine, the hookup gets its name because the emitter electrode is common to both the input and output sides of the transistor. When it is connected directly to circuit ground, this basic arrangement is sometimes called the *grounded-emitter* configuration.

2 BATTERY-POWERED RECEIVER

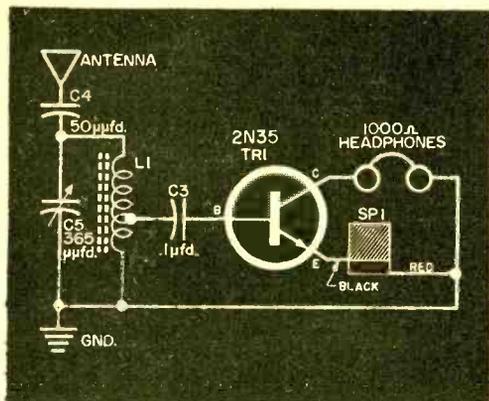


Though this simple receiver has a lot more gain than a crystal set, it still needs a good antenna and a ground for best results. A commercially available "transistor antenna coil"—tapped to provide a good impedance match to the input of the transistor—is used in the tuned circuit.

When you wire up the set, pay special attention to the polarity of the diode. On some 1N34's the cathode end is marked by a broad stripe or the letter "K"; on other diodes the terminals are identified by a small schematic diagram similar to the one which is used here.

Signals picked up by the antenna-ground system are coupled—through C_4 —to the tuned circuit made up of L_1 and C_5 . Variable capacitor C_5 is used for station selection as in any conventional receiver. The tap on L_1 is designed for good selectivity as well as maximum energy transfer to the transistor circuit. Detection—the separation of the audio and radio components of the tuned signal—takes place in the 1N34 diode and the base-emitter circuit of the transistor. The program that comes through should be heard clearly and with good volume in the headphone.

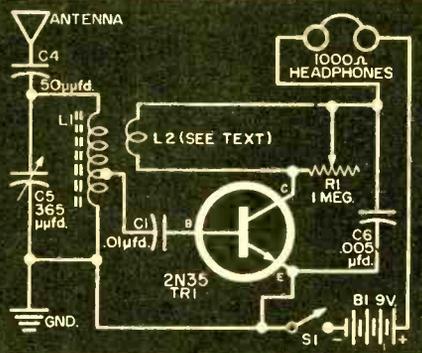
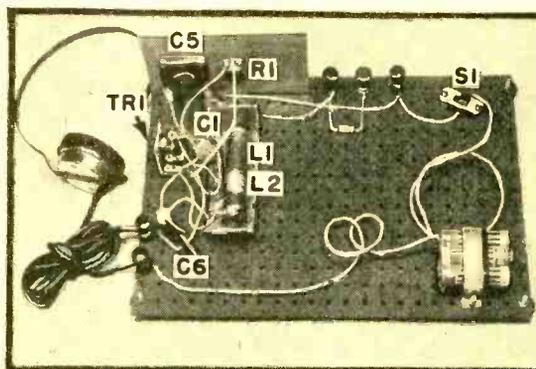
3 SUN-POWERED



Transistors are so efficient they can operate in radio receivers on electrical power taken from the sun. If you'd like to test this for yourself, you only have to substitute a selenium photocell for the 9-volt power-supply used in project 2. The unit shown (marked *SP1* in the diagram) is the B2M "sun battery" made by International Rectifier Corp.

In addition, you may want to substitute *C3* for the germanium diode. Whether this extra change will improve reception de-

4 REGENERATIVE RECEIVER



You can greatly increase the sensitivity of the receivers shown in projects 2 and 3 by adding regenerative feedback. A couple of simple wiring changes will do the trick.

One new part—"tickler" winding *L2*—appears in the diagram and photo above but not in the parts list because you make it yourself by winding 10 to 15 turns of plastic-covered hookup wire around the middle of *L1*.

Two other parts—*R1* and *C6*—are added to the circuit of project 2, and a .01- μ fd coupling capacitor (*C1*) is substituted for the 1N34 germanium diode.

After you have completed the wiring changes, slip on the headphones and slowly turn potentiometer *R1* through its entire range. At some point you should hear a "putt-putt" or oscillation tone. If you don't, reverse the connections from *L2*.

This feedback tone is a sign that the set is regenerating the way it should. Back off the potentiometer until the "putt-putt" sound just disappears, then carefully tune the station you want by adjusting capacitor *C5*. Readjust *R1* for maximum volume.

Circuit operation is similar to that of other regenerative receivers. Signals picked up by the antenna-ground system are coupled through *C4* to the tuned circuit consisting of *C5* and *L1*. Varying the frequency of *C5* selects the desired signal which is then transferred (through *C1*) to the base-emitter of the transistor. This circuit amplifies the radio frequencies and detects the audio.

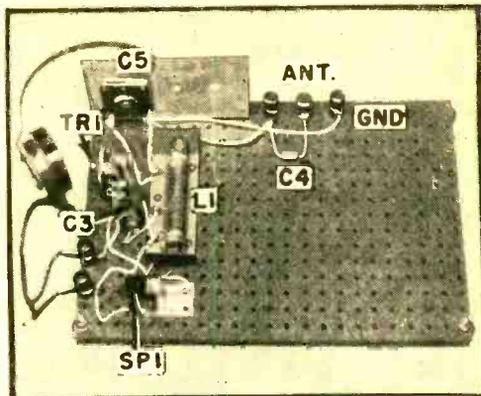
But as the name "regenerative" suggests, the amplified r.f. signal is routed back to the tuned circuit through the feedback winding of the coil. On its repeated journeys through the transistor it picks up ever greater amplitude.

The resistance across potentiometer *R1* governs the amount of energy that is fed back through the "tickler." Advancing the setting of the potentiometer—that is, increasing its effective resistance—boosts the r.f. feedback and thus increases the gain. Capacitor *C6* serves to bypass any r.f. that tries to sneak off in the wrong direction (through the headphones and battery) and carries it back to the transistor circuit.

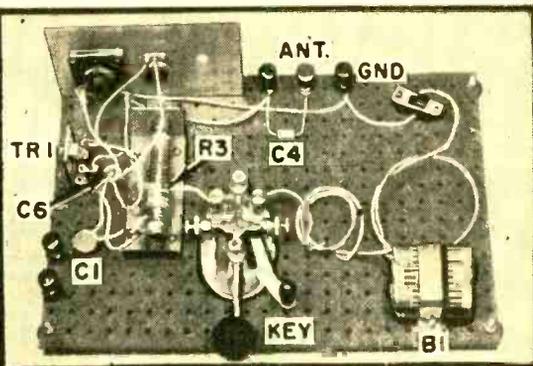
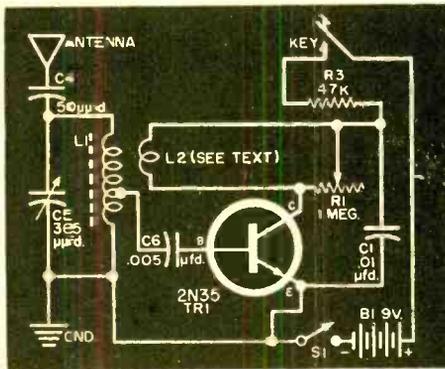
RECEIVER

depends on the characteristics of the individual transistor and on the antenna and ground that you use. The only way to make sure is to try both arrangements and see which gives better results. Keep in mind that a sun battery doesn't deliver as much power as six penlite cells—don't expect as much output from the receiver.

And notice that the circuit doesn't include a switch. When you want to turn this set on, you just expose the battery to direct sunlight.



5 CODE TRANSMITTER



If you've ever built a regenerative receiver like the one shown opposite, you know that misadjustment of the feedback potentiometer can make the set squeal like a stuck pig.

Squealing occurs when the circuit is thrown into oscillation. The high-pitched noise can be a bit of a nuisance in a receiver, but it does have this use—it permits you to turn a receiver into a transmitter by making a few minor changes.

As you can see by comparing the circuit above with the one at the left, the most important alteration is that a hand key and resistor *R3* take the place of the headphone. In addition, capacitors *C1* and *C6* have been interchanged to improve the tone quality of the broadcast signal.

Simple as it is, this transmitter is capable of radiating a weak modulated signal at almost any frequency in the standard broadcast band; you can pick your frequency by adjusting tuning capacitor *C5*. Keep in mind, however, that the circuit isn't stable enough for use as a ham transmitter, so don't let it broadcast too far

from home base. To hold the range down, use *only* a short antenna lead.

To set up the transmitter, place its antenna a few feet from any broadcast receiver. Turn the receiver volume full on and tune it to a dead spot near the middle or the lower end of the dial.

Next, switch on the transmitter, close the key, and set *R1* at nearly maximum resistance. Tune *C5* gradually till you hear a high-pitched tone in the loudspeaker of the receiver. You can now adjust the sound to your taste by resetting *R1* and sharpening receiver and transmitter tuning.

The transmitter works just like a regenerative receiver that has gone into oscillation. It puts out a *modulated* signal, however, because of a blocking action in the base-emitter circuit of the transistor. The frequency of the audible signal is governed by the amount of feedback plus the time constant of the *RC* circuit composed of *C6* and the input resistance of the transistor. Since the potentiometer determines the amount of feedback, it serves as a simple control over the modulation tone. -30-



Magnetic Sound Camera

IMPROVED SOUND FILMS for science and industry are expected to result from a device which permits both picture and sound to be recorded simultaneously on the same 16-mm. film. Developed by Berndt-Bach, Inc., 6900 Romaine St., Hollywood, Calif., and known as "Filmagnetic," the unit provides synchronous recording of action and sound on black-and-white or color film.

Film to be used with "Filmagnetic" is pre-stripped to record a magnetic sound track. Once exposed, the film is developed in the usual way and may be played back

on any 16-mm. sound projector. Installed at the factory as an optional feature in "Auricon" cameras, "Filmagnetic" can be removed readily without the use of tools to provide a choice of optical or magnetic sound recording.

Sound to be recorded is picked up by a sensitive microphone and fed through a hi-fi amplifier which drives the recording head. Another head provides instant monitoring. Included with the unit are the necessary cables, batteries, and carrying case.

Household Weather "Brain"

THE "GOLDEN CIRCLE" home temperature-control system designed by Minneapolis-Honeywell will automatically lower temperature at night, and raise it automatically in the morning. Listing at \$199.40, installed, it can also be used for controlling heating-cooling units.

The ultra-sensitive thermostats, styled by Henry Dreyfuss, are not much larger than a pocket watch. One thermostat is mounted outside the house to sense weather changes; the other unit is located at a convenient indoor position. Temperature signals from both feed to the electronic control center, which then adjusts indoor temperatures to outside variations.

Additional information is available on request from the manufacturer. (*Minneapolis-Honeywell Regulator Co.*, 2753 Fourth Ave. So., Minneapolis, Minn.)

Miniature Broadcasting System Assists Guided Tour

THE PERFORMANCE of a miniature broadcasting system highlighted an "open house" for the press conducted recently at Hughes Aircraft Co., Culver City, Calif. Each guest was provided with a tiny transistor re-

ceiver and earphone. Tour guides, equipped with headset microphones, spoke to the visitors over small portable transmitters.

This method of keeping guests informed of what was going on helped relieve the guides of the need for shouting, and assured that all visitors—even those at the rear of the group—were kept posted.

Guests were divided into six groups so spaced that only three different carrier frequencies were required for transmitting to each group without interference.

The transmitter itself (see photo insert) was a three-tube oscillator type with a range of about 40 feet. Receivers used by the visitors were Regency transistor sets. The entire operation met FCC requirements.



All-Purpose AM Receiver

AN INGENUOUS and highly versatile miniature AM radio receiver, the Darb "Holiday," has been introduced by the Darb Division of the S. C. Ryan Company. Listing at \$29.95, it is appropriate for bicycles, boats, caddy carts, farm tractors and other equipment.

Measuring only 4" x 5" x 6", the set weighs four pounds. It consists of two sections, one housing the receiver circuits and the other the power supply. Snap catches hold the two units together snugly.

Other features are: it can be operated on 110 volts a.c. or batteries; output jack permits use of internal speaker, extension speaker, pillow speaker, headphones, or hard-of-hearing aid; removable antenna and jack allow use of an auxiliary antenna on vehicles. Touch tuning provides a choice of three preselected stations. (*Darb Division, S. C. Ryan Co., 1316 Yale Place, Minneapolis 3, Minn.*)



Air Force Installs Portable Electronic Computer



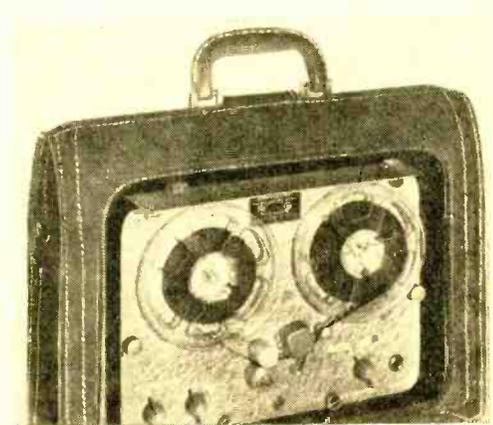
PROBLEMS of reconnaissance data for bombing missions are solved in a matter of minutes by the COMAR-1 (Computer, Aerial Reconnaissance) developed for the Air Force by IBM and installed recently at Wright-Patterson Air Force Base, Ohio.

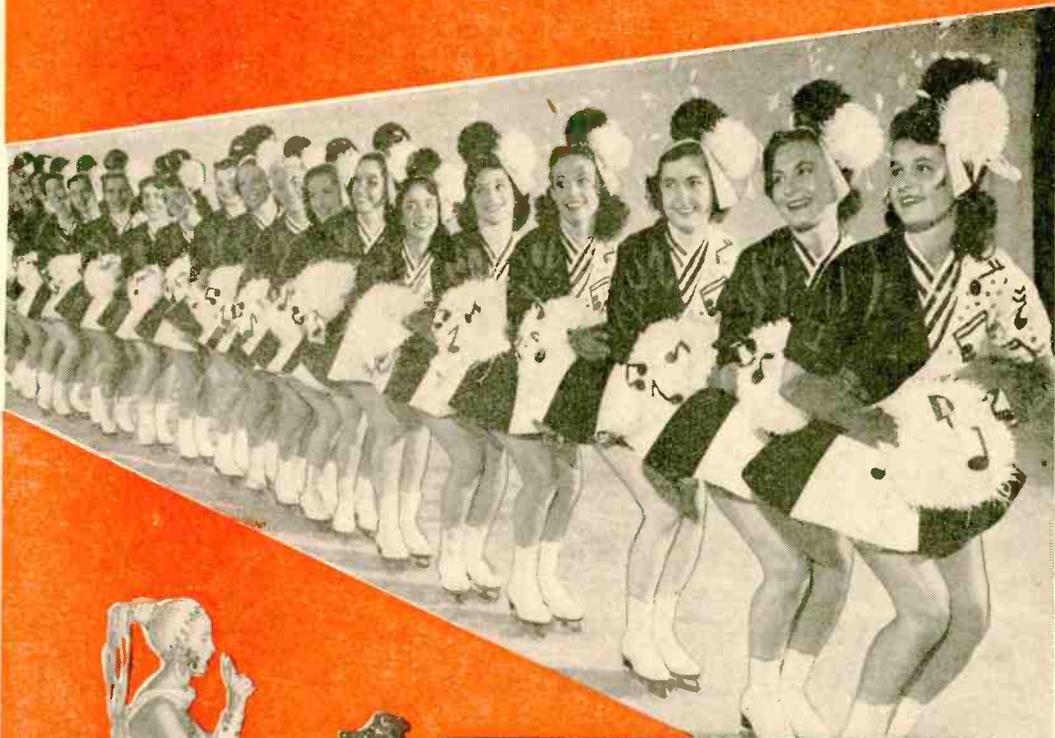
COMAR-1, despite its portability and relatively small size and low cost, has all the facilities normally found in larger computers. In its present form, it is regarded as the first experimental step toward the general use of miniaturized calculators. This device provides accurate answers to questions fed into it—answers that can mean the difference between a hit or a miss by our bombing aircraft.

Aside from its military use, COMAR-1 can be used for geodetic, photogrammetric, and other computations.

Secret Briefcase Recorder

THE Amplifier Corp. of America (398 Broadway, New York 13, N. Y.) is now offering a two-speed secret tape recorder designed for investigative work. It provides four hours of continuous recording at a tape speed of 15/16 ips using extra long-play magnetic tape. The low-drain motor is powered by five easily replaceable mercury batteries which last from 12 to 24 hours; the amplifier is powered independently of the motor by dry cell batteries that can last as long as 100 hours. Weighing less than 12 pounds, the recorder is built into a briefcase. The hidden microphone will pick up whispers in a quiet area 12 feet away.





AUDIO on ICE

By BILL K. FERMONT

Behind-the-scenes sound makes for smooth skating at ice show

SILVER SKATES flashing across the ice! Graceful limbs in a symphony of movement! Lights, costumes, and music! All of these elements are combined in a myriad of breathtaking spectacle, dancing, and acrobatics to make up the world-famous ice show "Holiday on Ice."

Smooth, flawless, expert timing between performers and orchestra? Yes! But is it as effortless as it seems? The preparations behind the scenes of a show become particularly painstaking when the margin for error is as wide as the entire slippery floor of ice which is used for in this case. Of equal significance are the electronic devices employed to assure a completely professional performance. Everyone concerned

—producer, conductor, master of ceremonies, musicians, and the skaters—relies on electronics to put over the show.

Designed and built especially for "Holiday on Ice," an ingenious audio control console eliminates the chance for human error in cueing performers and in synchronizing the movements of the skaters with the playing of the orchestra and the changing of lighting and of settings.

All music is played by the orchestra—but in exact pitch and timing with recorded music from a previously made tape. The tape plays through amplifiers and is heard via dozens of husky speakers placed strategically about the audience. The orchestra is heard "live." This double-bar-

reled presentation has proven to be the best way to fill a giant-sized arena with music.

In such a situation, live musicians must take their cue from the tape, which has been recorded to perfection as regards key, pitch, and tempo. The orchestra leader, hearing the tape via headphones, is much less apt to "goof" during his performance. What's more, the precise timing of the others on stage, and behind the scenes, is assured. The entire show is built around the timing incorporated on the tape, which—through the conductor—effectively corrects any "live" mistakes. For example, the beat of the music is pre-emphasized on the tape recording. The musicians follow the conductor, but the conductor follows the tape. As for pitch—tests have shown that musical pitch is accurate to one part in 500 with tape running at 15 ips.

In many cases, the audio setup has replaced live singers. Where vocalists are employed, the console serves as an electronic understudy, ready always and not subject to the sniffles and sore throats that could plague a singer at an ice show.

Unique Console for South America

A unique application of this audio system is the special console that was made for the show's South American unit. This console had to be compact and light in weight since it would be airborne. In addition, the equipment had to be capable of operating from line voltages and power frequencies that varied considerably from the standard power used in the United States. Worse, there could be no variations of the tape transport's speed, since this would be disastrous during playback—all recordings would already be made, with the pitch and timing determining the skater's movements. Also, it must be possible to inject both live and recorded program material native to the particular locale in which the show would be given. Finally, servicing of the equipment had to be relatively simple, precise, and immediate—since it wasn't certain that a home-based technician would accompany the company on tour.

Altec Service Corporation, who made the original console, turned over this new task to engineer Martin Bender, an audio specialist noted for—among other things—his work in stereophonic sound. Bender came up with the equipment shown in the accompanying photos. The big nut to crack was, of course, the variable power frequencies. Ordinarily, a rotary frequency changer would do the trick. But these devices are bulky; moreover, they require separate motors for the various line frequencies used in different countries. A device was needed that could be built right into the console



Martin Bender, designer of the console, adjusts output level control during test. Below, bottom view of console, showing how tuning-fork amplifier hinges out for easy accessibility. Smaller amplifier sitting on shelf is used for monitoring.



to make it completely self-contained and foolproof.

Bender hit on the Ampex Model 375 "Tuning Fork" amplifier. This unit accepts any power frequency and produces a smooth 60-cycle output. Changing only one capacitor extends its input acceptance range to 400 cycles!

In the "Tuning Fork" amplifier, a mechanical tuning fork is set in motion by incoming power. This tuning fork serves as the heart of an oscillator whose output is a constant 7 volts at 60 cycles. The output is then fed into a power amplifier which furnishes 0 to 130 volts at 60 cycles.

Thus, the all-important tape transport motor can be run at the precise speed needed for accurate cueing and timing of the entire show. What's more, a technician setting up the rig for a show does not have

to fuss with line input variations. All he has to do is fire up the Model 375, set the output control to 115 volts, and plug in the rest of the equipment.

An Altec amplifier was provided with input and mixing facilities to handle the tape playback, three microphones, and a phono pickup. The phono is included so that records of locally popular tunes may be played on the show. These records, plus live performances by local talent singing in the dialect characteristic of a particular region, have helped warm up many a cool audience.

Novel Switching Job

An unusual switching job is handled by a "Master Cueing Switch" built onto the console's front panel. During the original recording, several metronome-beats were recorded as loud clicks which permit the conductor to gear up his live orchestra to

the beat of the taped music. These clicks must be heard only by the conductor and the Master of Ceremonies, and not by the audience. The M.C. places the cue switch on "tape" and the tape's off-on switch on "off." As soon as the five or six beat clicks are audible, the M.C. moves the tape switch to "on" and the tape's output goes through the 70-watt amplifier to the loudspeakers. The audience hears only the music, never the tempo clicks.

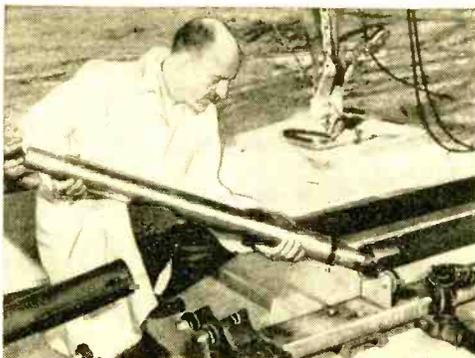
The entire system—console, microphones, and speakers—can be set up in a matter of minutes. How much it helps to put on a first-rate show is evident from the enthusiasm of audiences wherever "Holiday on Ice" has performed. Its ruggedness? The console was dropped accidentally from the tailboard of a truck during a recent delivery. Holding their heads, technicians checked it out, expecting the worst. But it worked beautifully!

-50-

"Baby" Neutron Generator Aids in Prospecting for Oil

THE High Voltage Engineering Corporation has developed a unique Van de Graaff particle accelerator for use in oil field prospecting. Classified as a "baby" neutron generator, the miniature atom smasher was built to fit inside a 3 $\frac{3}{8}$ " well logging assembly. Although only 47" long, the Van de Graaff can generate particle potentials up to 200,000 volts. These particles (nuclei of heavy hydrogen atoms) are fired into a target of tritium (super heavy hydrogen). The atom smashing collision then produces neutrons which penetrate the bore hole thousands of feet below the earth's surface. This in turn releases other atomic particles which can then be measured and identified. The miniature Van de Graaff

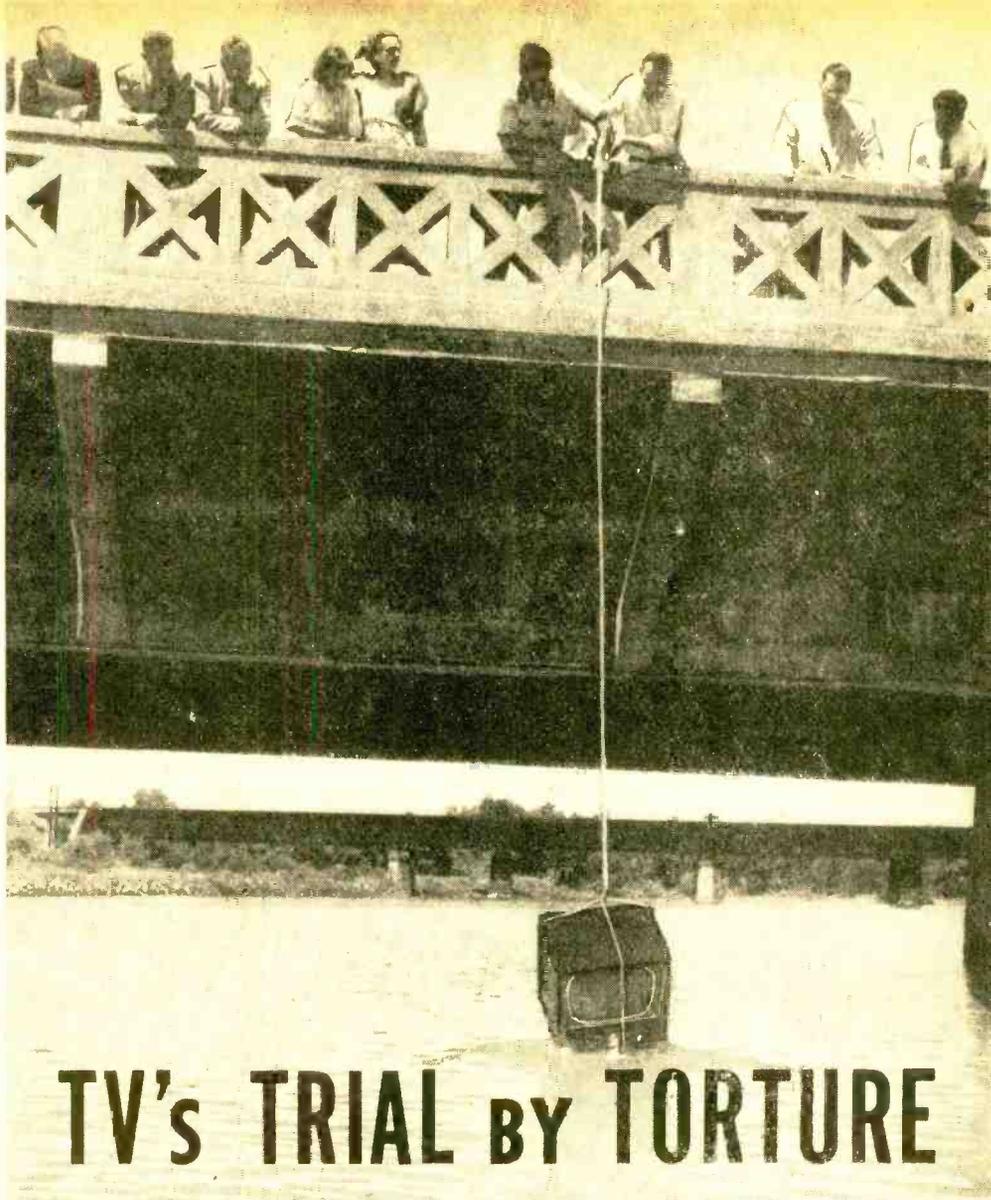
generator has been put to work by Well Surveys, Inc.



Ultrasonic Test Car

DEFECTS on tracks of the Santa Fe Railway are detected by the unusual truck shown in the photo. Ultrasonic frequencies are applied to the rails and tape recordings made of the reflected energy. In addition to inspections made when standing still, the car can test rails while traveling over them at speeds up to 16 m.p.h. Twin sets of wheels enable the vehicle to move on highways as well as over train tracks. Normal rails are also indicated.

POPULAR ELECTRONICS



TV'S TRIAL BY TORTURE

By Carl J. Quirk

FRIDAY-NIGHT wrestling isn't the only kind of roughhouse a TV set gets to see. Before it ever leaves the factory, a receiver may catch a glimpse of some refined industrial torture.

For instance? Well, delicate instruments tagged "Fragile! Handle With Care!" are tossed around like potato sacks. Some of them are dunked in bathtubs, chilled, heated, and even kicked downstairs.

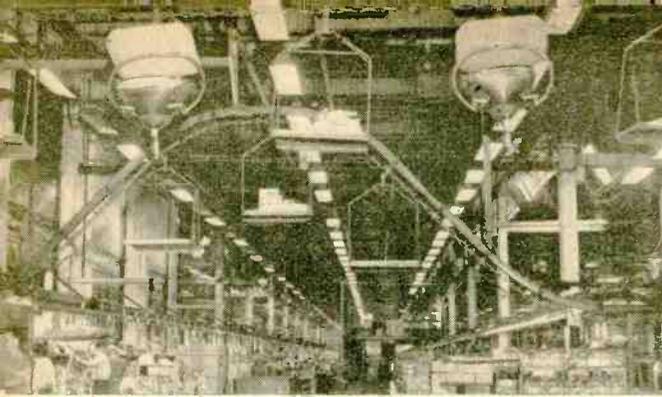
This scientific mangling is carried on by experts—men who really know how to give machinery a hard time. It isn't done for fun, but because manufacturers want to know just how much use, misuse, and abuse their products can take.

For while engineers can design just

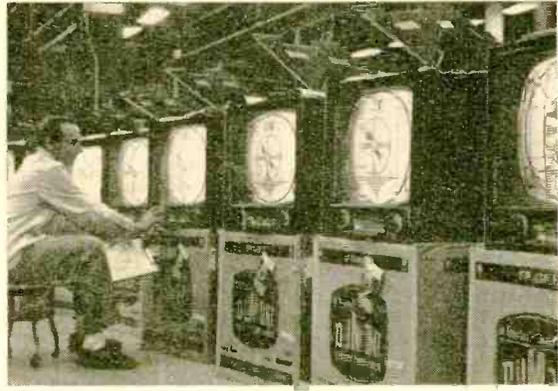
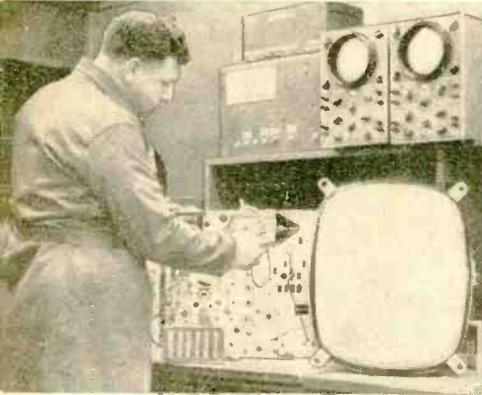
about any performance feature into a set, they can't always be sure the feature is rugged enough to hold up in every set that reaches a customer's house. To obtain this kind of information, they have to keep close tabs on assembly-line production.

The job of finding mistakes and weaknesses is only one part of the testing operation. It's even more important to keep mistakes from happening, so test information must be fed back quickly to the production line.

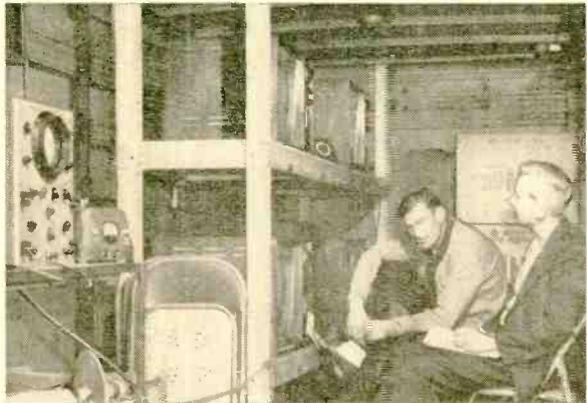
Some kinds of tests are applied on a spot-check or sampling basis and other tests are run on every set that comes off the line. The one shown above and those on the next two pages are part of the day-to-day quality control system used by a major electronics manufacturer.



PRODUCTION TESTING. A quality control station at the end of the production line (left) gives every set a look-and-listen test for such items as noise, sensitivity, and sound and picture level. More thorough bench tests are run on a random 25-set-a-day sample (below, left). In addition, 12 completed sets (below) are uncrated daily, critically re-examined, and then operated for 24 hours.



FIELD TESTING. Even after a set comes through factory tests with flying colors, it may still run into trouble when it gets into a fringe-area home, or one that happens to be near a trolley line, a police transmitter, a busy highway or some similar source of interference. To obtain a sample of actual operation under every type of field condition, the factory keeps a mobile test laboratory on the road. As shown at the right, engineers set up their antenna in a typical location, a weak signal area, or one that's noted for adjacent-channel interference. Inside the fully equipped lab truck (right, below), they get a customer's-eye view of most of the problems that arise in average homes as well as in special, troublesome locations. Sets made by other manufacturers are also checked in the field lab to provide comparative performance data. And in an entirely separate field-test operation, factory representatives follow up customer service problems and report back to the factory.

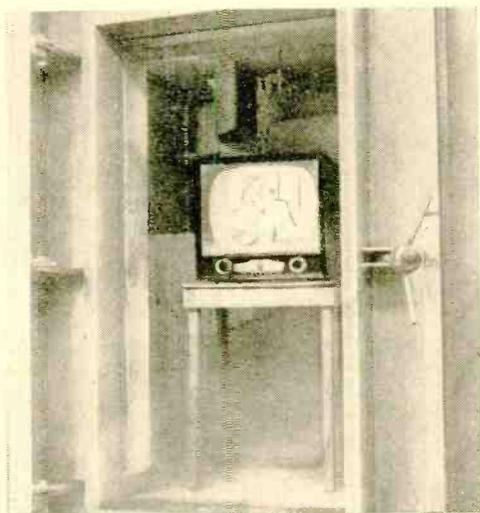




TYPE TESTING. A set that's passed a full series of "type" tests is usually ready for the graveyard. In this factory, five units a day are given thorough electrical-characteristic tests covering 25 separate measurements. Samples are checked also for ruggedness under extreme conditions of handling and use. The dunk test (shown on page 41) demonstrates a set's ability to withstand accidental wetting. Other ruggedness tests are shown below.



Screened room is used for electrical "type" tests. By eliminating noise, interference, and broadcast signals, it insures uniformity of all measurements.

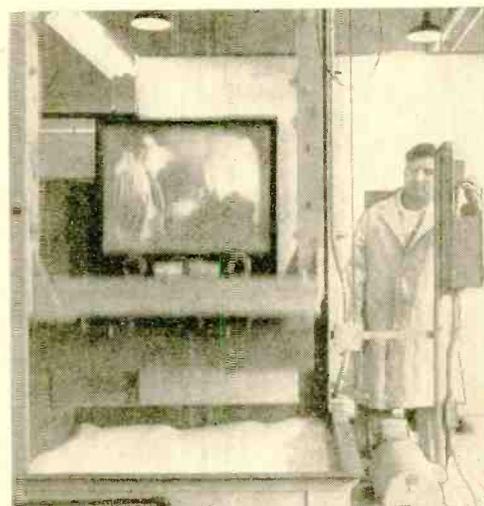


Heat and humidity tests are carried out in a vault-like chamber where temperature and moisture can be completely controlled by the test engineer.



Drop test checks the packaging. It's important because set quality doesn't mean much unless the product can safely survive the rigors of shipment.

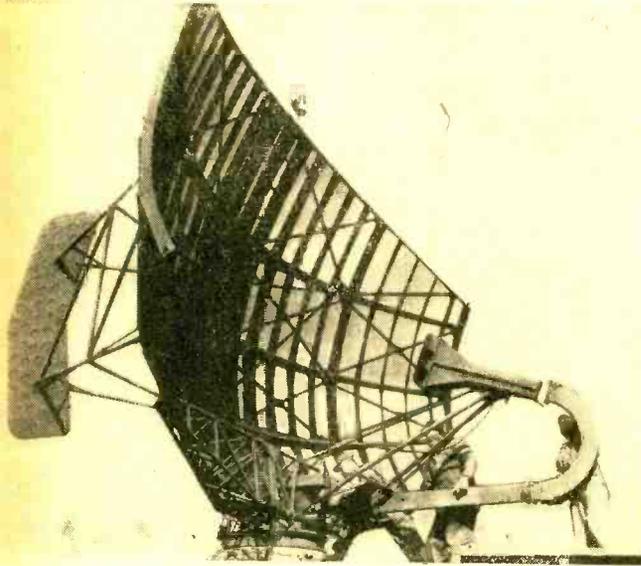
March, 1956



Shake test—or vibration test—is performed on a specially built jiggle platform. The set is supposed to keep operating as usual during this ordeal.

Radar Search System

A HIGH-POWERED radar set, which can be set up in less than three hours by a crew of 30 men, has been added to the Air Force's inventory. Designated as AN/MPS-11, the new equipment is a search system for early warning and long-range detection. It can "see" aircraft at high altitudes and can be used for interception purposes when coupled with a height-finding radar. Extremely mobile, AN/MPS-11 may be transported in nine trucks and two trailers, which include shelters for personnel. The antenna is erected with a powered winch attached to one of the trucks. Its 14'-high sections (see photo) are joined manually on the ground and pulled into operating position by a winch.



High-Flying Hi-Fi

THE "fi" is really "hi" for passengers aboard the Viscount fleet of Capitol Airlines. This air travel company has installed sound systems in its new ships for voice contact between crew and passengers as well as for background music during flight. Twenty-two Jensen "Viking" 4J6 loudspeakers are mounted between the windows on either side of the cabin. Two microphones and a Bendix 20-watt amplifier, in the radio rack, complete the installation.

Experience has shown that a relatively large number of speakers placed close to the passengers and operating at a low level will provide more satisfactory coverage than a few large units mounted overhead and operated at a high level.



Electronic Professor

THIS ELABORATE tape system helps teach foreign languages to students at the University of Florida. Listening through headphones, students are given drills, dictation, and ear perception exercises. Tapes are recorded by faculty members.

Recent tests, taken by students of French at six different institutions, have demonstrated the effectiveness of this method—those using the tape system scored higher than all others. The program, initiated by Dr. Joseph Brunet, head of the Department of Foreign Languages, is an important step toward wider use of audio devices in education.





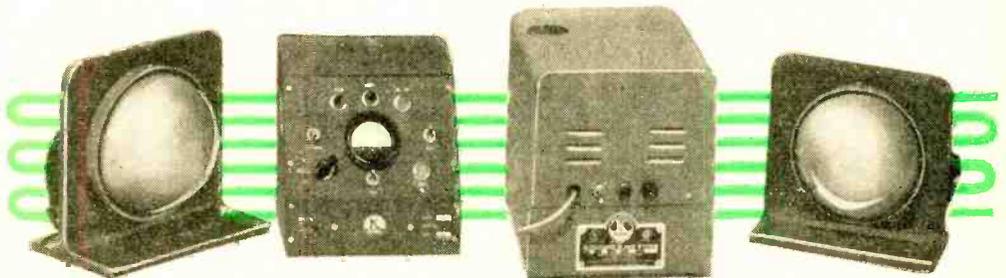
SILENT SOUND WAVES pulsed out by a new motion detector may overcome some serious blind spots in present burglar alarms. Ordinary door and window signals are useless against intruders who break in through the roof, or those who enter a building during the day and remain hidden until night. But no matter how or when a burglar enters a building protected by this device, the alarm will spot him as soon as he moves.

The mechanism, manufactured by Walter Kidde & Company, Inc., Belleville, N. J., is based on the so-called "Doppler effect." Johann Doppler, an Austrian scientist, observed more than a century ago that motion changes the apparent frequency of light or sound waves.

The ultrasonic alarm uses one or more pan-shaped transmitters to pulse out waves at 19,200 cycles a second. These waves, beyond the limits of hearing, saturate an enclosed area and are picked up by receiver pans similar to the transmitters. The waves are carried back to a master control unit and are compared electronically with the ones being sent out. Motion that causes a change in frequency trips an alarm relay.

Sensitivity of the system can be adjusted to suit the hardness of the walls or the contents of a room. Properly set, it won't detect slight gusts of air or the motion of small animals.

The alarm signal can be placed in the protected area, wired to another room in



Complete alarm system includes (left to right): transmitter or "speaker," monitor, master control unit, and receiver or "pickup." The combination will detect any motion in a room or other protected area.

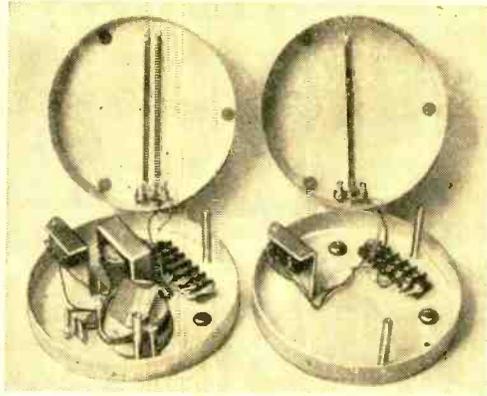
March, 1956

the building, or connected by telephone line to a detective agency in some other part of town. When an installation uses remote alarms, extra apparatus is added for checking the equipment from a central location.

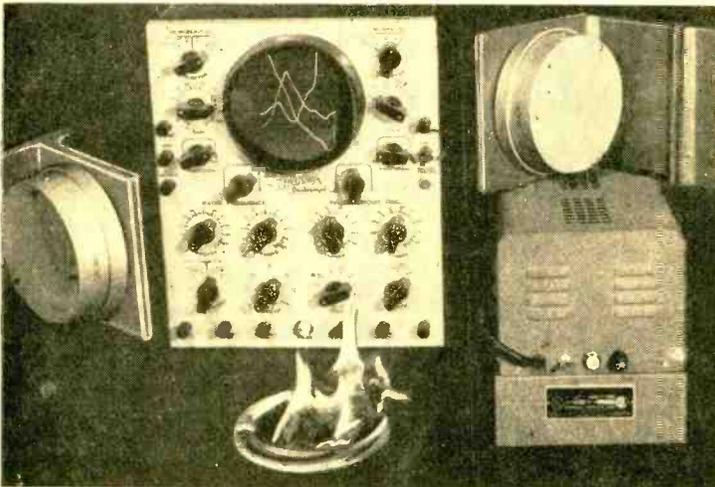
Transmitter and receiving pans—called “speaker” and “pickup”—work by magnetostriction. Changes in a magnetic field cause metal to expand or contract. Nickel rods, wrapped in wire coils, are riveted to the covers of both pans. An oscillator circuit sends the 19,200-cycle note through the transmitter coils, causing the rods to expand and contract; this flexes the pan cover 19,200 times a second. The receiver reverses the process and converts the movement of air into electric currents.

This alarm system will detect flames as well as intruders and has been tested in ships to spot stowaways and give warning of shifting cargo.

-30-



Transmitter and receiver pans are similar except that the former has two magnetostriction elements. V-shaped vane and tiny motor in speaker are part of tamper-proofing equipment added to system.

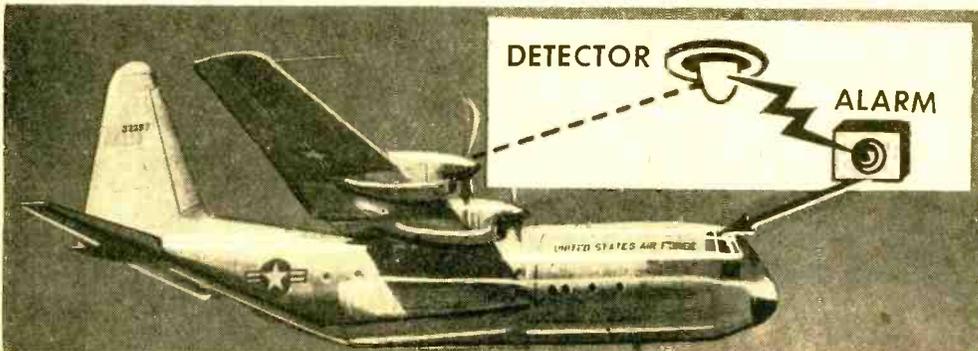


Fire moves air, too, so it can be detected by the ultrasonic alarm. Here, an oscilloscope has been substituted for the alarm, and frequency disturbance is indicated on the screen. Greater sensitivity is needed where the system is used as a fire alarm; setting can be adjusted by means of a knob on the master control chassis.

Photocell Gives Instant Warning of Aircraft-Engine Fires

A FLICKER OF FLAME in any engine of this turbo-prop transport would flash an instantaneous warning to the pilot. The plane is fire-protected by a new visual detection system that uses photocells to scan

the engine housings. The “Fireeye” detector, developed by Electronics Corporation of America, Cambridge, Mass., responds to any rise in illumination by setting off a signal on the control panel.



BONER BOX

By CARL KOHLER

I STARED, admiringly, at my mirrored image.

"By George!" I exclaimed feelingly, taking in the crisp sun-tans, the jaunty sun-cap and the gleaming half-boots—all newly purchased to accompany the just-completed Geiger counter dangling at my hip. "By George, you're going to make a romantic-looking millionaire, old man! Yessiree! You're a real picture of adventure!"

Suddenly, the bedroom door behind me swept open.

"Hoo-hah!" gurgled Missus Wife, goggling my finery with eyes the size of white-walls.

Averting my ill-concealed smile of pride, I busied myself with removing a stray thread from my sleeve. "Rather dashing, don't you think, old girl?"

"Dashing-smashing," she muttered, "what goes?"

"Well, you just don't grub around, in the great outdoors, in tweeds and a dress-shirt," I said, a bit defensively. "And I imagine I'll spend a certain amount of time, patiently exploring this canyon and that . . . over rock and rill . . ."

"You joined the *Boy Scouts*?" Her face registered incredulous amusement. "At your age?"

"I'm joining the great fraternity of Uranium Hunters," I said crisply. Boy Scouts, indeed! "For your further information, I fully expect to be successful, too. After all," I gazed up past lifted eyebrows, "having built my own de luxe Geiger counter . . ."

"What's a Geiger counter?"

I allowed myself a short, sophisticated chuckle. Then I drew her gently into a chair and began, as simply as possible, to relate the Kohler Plan For Wealth Beyond Your Wildest Dreams. It took, perhaps, thirty minutes . . . counting repeated details and a fine appraisal of my homemade Geiger counter. When I finished, she began sprouting questions.

"This another of your nutty schemes?"

I tossed her a dog-eared copy of POPULAR ELECTRONICS.

"Read the ads," I suggested. "Everybody is buying, building, borrowing or stealing this little bonanza-type box." I tapped the counter's neatly constructed 3' x 5' x 7' aluminum case. "It detects radioactive uranium. Uranium is precious. Ergo, once discovered . . . a uranium mine means untold millions. With this devilishly clever little box, I mean to roll in dough forever . . . so to speak."

She studied the counter with mingled greed and suspicion.

"So *this*'s what's been keeping you up nights, huh? How does it work, anyway?"

I indicated the switch, the neon lamp indicator and meter.

"Here," I slipped the headphone over her hair. "Listen a minute. Those clicks will mean uranium if they . . ."

She leaped to her feet.

"*Holy Toledo! The whole joint's full of uranium! Listen to it!*" She turned near-mad eyes upon me. "*Oh, you lovely, lovely little clicks! Clickety-clickety-click, click, click!*" She cackled insanely.

"That," I said, hastily removing the headphone, "is just the background count. Get your greed out of gear, my dear. It simply isn't quite that . . ."

"I can see it ALL now!" she cried, dancing spiritedly in great, bounding circles around the room. "Yep, life's gonna be a gravy train from here on in! No more housework! No more scrimping! No more worrying about bills! Wheeeeeeeee!"

"Look," I said, anxiously, "You only heard the background count, which doesn't mean there's any . . ."

"Diamonds!" Her eyes glittered with desire. "Diamonds and emeralds and rubies, and



I stared, admiringly, at my mirrored image . . . taking in the crisp sun-tans, the jaunty sun-cap and the gleaming half-boots . . .

maybe even mink! Oh, *definitely* mink! Acres and acres of mink. And I'll need some . . ."

"The background count," I whispered hoarsely, "merely denotes a . . ."

" . . . new clothes to go with all those Cadillac-lacs! Can't run around Europe dressed in rags, you know! No more shoddy old dollar-ninety-eight cottons! Not for *this* millionaire's wife! No sir! Nothing but the best . . . the most expensive creations . . . Paris origi-



“... The whole joint's full of uranium! Listen to it! Oh, you lovely, lovely little clicks! ...”

nals ... from now on!” She kissed me, wildly, on the nose. “And, of course, we'll have to join the better clubs ... mingle with the better set, and I'll ...”

“THERE IS NO URANIUM IN THIS HOUSE, DO YOU HEAR?”

“N-No uranium?” She sank, stunned, into a chair. “Then what were those little clicks you said meant ...”

“Background count,” I repeated wearily. “But don't you fret, sweets,” I assured her, tipping my cap to a rakish angle across my high, intelligent brow and winking a knowing wink at her, “I think I *know* where the uranium grows!”

“Y-You sure?”

“Sure, I'm sure ... I think,” I fondled the counter ... the little counter built from parts I bought with my own little money and, skillfully, put together with my own little screwdriver in my own little workshack. “You'll have all those luxuries,” I promised, “if there's any loot left after Uncle Sugar gets his cut and *if* there's anything after I buy a few electronic supply houses, a radio station or two, a few TV stations ... and I'll have to own those experimental ...”

“Stop dreaming, already,” she snapped. “Get the car out of the garage while I pack a lunch and some drinking water. We gotta *find* that radioactive egg before we can hatch it, friend.”

And I creaked away, in my new boots, toward the garage.

Two days later ... two exhausting, sun-scorched and totally footsore days later, Missus Wife limped into the pale shade of a huge boulder and collapsed. I followed suit. For perhaps an hour, we just slumped there ... thinking black, empty thoughts and letting the desert silence broil over us.

“You sure you *built* that thing right?” Missus Wife licked sun-cracked lips and glinted a glance off me. “Two days and all we've found, so far, is an occasional radioactive bone. Maybe you goofed the project, huh?”

I turned the counter over and over in my blistered hands. “Not unless the guy who drew the schematics for this baby was hung

over or half-asleep when he did them. I checked it, thoroughly, at least twice before I assembled it.” I stared glumly across the merry, shimmering heat waves. A lizard dragged himself into the sun, panted with the effort, and painfully inched back into the simmering rocks. “Let's face it, girl. Maybe there just isn't any uranium in these forsaken boondocks.” I tried to remember how cool felt.

“Hey, I been meaning to ask you,” Missus Wife flicked a contemptuous thumb at the probe. “Why such a fancy cowhorn gimmick for this gismo when the rest of the little flop is built so plain?”

“Staghorn, not cowhorn,” I murmured, wondering if those five miles to the parked car were humanly possible before sundown. “The instructions said encase the Geiger tube in bakelite tubing, but I didn't have any. So I found this roll of staghorn and it seemed ...”

“I *knew* it!” She groaned miserably. “I had a feeling, all along—call it feminine intuition—that you were doing something wrong. No *wonder* we've only been detecting bones!” Her glare would have fried me if I hadn't already been nicely done to a turn. As it stood, the very idea she expounded was half-baked.

“Feminine intuition,” I drawled folksily, “is merely a male hunch that made good. And I



... she stood triumphantly waving an ancient looking tibia ... or perhaps it was a femur ...

never mix science with superstition. Those bones we found must have possessed *some* degree of radioactivity, because if I thought your absurd theory that a staghorn probe only detected ...”

“Didn't those government charts say uranium deposits have been found in this area?”

“Sure, but that's no ...”

“Then, shouldn't we have been getting better than just background counts of thirty to forty clicks a minute—say, an occasional higher count, here and there?”

“Possibly.” I had a feeling she had me, and I knew she had a feeling that I knew she had me. It was a confusing, defeatist thought and

(Continued on page 122)

By HARVEY POLLACK



Fire may strike your home next! Build and install this effective system to warn of fire in its earliest stages

A SENSITIVE, quick-acting fire alarm can effectively protect the home-owner against the dangers of unchecked fires that often start around central heating plants, in basements, and in attics. Such an alarm, which can also be used as a high-temperature safeguard in countless other applications, will be described in this article.

By making minor circuit modifications, the alarm may be changed to an aquarium or incubator thermostat, a freezer cutoff alarm, or a control for individual room heaters. Because of its circuit characteristics, it is ideal for remote control in-

stallations where the building to be protected against rampaging fire is situated at a relatively great distance from the main house at which the alarm bell is to be located.

Performance

The circuit utilizes a modern heat-sensing element, the *thermistor*. A thermistor is a resistor whose ohmic resistance drops sharply with rising temperature, i.e., it has a high negative temperature coefficient. These interesting units are readily available in many sizes and values ranging from

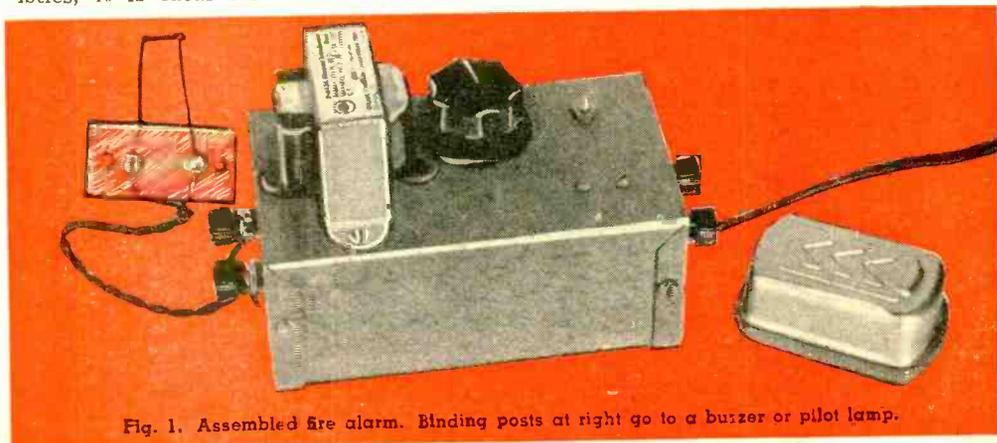


Fig. 1. Assembled fire alarm. Binding posts at right go to a buzzer or pilot lamp.

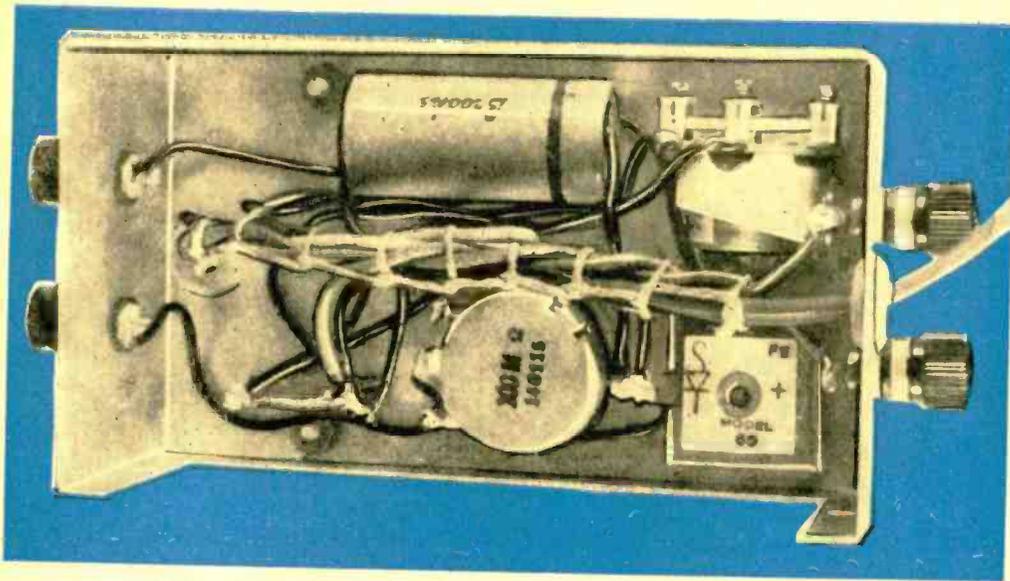


Fig. 2. Under-chassis view of unit shows locations of the major components.

about one ohm to hundreds of thousands of ohms. Correctly used, they enable the builder to meet the following performance specifications:

(1) *Low initial cost*—the relative simplicity of the circuit brings the over-all initial cost down to about \$11.50.

(2) *Low operating cost*—the choice of a high-resistance thermistor coupled with a low-current sensitive relay permits the circuit to idle continuously with a current drain of something under .002 ampere. At present power rates, this makes the yearly operating cost less than 24 cents.

(3) *Reliability*—alarms of this type should be inspected and checked periodically to insure reliability of operation in time of need. Since all circuit components operate at less than half-maximum rating,

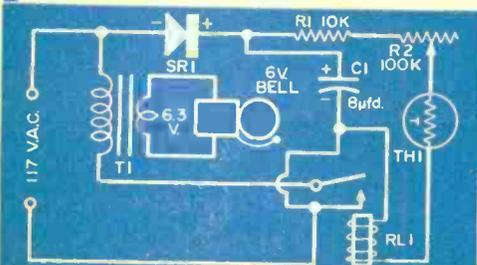
and because the relay and rectifier are enclosed in a metal case which is as close to being dust-proof as one could desire, dependability is assured even though the test-checks are few and far between.

(4) *Remote control*—to make the device universally applicable, components and design factors were selected to permit the builder to use very long leads—literally thousands of feet, if desired—between the thermistor and the control box. Even the alarm bell may be placed hundreds of feet from the control section should this separation be desirable.

(5) *Adjustable sensitivity*—to satisfy individual requirements, the circuit is arranged so that it can be made to react swiftly to almost any above-normal temperature between 120 and 500° F or higher.

Fig. 3. Schematic diagram and parts list for the thermistor fire alarm.

- C1—8- μ fd., 450-volt electrolytic capacitor
 R1—10,000-ohm, 1/2-watt resistor
 R2—100,000-ohm potentiometer, linear taper (IRC Q-11-128 or equivalent)
 RL1—Sensitive relay, 10,000-ohm coil, pull-in



rating 1 to 2 ma. (Advance SO-1C-10,000D, Sigma 2F, or equivalent)

SR1—65-ma. selenium rectifier (see text)

T1—Filament transformer, 6.3 volt @ 1.2 amp. (Stancor P-6134 or equivalent)

TH1—Thermistor, VECO Type 51R2 (Victory Engineering Corporation, Springfield Rd., Union, N. J.—a kit of thermistors and varistors, available from the company for \$10.00 by mail, contains this thermistor)

I—Line cord and plug

1—Standard doorbell or buzzer

1—Case, aluminum, gray hammertone finish, 5 1/4" x 3 1/2" x 2 1/8"

4—Insulated binding posts

1—2-lug tie point

1—Potentiometer knob, any type

Misc. grommets, machine screws, wire, solder, etc.

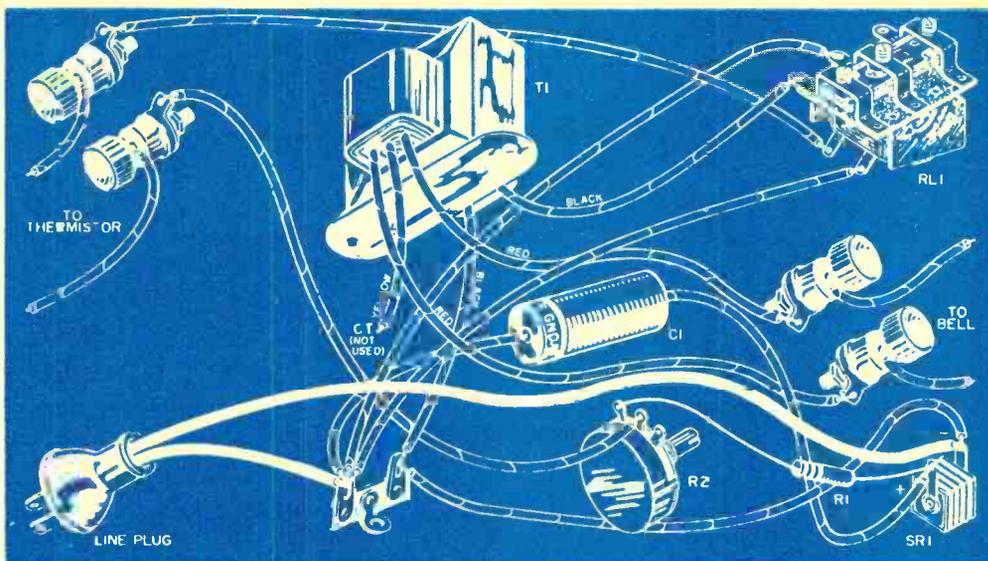


Fig. 4. Pictorial diagram of the alarm.

(6) *Latch-in feature*—once the fire alarm is triggered, the alarm bell continues to ring even though the heat around the thermistor sensing element temporarily subsides. This action is accomplished automatically by adjusting the relay properly, as will be described later.

(7) *No BX cable or conduit required*—low-voltage wires may be run between the bell and central control.

Construction

Whether the reader duplicates the alarm system exactly or makes modifications to suit his tastes, just a few preliminary constructional precautions are desirable. The rectifier (SRI, Fig. 3) should be rated at 35 ma. at the least, even though the total current drain is less than 2 ma.; this makes for cool operation over extended periods of time. Filter capacitor C1, an 8- μ fd. unit, should have a working voltage rating of 450 volts although the total anticipated potential across it never exceeds 150 volts; long capacitor life may be expected under these conditions. The transformer T1 may be mounted either inside or outside.

Terminals for the thermistor are isolated from the line by the 10,000-ohm resistance of the relay and by a protective 10,000-ohm resistor R1. An even better arrangement would be to use an isolating transformer, such as the Triad R54X. This unit has a 115-volt secondary for operating the thermistor and relay circuit, thus completely isolating it from the line. Also included is a 6.3-volt winding for operating the alarm bell. With such an arrangement, the relay contacts would be connected in series with

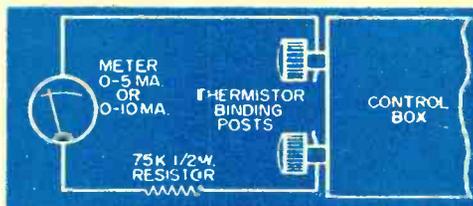


Fig. 5. Hookup for initial adjustments.

the 6.3-volt winding and the alarm bell.

The binding posts are insulated from the case by means of shoulder or extruded fiber washers. Holes drilled to take these washers must be large enough to allow the extrusion to "sit" inside the rim of the opening, thus preventing the metal screw of the post from touching the case. Live rubber grommets are necessary for all feed-through leads to protect the latter against fraying over the years.

Testing and Adjustment

All wiring should be completed before proceeding with adjustment and testing. A.c. power should not be applied until it is determined, by means of an ohmmeter, that no bare wires are in contact with the case and that there are no short circuits which might injure the selenium rectifier, the thermistor, or the relay. An ohmmeter is mentioned because it is usually a part of a multitest meter which is needed for current measurements.

For the following test, do not connect the thermistor into the circuit at all. Instead, connect the multitester as a low-range milliammeter (0-10 ma. range is just about right) in series with a 75,000-ohm resistor across the thermistor binding posts,

as shown in Fig. 5. To avoid raucous buzzing or bell-ringing during the test, a 6-volt pilot lamp may be substituted for the alarm signal device as an indicator.

First rotate the knob of the *sensitivity* control *R2* so that it presents maximum resistance to the series circuit (fully clockwise in this model), then insert the a.c. plug into a 117-volt a.c. outlet. The milliammeter should show a reading of a small fraction of a milliampere. Gradually rotate the potentiometer while watching the meter and the pilot indicator, noting the current at which the pilot lamp first lights up. This is the "pull-in" current of the relay. Adjust the relay according to the manufacturer's instructions (these accompany the relay when purchased) so that it pulls in at 2 ma. and drops out at an appreciably lower figure, such as .8 ma. to 1 ma. Once this adjustment has been made, it is advisable to seal the adjusting screws with flexible polystyrene coil dope.

Again rotate *R2* to maximum resistance and replace the 75,000-ohm resistor with the thermistor, leaving the meter connect-

ed. Repeat the "creep-up" procedure given above, adjusting the potentiometer in small steps. This is necessary because, as the current is allowed to rise in the thermistor and it begins to warm up, its resistance diminishes, permitting more current to flow. The increased flow of current, in turn, warms it some more, again reducing resistance. This cycle continues until the thermistor radiates its heat away as fast as it is generated, stability being reached in about ten seconds. From the above procedure, determine the position of the control knob for a setting which is just short of pull-in. Leave the control in this position, remove the meter, and connect the thermistor alone across the binding posts. The alarm is now set for a heat test.

Pass a lighted match quickly under the thermistor body; the pilot lamp should come on instantly, simulating ringing of the alarm bell. Once the correct setting of *R2* has been obtained, the response should be instantaneous when the ambient temperature around the sensing element exceeds 120-150° F. -30-

More Power from Sun Batteries

AS FAR AS this generation is concerned, the sun is an inexhaustible source of power. Take advantage of that untapped power to operate small transistorized radios, light-operated relays and other electronic assemblies requiring a few milliwatts. The B2M "Sun Battery" provides a convenient, cheap method of tapping the sun's energy.

I have been experimenting with B2M selenium cells by wiring them in series and parallel to obtain more voltage (series ar-

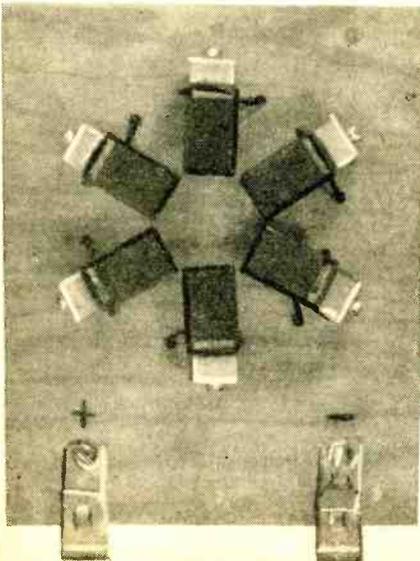
rangement) or more current at the same voltage (parallel arrangement). The best layout plan for five or six B2M cells has been a circle; this type of circuit has the advantage of receiving maximum light from the sun when used outdoors and an equal light distribution from a ceiling spotlight when used indoors.

Mount the five or six cells on a plywood base (about 4" x 4½") and run the connecting leads through holes to "beautify" the arrangement. Solder all of the wires to reduce circuit losses. Attach two thin strips of plywood to the underside of the base to raise it above the workbench, and thus prevent the wiring from being chafed.

A test made in bright sunlight gave the data for the following table, which shows the voltage and current output through various resistances:

Ohms	Volts	Microamperes
200,000	2.71	12
100,000	2.69	25
54,500	2.65	40
20,000	2.54	115
8000	2.43	300
5000	2.28	450
414	.90	2160
220	.58	2550
150	.31	3000

All of the above figures were obtained using six cells connected in series.—George P. Pearce. -30-



Jim Caukins Learns to Tune In a Single-Sideband Station

By E. H. MARRINER

There is a little trick to it—but once you have mastered the technique, the band is yours!

BILL JONES had just about hooked a ∇ Q4 on his amateur station, when the doorbell rang. It always rang just at the wrong time. Bill slowly took his earphones off and laid them down on the table, got up and went to the door. Just outside stood Jim Caukins, the Novice from down the street.

"Hi, Bill, hope I didn't bother you."

"Naw, come on in, Jim. What's on your mind this evening?"

"Well, I've been listening to all these 'Donald Duck' stations, trying to tune one of them in, but I give up!"

"You mean one of the single-sideband stations on 3800 kc. or on 4000 kc.?"

"Yeah, I can't seem to tune them in properly. Can you show me how?"

"OK, we'll see if we can tune one of them in on the HQ-129X. Let's see if we can find one first. There are generally a few on after 4 p.m., and most of the W6's hang around 3800 kc. They generally have lots of power and are easy to tune in.

"Here, Jim, I think I got one now. The book says turn the audio volume on full, then turn the r.f. sensitivity control down, until we still hear the signal. Does that make sense to you?"

"I heard you have to turn the c.w. switch on. That's the b.f.o. switch, isn't it?"

"Yup, just like we were receiving code signals, Jim. Doesn't sound very practical, does it? Well, we're all set up. Have the station tuned in, the r.f. control down, audio turned up full, and the c.w. switch on. Now there's just one more item—a very important one too. Probably the reason most fellows can't make sense out of a single-sideband signal.

"It happens there is an upper and lower sideband and the boys use one or the other. The fellows on 3800 kc. generally use the lower, and the fellows on 4000 kc. use the upper."

"Sounds like it isn't going to work, Bill."

"Hold your horses, Jim. See that knob marked 'beat oscillator'? That's the b.f.o. knob. I won't get too technical, but for receiving stations on the 3800-kc. end of the band we want to turn it to the left

of center. Not much, just a very little."

"OK, I'm still following you, Bill; go ahead."

"All set? Let's turn it just a little to the left, and at the same time tune the main tuning dial. Now adjust the b.f.o. just a little. Hear it dip and sort of lock in? Now we can understand the station; doesn't sound bad at all does it?"

"Sounds just about like an AM station now, Bill. Think I'll ever get used to all that tuning?"

"Once you get the receiver set up, you won't have to touch the b.f.o. knob all evening, except for an occasional touch-up, or unless you want to listen to the other sideband."

"Won't the receiver drift off the station?"

"Not if you let it warm up for a while. If you want to listen to the other sideband, just reverse the process of tuning. Down at the 4000-kc. end of the band most of the fellows are on the upper sideband and you'll have to tune the b.f.o. knob to the right of center."

"Well, Bill, I don't have a b.f.o. knob on my ARC-5 surplus receiver. I guess I'm stuck."

"Not exactly, just a little more difficult to tune in, but it'll work just fine. In place of the b.f.o. knob, you'll have to use a screwdriver, and vary the b.f.o. setting at the screw hole near the back right side of the ARC-5 receiver. Once you get it set off to one side, you can copy most of the boys OK. Better yet—you can put a variable 25- μ fd. capacitor on the side and hook it across the b.f.o. coil. Then you can control it from a knob."

"That would be a lot better than using a screwdriver."

"Maybe you could fasten a shaft on the screw to make it easier, Jim."

"Fine, Bill, thanks a lot. I better get along home now. Hope I can remember how to tune those stations in. They say you can hear them right out in the clear, no interference."

"Yep."

"So long and thanks again, Bill." —30—

Transistor Topics

READER RESPONSE to this department has been two-fold. Some readers want to see experimental circuits while others are more interested in knowing about the latest transistor releases, reports of recent developments, etc. In an effort to please everyone, a division has been made which should permit both fields of interest to be served.

In the first part of each column, we will feature several experimental circuits suggested by our readers. Under the heading "Tech Talk," we will discuss new products and developments at a somewhat higher technical level. We hope you like it—comments will be appreciated as always.

Transistor Radio in a Hat

The wiring schematic at the bottom of this page shows a receiver designed by A. E. Munich which he has installed in his "ten gallon hat." In high signal strength areas, this receiver will work without an antenna or ground connection. In some localities, a short piece of wire taped to the hat brim will be all the antenna required.

Low-cost transistors are used throughout, and the circuit is straightforward without unnecessary frills. The first stage is a grounded collector regenerative detector. No tuning capacitor is shown as Munich leaves his receiver spot-tuned to one broadcast station. The slug of the loopstick can be adjusted to cover the band from 650 to 950 kc., using the 200- μ fd. (C6) fixed capacitor.

The tickler coil, L2, is wound of 15 turns of No. 28 wire. It is best not to solder this coil into position until the receiver has been completed. As in the usual regenerative circuit, it is possible that the coil leads will need to be reversed. If the circuit sounds weak, it

may be that the leads are making the coil "degenerate" rather than "regenerate" as it should. Experiment by shifting L2 leads until the best signal is heard.

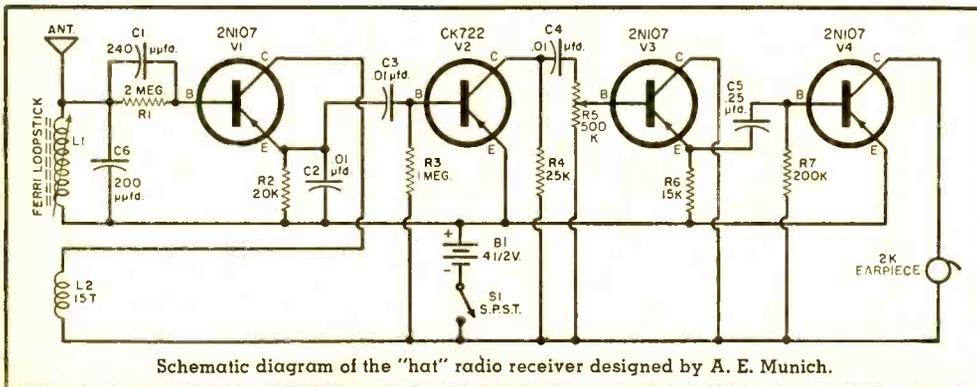
Munich reports that all of the parts may be purchased new for under \$11. The earpiece is



cut to provide just the necessary length when the hat is worn. When he wants to wear the hat without using the radio, the earpiece can be fastened inside the brim with a piece of tape.

Improved Production Technique

A major headache in *p-n-p* transistor production is the "doping" of the *n*-type germanium to make a *p*-type coating. It is done by sandwiching a thin slice between two layers



Schematic diagram of the "hat" radio receiver designed by A. E. Munich.

of aluminum and heating the whole assembly until the impure *p*-type coating is formed over the *n*-type center. Perfection of this method requires close control of the applied heat. Weak *p-n-p* transistors generally have a "thick" *n*-type center, while very active units for high frequency use have an extremely thin center.

According to a recent announcement, Westinghouse Research Laboratories has developed an improved technique for making *p-n-p* transistors. As the temperature can be virtually uncontrolled, transistors are produced which are more consistent in quality from unit to unit. The key to the process is a "cooling off" period during the heating of the transistor sandwich. This new technique has also produced transistors which are at least 10,000 times more sensitive to light than photoelectric cells. Westinghouse will probably call them "photodiodes."

No information has been released on availability or type numbers.

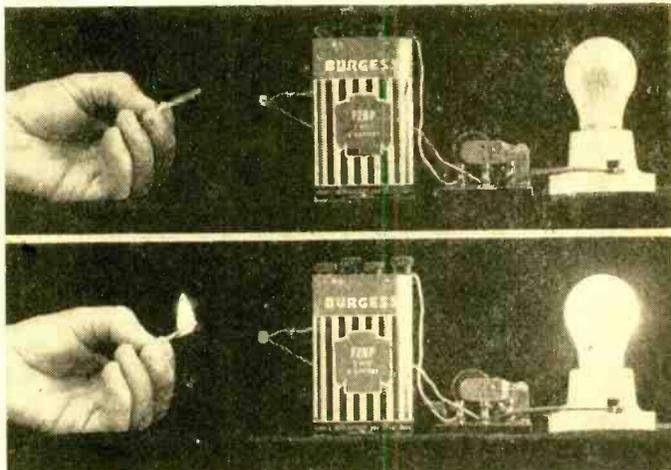
Solar Batterylike Transistor

The "diffusion" technique employed by the Bell Telephone Laboratories in producing silicon cells is roughly similar to certain processes used in manufacturing transistors. Thin slices of very pure silicon are treated under gas at high temperatures. This permits the controlled introduction of special impurities at the surface of the silicon. Surface penetration is less than one ten-thousandth of an inch. The boundary created in the cell between the two different regions of electrical conductivity is referred to as a "*p-n* junction." Transistors use two such surfaces and hence are known as "*p-n-p* junctions" or "*n-p-n* junctions." Unfortunately for the average experimenter, the cost of pure silicon is quite high, and the only true silicon solar battery on the market is sold for about \$20.

Tech Talk

Six *p-n-p* transistors have been packaged into a convenient kit by the General Transistor Corporation. Called "Kit #2," the transistors are contained in a functional Lucite box. They consist of three *p-n-p* transistors for audio applications, two for i.f. amplification up to several hundred kilocycles, and one transistor that will work as an oscillator/converter. The kit is designed for experimenters and will be sold for about \$17. . . . Two transistors intended for use in broadcast AM receivers were recently placed on the market by RCA. They are the 2N139 and the 2N140. The 2N139 will provide a 30-db gain at the 455-kc. i.f. channel with a common-emitter circuit, while the 2N140 will work nicely as a mixer/oscillator or converter. Both are *p-n-p* types.

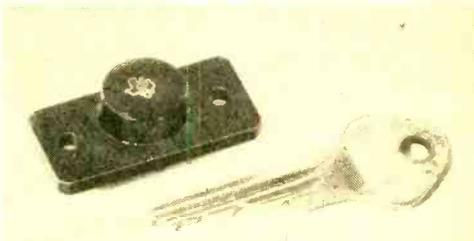
March, 1956



New Westinghouse "photodiodes" are super-sensitive to light.

Germanium *p-n-p* power transistors have been perfected by CBS-Hytron, each of which has a large copper base that may be bolted to the chassis. This allows the heat to flow from the power transistor to the chassis, thus providing a large area of heat radiation. Recently released CBS-Hytron transistors of this type include the 2N155, 2N156, 2N157, and the 2N158. A pair of 2N156 power transistors can furnish 8 watts output in an audio circuit. . . . General Electric has a new brochure on transistors. It is known as No. ECG-95 and may be obtained from the Semiconductor Products Division, General Electric Co., Electronics Park, Syracuse, N. Y.

Texas Instruments has a new silicon power transistor with a dissipation of 3.5 watts. Although intended for use by the military services in specialized applications, the Type 970 would probably work in hi-fi power amplifiers. Silicon transistors are particularly useful



TI's Type 970 silicon power transistor.

where high operating temperatures are permissible. TI's new one is an *n-p-n* type with a gain of 18 db (class A operation) at 2.5 watts output.

Once again, we would like to mention the Raytheon book titled "Transistor Applications," which is available at most radio parts jobbers. It costs only 50 cents and contains more than 50 schematics of practical ideas for transistor projects. If you have not seen a copy, be sure to drop in at your local jobber today.

Signal

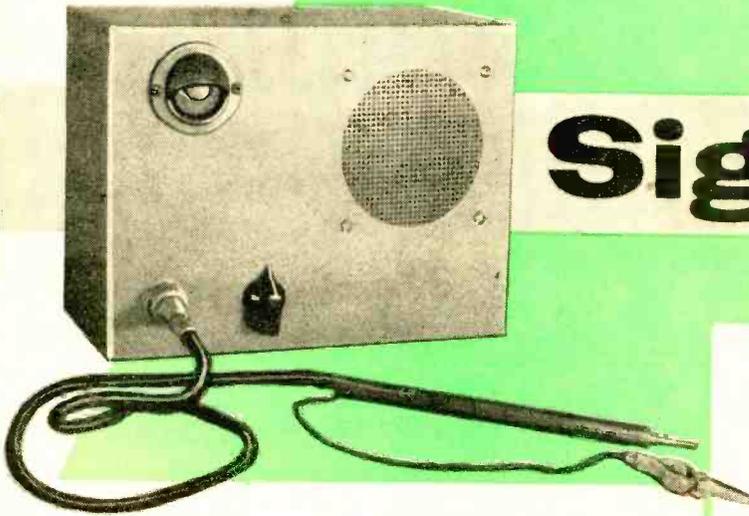


Fig. 1. The only control on the front panel is the volume control, *R1*, which also operates the on-off switch, *S1*.

MANY service technicians rate signal tracing as the most useful technique ever developed for fast trouble-shooting. A signal tracer doesn't have to be tuned, and you don't need an engineering degree to understand how it works. In fact, a tracer is easier to handle than some meters; it can be used to locate trouble in radio, TV, audio, and other equipment.

If you're willing to pass up some of the extra features built into commercial signal tracers, you can put one together for very little money. New parts for the instrument shown here will cost about \$17.00 at retail; you can push that down quite a bit by shopping for bargains or digging into your spare-parts box.

How It Works

To illustrate how this signal tracer is used, let's assume that we are checking a radio. First, we connect a live amplitude-modulated r.f. signal generator to the antenna and ground terminals of the set. Next, we tune the signal generator and radio to the same frequency. Then, with the radio operating, we touch the pickup probe of the signal tracer to the input and output point of each stage in the set—starting at the antenna terminal and working step-by-step through to the loudspeaker.

At each "live" point in the circuit, the tone from the signal generator will be heard from the speaker in the signal tracer, and the magic-eye indicator in the tracer will close to show the presence of a signal. When the speaker is quiet and the eye remains open, the tracer probe is touching a dead point in the circuit. This shows that

trouble is present between the point just touched and the last live point. An intermittent fault is indicated by sputtering sounds from the speaker and winking of the eye. Oscillation, interfering signals, and hum are identified by ear.

Circuit Description

What is the circuit of the signal tracer? Basically, it is nothing more than a crystal detector (in the test probe) followed by a sensitive audio amplifier. The amplifier operates both a loudspeaker (for aural indications) and a magic-eye indicator tube (for visual indications). The amplifier power supply is self-contained.

Figure 3 shows the complete circuit schematic, and details of the probe are given in Fig. 5. The detector consists of the miniature germanium diode *V4* and input capacitor *C8*, and is built into the pickup probe. If you already own an oscilloscope demodulator probe (such as Heath-kit 337-C, or EICO PSD or PSD-K), you can use that instead of building a separate detector probe for the signal tracer.

Output of the detector goes to the grid of the high-gain 6AU6 audio amplifier stage. Gain is controlled by means of potentiometer *R1*. The power output stage, which uses a 6AQ5 tube, drives the loudspeaker. The audio signal applied to the control grid of the 6AQ5 is applied also to the grid of the 6E5 magic-eye indicator tube, thus giving simultaneous operation of the speaker and eye.

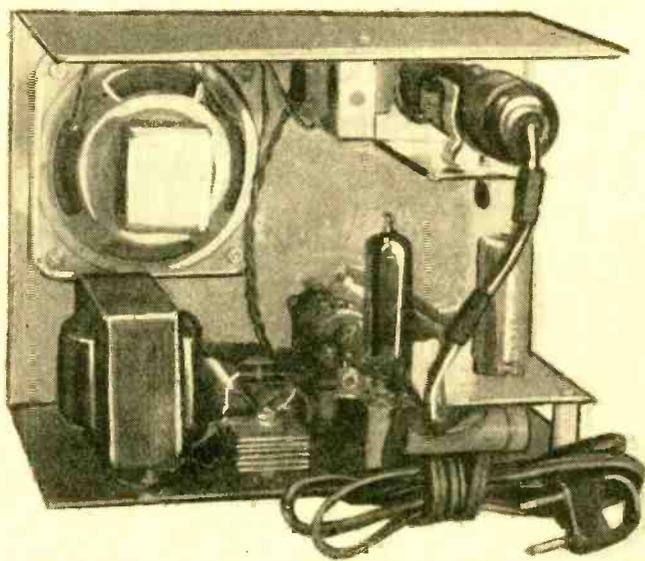
You can get professional results with this low-cost tracer which can be used for both audio and r.f. work

Tracing

By RUFUS P. TURNER

on a Low Budget

Fig. 2. Rear view with the cabinet disassembled shows location of parts. Tubes are mounted on a metal shelf, shown at lower right, which is supported by stand-offs. The speaker and magic-eye assembly are mounted on the front panel of the metal cabinet.



The internal power supply of this unit consists of a miniature power transformer *T1*, a 75-milliampere selenium rectifier *SR1*, filter resistor *R7*, and electrolytic filter capacitors *C5* and *C6*. No pilot light is used, since the glow of the magic-eye tube serves the same purpose.

Mechanical Construction

Figures 1 and 2 show the mechanical construction of the signal tracer. This instrument is built into a $4\frac{1}{2}'' \times 6'' \times 8\frac{1}{4}''$ aluminum case, though a less expensive wooden box (and a metal chassis) could be used instead.

A 3" loudspeaker opening is cut on the right-hand side of the front panel and backed with a 4" square of perforated grille material. A $1\frac{1}{4}''$ hole at the upper left of the panel serves as a window for the magic eye. Input jack *J1* and gain control *R1* are

mounted near the lower left corner of the panel (see Fig. 1).

The magic-eye tube is held in a standard Amphenol 58-MEA6 bracket. Six leads, color-coded as in Fig. 3, come out of the socket of the assembly. Resistor *R8* is supplied with the unit and is already connected inside the socket shell.

Shielding is necessary on the 6AU6 to reduce hum pickup and oscillation. Mount the 6AU6 and 6AK5 tubes on a small metal shelf and install it below the magic-eye assembly. Mount the amplifier circuit components on the under side of the shelf. This type of construction is not a "must," however, since you can support the sockets by long screws from the bottom of the case if you wish.

Figure 5 shows details of the pickup probe. When you make it, keep capacitor *C8* and diode *V4* as close to the prod point

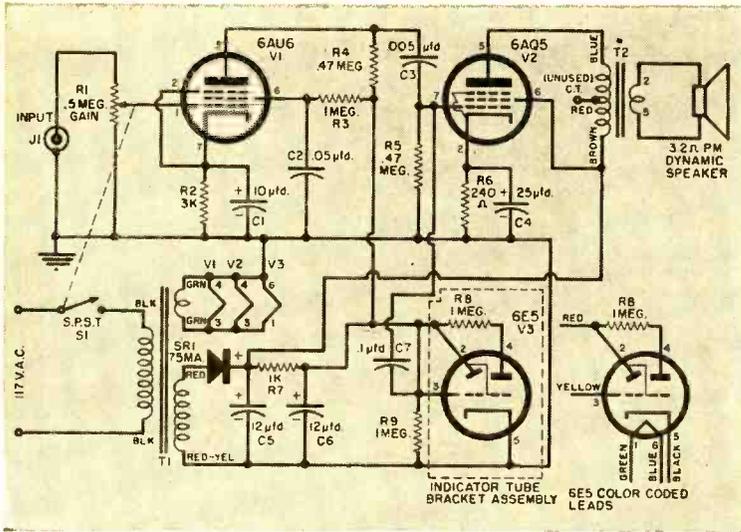


Fig. 3. Schematic diagram and parts list for the main unit. The probe is shown in Fig. 5.

- C1—10- μ fd., 25-volt midget electrolytic capacitor
 C2—0.05- μ fd., 200-volt midget tubular capacitor
 C3—0.005- μ fd., 200-volt midget tubular capacitor
 C4—25- μ fd., 25-volt midget electrolytic capacitor
 C5, C6—12- μ fd., 250-volt midget tubular electrolytic capacitor
 C7—0.1- μ fd., 200-volt midget tubular capacitor
 J1—Chassis receptacle connector, Amphenol 75-PC-1M
 R1—500,000-ohm potentiometer (with S1)
 R2—3000-ohm, 1-watt resistor
 R3—1-megohm, 1-watt resistor
 R4, R5—470,000-ohm, 1-watt resistor
 R6—240-ohm, 1-watt resistor
 R7—1000-ohm, 2-watt resistor
 R8—1-megohm, $\frac{1}{2}$ -watt resistor (supplied with tuning-eye assembly)
 R9—1-megohm, $\frac{1}{2}$ -watt resistor
 S1—S.p.s.t. switch (on back of R1)
 SR1—75-ma. selenium rectifier
 T1—Power transformer, 135 volts @ 50 ma., 6.3

- volts @ 1.5 amp. (Triad R-30X or equivalent)
 T2—Universal output transformer (Merit A-2900 or equivalent)
 V1—Type 6AU6 tube
 V2—Type 6AQ5 tube
 V3—Type 6E5 tube
 1—7-pin miniature tube sockets (one shielded)
 1—6-prong magic-eye assembly (Amphenol 58-MEA6)
 1—3" PM dynamic speaker (3.2-ohm impedance)
 1—4" square of perforated speaker grille material
 1—Power cord and plug
 1—Pointer knob for gain control
 1—Metal case, $8\frac{1}{4}$ " long, 6" high, $4\frac{1}{2}$ " deep
 1—Metal shell for mounting tube sockets
 1—2-lug tie point
 1—1-lug tie point
 4—Stand-offs for mounting metal shell
 Misc. machine screws, solder lugs, grommets, wire, solder, etc.

as possible to reduce hand-capacitance effects.

Peel off two inches of the rubber jacket of the microphone cable that forms the lead for the probe. Then solder the cathode end of the diode lead (marked "+" or "K") to the end of the exposed shield braid (point B). Solder the other diode lead to capacitor C8 and connect the junction of C8 and V4 to the center conductor of the cable. Solder the ground-clip lead to point A on the exposed shield braid. Finally, push the assembly forward into the probe shell and join the free lead of capacitor C8 to the prod. Tighten the prod on the probe and attach plug PL1 to the free end of the shielded cable.

Chassis Wiring Instructions

As in most types of construction, the tube heaters are wired first. The heater leads between the tube sockets and the two green pigtailed of transformer T1 must be

twisted tightly together to reduce hum. After the connections are made, press the twisted leads firmly against the chassis.

Next, wire the power supply, keeping the 117-volt a.c. leads as far as possible from the 6AU6 and 6AQ5 circuits.

Finally, wire the amplifier portion of the circuit. A very important caution in this work is to return all components which are to be grounded in each stage to a *single* ground point *in that stage*. Though the separate ground lugs of the 6AU6, 6AQ5, and power supply stages are bolted to the chassis, they are also wired together.

To minimize hum pickup, the connection from input jack J1 to the top of gain control R1 is made by a short length of shielded cable and the shield is grounded. This can be a piece of the same microphone cable used with the pickup probe. The lead from the center terminal of R1 to terminal 1 of the 6AU6 socket is also a short piece of shielded cable.

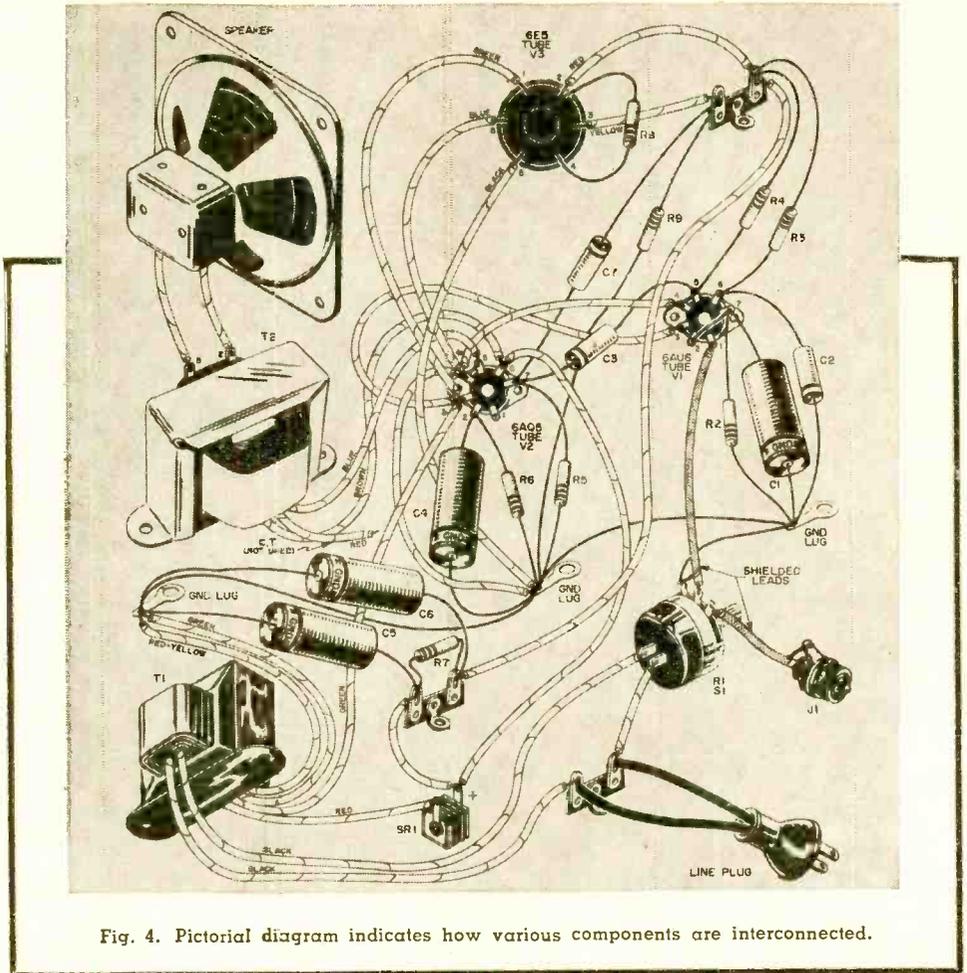


Fig. 4. Pictorial diagram indicates how various components are interconnected.

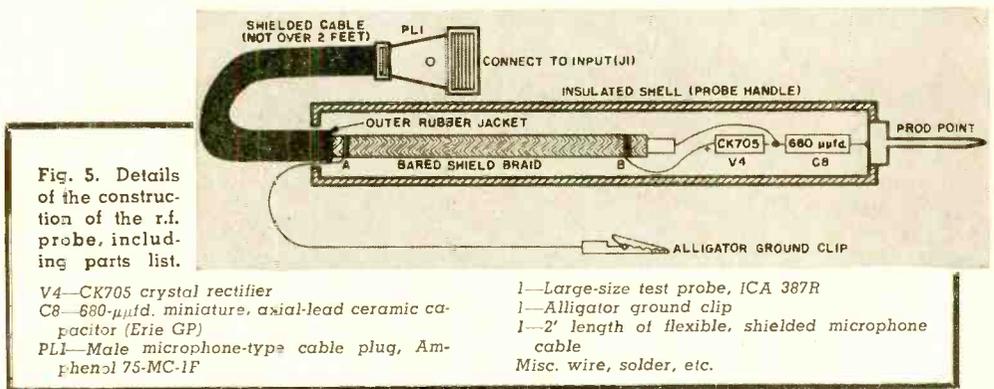


Fig. 5. Details of the construction of the r.f. probe, including parts list.

V4—CK705 crystal rectifier
 C8—680- μ fd. miniature, axial-lead ceramic capacitor (Erie GP)
 PL1—Male microphone-type cable plug, Amphenol 75-MC-1F

1—Large-size test probe, ICA 387R
 1—Alligator ground clip
 1—2' length of flexible, shielded microphone cable
 Misc. wire, solder, etc.

Initial Checking

The completed instrument may be checked in the following manner: (1) Set gain control *R1* to zero (extreme left). (2) Plug in the pickup probe. (3) Connect the probe to the output of an AM signal gen-

erator (tuned to any radio frequency). (4) Connect the ground clip of the signal tracer probe to the signal generator ground. (5) Plug generator and tracer into the a.c. power line, switch both on, and allow a

(Continued on page 108)



TWISTS

A good turn in the home radio shop

By H. Leeper

DO YOU EVER take a chassis out of a cabinet to test, repair, or replace a part? Do you have to adjust the tension of a spring? Peak a trimmer capacitor? Move a control to a handier spot? Whatever the job, you'll find it goes better and faster if you have a good assortment of twisting, turning, and gripping tools.

Since the electronic parts of an assembly—and the cases, cabinets, brackets, and hold-downs—are usually put together with screws, bolts, and nuts, a selection of screwdrivers heads the list of most-used tools. With the right ones, you won't chew

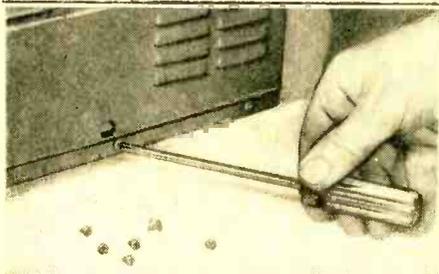
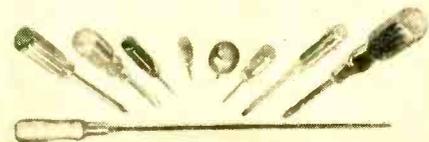
up a slotted head or develop blisters trying to budge a frozen bolt.

What is the right screwdriver? The best rule is that the tip should be almost as wide and thick as the slot it's supposed to fit. If a driver tip is wider than the screw head, it may scratch surrounding surfaces; if it's too thin or narrow, it is likely to jump the slot and leave its mark on you or on some nearby part.

That's why you need a full range of drivers from the thin setscrew type to the husky, heavy-handed kind that's built for maximum turning power. One or two long-shaft drivers will come in handy, too. Though shaft length doesn't have much to

SCREWDRIVERS

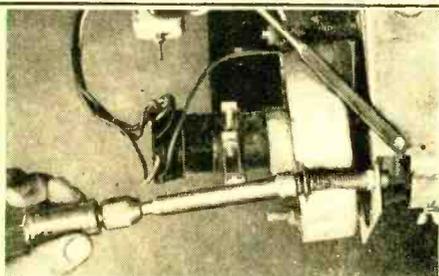
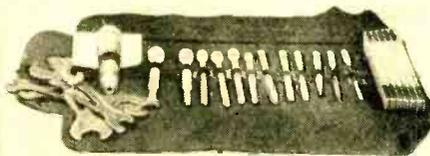
This assortment of shaft lengths, handle diameters, tip sizes, and shapes will give you the reach and turning power you need for just about any job that may crop up in your electronic building and maintenance work.



Phillips screws with cross-slotted heads are widely used in factory-made assemblies. To get at a chassis like this, you should have matching, ribbed-tip drivers. The small and medium sizes will fit the most-used screws.

WRENCHES

Open-end wrenches (left) can be used to turn nuts or to keep them from turning while you draw up on a screw or bolt. Like the nut drivers shown in the carry-kit, they come in complete sets that fit most standard nut sizes.



A socket wrench, or nut driver, is handiest in a case like this where a nut rather than a screw head is made accessible for adjustment. The hollow shaft of the driver "swallows" the part of the bolt that projects beyond the nut.

AND TURNS

deserves a turning tool of the right type and size

do with power, a long blade can reach through cabinet openings or let you start screws in hard-to-get-at spots. And cross-slotted Phillips screws show up so often that no radio kit is complete unless it contains a couple of Phillips drivers.

Another screwdriver "must" for the electronic workshop is the kind that has an insulated shaft and handle. The exposed metal tip will serve as a regulation light-duty driver; the insulation makes it a good tool for drawing sparks and a safe one when you touch a "hot" circuit by accident or on purpose.

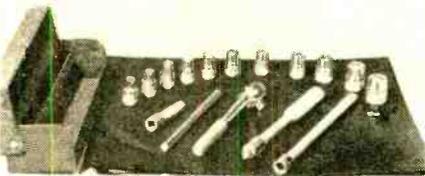
Wrenches—of the open-end and socket type—handle tightening and tensioning jobs

from the opposite end. Self-tapping screws are commonly used for parts mounting because they cut their own threads in drilled holes. Many of these screws are made with slotted, hex-shaped heads so that they can be turned with either a screwdriver or a wrench. Socket wrenches, commonly called "nut drivers," cope with them in easy, non-slip fashion. Five or six common sizes of open-end and socket wrenches will take care of most of the building and maintenance jobs that are likely to turn up in the home radio shop.

These and other tools that can speed your electronics work are pictured below and on the next page.

RATCHETS

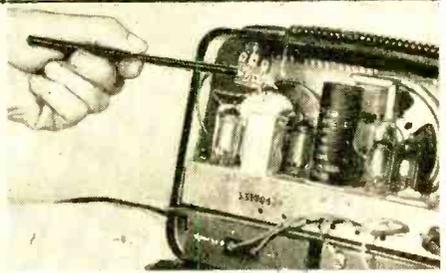
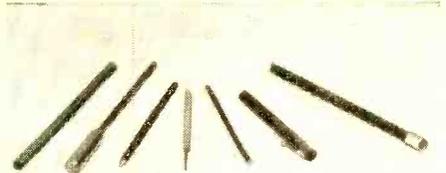
Back-and-forth action of a ratchet gives increased leverage plus extra freedom of movement in tight places. This set has reversible ratchet handle and socket attachments to fit common hex nuts or hex-headed screws.



Easy ratchet movement—plus the offset angle of this tool—is a big help when you have to turn a screw or nut in a half-hidden corner. The rubber pad in background is used to protect TV tube from accidental slips.

ALIGNING TOOLS

Plastic or fiber wands resembling screwdrivers and socket wrenches are made to fit both hex-headed and slotted adjustment screws. Some blades are enclosed in sleeves that keep tips from jumping out of slots.



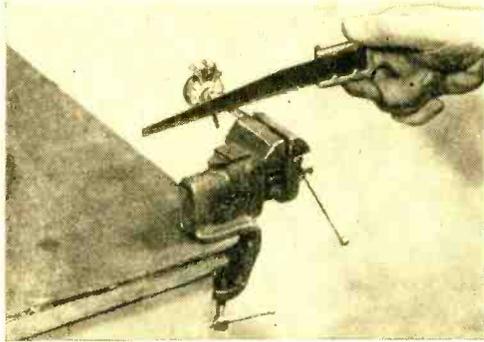
Non-conductive shafts keep your hands at a distance from frequency-sensitive peaking screws. Tips are often made of soft material; if you exert too much pressure, they'll break before they can seriously damage the screws.

GET A GOOD GRIP . . .

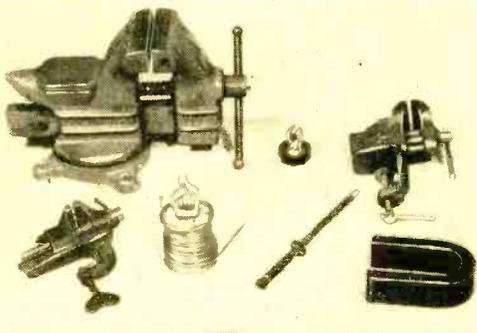
Standard radio parts don't always come in just the size and shape that you want them, and even when they do, you can't work on them if they're bouncing and bobbing freely in the air. Whenever you want to cut, bend, grind, shape, or smooth a part—or just hold it down so that you can solder something to it—you'll find uses for vises, pliers, clips, and magnets.

Tools that keep parts from moving are matched in importance by those that spin around at high speed. Electric drills and rotary tools have grown in usefulness as new attachments have become available. Many different kinds of stands and jigs, buffing, reaming, and polishing attachments now bring power-tool convenience to a wide range of building and assembling jobs.

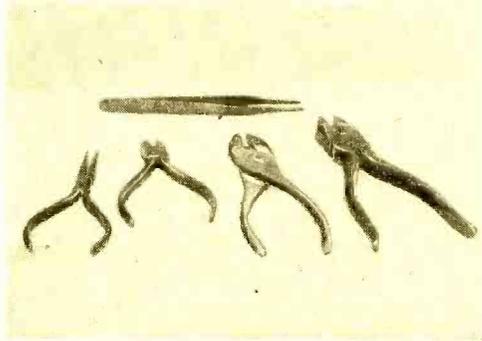
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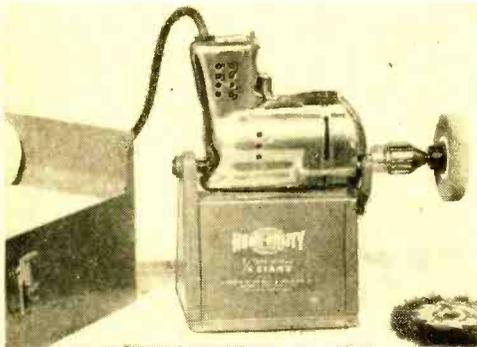
For clean, safe cutting, make sure the part you're working on can't slip or twist. A lazy short cut—like holding a shaft in your fingers while you saw it down to size—is more apt to shave your fingers than it is to shorten the work.



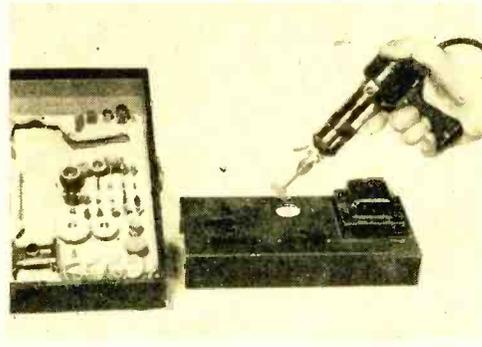
Vises, like other tools, are made in different sizes to suit different work. A spring clip, forced into the end of a bottle cap or a solder reel, makes a good emergency vise for light holding jobs. A magnet can also serve at times as a third hand.



Pliers and nippers in full assortment could fill a large tool chest, but a good general-purpose kit should have at least one pair of tweezers (top) and, left to right, long-nose pliers, diagonal cutters, slip-jaw or "gas" pliers, and parallel-jaw pliers.

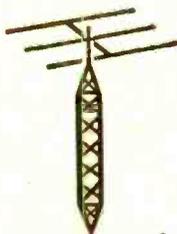


An electric drill becomes much more than a hole-making tool when you add a stand and attachments for grinding, buffing, wire-brushing, sandpapering, and other jobs. Most of the common drill attachments are made to fit quarter-inch chucks.



A rotary tool or a miniature electric drill outfitted with a kit of small craftwork accessories can be a real help in grinding off rough metal edges, enlarging holes, or routing special shapes in wood, plastic, or soft-metal chassis and cabinet blanks.

POPULAR ELECTRONICS



THE TRANSMITTING TOWER

Herb S. Brier, W9EGQ

THE NOVICE CLASS amateur license is designed to allow people without previous radio experience to get on the air with a minimum of trouble and to "learn by doing" while studying for a permanent license. Consequently, the Novice examination is very simple. It consists of 20 questions, each with four possible answers—one of which is correct. To pass, an applicant must answer a minimum of 15 questions correctly. (A 5-wpm code test must also be passed. As "Learning the Code" was discussed fully in the September, 1955, *Transmitting Tower*, we will concentrate here on the written amateur examinations.)

One way of preparing for the Novice written examination is to memorize the Novice questions and answers in the *License Manual*. Because of the simplicity of the examination, most applicants who prepare for the test in this manner pass it, even though they understand little of what they have memorized.

A much better way to prepare for the examination is to study systematically a course dealing with the points covered in the examination, so that you will understand them. The course should also instruct you on how to set up and operate your station after you pass the examination.

An excellent course of this type is the RETMA "Amateur Radio Course" (Novice License). It consists of an 84-page instruction book divided into six chapters covering the requirements outlined above. Each chapter is concluded with a page of test questions, so that the student may check his assimilation of the material presented. A copy of the latest edition of the *License Manual* is also included with this book.

Code reception is taught on five 12" long-playing discs recorded at a speed of 33 $\frac{1}{2}$ rpm. All that need be said about them is that it would be hard to see how anyone could possibly *not* learn the code well enough to pass the Novice code test in a few weeks with these records.

Cost of the RETMA "Amateur Radio Course" is \$10.00, which should be a very attractive price for any prospective Novice who has a 33 $\frac{1}{2}$ -rpm record player available. It is obtainable from the Radio-Electronics-Television Manufacturers Association, Suite 800, Wyatt Bldg., 777 14th Street N.W., Washington 5, D.C.

Novice Examination

What trouble applicants have in answering questions in the actual Novice examination is

March, 1956

apparently caused by a tendency to study the questions and answers in the *License Manual* as if they had no possible connection with the other questions and answers in it, and by a tendency to skip over the explanations accompanying some of the answers.

These facts usually show up in connection with the following type of questions. Assuming a plate potential of 650 volts and a plate current of 80 ma. to the final amplifier stage of a transmitter, what is its power input in watts? 80.125 watts? 52 watts? 5.2 watts? 40 watts? What is the wavelength of a 4-mc. signal? 120 meters? 75 meters? 750 kc.? 750 meters? And how much current will flow through a circuit containing 50,000 ohms of resistance across which is impressed a potential of 400 volts? 0.125 ma? 12.5 amperes? 8 ma? 2000 amperes?

Suddenly the applicant realizes that although he knows Ohm's law and the formulas for determining power and wavelength or frequency, he cannot solve problems with them because he has not learned the meanings of terms like *kilocycle*, *megacycle*, *milliampere*, *microampere* and their abbreviations well enough to change amperes to milliamperes, kilocycles to cycles, etc. Having four possible answers to choose from does not help resolve the dilemma—they suggest possibilities he would never have thought of otherwise.

In spite of these difficulties, over 90% of those taking the Novice written examination



Bernie Nickles, KN4BPY, 187 Frankford St., Versailles, Ky., is shown operating his one-tube transmitter (described in *POPULAR ELECTRONICS*, Feb., 1955), and his SW-54 receiver.

pass it the first time they take it. Nevertheless, such difficulties give clear warning of further trouble to come in taking the General Class examination, because that also contains quite a few problems involving the terms just discussed.

General Class Examination

With a little luck, you can probably pass the General Class written examination (and the Conditional or Technician Class examinations—they are all of the same type) by memorizing the questions and answers in the appropriate section of the *License Manual*, probably after failing it a couple of times. But that certainly is not the easiest way to pass the test.

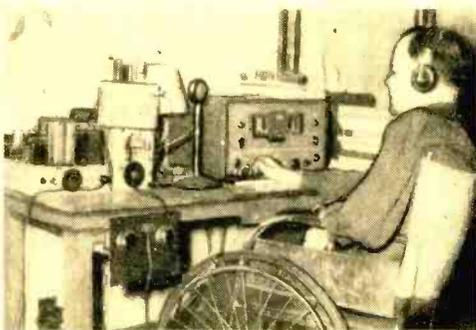
The number of questions and answers to be memorized—over 100, including 15 diagrams and the same number of formulas—makes doing so a formidable task. On top of that, the questions in the examination are different from those in the *License Manual*, although they do cover the same scope of knowledge. Therefore, it is easier and smarter to prepare yourself to *know how* to answer the questions you will be asked in the examination than to *memorize* answers to questions you will not be asked.

The only way to do this is to put the *License Manual* aside for a while and study a good textbook on radio fundamentals from the very bottom up. In this way, every time you are introduced to a new fact or idea, you will see its connection with what you already know. It will then be easy to understand and remember.

You will be introduced to atoms, electrons, and protons, with their minute negative and positive electrical charges, and you will learn how electrons in motion produce an electric current. You will meet again the ohm—the unit of electrical resistance—and see how it is indicated in circuit diagrams and why different materials have different amounts of resistance. Again, you will meet the volt—the unit of electromotive force that pushes current through resistance.

Next, you will learn how these quantities are combined in Ohm's law, the most important of all electrical formulas. And you will really work over the pesky little formula in

its three disguises of $E = IR$, $R = E/I$, and $I = E/R$, until you can use it with confidence. More important, you will have established a



Cooper Walker, Seymour, Ind., is shown at the controls of his amateur station, W9HGV. A victim of polio, Cooper is one of many who have found that a physical handicap is no barrier to becoming a radio amateur. His transmitter is a modified BC-696A war-surplus unit and his receiver is a Hammarlund HQ-129X.

firm foundation for the next step in your electronic education.

Then you will learn about alternating current and how it differs from direct current, and the relationship between frequency and wavelength.

Step by step, you will also learn about:

(1) *Capacity*—what it is, how it is formed, its unit of measurement, how it behaves in d.c. and a.c. circuits; what its effects are called, and how they can be calculated; the symbol used to represent capacitors in circuit diagrams.

(2) *Inductance*—what it is, how it is formed, its unit of measurement, how it behaves in d.c. and a.c. circuits; what its effects are called, how they can be calculated; the symbol used to represent inductance in circuit diagrams; inductive coupling, and how it is used to form a transformer.

(3) *Circuits* containing combinations of capacity, inductance, and resistance; how capacity and inductance may be joined to form resonant circuits to accept or reject signals of any desired frequency; how to calculate the resonant frequency; filters.

(4) *Vacuum Tubes*—basic theory; how a two-element tube (diode) can change alternating current to direct current; how adding a control grid produces a triode capable of generating or amplifying signals of any frequency; the effect of adding more grids to a tube.

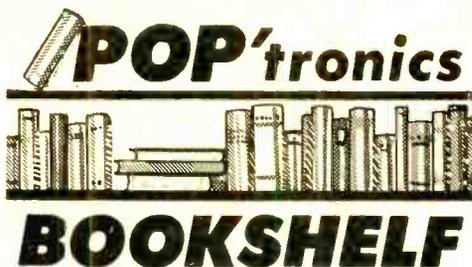
When you reach this point in your studies, you will have acquired sufficient knowledge of fundamentals to be able to *understand* the questions in the *License Manual*. You can then use them for their intended purpose, as a guide to the information you must have to pass the examination. You will be able to understand the answers, too.

Apply your knowledge of fundamentals when you start learning how to draw the diagrams. Start with the simpler ones, of course.

(Continued on page 100)



Ted Heyck, KN5BXT, Houston, Texas, reports working 25 countries in all six continents in three months of operation. (See News and Views, p. 105, for details of this station.)



POP'tronics

BOOKSHELF

"AUTOMATIC GARAGE DOOR CONTROL" published by Richards-Lawrence Book Co., Van Nuys, Calif. 38 pages. Paper bound. Price, \$1.50.

Here is a do-it-yourself book containing instructions for building a simple but effective electronically controlled garage door opener. The parts needed are relatively few and the layout is fairly easy. The system may be installed on most overhead garage doors. Complete details on the receiver, transmitter, and related mechanical parts are included. The volume is amply illustrated.

Recommended: for the person of average skill who wants to build his own.

"TV CONSULTANT" by Harry G. Cisin. Published by Harry G. Cisin, Amagansett, N. Y. 69 pages. Paper bound. Price, \$2.00.

This is the latest edition of a work which sets forth the author's method for troubleshooting television receivers. Aimed at the practicing technician, the book contains no theory and no mathematics. The various TV disorders are coded and rapid checks and steps for correction are presented. Drawings of TV screens showing faulty presentations, representative of each defect, enhance the text.

Recommended: as a possible "quicky" guide for the professional service technician.

"PRACTICAL RADIO AND ELECTRONICS COURSE FOR HOME STUDY" prepared under the direction of M. N. Beitman. Published by Supreme Publications, 3727 W. 13 St., Chicago 23, Ill. Paper bound. Price, \$3.95.

Instead of starting with basic theory, this book opens with a study of the typical a.c.-d.c. home receiver. In explaining the set—both as a whole unit and in terms of its components—the book brings in the necessary theory as an adjunct to practical work.

The pages themselves are divided into two columns: the left-hand side contains the main text while the right-hand column presents valuable hints and points for fur-

ther study. These are oversized pages, and the material contained in the left-hand column alone is more than appears on the page of an average-sized book.

The scope of the volume is quite ambitious, covering topics from basic receiver circuits to such advanced subjects as electronic stress gages. It is completely illustrated, indexed, and liberally sprinkled with charts and diagrams.

Recommended: for the beginner in the field as well as the advanced technician seeking a handy reference source.

"GUIDE TO HIGH-FIDELITY LOUD-SPEAKER SYSTEMS" published by Electro-Voice, Inc., Buchanan, Mich. 20 pages. Paper bound. Price, 25 cents.

This catalog features complete descriptions of E-V speakers, enclosures, and do-it-yourself kits. Advice on selection is based on the user's budget and other considerations.

"PLANNING BUILT-IN HI-FIDELITY SYSTEMS FOR THE HOME" published by Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. 16 pages. Paper bound. Price, 25 cents.

Planning a hi-fi system that will become an integral part of your home? Better consult this booklet for some worthwhile advice regarding space, ventilation, wiring, and materials. Included is a typical home "music wall."

Free Literature Roundup

CIRCUIT BUILDERS will be interested in *Anchor Solder and Its Proper Application*, available from Anchor Metal Co., Inc., 244 Boerum St., Brooklyn 6, N. Y.

A WIDE RANGE of Precision brand test equipment is described in *Catalog No. 23*, issued by Precision Apparatus Co., Inc., 70-31 84th St., Glendale 27, L. I., N. Y.

KITS FOR BUILDING test instruments and audio amplifiers are listed in EICO's new catalog. For your copy, write to EICO, 84 Withers St., Brooklyn 11, N. Y.

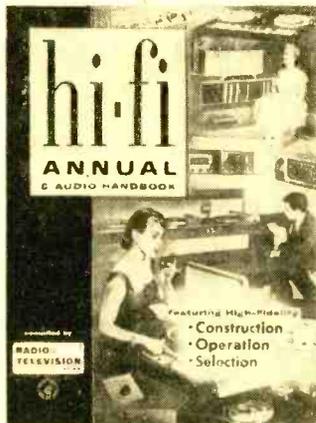
PRESENT AND FUTURE electronic service dealers will want a copy of Sylvania's *A Guide to Good Business*. This 20-page volume is crammed with vital information on the service and retail trade. Well printed and beautifully illustrated in color, it is one of the most worthwhile free items offered yet. Write to the Public Relations Dept., Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. —30—

hi-fi

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Disc and Tape Review

By **BERT WHYTE**

MANY FOLKS I know received hi-fi rigs as Christmas presents, and it was interesting to see how quickly some of them realized that the Achilles heel in their hi-fi systems was the quality of LP recordings. They learned the hard way that a hi-fi system in itself is no guarantee of quality. In fact, they learned one of the truer meanings of the much abused term "hi-fi" . . . that it means faithful reproduction of *all* elements in a recording, whether this is wondrously "live" clean sound or harsh distortions with scratch, hiss, etc. There is no doubt that careful selection of recorded material is necessary if full enjoyment is to be obtained from a hi-fi music system. It is my hope that this column has been helpful in guiding you to recordings of the desired quality, and that it will continue to be so in the future.

Classical Gems

Last month, we concerned ourselves with Mr. Paganini and his works. This month, we'll roam around the LP catalog and see what we come up with. First, let's talk about one of Francis Poulenc's works.

Poulenc is a modern French composer noted mostly for light, witty, rather satirical and amusing music. But he has done quite a number of more serious works as well, one of which is his masterful *Concerto for Organ, Strings and Tympani*.

CONCERTO FOR ORGAN, STRINGS AND TYMPANI

In spite of the rather dry-sounding title, this is a tremendously exciting work and is a very spectacular hi-fi vehicle. There is but one recording of it in the LP catalog, on Columbia ML4329,

with E. Power Biggs on the organ and Burgin conducting the Columbia Symphony. (This orchestra is strictly a "pickup" recording group, comprised mainly of Boston Symphony men.) The organ is used in true concerto form; and under Biggs' expressive hands, the work receives an expert performance. Slow movements are quite dramatic, and the scherzo and finale fairly froth and bubble with brilliance.

This is highly listenable modern music, really more romantic than "modern" in cast, and throughout the work there are sections with scoring of great beauty. The recording is old as LP's go (1950), and in those early days of LP found much usage as a hi-fi demonstration piece. In spite of its age, the disc can still more than hold its own as a hi-fi spectacular. The orchestral scoring is all strings, and they are heard with remarkable cleanness and with nice bright incisiveness when necessary.

The organ is the prize on this disc, however. It is very brightly voiced in certain sections, and its clean, clear articulation is wonderfully effective in the projection of the Poulenc scoring. It is in the pedal organ that the disc earned its hi-fi reputation . . . there is a great feast of huge pedal sonorities, up to and including 32 foot contra bombardons! The huge throbbing magnificence of these pipes is captured with a realism which few organ recordings surpass even today.

Oh, there were some boo-boo's and distortions here and there, but this disc can still qualify as one of Columbia's best engineering jobs. The frequency and dynamic range was very wide for the time and measures up to many present discs, transient response was excellent, and the acoustic perspective was logical. This is an off-beat work to be sure . . . but I can practically guarantee you'll enjoy it!

KING OF INSTRUMENTS, VOLUME ONE

Speaking of organs and organ music brings to mind one of the most remarkable recordings in the LP catalog. While the recording is over a year old, it is not the sort of thing that is generally reviewed, and for the benefit of those who may have missed it, we'll give it a whirl. I am referring to a record called *King of Instruments, Volume One* issued by Aeolian-Skinner.

As any organ aficionado can tell you, Aeolian-Skinner is the name of one of the foremost organ builders in America. Frankly, the record was first issued by the company as a sort of advertising gimmick, but it soon became so popular that it was made commercially available. Pleased with its success, Aeolian-Skinner subsequently issued three more volumes. While all of these discs are made to a very high quality of fidelity and musical content, it is the first volume that remains the most interesting. This is because what it amounts to, literally, is a brief course in organ construction and organ voicing and registration!

Donald Harrison, of Aeolian-Skinner, is one of the most highly regarded organ building experts in the world, and it is he who is our

guide and instructor. With his slightly British, softly modulated voice pleasant to the ears, he takes us into the musical armament of the organ. He describes the construction and the sound of the various pipes such as the principals, the flutes, strings, reeds, and the way they can be varied and used in mixtures and mutations. The pedal organ, so beloved of the hi-fi fan, is explained.

The best part of the whole recording is that after each verbal explanation there are musical examples of excellent fidelity. And Mr. Harrison is thorough, believe me! You will learn about and hear the difference between an open pipe and a stopped pipe, a stopped chimney pipe, flue pipes, differing tonal qualities of metal vs. wooden pipes, the sounds of the baroque organ vs. the sound of the romantic organ, etc., etc.!

As noted, the musical examples are beautifully recorded, so that it is very easy to differentiate between even the most subtle changes in sound; and the lows in the pedal organ are among the best available for testing your speaker's low-frequency response. Anyone who loves organ music will certainly derive much benefit from this unusual recording.

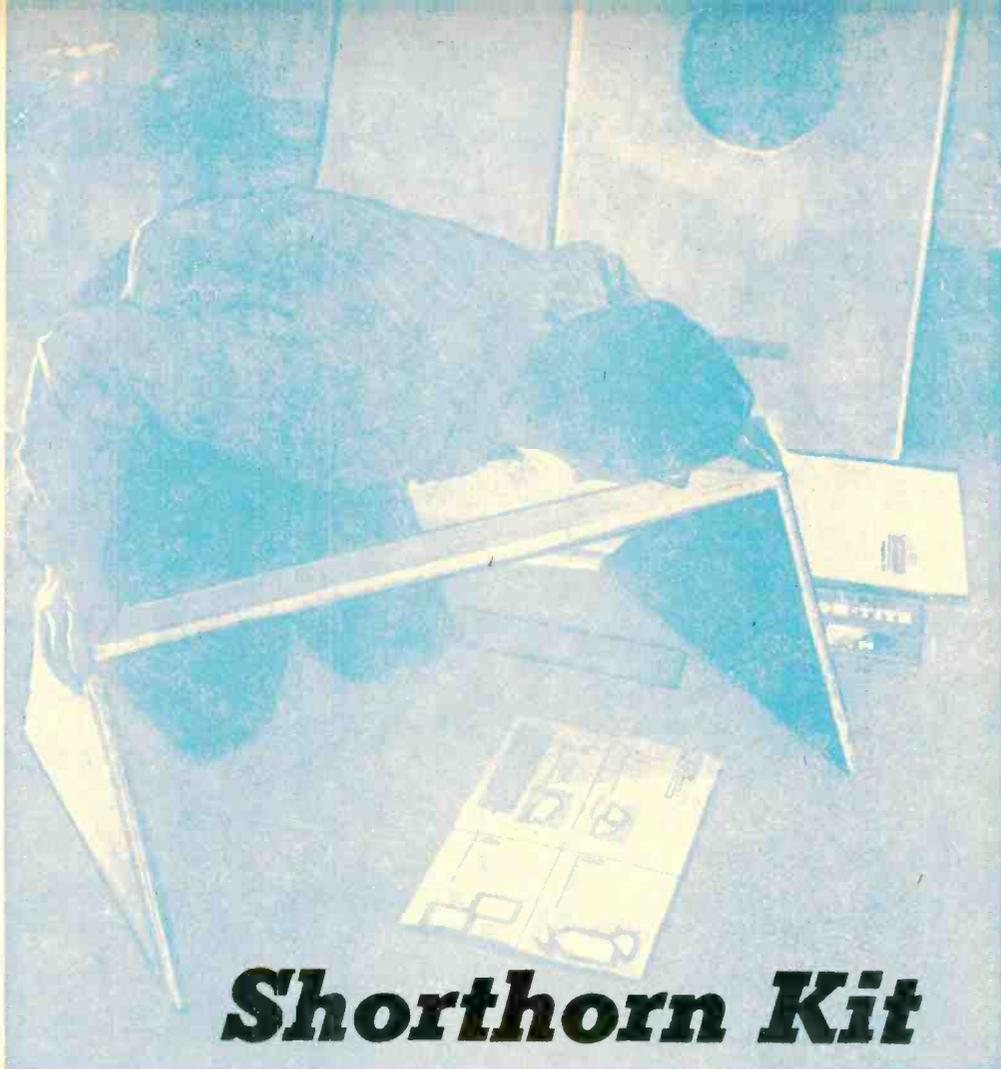
MAHLER'S THIRD SYMPHONY IN D

For a romantic work this month, we turn to that champion of the super symphony, Gustav Mahler. Mahler occupies a peculiar niche in musical history. His music has been decried by some as too bombastic and over-long in length; others have described him as the greatest symphonist since Beethoven. In recent years, his music has been gaining steadily in popularity and acceptance, a large part of which is due to the fact that Mahler's music is absolutely sensational when recorded with high-fidelity techniques. This fact is well attested by the nine recordings of his first symphony in the LP catalog!

The work we are concerned with, Mahler's *Third Symphony in D*, has only been recorded once—on two 12" LP's issued with the SPA label. Reasons for the dearth of recordings in spite of the spectacular nature of the score are found in the huge orchestral forces which must be employed, and in its great length. F. Charles Adler, who is something of a specialist on Mahler, conducts the Vienna Philharmonic Orchestra in this performance and does a thoroughly praiseworthy job. The work itself is full of Mahler's typical episodes of dramatic crisis and conflict alternating with melodic passages of great beauty.

We are fortunate that this only available recording is of fairly hi-fi sound quality . . . not up to our top standards by any means, but better than many domestic issues. The main faults I found were a somewhat "brittle" high end especially noticeable on cymbal clashes. As near as I can figure it, the microphone was overloaded or saturated on these cymbal peaks because they sound "clipped." Bass end is tubby at times, acoustic perspective a shade too distant; there is some evidence of tape hiss, and the surfaces are not the best. Still, taking an over-all view, it is a thrilling work well worth owning.

(Continued on page 120)



Shorthorn Kit

Is Hi-Fi Bargain

Assemble it yourself and save money
on this first-rate speaker enclosure

By JOHN A. NORMAN

DO YOU believe that top-flight high fidelity has to separate you from your bankroll? Then you ought to get an earful of this do-it-yourself loudspeaker box.

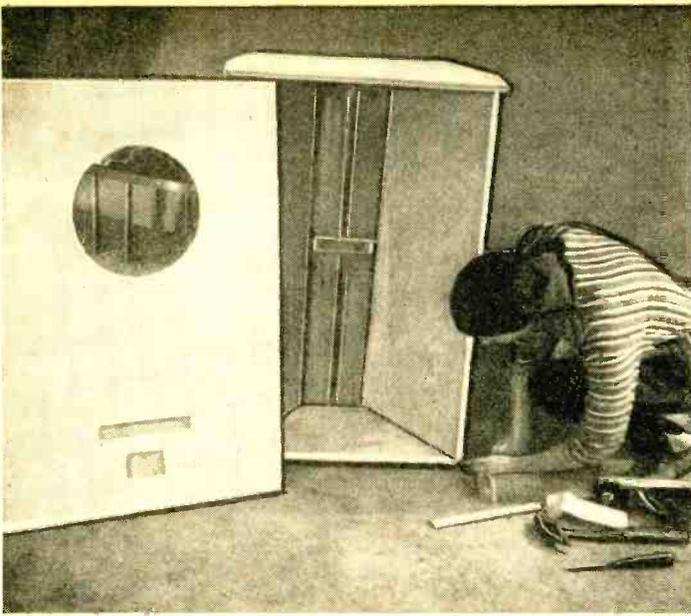
The "Shorthorn," a scaled-down version of the famous Klipsch corner horn, pumps out some of the sweetest audio you ever heard. And it sounds all the sweeter because you don't have to go into hock to hear it.

In kit form, the K-36 enclosure made by Klipsch and Associates retails for about \$39. That's a far cry from the higher price tag that goes with its big brother.

As you might expect, the little fellow is also a little shorter on size and bass response, but it delivers clean, listenable music that can add a new dimension of pleasure to an inexpensive system.

Aside from what it saves you on assembly and finishing, the Shorthorn spares your budget in still another way. It will work with many low- and medium-priced speakers—including units you may already have on hand, such as a 12" or 15" wide-range speaker, or separate 2- or 3-way systems.

Why a Corner Horn? No matter what kind of speaker and enclosure you use,



Rubber weather stripping is cemented to front edges of top, side, and bottom panels. This stripping helps secure fit of front panel which is screwed in place last. Fourteen screw holes are pre-drilled; round-head screws are supplied in kit. Some skewing may be required to get an exact fit; the plane was used to shave off an overlap of about $3/32$ " on one edge.

they'll sound richer if you put them in a corner of a room. The reason is simple: the walls—and floor—stretch the effective size of the speaker cone so that the longer sound waves (or lower bass tones) can be pushed out more efficiently. It's worth noting that this doesn't *add* bass tones to a system. But it does let you hear more of the bass that is actually there.

The walls of a room offer a second bonus that can be turned to advantage by a corner horn. They catch the back waves from a speaker and use them to "load" the cone. Loading increases a speaker's efficiency and transforms more of the electrical energy in the voice coil into hearable sound waves.

One of the pleasantest things about adding walls and floors to your sound system is that they don't cost anything extra. The Shorthorn—like many other corner units—makes free use of these acoustical facts of life. The horns of the K-36 are formed by its sides and the walls of the room.

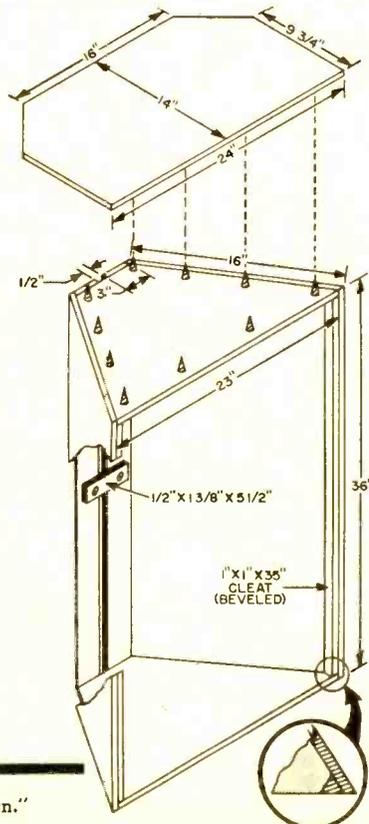
Assembling the Enclosure. The K-36 kit reduces actual construction to a few simple operations. If you follow the instructions supplied with the parts, you'll need only a hammer, a screwdriver, wood glue, and about five hours to put the whole thing together.

It may be, however, that simplification has been carried a bit too far. The panels, made of $1/2$ " plywood, seem a little on the skimpy side, although there's no noticeable reverberation in the finished enclosure.

And in an apparent effort to eliminate difficult jobs, the carpentry has been made rather primitive. Except for the front panel and top cover, all parts are assembled with

glue and nails. Wood screws have a lot more holding power than nails and might even be easier to install if the panels were properly predrilled.

The birch-veneered front panel is screw-fastened from the outside because it has to be removable for speaker access. But this also leaves something to be desired. The



Dimensions and detail of beveled strip in the "Shorthorn."

visible screw heads don't add very much to the appearance of the furniture. Of course, those who object strongly to this feature can cover the entire front panel with decorative grille cloth.

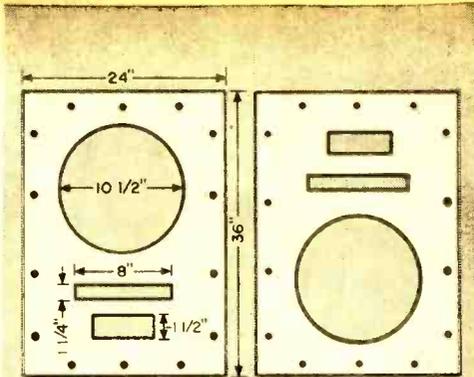
Despite these minor shortcomings, the cabinet has a neat, modern look and is still a good bargain in first-rate audio equipment. For best results, place the K-36 in accordance with instructions in the kit.

What Speaker Sounds Best? Your choice of loudspeakers for the enclosure depends as much on what you like to hear as on what you want to spend. A single-cone, wide-range speaker in the moderate price class pushes out very listenable low notes—the kind that let you distinguish the thump of the big drum from the velvet of the string bass.

The other tonal ranges are all there, too. They are surprisingly smooth and have minimum "hangover."

The highs sound clean and clear, though they could be improved by the addition of a separate tweeter (or the substitution of a coaxial or triaxial speaker)—which all adds up to the fact that the Shorthorn has a lot of built-in versatility. It invites you to start with a very modest speaker or use one that you have. The rig will sound fine now, and you can make it better any time you like.

You also have a choice of speaker size. The big cutout on the panel is said to be equally good for either a 12" or a 15" cone. Separate cardboard-blocked openings are provided for a high-frequency tweeter and a mid-range squawker. These cutouts can be unblocked whenever you add the extra speaker or speakers. Crossover networks may be placed on the bottom panel.



When single-cone or coaxial speaker is used, fit front panel so that the large circular hole is at top; cutouts remain blocked. With two-way or three-way system, mount front panel so that the large opening is at the bottom; unblock the cutouts to accommodate squawker and tweeter units.

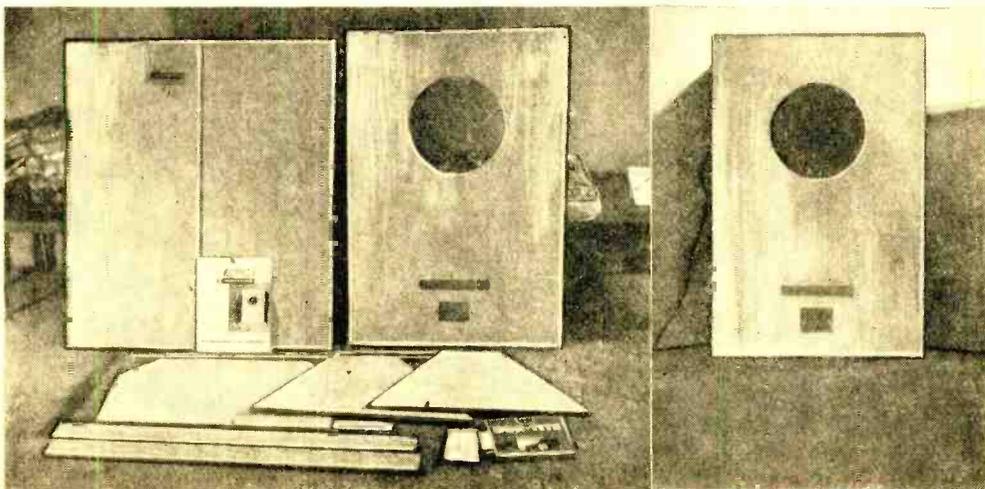
For still greater versatility, the front panel is arranged for mounting in either of two ways. With a single-cone job or a coaxial, the large opening goes near the top to let the high notes radiate best (see the diagram above).

Should you add a separate tweeter or a three-way system later on, you can turn the panel upside down. That will keep the high-range speakers upstairs where they belong. And lowering the woofer lets the floor surface do a better job of spreading the bass tones. In other words, adding a tweeter to this upside-down system improves the low notes as well as the highs.

And whatever equipment you use, the corner cabinet puts more and better sound out where you can hear it.

-30-

Before and after: left, the kit as it comes from the factory; right, the finished "Shorthorn."





Sound Waves Wash Clothes

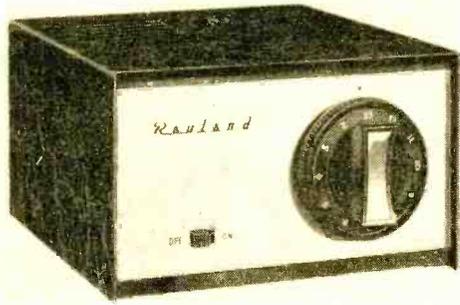
TALK ABOUT "CLEAN" SOUND—here's a gadget that uses low-frequency audio waves both to wash clothes and rinse them!

Resembling a child's top, the "Gnome Vibrator" is a British invention. Wash is placed in a sink full of water and soap, and the Gnome shoots sound waves at it to the tune of 100 cps. The energy generated presses the soapy water through the fabric. After the wash has been lathered, it may be rinsed clean in clear water, also with the aid of the Gnome.

The manufacturers of this device claim that it outdates the conventional washing machine and will clean safely all delicate materials, as well as heavy fabrics. (*G.I. Developments Ltd.*, 48 Moorgate, London E.C.2, England.)

Hi-Fi TV Sound Unit

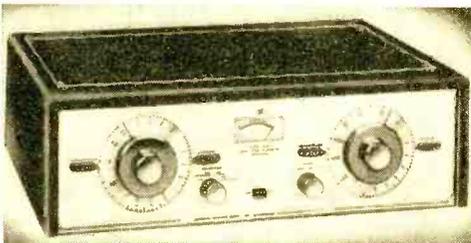
BETTER RECEPTION of the sound portions of television programs can be had using the new Rauland Model TV 55 "Television Sound Tuner." Designed for use only with Rauland AM-FM tuners or tuner-amplifiers, the new unit feeds TV audio through those components for better listening or tape recording. Its selector switch and fine tuning control cover all 12 v.h.f. channels. Volume, treble, and bass are adjusted on the amplifier. (*Rauland-Borg Corp.*, 3515 West Addison St., Chicago 18, Ill.)



New Tuner Provides High-Fidelity AM and FM Reception

HIGH-FIDELITY RECEPTION on both AM and FM is assured with the Scott Type 330-A tuner. This set pulls in the full 10-kc. band transmitted by better AM stations, while a

\$169.95. An external amplifier is needed. (*H. H. Scott, Inc.*, 385 Putnam Ave., Cambridge 39, Mass.)

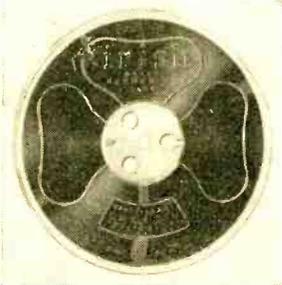


three-position i.f. bandwidth switch adjusts the receiver for different broadcast conditions. Distortionless AM signals are furnished, even when stations use 100% modulation.

Wide-band FM design has eliminated drift, spurious cross-modulation by strong local signals, and loss of stations close to each other on the tuning band. Including provisions for binaural and multiplex operation, the Type 330-A tuner nets for

Improved 7" Tape Reel

IRISH BRAND RECORDING TAPES are now available on an improved 7" reel which features 32 square inches of indexing area. Four sections of the tape may be marked by the user with china crayon or adhesive labels. In addition, threading is made easy by two greatly enlarged side openings. Said to be 28% more rigid than the former standard reel, the new reel is sold at the same price. (*OR-Radio Industries, Inc.*, T-120 Marvyn Rd., Opelika, Ala.)



Talking "Flash Cards" Aid in Speech and Language Study

HIGHLY USEFUL in all phases of language learning and speech training is an audio device known as "The Language Master." This compact unit operates like a tape recorder on playback, except that the sound is on a strip of tape glued to a card. The card is placed in the machine, a motor pulls it past the playback head, and a built-in amplifier and speaker then reproduce the message.

Five series of these audio "flash cards" have been prepared, with more on the way. Each series contains key words and phrases for specific applications, such as speech courses in schools, or speech correction clinics. Cards can be selected from a file, arranged in a desired sequence, and played repeatedly. Each card contains, in addition to the spoken message, a printed version and—in most cases—a picture of what is heard.

Part of the Master's educational value lies in its very simplicity. A child, or even a partially disabled person, can operate it. The constant use of the device and the handling of the cards help keep a subject alert. When used for rehabilitating sick people, the instrument acts as an occupational therapy aid. Recent tests using these cards have demonstrated their value in helping people with speech defects, including many aphasiacs, the hard-of-hearing, and those suffering from cerebral palsy.



Two controls are provided. One turns the unit on and regulates its tone; the other is a volume adjustment. Once the machine has been turned on, all the user need do is place a card in the guide on the front panel. A standard phone jack on the front panel may be used to plug in an external speaker for listening in large rooms, or a headphone for complete privacy.

The Language Master is made by Ellemac Inc., of Chicago, and distributed by the McGraw-Hill Book Co., 330 W. 42 St., New York, 36, N. Y. Editor of the library of cards is Dr. Paul Moore of Northwestern University.

Audio Topics on Radio Show

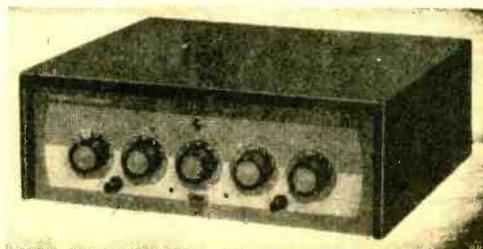
REPORTS on the hi-fi field and valuable tips for using home equipment will be offered on a new radio series called "Sound Thinking." A weekly quarter-hour program, it will feature prominent people in the audio industry as guests. Originator of the show and its host is Oliver Berliner, Jr., audio engineer, writer, and president of Oberline Inc., Hollywood. Scheduled guests include representatives from Capitol Records, Altec Lansing, Stancil-Hoffman, American Microphone, James B. Lansing, Minnesota Mining and Manufacturing. Each program will cover a different phase of hi-fi, with emphasis on do-it-yourself aspects. National distribution plans are being made; watch your local paper for announcements.



Twin-Chassis Amplifier

TWO SEPARATE CHASSIS that function as one complete unit are featured in G.E.'s new 20-watt high-fidelity amplifier. One chassis contains the power amplifier and power supply; the other constitutes the pre-amplifier and control unit. Each may be mounted and installed independently of the other, or fitted together as the user desires.

Five inputs, three outputs, and nine independent panel-mounted controls are provided. Reported frequency response is: 20 to 20,000 cps at 2 watts output, ± 1 db; 30 to 15,000 cps at 15 watts, ± 2 db. Net price is \$99.95. (General Electric Co., Electronics Park, Syracuse, N. Y.)



**Noted authority leads off
new series with "do" and "don't"
rules on tape hookups**



By R. S. LANIER

Adding Tape to Your Hi-Fi System

GOOD TAPE RECORDING and playback, through a hi-fi system, is no accident. It's the result of proper interconnections between the tape machine and the rest of the system. Though there's no single, simple way to obtain good results, a tape fan can get more out of his machine by observing a few important rules.

Tape machines come in five main classes, with variations of input and output within each class. First, there is the all-in-one recorder-playback set. This is a complete, self-contained unit with all provisions for recording and playback. In most cases, better playback can be had by connecting the output signal to an external hi-fi amplifier and speaker instead of using the ones built into the machine.

Next, there is the recorder with a recording and playback preamplifier, but no power amplifier or speaker. To listen to this recorder, you *must* feed its output to an external amplifier and speaker.

A third kind of tape machine is the complete playback-only set. Often called a "tape phono," this unit does not record; it is designed to play prerecorded tapes. Many

versions are available, including units for stereophonic playback.

A variation of the "tape phono" is the tape deck for playback only. While this unit includes a playback preamplifier, it needs an external amplifier and speaker in order to be heard on playback.

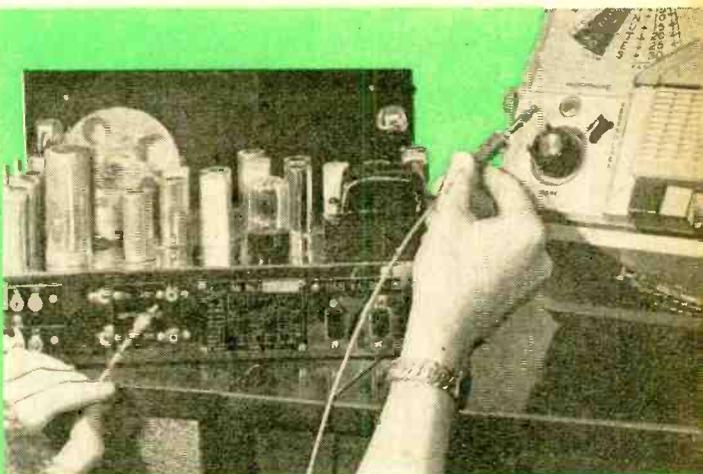
Finally, there is the tape transport mechanism only. It includes just the mechanical parts needed to make two tape reels spin around. By adding to it such electronic parts as record and playback heads, bias oscillator, preamplifiers, power amplifier and speaker, you can adapt it for recording and playback.

Regardless of what tape machine and what amplifier you use, the principles outlined in this article will guide you in making the right hookups. The pitfalls to avoid apply in all cases.

Signal Level

For recording, the tape machine may be connected directly to a radio, phono, or microphone, or to a control unit to which these signal sources have already been connected. In either case, the recorder must

An AM-FM tuner is connected to a conventional home tape recorder by running a shielded cable from the tuner's output to the recorder's input. One method is to connect the low-level output of the tuner (often marked "DET") to the low-level or high-gain input on the tape machine. This enables the tuner's other output, marked "AMP," to feed an audio amplifier and speaker for monitoring the program being taped.



Another method of connecting the same type of tuner to a tape recorder is to run the cable from the high-level output of the tuner to the high-level (low-gain) input on the recorder. This means that the signal to be recorded will pass through the audio circuits in the tuner, which include tone, volume and—sometimes—loudness controls. The effect of these controls on a signal to be recorded is explained in the text.



A phonograph using a high-level pickup (crystal or ceramic) may be taped by feeding its signal into the machine's high-level jack. Phonographs using low-level pickups (magnetic) should feed into a preamplifier-equalizer and then into the tape machine. A low-level magnetic phono signal may be fed into the tape recorder's low-level jack, but this does not assure proper phono equalization and is not recommended.



receive a signal that is strong enough to modulate the tape fully, so that even the lowest passages will be comfortably above the noise level. On the other hand, the signal must not be so high that it overloads either the circuits in the recorder or the tape itself. Either kind of overload means distortion.

The tape machine, if it includes recording circuits (bias oscillator and preamplifier-equalizer) will have both a recording-level indicator and a control for adjusting

the level. But the circuits *ahead* of this control can be overloaded even when the signal reaching the tape is at the proper level. Faulty interconnection is most dangerous with respect to this particular form of overloading.

Equalizing

In recording, it is essential that a *flat* signal, which has not passed through any tone control or loudness control circuits, be supplied to the tape machine. Every complete tape machine has its own equalizing circuits, designed by the manufacturer so that a flat signal going into the machine will come out again as a flat signal.

The reason for not passing the recording signal through the tone control circuits on the main amplifier or "front end" is that there will very likely be small variations from flat response. Normally, these variations would have little effect. But—if a signal passes through the tone circuits twice (once going into the tape recorder and once coming out), small "bumps" in response become troublesome peaks, and small drops become serious cuts.

A loudness control, at low volume settings, produces a very *bumpy* frequency characteristic. It is, in fact, designed to boost bass and treble to make up for what the ear doesn't hear at low listening levels. If a signal passes through a loudness control on its way to the tape, certain frequencies will be emphasized in the recording. This boost may be just right for a specific listening volume level, but it will sound wrong at any other volume level. Moreover, the deliberate skewing of the frequency curve (Fig. 1) will become impossibly exaggerated when the signal passes through the loudness control a second time, on playback.

A tape signal that is essentially flat, however, can be played through tone and loudness controls; and its frequency balance can be adjusted to the listener's preference, as well as to room conditions.

The only time equalization should be used is when phono discs are being transcribed onto tape. The records should then be compensated so that the signal comes off with a flat characteristic. This can be done with the equalization controls included on all modern control amplifiers—the "record compensation" or "bass turn-over and treble roll-off" controls. When recording from a disc onto tape, these controls should be set just as they would be if the record were being played for listening.

Impedance Levels

You can avoid many difficulties by making sure that lines feeding into a tape machine—or coming out—are coupled to low-

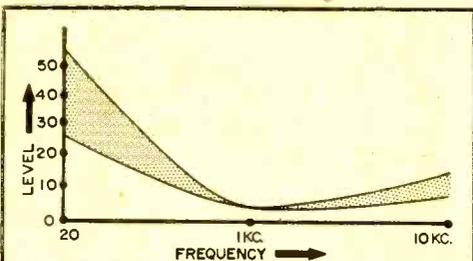


Fig. 1. Too much boost (shaded area) caused by running tape through loudness control twice (during recording and playback).

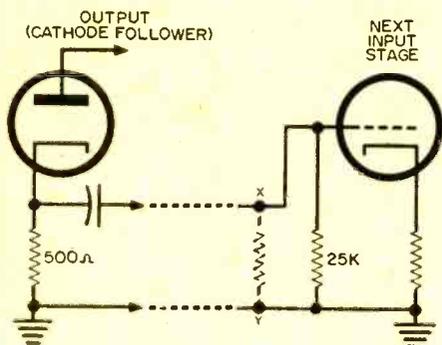


Fig. 2. Correct impedance level, after cathode-follower output, must be no lower than 25,000 ohms (between points x and y).

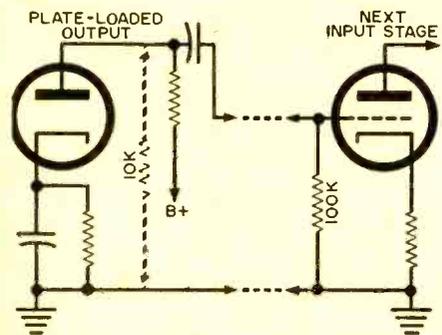


Fig. 3. Plate-loaded output of typical triode has impedance of about 10,000 ohms. Next input must be at least 100,000 ohms.

impedance sources. The cathode-follower tube provides the best-known low-impedance output. The net impedance across the line, "looking back" at a typical cathode follower, is about 500 ohms. This low impedance has many advantages in the coupling of voltage amplifier stages. (Incidentally, *all* interconnections in typical hi-fi systems, except output-stage-to-loudspeaker, are between voltage amplifiers.)

The advantages of low impedance are: (1) a wide range of input impedances is possible, subject to the limitations stated below, without losing signal strength because of the voltage developed across the output stage; (2) the cable is much less likely to pick up hum; and (3) there is little loss of high frequencies due to cable length and capacitance.

The general rule for output-to-input impedance between voltage amplifier stages is that the signal should always go from a low impedance to one that is several times greater. In Fig. 2, for example, if the cathode-follower output has about 500 ohms across its output line, then a good impedance at the following input would be 25,000 ohms. *Never* put a low-value resistor, 500 ohms or less, across the far end of a line from a cathode-follower; it will upset the action of the cathode-follower and produce serious distortion.

Typical plate output from a triode, shown in Fig. 3, has an impedance (to ground) of the order of 10,000 ohms. The following input should be at least 100,000 ohms, and a higher impedance would be better. The reasons, again, are to avoid upsetting the operation of the output tube and to minimize signal loss. Note that in each case the effective impedance across the line will be that of the output stage: about 500 ohms for the cathode-follower, and about 10,000 ohms for the plate-loaded stage.

If it feeds into a sufficiently high impedance, the 10,000-ohm plate-loaded output will serve as well as the cathode-follower in many cases. The advantages of the cathode-follower over the plate-loaded stage are: (1) a much longer cable can be used without trouble from capacitance effects and noise pickup; and (2) it can accommodate a much wider range of input impedances at the far end.

Circular Connection

A tape recorder is connected into a hi-fi control unit in two places: the tape output goes to a control input, and a control output goes to the tape input. With many control units, such an arrangement could set up a dandy positive feedback loop through the tape machine, and cause the amplifier to oscillate furiously (Fig. 4). The feedback circuit will be completed in most cases

if the tape controls are left in the "record" position, and the amplifier control selector is turned to "tape." Ways of avoiding the above situation with particular machines will be discussed in the next article in this series.

Hum Pickup

All connections between a tape machine and a control unit should be made with shielded cables. Hum that develops any-
(Continued on page 118)

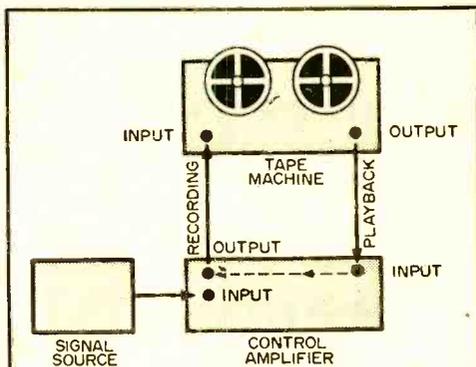


Fig. 4. This type of "circular connection" could cause positive feedback.

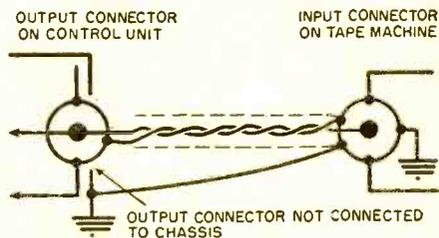


Fig. 5. Method of "floating" the shield on connector cable which reduces hum.

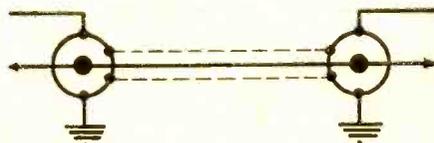


Fig. 6. When output connector is grounded at chassis, ground shield at both ends.

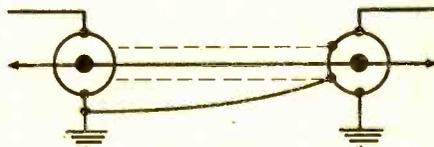


Fig. 7. Shield may be floated this way when output jack is grounded at chassis.

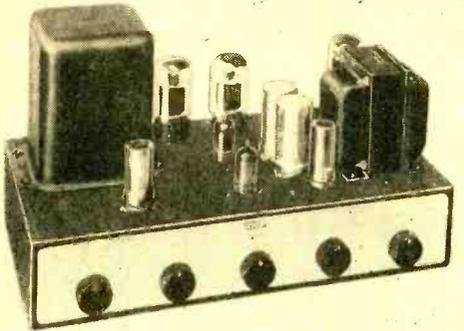
Kit for Building a 20-Watt Williamson Amplifier

A NEW EICO KIT (the HF20) includes parts and instructions for home assembly of a 20-watt ultra-linear Williamson ampli-

fier, complete with preamp and all controls. The kit nets for \$49.95. A factory-wired unit, ready to use, sells for \$79.95.

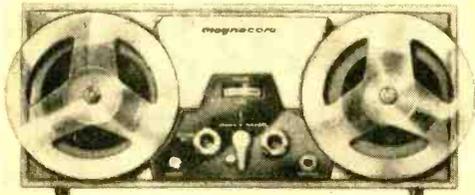
Featured are five positions of feedback equalization, independent bass and treble controls, loudness compensation control, inputs for all types and levels of program sources, and outputs for speakers of 4, 8, or 16 ohms impedance.

Frequency response of the HF20 at full rated output is 20 to 20,000 cycles $\pm 1/2$ db; at $1/4$ -watt output (average room level), the amplifier covers from 13 to 35,000 cycles $\pm 1/2$ db and from 7 to 50,000 cycles ± 1.5 db. Units are backed by a lifetime guarantee which includes service and calibration. (*Electronic Instrument Co., Inc.*, 84 Withers St., Brooklyn 11, N. Y.)



Versatile Tape Recorder

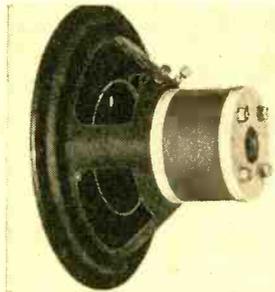
READILY ADAPTABLE to hi-fi systems as well as for use in schools and offices is Magnecord's "Citation" tape recorder. A 10-watt amplifier-speaker system in a single case is supplied; if desired, this system can be used alone for p.a. work. At the same time, the tape's output can be connected to another amplifier and speaker. Using a hysteresis synchronous motor, the machine provides a frequency response to over 10,000 cycles at $7\frac{1}{2}$ ips and over 5000 cycles at $3\frac{3}{4}$ ips. (*Magnecord, Inc.*, 1101 S. Kilbourn Ave., Chicago 24, Ill.)



Improved Wide-Range Speaker

LATEST IN A LONG LINE of Hartley loudspeakers is the improved Model 215. It is a 10" wide-range reproducer whose predecessors go

back to 1927, when Mr. Hartley claimed the invention of the first hi-fi speaker. The 215 is said to have no resonance through its response range of 1 to 18,000 cycles. The single cone is sectioned and a mechanical cross-over is used to separate highs and lows. Cloth suspension of the cone improves bass response. With a five-pound magnet, the 215 can handle power peaks up to 20 watts. Net price is \$65.00. (*Hartley Products Co.*, 521 E. 162nd St., New York 51, N. Y.)



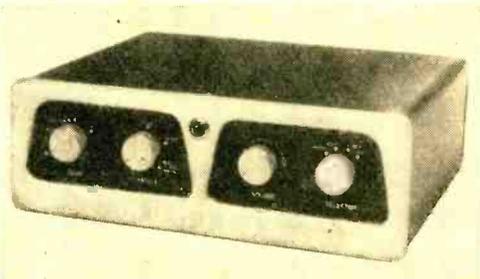
Tone Controls Calibrated for Record Equalization

TONE CONTROLS calibrated for record equalization are featured in Munston's new Model HF-12 amplifier. When reproducing program sources other than discs, these controls serve as ordinary treble and bass adjustments.

Frequency response is reported as 20 to 20,000 cycles, $\pm 1/2$ db. Harmonic distortion at full rated output (12 watts) is $1/2\%$. Hum and noise are said to be inaudible.

Inputs are provided for accepting all standard program sources such as any phono pickup, tuner, tape, TV sound, etc. Outputs will match speakers of 4, 8, or 16 ohms impedance. Net price of this compact

instrument is \$79.50. (*Munston Manufacturing and Service, Inc.*, Beech St., Islip, Long Island, N. Y.)



Clubs Provide Good Records for Less \$\$\$



Variety of selections available to club members is shown by these photos of Columbia artists. Top, Dimitri Mitropoulos leads N. Y. Philharmonic Symphony. Left, Bill Corey and "The Four Lods." Right, Louis Armstrong.

MUSIC LOVERS and audio fans have reaped the benefits of microgroove vinylite records in more ways than one. In addition to their long-play, wide-range features, LP's are non-breakable and light in weight—which means that they can be sent safely through the mails.

Taking advantage of this fact, mail order record clubs have put hi-fi into millions of homes. Wide mail distribution has lowered prices and boosted subscription sales to the tune (no pun intended) of 20 million dollars a year. One outfit alone—the Concert Hall Society, which comprises three separate clubs—boasts a membership of about 500,000. A recent analysis made by the Society reveals that the majority of its mem-

bers did not buy records regularly before joining.

How They Started

The basic idea for this type of consumer service was first used by the Book-of-the-Month Club, started in 1926. Its application to records was largely the work of the founders of CHS, the brothers David and Samuel Josefowitz. In 1946 they founded CHS as a record company which sold chiefly through the mails. CHS was the first company to put all of its recordings on vinylite—at that time, 78 rpm. The high technical and musical quality of these discs earned for them the Annual Recorded Music Award as well as several international

CLUB NAME AND ADDRESS	RECORD PRICE	BONUS	HOW IT WORKS	WHAT YOU GET
Jazztone Society 43 W. 61st St. New York 23, N. Y.	\$2.75	Introductory record for \$1.00. Free booklet on jazz.	No minimum purchase required. You receive advance notice of selection. Records are sent on approval, may be returned after playing.	The best in old and new jazz performed by top ranking musicians.
LP Record Club c/o Columbia Records 799 Seventh Ave. New York 19, N. Y. (or through local record retailers)	Regular Columbia list prices; CL 12" series, \$3.95; ML 12" series, \$4.98.	Free record when you join; bonus record for each two you buy.	Minimum purchase is four records a year. You receive advance notice of selection, may reject record or choose alternate by mailing back form by certain date.	All types of music; classical, show tunes, swing, etc., performed by leading Columbia artists.
Music-Appreciation Records c/o Book-of-the-Month Club 345 Hudson St. New York 14, N. Y.	\$3.60 for 12" discs; \$2.40 for 10" discs.	Introductory record free. Included with first purchase is album for holding ten records and glossary of musical terms.	No minimum purchase required. You receive advance notice of selection, may reject record by mailing back form by certain date.	Standard classical works performed by leading ensembles; analyses narrated by well-known critics and musicologists.
Musical Masterpiece Society 43 W. 61st St. New York 23, N. Y.	\$1.65	Two introductory 10" records for \$1.00. Free booklet by Olin Downes.	Same as Jazztone Society	Classical works (standard plus some rarely heard) performed by first-rate ensembles.
Opera Society 45 Columbus Ave. New York 23, N. Y.	\$2.95	Introductory record for \$1.00.	Same as Jazztone Society	Operas (standard plus some rarely heard) sung and played by outstanding artists.

Comparative highlights of the leading record subscription clubs.

awards of the *Grand Prix du Disque* (Grand Prize for Records).

With the changeover from 78 rpm to microgroove records, CHS branched out into three divisions: The Opera Society, The Jazztone Society, and The Musical Masterpiece Society. CHS itself, no longer a mail-order service, continues to issue records under its own label for over-the-counter sale.

About two years ago, the Book-of-the-Month Club entered the field by launching Music-Appreciation Records. In addition to full performances of symphonic works, each record includes an explanation of the music, narrated in lay language, and illustrated by musical passages. This feature has proven especially attractive to new listeners, music teachers, and students.

The first subscription service to be started by a major recording firm is Columbia's LP Record Club. Organized less than a year ago, it has made available much of Columbia's impressive catalog of top-artist, top-quality recordings. By including a bonus record free for every two bought, the plan effectively cuts the list price of each record to the familiar "33% discount" level.

While these clubs are the major ones operating now, they are not the only outfits that sell music through the mails. Many smaller groups, specializing in certain types of records, enjoy a brisk trade. One enterprising musical organization has gone into the business, too—the Louisville Symphony has placed its recordings on a subscription basis.

The great advantages of buying records from clubs are the convenience and savings involved. A limiting factor is in the

choice of records. As compared with going into a store, listening to, and buying what you want, the club method limits the choice to a narrow margin. Each of the clubs in the CHS group offers one selection a month—take it or leave it. However, no minimum must be bought during the year to retain membership.

Music-Appreciation Records operates in the same way, but permits members to choose either the complete record (performance and analysis), or one containing only the analysis.

Columbia's LP Record Club offers a selection of up to eight different records a month. Choice of the bonus record is limited to one out of four. To remain a member, you must take at least four selections a year.

Record Quality

Records sent by clubs are of high technical quality, made by the same methods used for producing all modern LP's—the standard tape-to-master-to-mother-to-stamper routine described in detail in *POPULAR ELECTRONICS*, February, 1955.

From a business viewpoint, record clubs are thriving. CHS has mushroomed from its modest beginnings ten years ago to an outfit that employs more than 200 people. Two floors of a large office building, plus two shipping plants and batteries of automatic tabulators are needed to handle shipments, payments, accounts, cancellations, and correspondence.

Comparative highlights of the major clubs are shown in the accompanying chart. Free literature is available on request from any of the clubs listed.

RESONATORS-



LARGE and SMALL

By H. H. FANTEL

How the bass reflex enclosure improves hi-fi speaker response...second article in series

WHILE the infinite baffle (POPULAR ELECTRONICS, Feb., 1956) prevents the back wave of a speaker from cancelling the front wave, the bass reflex enclosure goes one step further.

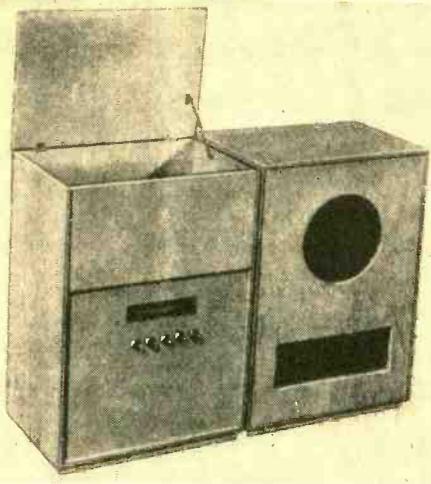
Instead of wasting the back wave by suppressing it, a bass reflex enclosure literally turns the back wave around, both in phase and direction, and lets it come out in front through a special hole called the "bass port." The enclosure is so dimensioned that the bass frequencies of the back wave emerge from the bass port in phase with the front wave, reinforcing rather than cancelling the frontal bass radiation. The reflex enclosure thus acts as a phase inverter which, by a 180° shift, turns the troublesome back wave to good account.

Since the back wave contributes as much energy as the front wave does, a speaker mounted in a bass reflex enclosure

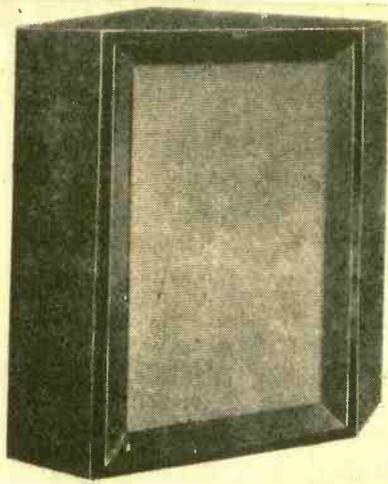
radiates twice as much effective bass as it would in an infinite baffle. By infinite baffle standards of efficiency, this is virtually like having two speakers instead of one. Besides, the active radiating surface is increased by the area of the bass port.

The greater efficiency of the bass reflex enclosure permits economy in amplifier output and loudspeaker power rating since the reflex enclosure produces equivalent bass at much less power. Considering that the cost of amplifiers and speakers rises sharply for higher power ratings, the reflex enclosure is a boon for obtaining effective bass at low cost.

The cabinet's own simplicity, amenable to household carpenters, adds to the over-all economy. The bass reflex baffle is nothing but an absorbent-lined box with two holes, one for mounting the speaker and one acting as a bass port.



This bass reflex enclosure, and matching equipment cabinet, by Cabinart, can both be built at home from a kit costing about \$50.



Neat-appearing Altec Lansing 606A enclosure is designed for corner placement to take advantage of reflection from walls.

In principle, a bass reflex baffle is a tuned resonator—excited by the back of the speaker cone, which protrudes into it, and vented through the port. The resonant frequency of the enclosure depends on cubic content as well as on the area and shape of the bass port. If the enclosure is so dimensioned that its resonance equals the resonance of the speaker, that particular frequency emerges from the port without

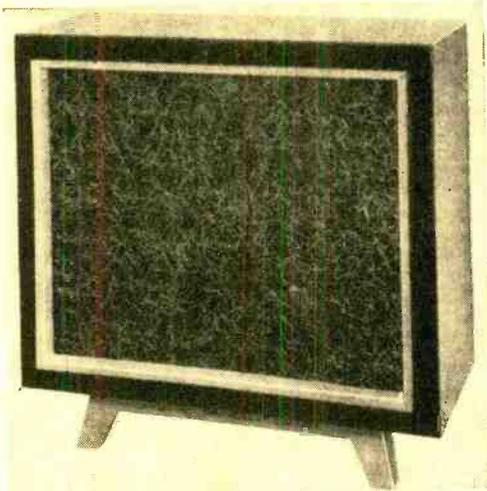
phase inversion. This means that the back wave will be opposed to the front wave of the speaker, resulting in wave cancellation. Yet such selective and controlled wave cancellation, confined to the resonance region of the speaker, is highly desirable. It reduces the speaker's own resonance peak (often responsible for a thudding one-note bass), flattening the frequency response in the critical area about the lower limit.

Construction data for building your own. Wood should be $\frac{3}{4}$ " thick plywood; all joints must be glued and screwed. Three non-parallel inner surfaces should be padded.

LOUDSPEAKER SIZE	OPENING		OVER-ALL CABINET DIMENSIONS				VENT DIMENSIONS	
	A	B	C	D	E	F		
8"	6½" diam.	23"	17½"	10½"	3"	9½"	28 sq. in.	2800 cu. in.
10"	8½" diam.	28½"	22"	12½"	4"	12½"	50 sq. in.	5700 cu. in.
12"	10½" diam.	34"	26"	14½"	5½"	16½"	86 sq. in.	10,000 cu. in.
15"	13½" diam.	41"	30½"	17½"	7½"	21"	150 sq. in.	16,200 cu. in.

BASS REFLEX CABINETS

DETAILS OF THE SLIDING PANEL CONSTRUCTION BY WHICH THE VENT OPENING MAY BE ADJUSTED TO CHANGE THE RESONANT FREQ. OF THE CABINET.



Where corner placement is not feasible, Altec recommends their 608 enclosure, acoustically identical to the Model 606A.



Briggs enclosure boasts sand-filled panels to assure rigidity and freedom from vibration. Separate top section holds tweeter.

The enclosure's own resonance also presents the proper acoustic impedance to the rear of the cone, so that the speaker works against a matched load at resonance. This keeps the speaker cone from "running away with itself" near the resonance point. It also results in improved speaker damping and "cleans up" the sound of the entire system.

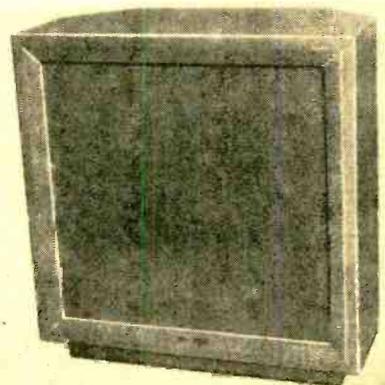
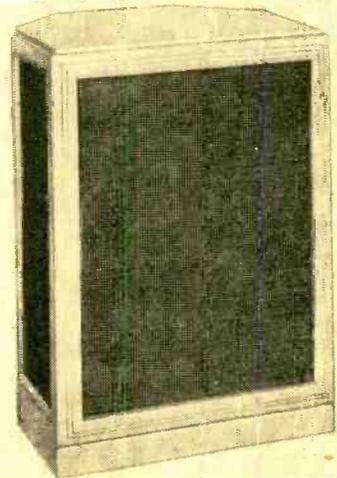
Critical resonance matching between speaker and enclosure is a "must" for this interaction of the two components. It is therefore necessary to fit the dimensions of a bass reflex baffle to the particular speaker intended for it. Otherwise, the bass response is likely to be spotty and marked by booming resonances that may blur the entire tonal picture. Instructions given by the speaker manufacturer concerning baffle dimensions should be carefully observed. However, a reflex enclosure built for a certain speaker size and resonance usually works well with any other speaker of the same resonance and diameter.

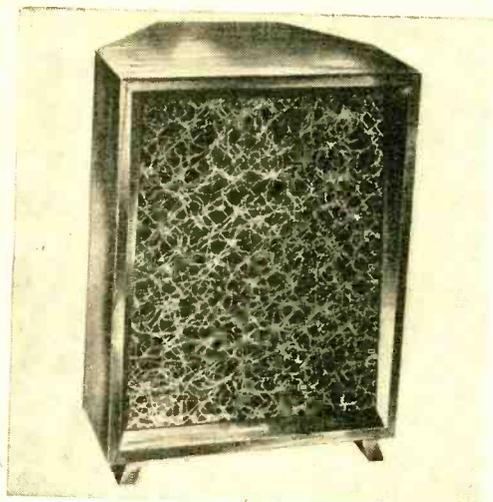
In recent years, another version of resonant phase inverter baffles has become popular, especially for use in "miniature" hi-fi systems where space is at a premium. Outwardly, these enclosures resemble bass reflex baffles, but behind the bass port is a critically dimensioned open duct extending into the interior. In some designs, the speaker is suspended within the duct on a special panel in the interior of the baffle, in which case only one outside opening is required.

These baffles are known as "Helmholtz resonators" because the duct corresponds

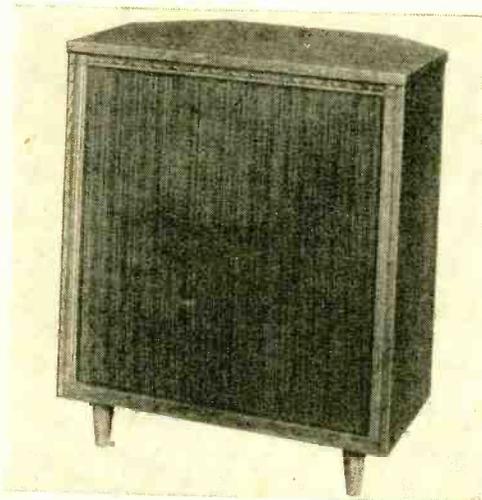
Right, Stephens "Tru-Sonic" enclosure, suitable for either corner or wall placement.

Jensen enclosure (below) adds rear horn-loading to augment bass reflex action, is available in variety of sizes and decors.





Adding duct behind port is University's approach to "more bass in less space."



Recent G.E. enclosure uses specially perforated panel to spread bass into room.

to the neck of the tuned cavities used by the great German physicist, Helmholtz, to explore the basic laws of sound a hundred years ago. (Strictly speaking, all resonant baffles, including bass reflex enclosures, are Helmholtz resonators. Yet in audio usage, the term usually designates the new ducted enclosures.) In principle, the Helmholtz resonator works just like a bass reflex baffle. The vital difference is in its size. Other factors (such as the speaker) being equal, a Helmholtz resonator puts out as much bass as an ordinary reflex baffle about three times as large!

This remarkable ratio has enabled many audio manufacturers to shrink speaker cabinets to a fraction of their accustomed

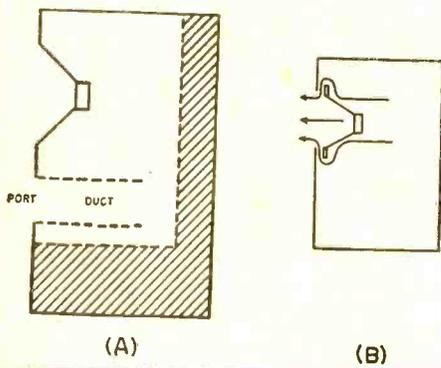
size without sacrificing bass. With the aid of the Helmholtz resonator, the audio industry finally tackled the tricky problem of hi-fi in small apartments. A pioneer effort in this direction was the popular R-J enclosure. Since the advent of this unit, many audio designers have created several complete speaker-and-baffle systems, small enough to fit on a bookshelf yet capable of reproducing most of the musical spectrum at moderate volume level. To hear full-bodied sound pouring out from a box no larger than a small travel bag is an uncanny experience for some audio fans. Matching it to a suitable amplifier creates a small—but really hi-fi—system.

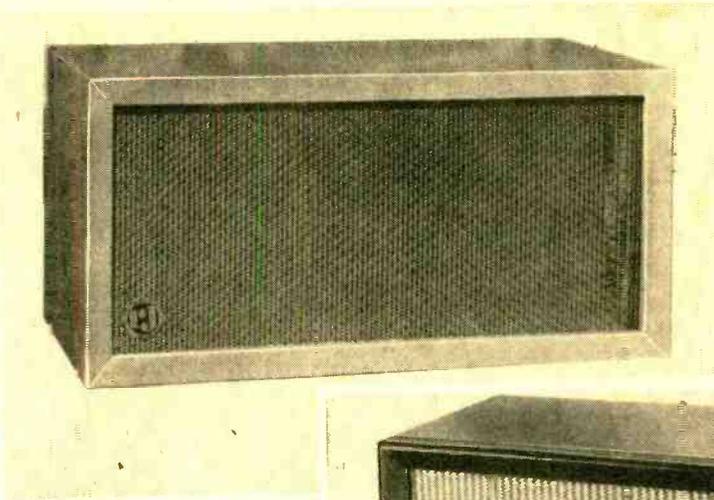
Speakers for Small Resonators

To take full advantage of the miniaturization possibilities inherent in the Helmholtz resonator, new 8" speakers were developed to hi-fi standards formerly met only by larger speakers. Compensating for the naturally higher cone resonance of these small speakers, the Helmholtz enclosures are often tuned to a resonance slightly below that of the speaker, thus broadening the resonant peak of the speaker and pulling the over-all frequency response further down. In case the bass response of the small systems still seems weak, some bass boost from the amplifier is readily absorbed by these modern speakers and quickly restores the balance.

Reproducer units like the R-J—Wharfedale combination, the Elektra system, the Jensen "Duette," the Permoflux "Diminnette," the Altec "Melodist," the University "Companion," or such modifications of the Helmholtz principle as the Kelton and Lorenz systems are proof that the audio

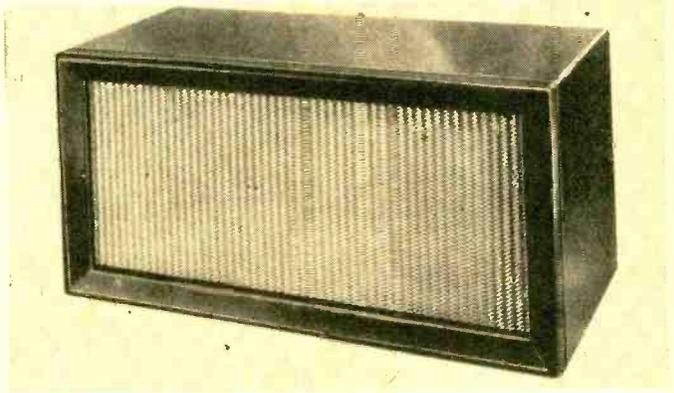
Two widely used methods of reducing size of bass reflex enclosures. (A) Shaded area is space saved by adding duct behind port. (B) The basic design principle of the famous R-J enclosure. Speaker is set on panel slightly behind front panel. Back waves emerge from specially shaped aperture.





Although the R-J enclosure was designed originally to hold the Wharfedale 8" speaker, it may be used with any well-designed 8" driver. Larger versions are available for 12" and 15" speakers.

The "Audette" of Kingdom Products, Ltd. is an example of a miniature 2-way system utilizing the miniature resonator principle. The trend toward miniaturization has become fairly widespread, with units such as Jensen's "Duette," Permoflux's "Diminnette," Elektra system, etc.



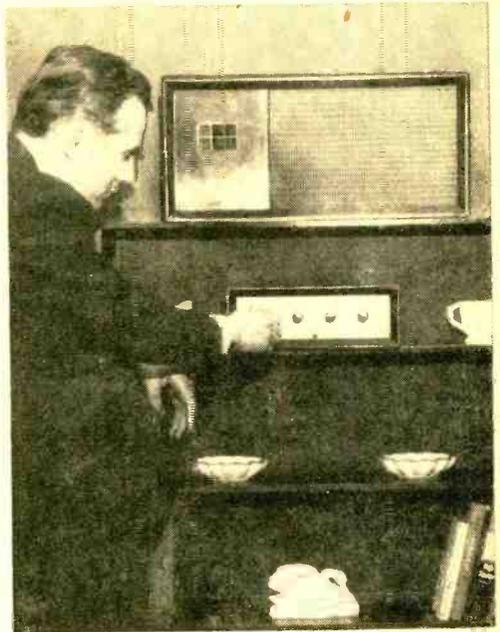
industry has succeeded in putting hi-fi in a handy package.

Yet miniature enclosures do not represent the ideal. At best they are a successful compromise when compared with the big speaker systems. Although highly effective for their intended purpose, the smaller enclosures may sacrifice some tonal cleanliness. For instance, extending the bass response by auxiliary resonances inevitably adds false harmonics. (It should be emphasized, however, that neither resonance juggling nor miniaturization are necessary attributes of the Helmholtz principle.)

Another drawback affecting the tonal cleanliness of a small speaker system is that it has to work harder than a big one to produce a given quantity of sound. It is therefore more likely to approach the marginal region of its inherently limited power-handling capacity.

For these reasons, a small Helmholtz-type enclosure is no substitute for a full-sized speaker and baffle. Yet for small rooms, where space is precious, where only moderate loudness is required, and where the potentialities of a larger system could never fully unfold, the miniaturized Helmholtz baffle is a wise choice.

The next article in this series will discuss the folded horn enclosure.



How it looks installed in a living room: relative size of a typical miniature resonator is shown in this photo of Altec's "Melodist," another example of a 2-way system reduced to book-shelf dimensions.

Tuning the Short-Wave Bands

with Hank Bennett



THE OPERATION of Station CHU, the Dominion Observatory Station in Ottawa, Ontario, which transmits time signals was discussed last month. In this issue, we will present the facts behind the "Speaking Clock." Once again, our thanks go to Mr. Malcolm M. Thomson and Mr. J. P. Henderson, of the Observatory staff, and to the Canadian Government Department of Mines and Technical Surveys for providing this information.

Since January 1, 1955, the Dominion Observatory has been transmitting voice-announced time signals each minute over Station CHU on the following frequencies: 3330, 7335, and 14,670 kc.

The voice is produced from sound track cut from 35-mm. film. Power for the film drive motor comes from an amplifier controlled by the 60-cycle multivibrator output of one of the five crystal clocks comprising the Dominion Observatory time standard.

Cam-operated microswitches select the proper sequence for the announcements, i.e., station, hours, and minutes. Alarm circuits alert the operator if trouble develops.

The Dominion Observatory has regular pub-

lic observing periods during the summer months, April to September inclusive, on Saturday nights from 8:00 p.m. to 10:00 p.m. EST. During the winter months, November to March inclusive, groups of 15 or more are accommodated on special request. There is no fee for this service; the idea is to encourage public interest in astronomy. On regular observing nights during the summer months, one of the five divisions is also available for public inspection. The Time Service Division is thus available about four times during the course of the summer.

Station Logs

Two publications are currently on the market for anyone interested in obtaining them. One is the 1956 *World Radio Handbook*, available from Gilfer Associates, Box 239, Grand Central Station, New York 17, N. Y., for \$2.00. The other is a set of four books, published by the U.S. Foreign Broadcast Information Service, available from the Government Printing Office, Washington, D.C. These four books, which cost \$4.10 per set, contain the following information:

1. A listing, according to country and city, of the broadcasting stations of the world, from 150 kc. to 26,520 kc.
2. The same listing, but by frequency
3. Station listings by station name or slogan
4. FM and TV

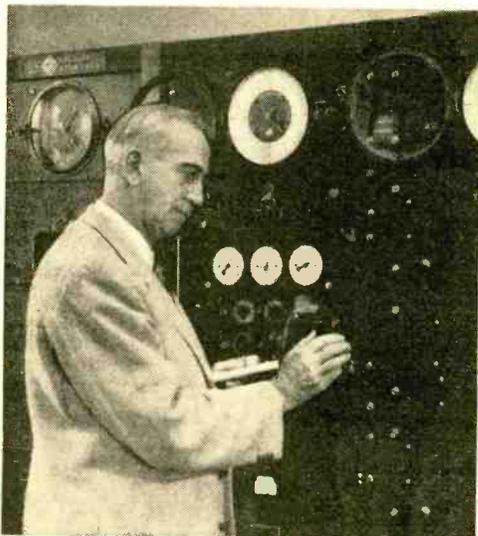
World Radio Handbook, on the other hand, publishes the addresses of most of the s.w. stations, as well as the names of personalities to whom letters should be addressed. The FBIS books do not list the broadcast-band stations in the continental United States.

Current Reports

Now for this month's reports. All times shown are Eastern Standard, based on the 24-hour clock. When compiling your reports, please be sure to specify what time zone you are using. Reports come in once in a while written in PST or GMT and are not so stated. Please help us to serve you better. Thanks!

Albania—*Radio Tirana*, ZAA, 7850 kc., has English at 1700-1730 s/off. This station verifies quickly but is a poor card. There is usually much QRM on the channel; it is difficult to read some days. (SH)

Andorra—*Radio Andorra*, 5978 kc., can be heard just above *La Voz Dominicana* on 5970 kc. Signal is best around 1600-1700; they feature Spanish music. (SH)



J. P. Henderson, of the Dominion Observatory staff, makes an adjustment to the signal output of one of two Muirhead timing devices utilized in the transmission of time signals.

Angola—Best reception from Angola at present is provided by *Radio Angola*, Luanda, 11,862 kc., which is heard at 1330-1800 with musical programs. (RL)

Argentina—The Argentine Overseas Service now has news in English, Spanish, Portuguese, Italian, and German starting at 1730 and 2130 on *Radio Del Estado*, LRA, Buenos Aires, 9690 kc., parallel with LRA, Mendoza, 6180 kc. Starting times for English may vary. No English is noted on Sat., Sun. (LM, MM, BJ, JM, DB)

Australia—*Radio Australia*, Shepparton, on 15,320 kc., carries world news at 1815; it is heard on 15,200 kc. at 2300 with "Australia Calling DX'ers." (FB, BW)

Brazil—A new Brazilian station, *Radio Mayrinck Veiga*, at Rio de Janeiro, is heard at 1700-2230 on 11,775 and 9575 kc. Reception is good on 11,775 kc., but Rome provides QRM on 9575 kc. (RL)

Radio Jornal do Comercio, Recife, 11,825 kc., is being heard well on the West Coast almost daily around 2030. Call is ZYK32 and programs are all Portuguese. (FL)

British Honduras—ZIK2, Belize, 3300 kc., has English news on Friday at 1934, followed by a weather report. They ask for reports to British Honduras Broadcasting Service, Belize. Power is 5000 watts. (BB)

Bulgaria—Sofia, 9700 kc., carries English news and sports at 2000: s/off in North American service is at 2030. (MG, SW)

China—*Radio Peking*, 15,060 kc., can be heard daily at 1800-1900; antenna change at 1900 causes signal to fade. English news is heard at 1930. No verification will be sent unless you report on an English program. (SH)

This station was noted on 15,070 kc. with Chinese program at 1630-1730. Does anyone know the power? It was also tuned at 11,300 kc. with English news at 0730. (GN)

Denmark—Copenhagen, OZF, 9520 kc., has English beamed to North America at 2100-2130. First half hour is sometimes in Danish. (BB, BW)

Egypt—Cairo is switching from 9790 kc. to 6215 kc. to avoid QRM. The 6215-kc. channel is to be dual with 11,670 kc. at 1900-2000 with a program of Arabic news and music; 11,670 kc. has Spanish at 2000-2030 s/off. (AB)

Cairo, on 12,030 kc., identifies as *Huna El Kahira*; it carries Arabic around 0930 although heavily QRM'ed by c.w. (RR)

El Salvador—YSWW, Santa Ana, listed on 5976 kc., is reported on 5998 kc. at 1900. Reports to this 250-watt xmtr should be sent to Alenjandro Calderon, Station YSWW, Santa Ana, E. S. (RW)

French Equatorial Africa—Latest schedule from *Radio Brazzaville* is as follows: to Europe and North America on 11,970 and 9730 kc. at 0000, 0100, 0200 in French, at 0015 in English; to the Orient on 15,595 kc. at 0630-0715 in French, at 0515 in English; to the Far Orient on 11,970 kc. at 1200 (French), at 1100 (English); to Europe and the Orient on 11,970 and 9730 kc. at 1330 and 1530 (French), at 1315 and 1546 (English), at 1415 (Portuguese); to North and South America and the Far Orient on 11,970, 9625, and 9730 kc. at 1615 and 2015 (French), at 1745 (English), at 1800 (Portuguese), at 2200 (Spanish). (LM, FB)

French Morocco—Rabat, 15,205 kc., is heard in Arabic with news and music at 0730-0930 with heavy QRM from WLWO. They ask for reception reports in Arabic, English and French before signing off at 0930. (AB)

Gold Coast—According to *Radio Denmark*, Accra operates on 3366 kc. at 0025-0230, on 6015 kc. at 0600-0845, and on 4915 kc. at 0830-1330. No news has been heard as yet of the 20-kw. xmtr. (LM)

Guatemala—TGNC, 11,850 kc., Guatemala City, can easily be observed at 1900-2030



This is the SWL listening post of Max Leonard, Bellevue, Ohio. His equipment includes: a phono turntable, Bud frequency calibrator, Hallicrafters SX71 speaker and receiver, Crosley BCB receiver, remote recording panel, NC57M, antenna switching unit, intercom, Howard FM receiver, and a Knight tape recorder.

with a missionary program in English. (GN)
TGNC, 9668 kc., carries religious programs and music at 2205-2340, in English. They send a QSL card showing a picture of the Quetzal bird. (LM)

India—A new frequency for VUD, Delhi, is 15,325 kc. This can be heard at 0730-0740 with Home Service news broadcast in English and Hindi. (RL)

Indonesia—*Radio Indonesia* now has the following frequencies when in use for foreign broadcasts (all listed are rated at 100 kw.): YDF2, 11,770 kc.; YDF3, 11,795 kc.; YDF4, 17,810 kc.; YDF5, 7220 kc.; YDF6, 9710 kc.; YDF7, 11,770 kc.; YDF8, 9865 kc.; and YDC, 15,150 kc. (EB)

Iran—*Radio Teheran*, 15,100A kc., has English at 1515. Patience and careful tuning might result in this country for you! (FB)

Italy—Rome, 6060 kc., has English news at 2115. (JM)

Ivory Coast—*Radio Abidjan*, 4945 kc., is often noted at 2300-0000 and 0145. Language is mostly French. American records help you to identify this station around 0145. Slogan is *Ici Abidjan*. (LM, GN)

Japan—English news to North America can be heard on JOA4, 11,705 kc., at 1800, and on JOB6, 11,725 kc., at 2235. The N. A. East Coast xmsn on 15,235 kc., JOB5, is widely reported at 1800-1830. Program consists of 10 minutes of news, a 5-to-10 minute talk on various subjects. Remainder of program is

(Continued on page 123)

CARL & JERRY

By

JOHN T. FRYE

Electronic Trap

"WHAT are you doing?" Carl demanded lazily, as he turned over on his side on the leather couch to watch his chum, Jerry, who was busily twisting the knobs of a small box sitting on the basement laboratory workbench.

"Deciding whether to take French or Spanish next year," Jerry answered curtly, as he continued to adjust the dials.

Carl heaved his lanky frame erect and strode over to the bench.

"It sounded just as if you said you were deciding whether to take French or Spanish next year," he said laughingly, and peered curiously through his horn-rimmed glasses at the little cabinet studded with knobs, switches and a small meter.

"That's what I *did* say."

"Then you've flipped your wig for sure. I suppose you just say:

'Black box, black box, on the bench,

Which shall I take: Spanish or French?' and then this electronic understudy for the Delphic oracle mulls it over for a few microseconds and comes up with the right answer."

"That's not too far off," Jerry said, with a grin on his round face. "This thing is the 'Decision Meter' described back in October, 1955, POPULAR ELECTRONICS. You can read the article for yourself, but briefly the gadget works like this: when these five dials, which operate potentiometers, are all set at zero, zero voltage appears across this meter. Turning a knob in a counterclockwise direction applies an increasing negative voltage to one terminal of the meter; turning the knob in the opposite direction applies an increasing positive voltage. I arbitrarily assigned negative values to arguments for French and positive values to arguments in favor of Spanish. As each point came to me, I turned one of the knobs to right or left in accordance with whether Spanish or French was favored by that particular consideration. How far I turned the knob depended upon how important the consideration was. Finally, when all the arguments had been recorded, the instrument automatically and electrically summed up the influence of all the knob settings, and showed by the way the meter was deflected whether Spanish or French was favored. As you can see for yourself, for me personally, Spanish was indicated the better choice."

"Well blow my fuse!" Carl exclaimed.

"Imagine us having an electronic brain!"

"That's what it really is, in a modest sort of way. Say, Carl, I want to show you something," Jerry said suddenly, and he went over and opened the cellar door leading to the

outside. "See these bad scratches on the outside of the door? Pop is pretty steamed about them. He thinks Bosco is doing it, and he says—and I quote—'Either Carl's got to put boxing gloves on that mutt or give him a close manicure before we have the house repainted this spring'—unquote."

"Bosco wouldn't do a thing like that," Carl denied hotly, getting down on his knees to examine the scratches closely. "In the first place, he's too lazy to scratch that hard."

"Well, I'm neutral, but I have an idea how we can find out what's doing it."

As he finished speaking, Jerry dived into the large junk box beneath the bench and came up with a small dusty chassis bearing two tubes, a couple of knobs, and a relay.

"What's that nasty-looking thing?" Carl asked suspiciously. "I'm not going to have Bosco hurt."

"Don't worry. I'm as fond of that animated flea-garage as you are. This is a capacity relay that will let me know when anything gets close to that door during the night. I built it according to an article that appeared in the very first POPULAR ELECTRONICS back in October, 1954."

"How does it work?"

"A sensing wire fastens to this binding post which is connected to the grid of the triode section of the 12SQ7 tube. This triode section is hooked up as an r.f. oscillator. Some of the r.f. voltage produced by the oscillator is rectified by the diodes of the 12SQ7, and this d.c. voltage is applied as negative grid bias to the 50L6 tube—which has a sensitive relay in its plate circuit. As long as the oscillator is operating strongly, a high bias is produced and the plate current of the 50L6 is low, allowing the relay to stay open. However, if any living thing or large metallic object approaches the sensing wire, the capacity between that object and the wire provides a path through which some of the oscillator energy is drained off. As the oscillation weakens, so does the negative voltage produced by the rectifying diodes. This decreasing negative bias causes the 50L6 plate current through the relay to climb, closing the relay. The closing contacts can turn on a light, ring a bell, or operate any other electrical device."

While talking, Jerry had been installing a short sensing wire along the door jamb and connecting a light bulb so that it could be turned on and off by the relay contacts. After carefully adjusting the sensitivity controls of the capacity relay, he could cause the light bulb to turn on simply by walking within three or four feet of the door. When he

stepped back again, the light would go out.

"Now I'll feed this light current through the relay contacts into the pair of wires I have going up to my bedroom," Jerry explained; "and whenever anyone or anything comes close to this door, it will automatically turn on the light up there. That will wake me, without disturbing anyone else, and I can sneak down here and discover Old Scratch—whatever he is—right in the act."

"It sounds just goofy enough to work," was Carl's comment as he started for home. He could not resist waltzing back and forth across the threshold a couple of times to make the light blink on and off before he started climbing the steps that led up to the yard level.

... It must have been around two o'clock in the morning when Jerry was awakened by the light that winked on and off a few times in his face and then shone steadily. Quietly, he slipped into his bathrobe and soft-soled slippers, and started for the basement laboratory. When he reached the door that led from the furnace room into the laboratory, he stopped short at the sound coming from the outside laboratory door. It was not a scratching sound. Instead, it sounded more as though some heavy metallic object was being run up and down the edge of the door.

"I always knew old Bosco was plenty smart, but I never thought he knew how to use a crowbar," Jerry marveled to himself.

At that instant there was a sort of crunching sound, and the door swung open. Jerry waited only long enough to see the tall outline of a man step inside and start probing the workbench with the narrow beam of a flashlight held in his hand; then the boy fled silently up the stairs behind him. When he reached the kitchen at the top of the stairs, he debated briefly as to whether or not he should go on upstairs and try to wake up his father; but as he recalled how hard that worthy was to awaken, and how panicky his

mother was likely to become, he quickly decided against this. He moved silently into the den and lifted the telephone receiver from the cradle. Silently he gave thanks to his scoutmaster for making every boy in the troop memorize the numbers of the fire department, the police department, and a twenty-four hour ambulance service. Using only his sense of touch, he fumblingly dialed the number of the police department. Although the dial mechanism was really very quiet, its whirring sounded like the grinding of a concrete mixer to the frightened boy—in fact, it made almost as much noise as his pounding heart.

"Police department, Sergeant Anderson speaking," a drawling voice came from the receiver.

"This is Jerry Bishop at 1810 Spear Street. A burglar just broke into our outside basement door on the west side of the house and is prowling around here somewhere right now. Come quick," Jerry whispered hoarsely into the mouthpiece that he was wearing almost like an oxygen mask.

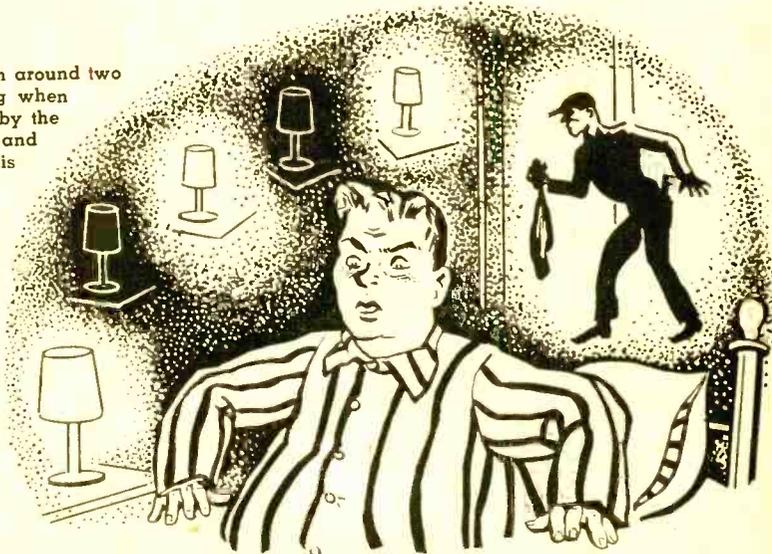
The voice that answered was crisp and businesslike, with all the drawl gone from it: "I gotcha, kid. Don't get in his way. Just lay low. Our squad car will be there in a few seconds. Don't try to answer. He may hear you. Just hang up and make yourself scarce until we get there."

Jerry tried to replace the receiver softly in the cradle, but at the moment of contact it chattered against the base with a rattle like that of castanets. Holding his breath, Jerry stood there in the dark listening intently. For a few long seconds he heard nothing except the pounding of his heart; then, very softly, there was a familiar creak of the basement stairs. The burglar was coming up to the first floor. Peering through a crack in the door of the den, Jerry could see a suffused glow of light on the kitchen ceiling.

For the next few minutes—which seemed

(Continued on page 119)

... It must have been around two o'clock in the morning when Jerry was awakened by the light that winked on and off a few times in his face and then shone steadily ...



AFTER CLASS

DEVELOPMENT OF THE PENTODE

RANKING HIGH among the frustrations of the pioneers in radio and vacuum tube design was the aggravating condition in which a triode radio-frequency amplifier (Fig. 1) in a receiver—unbidden and unencouraged—commenced oscillating even though the design called for amplification only. An oscillating amplifier, being neither “fish nor fowl,” is utterly useless. To avoid oscillation, tube makers were forced to keep the triode gain down low, with the result that the available amplification was insufficient to do a good job.

The root of this unwanted oscillation was quickly uncovered: it was the capacitance between the control grid and the plate, a feedback path which converts the r.f. amplifier tube into a variation of the tuned-plate, tuned-grid (TPTG) oscillator as indicated by the bold lines in Fig. 1.

To resolve the difficulty, tube designers went all the way back to one of Michael Faraday’s discoveries—the electrostatic

shield. Faraday had demonstrated early in the 19th century that capacitance may be reduced practically to zero by inserting a metal shield between two capacitor plates. Since a solid plate of metal between the grid and anode of a tube would block the electrons, a perforated grid-like structure was substituted for the sheet material to shield one electrode from the other, yet permit free passage of electrons from cathode to anode in the tube.

This addition marked the birth of the *tetrode* or four-element tube. The additional grid, now called the screen, is schematically pictured as a perforated element between control grid and plate. In practice, however, the screen is a spirally wound structure similar to the control grid.

Electrically, the screen cannot be permitted to “float” (remain unconnected to other common parts of the circuit). Unless it is given a fixed positive potential, it impedes the flow of the electron stream and causes the tube to behave erratically. With a positive voltage applied to it, the screen accelerates electrons toward the plate while appreciably reducing the capacitance between the grid and plate. Since it is a positive electrode, it does snare a few electrons of its own; these electrons, as they flow through the external circuit back to the cathode, constitute the screen current.

Figure 2(A) illustrates how the positive voltage is brought to the screen from the same source that supplies the plate voltage. The values given are for the now-obsolete 24A tetrode. They indicate the relative magnitudes of the plate and screen volt-

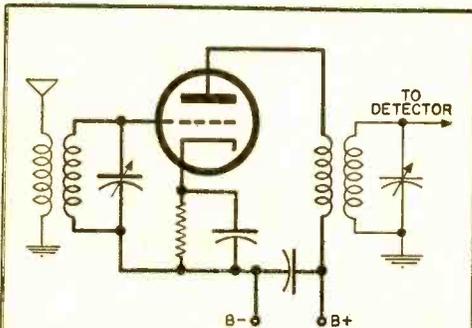
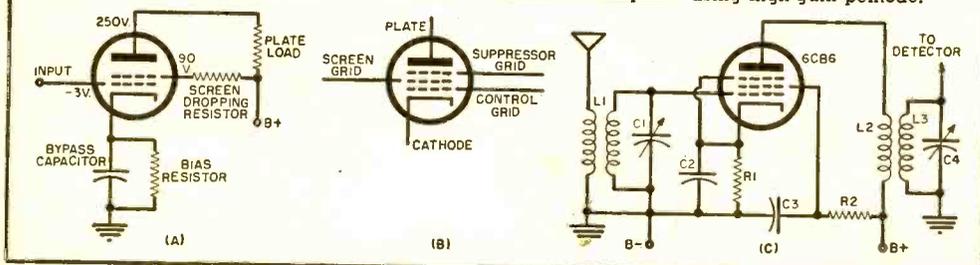


Fig. 1. Triode r.f. amplifier circuit.

Fig. 2. (A) Relative magnitudes of voltage in typical circuit using obsolete tetrode. (B) Schematic representation of pentode. (C) Modern r.f. amplifier using high-gain pentode.



ages and currents used in such a tetrode.

Use of this tube in early receivers disclosed a serious defect: at certain points in its operation, the tetrode showed an inclination to draw diminishing plate current as plate voltage was *increased*. Amplifiers using the 24A in the region of this so-called *tetrode dip* were subject to intolerable distortion.

What was it that caused this peculiar behavior? Engineers quickly traced it to the ejection of secondary electrons from the plate of the tube; electrons literally bounced out of the metallic atoms in the anode due to the impact of the high-velocity primary electron stream from the cathode. The effect is much the same as the flying shards that come off a concrete wall when it is blasted by a stream of machine gun bullets.

In the case of the tetrode, the presence of the positively charged screen grid causes the secondary electrons to flow backward in the tube, i.e., from the plate toward the cathode instead of the other way around. This swarm of electrons, moving in a direction opposite to the primary particles from the cathode, subtracts from the plate current and causes it to diminish. The effect occurs as the plate is made positive enough to accelerate the primary electrons to the point where the impact velocity gives rise to the emission of large numbers of secondary electrons. It might be mentioned that secondary emission takes place in a triode, too, but since there is no nearby positive electrode, these electrons merely return to the plate without producing detrimental effects.

The problem of the tetrode dip was solved by inserting still another spiral grid, this one between the screen and the plate, as shown in Fig. 2(B). The *suppressor grid* is connected either to the cathode or directly to the common ground of the amplifier. Its potential is, therefore, highly negative as compared with the plate. Under this new set of conditions, as the secondary electrons are driven from the plate, they "see" a nearby negative electrode rather than a positive one as in the tetrode. Thus, they return to the plate immediately, there is no reverse flow, and hence no dip.

Illustrated in Fig. 2(C) is a modern r.f. amplifier employing a high-gain pentode. Signal input from the antenna or preceding amplifier stage is coupled to the grid of the 6CB6 through a resonant circuit comprising *L1* and *C1*. *R1* provides normal cathode bias while *C2* maintains the bias voltage constant despite the changing current flowing through *R1* due to the signal. *L2* is the primary of an r.f. transformer which acts as the plate load for the pentode. The voltage across this coil is

transferred to the detector stage by transformer action and through the resonant circuit *L3C4*. *R2* is the dropping resistor which establishes the correct d.c. screen potential; for the 6CB6 with 300 plate volts, the screen potential recommended is 150 volts.

Since the screen is like an anode (150 volts with respect to cathode), signal currents flow through the screen dropping resistor to the B+ and back to the cathode via the power supply. These currents, small as they may be, tend to generate a fluctuating voltage drop across *R2* which is communicated to the screen as a varying potential. Such a voltage would appreciably reduce the effectiveness of the screen as a shielding electrode if steps were not taken to prevent it. *C3*, connected directly from screen to ground, stabilizes this voltage by charging to the average voltage drop across *R2* and maintaining this drop constant.

QUIZ

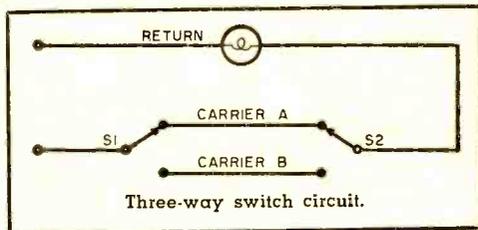
1. What is the most general cause of oscillation in a triode r.f. amplifier?
2. Why can't a screen grid be made of sheet metal?
3. How does the screen current of a tetrode or pentode compare in size with the plate current of the same tube when it is operating properly?
4. What is the cause of the so-called "tetrode dip"?
5. Since secondary emission occurs in the triode, too, why isn't a suppressor grid necessary in this tube?

(Answers appear on page 119)

MULTIPLE SWITCH CIRCUITS

OFTEN, unenlightened home-owners attempt to install lighting systems in which two or more switches are to operate *independently* a garage or hall light by using ordinary "on-off" types in all kinds of series and parallel arrangements. Although nothing is impossible to the ingenious experimenter, the job is best handled as shown in the diagram below.

Both *S1* and *S2* are single-pole, double-



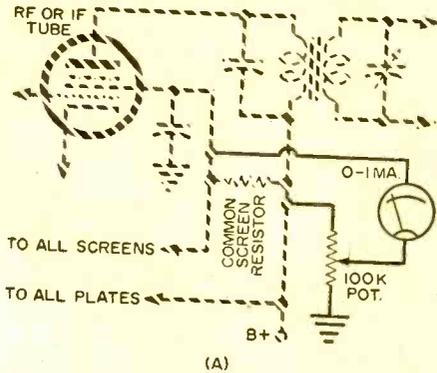
throw toggles with no neutral position. Switches like these are available in either mechanical blade or mercury types from

(Continued on page 106)

S-Meter for Your Receiver

A SIGNAL strength indicator (S-meter) can be added to any receiver employing automatic volume control (a.v.c.). This can be accomplished by measuring the screen voltage or both the plate and screen voltages.

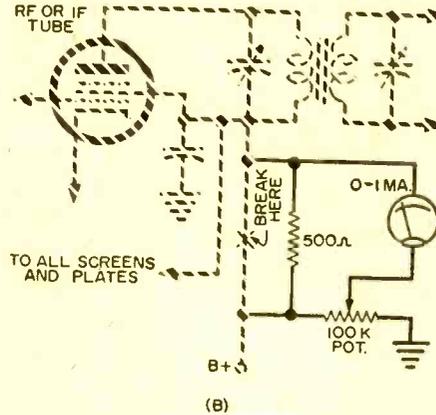
As the signal strength of the incoming station increases, more negative voltage is sent from the second detector to the a.v.c. circuit. The increased negative voltage on the grids of the r.f. and i.f. amplifier tubes causes them to draw less current, thereby



raising their plate or screen voltages. If, using a meter, this varying B+ voltage is compared to a fixed voltage, the meter will deflect more or less as the voltage difference between the two points varies.

Several possible circuits are shown in the two figures. If your receiver has a sep-

arate screen dropping resistor, circuit (A) would be preferred. If the receiver uses a common plate and screen line, it will be necessary to break the circuit and insert a resistor. This is important so that we may have two points with a potential difference. In circuit (B), the resistor will determine

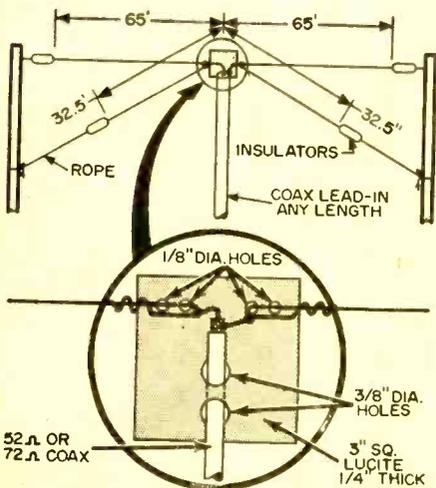


the meter sensitivity. The larger the resistor, the greater the potential difference across it. Of course, the meter sensitivity will affect the amount of meter deflection.

For correct operation, the meter should swing to full scale on the strongest station heard. This will be 60 decibels over S9, and midscale will then be an even S9. The rest of the scale can be marked off from these points.—Donald L. Stoner.

-30-

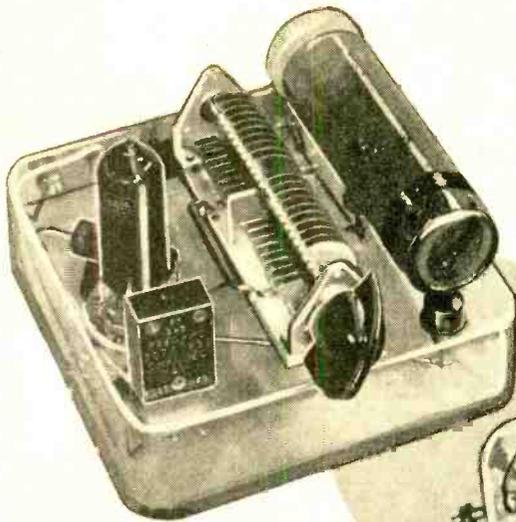
Dual-Band Novice Antenna



NOVICES operating 80 and 40 meters often find that they have an antenna problem. The coaxial-fed dipole will only work on the fundamental or odd-order harmonic frequencies. A 130-foot antenna cut for 3700 kc. will not work on the 40-meter band.

An old trick to permit two-band operation from the same antenna is to hang two "stringers" at the feed point, as shown in the drawing. Without the stringers, the center impedance is extremely high at 40 meters, causing a mismatch. When the 40-meter half-wave stringers are connected at the feed point, the impedance will drop to about 60 ohms, providing a good match. On 80 meters, the stringers are in parallel with the antenna flat top, causing no mismatch. Antenna switching from 80 to 40 is automatic.—Donald L. Stoner.

-30-



Beginners and old-timers alike will want to build this handy little crystal-controlled rig that uses a single 6AQ5 tube

Chassis consists of a small plastic sandwich box, found in most five-and-ten-cent or hardware stores. The coil is wound on a plastic pill carton.

By ELTON V. STOLBERG, W7OUV



Sandwich Box Transmitter

THIS inexpensive little transmitter consists of a one-tube crystal oscillator using a 6AQ5. It is a very active oscillator having plenty of output even with the most stubborn crystals. Incidentally, this circuit can be made to double and even quadruple the crystal frequency with good output.

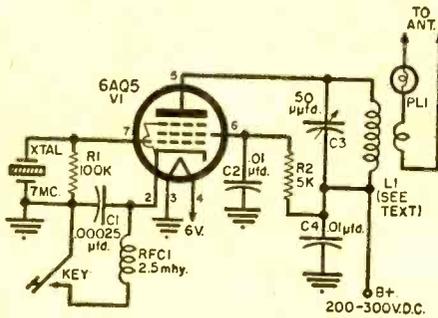
The transmitter was built on a plastic sandwich box turned upside down. Such boxes can be purchased in most five-and-ten-cent stores or hardware stores. Extreme care must be exercised when drilling the slightly fragile plastic.

In this particular rig, a piece of No. 14 wire scraped clean of insulating enamel was run from the crystal socket to the ground terminal on the back edge of the chassis to serve as a grounding bar. Bypass capacitors and the grid resistor are then grounded to this common bus. Using an insulated chassis has its advantages too, as you can mount the tuning capacitor (C3) and coil (L1) directly on the chassis.

The coil socket consists of two pin-type jacks mounted on the chassis alongside the tuning capacitor. The coil was made from a plastic pill box obtained from the corner drugstore. One inch in diameter and having a plastic cap, it was wound with 17 turns of No. 26 enamel wire, close-wound, and doped with coil cement. If desired, the coil form could be shortened and the cap replaced.

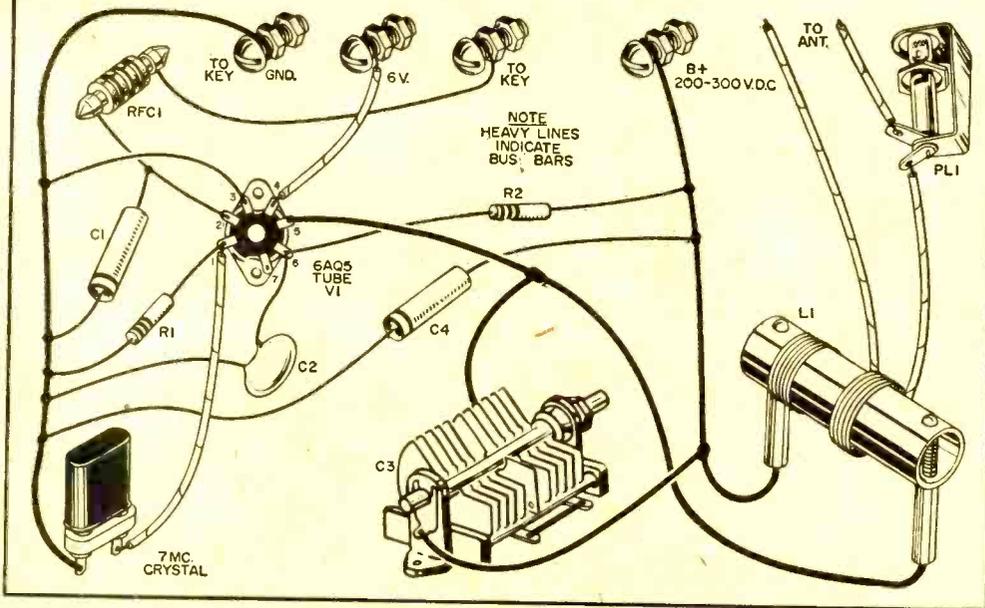
The coil prongs are two finishing nails, cut approximately in half, which fit snugly in the pin-type jacks. They are soldered to the heads of two 6-32 bolts which are then bolted to the coil form in the proper places. Coil wires are fastened to these bolts before they are tightened. The lower or pointed half of each nail was used, the upper half discarded.

Coil pins were deliberately spaced farther apart than necessary in order to give plenty of room for an 80-meter coil and also to allow room for the antenna link to



Wiring diagram of the transmitter, parts list, and pictorial diagram.

- C1—250- μ fd. ceramic capacitor
- C2—.01- μ fd. ceramic capacitor
- C3—50- μ fd. variable capacitor
- C4—.01- μ fd., 400-volt tubular capacitor
- L1—Primary, 17 turns of No. 26 enamel wire close-wound on 1" diameter form; secondary, 2 or 3 turns of hookup wire (see text)
- PL1—Pilot light, 6.3 volt, with mounting assembly (for indicating r.f. current—not shown in photos)
- R1—100,000-ohm, $\frac{1}{2}$ -watt resistor
- R2—5000-ohm, 2-watt resistor
- RFC1—2.5-mhy. r.f. choke
- V1—6AQ5 tube
- Xtal—7-mc. crystal
- 1—Plastic sandwich box
- 1—Plastic pill box
- 1—7-pin miniature tube socket
- Misc. machine screws, wire, solder, etc.



be placed around the coil form. In the photographs, the coil is shown without the antenna link in place.

A simplified method of mounting the crystal socket was used in that it is completely suspended underneath the chassis with a small bolt. Holes were drilled in the chassis where the crystal holder pins pass through.

As can be seen in the photographs, the power and key terminals are simply four 6-32 bolts along the back edge of the chassis. Use three nuts on each bolt, two to secure it to the chassis and the third for securing the power supply wires. Do not attempt to solder any wires to the bolts as the heat will melt the plastic chassis. The leads are twisted around the bolts before being tightened.

A separate power supply which gives 6.3 volts a.c. for the heater and about 200 to 300 volts d.c. for the plate supply should

be built if one is not readily available. The antenna pickup loop is merely two or three turns of hookup wire wound around the coil form and slid along for best output.

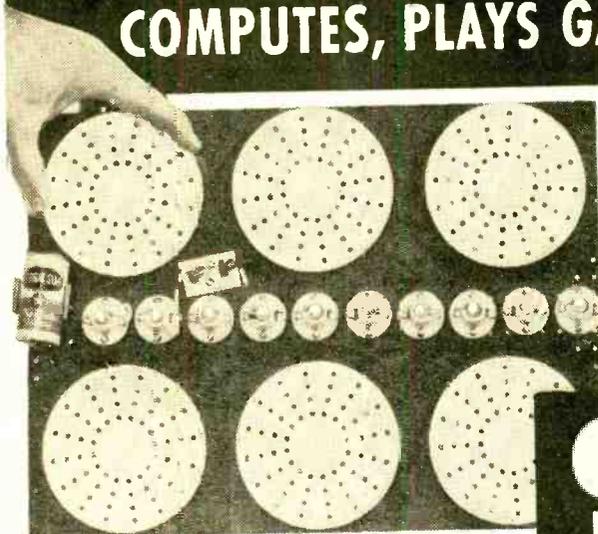
Check operation of the oscillator without the crystal but with the key closed and B+ applied. There should be no oscillations regardless of the tuning capacitor (C3) setting. Also, have a friend of yours check for harmonic and spurious radiation after you get the rig on the air. With such low power, TVI will probably not be a problem even though the rig is not shielded.

Using this little transmitter and a surplus receiver operating from a 6-volt battery and vibrapack, I made 53 contacts in seven states and the Hawaiian Islands during a recent national field day test sponsored by the ARRL. Transmitter input was 11 watts and the antenna a simple 40-meter dipole.

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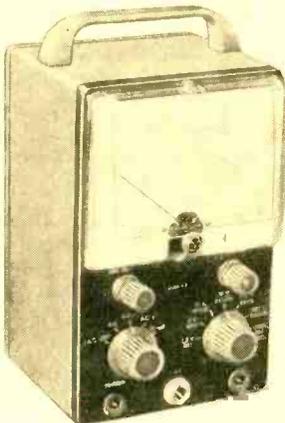
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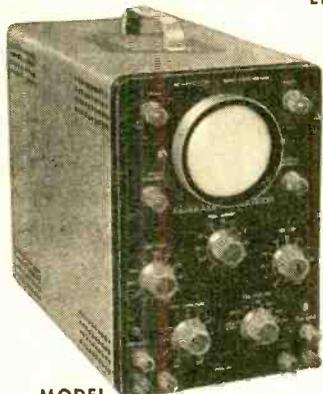
20,000 ohms/v. DC and 5,000 ohms/v. AC sensitivity. Ranges (AC and DC) are 0-1.5, 5, 50, 150, 500, 1500, and 5000 v. Direct current ranges are 0-150 ua, 15 ma, 150 ma, 500 ma, and 15 a. Resistance ranges provide center-scale readings of 15, 1500 and 150,000 ohms. DB ranges cover -10 db to ±65 db.

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Heathkit 3" oscilloscope kit

ETCHED CIRCUIT



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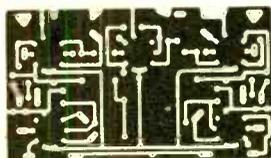
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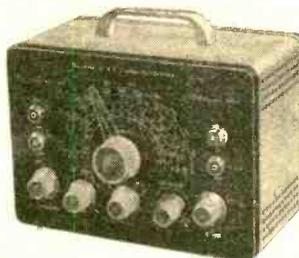
This compact little oscilloscope is just the ticket for use in the ham shack or home workshop. Measures only 9½" H. x 6½" W. x 11¼" D. Weighs only 11 pounds.

Employing etched metal circuit boards, the Model OL-1 features vertical response with in ± 3 db from 2 cps to 200 kc. Vertical sensitivity is 0.25 volts rms per inch, peak-to-peak, and sweep generator operates from 20 cps to 100,000 cps. Provision for direct RF connection to deflection plates. Incorporates many features not expected at this price level. The 8-tube circuit features a type 3GP1 cathode ray tube.

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No oscillator calibration required.

Covers 160 kc to 220 mc (including harmonics).



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MODEL
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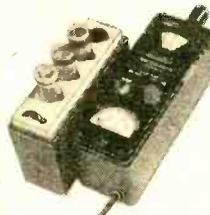
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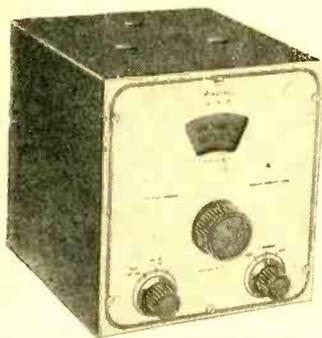


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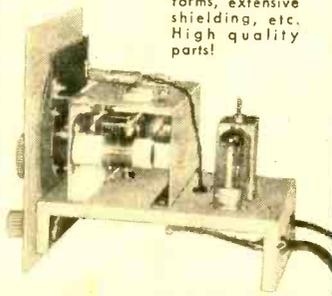
Features illuminated and pre-calibrated dial scale. Cable and plug provided to fit crystal socket of any modern transmitter.

Heathkit
vfo
KIT

- ☆ 6AU6 electron-coupled oscillator.
- ☆ OA2 voltage regulator tube for stability.
- ☆ Smooth-acting illuminated dial.
- ☆ Easy to build and attractively styled.

This variable frequency oscillator covers 160-80-40-15-11 and 10 meters with three basic oscillator frequencies. RF output is better than 10 volts average on fundamentals. Enjoy the convenience and flexibility of VFO operation at no more than the price of crystals. May be powered from

Extra features include copper-plated chassis, ceramic coil forms, extensive shielding, etc. High quality parts!



SPECIFICATIONS:
RF Amplifier Power Input... 25-30 watts
Output Connection... 52 ohms
Band Coverage... 80, 40, 20, 15, 11, 10 Meters
Tube Complement:
5U4G... Rectifier
6AG7... Oscillator-Multiplier
6L6... Amplifier-Doubler

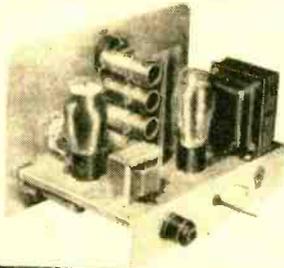
Heathkit CW amateur transmitter kit

This CW transmitter is complete with its own power supply and covers 80, 40, 20, 15, 11, and 10 meters. Incorporates such outstanding features as key-click filter, line filter, copper plated chassis, pre-wound coils, and high quality components. Employs a 6AG7 oscillator, 6L6 final amplifier. Operates up to 30 watts plate power input.

MODEL AT-1
\$29.50
Shpg. Wt. 15 Lbs.

Single-knob band-switching for 80, 40, 20, 15, 11 and 10 meters.
Plate power input 25-30 watts.

Panel meter monitors final grid or plate current.
Best dollar-per-watt buy on the market.

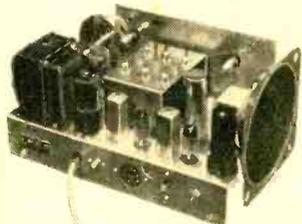


Slide-rule dial-electrical band-spread-ham bands marked.

Slug-tuned coils and efficient IF transformers for good sensitivity and selectivity.

Transformer-operated power supply for safety and high efficiency.

Heathkit COMMUNICATIONS TYPE all band receiver kit



\$27.95 MODEL AR-3
Shpg. Wt. 12 Lbs.

CABINET: Fabric-covered cabinet available. Includes aluminum panel, speaker grille, and protective rubber feet. Measures 12-1/4" W. x 6-3/4" H. x 7-3/4" D. No. 91-15. Shpg. Wt. 6 Lbs. \$4.60.

The Model AR-3 covers from 550 kc to 30 mc on 4 bands. Covers foreign broadcast, radio hams, and other interesting short wave signals.

Features good sensitivity and selectivity. Separate RF and AF gain controls—noise limiter—AGC—VFO, headphone jack—5 1/2" PM speaker and illuminated tuning dial.

SPECIFICATIONS:
Frequency Range... 550 kc to 30 mc on four bands
Tube Complement... 1—12BE6 oscillator and mixer
1—12BA6 IF amplifier
1—12AV6 second detector, AVC, first audio amplifier and reflex BFO
1—12A6 beam power output
1—5Y3 full wave rectifier

HEATH COMPANY A SUBSIDIARY OF DAYSTROM, INC.
BENTON HARBOR 10, MICHIGAN

The Transmitting Tower

(Continued from page 64)

Compare them carefully and note the many points of similarity between them. As soon as you learn how to draw one diagram and start to learn how to draw another, look at the old one and at the new one, and ask yourself questions.

In what details are those diagrams the same? How do they differ? What has been added to the new one? What has been left out? Why? Draw the new diagram several times, reading the question which it is supposed to answer carefully before starting to draw. If you get stuck, read the question again before referring to the diagram in the manual. Frequently, you will discover that the question actually tells you exactly what to draw.

What Books to Get

The Radio Amateur's Handbook (ARRL), \$3.00, is a one-volume source of practically all the information needed in an amateur station. Chapter 2 ("Electrical Laws and Circuits") and chapter 3 ("Vacuum Tube Principles") cover fundamentals adequately in about 50 pages, and the remaining chapters show their usage in amateur equipment.

The main trouble with the *Handbook* as a beginner's text is that some students who

study alone find that learning anything from it is comparable to cracking hickory nuts with their teeth and prying the meat out of them without a nut pick. Consequently, they make more progress by studying a text specifically designed to teach fundamentals from the ground up. The many tests, quizzes and reviews found in such textbooks help in impressing the important points on the student's mind.

A couple of the many excellent texts of this kind that are available are: *Elements Of Radio* (Prentice-Hall), by Marcus, Marcus, & Horton, \$6.00; and *Basic Electricity and Basic Electronics* (John F. Rider), \$9.00 for each 5-volume course.

Excellent for determining when you are ready for the test, Novice or General, is the new edition of the "AMECO" *Radio Amateur Question and Answer License Guide* (American Electronics Co.). It is based upon the same questions that appear in the *License Manual*, but the answers are given in multiple-choice form. Featured in the booklet are "typical" Novice and General Class exams.

If you can pass these tests "cold," you are ready for the appropriate examination. However, they should not be studied along with the practice questions in the *License Guide*, because this will destroy their value as test examinations.

(Continued on page 104)

HELP WANTED

Each month, the names of prospective amateurs requesting help in obtaining their licenses are listed in this section of the *Transmitting Tower*. To have your name listed, address your request to: Herb S. Brier, W9EGQ, c/o POPULAR ELECTRONICS, 366 Madison Ave., New York 17, N. Y.

Frank Dunn, R.D., Cleveland, New York, needs help with code and would like suggestions for his transmitter.

Jerry Reaves, 104 E. 14th St., Marion, Ind.

Steve Dubnoff (11), 1930 N. Normandie Ave., Los Angeles 27, Calif. (Telephone: 46604).

Fred L. Gatz (15), 5 Edward St., Lancaster, N. Y.

Cliff Gardner (15), 3839 Preston St., Rockford, Ill., and **Lawrence Johnson** (13)—address c/o Cliff—are studying together, and would like a little help.

Norris Sapp (15), 365 E. 4th So. St., Green River, Wyo., is a freshman in high school, and needs help in theory and general information. He would also like a few pen pals.

Richard Russell, 101 Raynor St., Lowell, Mass.

Cliff Frieze (16), Box 11, Lintlaw, Sask., Canada, has been studying amateur radio for two months. He is interested in pen pals all around the world, and will answer all letters.

Manfred Kroeger (19), 23 Oldenburg Oldb., Ziegelhofstr. 71 ptr., Germany. (This name was suggested by Mrs. L. Kroeger, Bovina Center, N. Y. She reports that he would like to hear from American amateurs and to have a few pen pals.)

James Polk, Jr., Box 185, Hunter, N. Y.
Robert Reynolds, 755 Marietta Ave., Lancaster, Pa.

Rand Evans, 1422 North Market St. Loop, Baytown, Texas (telephone: 4908) needs help on code and wants dope on 6- and 2-meter receiver.

Jerry Pearson, 622 Cherry St., Hammond, Ind.

Loren E. Lippoldt, 4539 S. Cherry St., Wichita 13, Kansas.

Victor Barton, Rt. 2, Box 980, Clover Rd., Tracy, Calif.

John Schroeder, 5735 Jefferson Ave., Hollydale, Calif.

Paul Handfield, 15 Queen St., Worcester, Mass.

James Lange, 1217 No. Railroad Ave., Staten Island 6, N. Y.

Ernest Clark, 11795 Gateway Blvd., Los Angeles 64, Calif.

E. L. Stohl, 830 Lake, Apt. 3, San Francisco 18, Calif.

Thomas Mullin (27), 6510 MacArthur Court, Seattle 6, Wash.

Randy Wilgus (14), Oak Park, Tansdale, Pa.

Gene Rowe, R.D. Box 328, Oconomowoc, Wis.

Electron Tubes With Energy Like The Sun

SOLAR ELECTRONICS

To insure only top quality merchandise Solar Electronics "set tests" each electron tube in powerfully loaded chassis!

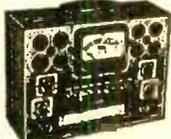
Here Is Our New Guarantee Policy:

Money back within 5 days of receipt of merchandise PLUS 5 year free factory replacement.
ALL TUBES ARE CODED BY MONTH AND YEAR!

FREE INTRODUCTORY Clip This Ad

With every order of \$15 or more—one 6N7GT, one 6W4GT, 5 assorted resistors, 5 assorted attractively colored tube cartons; or with every order of \$30 or more—1 RCA Cheater Cord, 5 assorted resistors, one 6SN7GT, one 6W4GT, one 6K6GT and Vidraire 2 set Coupler.

FREE BONUS OFFER!



Model 625K

A terrific Eico tube Tester or TV FM Sweep Generator FREE when you buy \$200 worth of receiving tubes or more within 60 days at Solar. Tester or generator may be bought outright from Solar for \$33.50

ANTENNA SPECIALS

COMPLETE OUTDOOR ALL CHANNEL CONICAL
Includes: 8 element antenna with cross-bar, 5 ft. seamless aluminum mast chimney mount or 7" wall bracket, 8 stand offs, 50 ft. of 300 ohm wire. State your need. List \$15!

\$845

NEW INDOOR ANTENNA
Brings in UHF and VHF. Use on top of TV. List \$9.95.

\$375

YOUR PRICE.

USED TV SETS

Picture tube guaranteed to work.

	Table Model	Console
10 inch set.....	\$17.50	\$20.00
12 inch set.....	\$22.50	\$25.00
14 inch set.....	\$27.50	\$30.00
16 inch set.....	\$32.50	\$35.00
17 inch set.....	\$36.00	\$38.50
19", 20", and 24" Sets—Prices on request.		

FAMOUS MAKE TEST EQUIPMENT!

TUBE TESTER KIT
In carrying case! Factory wired, \$44.95.

\$33.25

VACUUM TUBE VOLTMETER KIT
Factory wired, \$37.50.

\$24.95

FLYBACK TRANSFORMER and YOKE TESTER KIT
Factory wired, \$31.75.
Test Equipment Factory Guaranteed For One Year!

\$21.75

ALL PARTS SHIPPED F.O.B. HARRISON, N. J.

EASY TERMS!

We pay all postage or freight in U.S.A. Territories and A.P.O.s. 25¢ handling on orders less than \$5. Please send 25¢ deposit with C.O.D.'s. Remember! Your money cheerfully refunded within 5 days if you are not completely satisfied.

Visit our tube and parts showroom next time you're in Harrison. A free gift awaits you!

PICTURE TUBE SPECIALS!

Brand New—RCA		Licensed—One Year Guarantee	
Type	Price	Type	Price
10BP4 or A	\$11.25	16AP4 or A	\$18.95
10FP4	\$14.95	16CP4 or A	\$18.75
12LP4 or A	\$13.95	16DP4 or A	\$19.45
12JP4	\$13.25	16EP4 or A	\$18.75
12UP4	\$14.95	16GP4 or A	\$19.45
12RP4 or A	\$15.95	16HP4 or A	\$18.75
14CP4	\$15.95	16JP4 or A	\$18.75
15DP4 (for Dumont)	\$17.95	19AP4	\$23.95
		16JP4 or A	\$18.75
		16KP4 or A	\$18.50
		16LP4 or A	\$18.50
		16MP4 or A	\$19.25
		16NP4 or A	\$19.85
		16OP4 or A	\$18.50
		16PP4 or A	\$18.50
		16QP4 or A	\$18.50
		16RP4 or A	\$19.25
		16SP4 or A	\$19.85
		16TP4 or A	\$18.75
		16UP4 or A	\$19.45
		16VP4 or A	\$18.75
		16WP4 or A	\$19.45
		16XP4 or A	\$18.75
		16YP4 or A	\$19.45
		16ZP4 or A	\$18.75
		16AP4 or A	\$19.25
		16BP4 or A	\$19.85
		16CP4 or A	\$18.50
		16DP4 or A	\$18.50
		16EP4 or A	\$19.25
		16FP4 or A	\$19.85
		16GP4 or A	\$18.50
		16HP4 or A	\$19.25
		16JP4 or A	\$19.85
		16KP4 or A	\$18.50
		16LP4 or A	\$18.50
		16MP4 or A	\$19.25
		16NP4 or A	\$19.85
		16OP4 or A	\$18.50
		16PP4 or A	\$18.50
		16QP4 or A	\$19.25
		16RP4 or A	\$19.85
		16SP4 or A	\$18.50
		16TP4 or A	\$19.25
		16UP4 or A	\$19.85
		16VP4 or A	\$18.50
		16WP4 or A	\$19.25
		16XP4 or A	\$19.85
		16YP4 or A	\$18.50
		16ZP4 or A	\$19.25

BIGGEST VALUES! BIGGEST SELECTIONS!

PARTIAL LIST ONLY!

Type	Price	Type	Price	Type	Price	Type	Price
0A2	.67	6AC7	.65	6SQ7	.37	12S17	.44
0B3/VR150	.90	6AF4	.85	6S57	.43	12SK7	.43
0Z4	.44	6AG5	.54	6T4	.69	12SL7GT	.59
1A4P	.30	6AH7	.75	6TR	.65	12SN7GT	.53
1A7GT	.45	6AH4GT	.65	6U8	.73	12SQ7	.35
1A2Z	.65	6AH6	.65	6V3	.77	12V6GT	.44
1B3GT	.63	6AK5	.57	6V6GT	.44	12X4	.35
1R4P	.88	6AL5	.38	6W4GT	.38	14A5	.90
1C5GT	.45	6AN4	1.25	6W6GT	.55	14A7	.39
1D5GP	.40	6AN8	.99	6X4	.35	14B6	.60
1E7GT	.40	6AQ5	.45	6X5GT	.35	14E6	.59
1H4G	.35	6AS6	1.50	6X8	.75	14E7	.59
1H5GT	.45	6AT6	.36	6Y6G	.49	14F7	.59
1L4	.47	6AU4GT	.70	7A4	.44	14F8	.69
1L6	.53	6AU5GT	.60	7A5	.53	14N7	.69
1LA4	.55	6AU7	.85	7A6	.44	19B6GG	1.10
1LA6	.55	6AV5GT	.65	7A7	.44	19B7	.64
1L84	.55	6AV6	.36	7B4	.43	24A	.35
1LC6	.51	6AX4GT	.85	7B5	.40	25BQ6GT	.75
1LH4	.55	6AX5GT	.59	7B6	.44	25CUB	1.10
1LN5	.51	6B8	.75	7B7	.44	25L6GT	.45
1N5GT	.53	6BA6	.45	7B8	.44	25W4GT	.42
1R5	.58	6BA7	.55	7C4	.44	25Z5	.39
1S5	.41	6BC5	.50	7C5	.44	25Z6GT	.35
1T4	.49	6BE6	.46	7C6	.44	26	.48
1T5GT	.57	6BF5	.42	7E5	.59	27	.29
1U4	.55	6BG6G	1.10	7F7	.59	32L7GT	.52
1U5	.41	6BH6	.52	7F8	.69	35	.33
1V2	.63	6BJ6	.49	7H7	.69	35/51	.33
1X2	.65	6BK5	.75	7J7	.69	35A4	.44
2A7	.50	6BL7GT	.69	7K7	.69	35B5	.48
2X2A	.55	6BN6	.60	7N7	.64	35C5	.48
3A4	.55	6BQ6GT	.75	7X7	.69	35L6GT	.45
3A5	.55	6BQ7	.80	7Y4	.39	35W4	.35
3AL5	.48	6BY5G	.60	7Z4	.39	35Z4	.35
3AV6	.48	6BZ7	.80	12AT6	.38	35Z5GT	.35
3BC5	.56	6C4	.35	12AT7	.65	39/44	.35
3BN6	.65	6C86	.50	12AU6	.42	50A5	.44
3CB6	.56	6C06G	1.10	12AV7	.52	50A5	.44
3Q4	.45	6C6	.90	12AV6	.38	50B5	.48
3Q5GT	.55	6C6	.45	12AV7	.73	50C5	.48
3S4	.52	6F6	.40	12AX4GT	.67	50L6GT	.45
3V4	.52	6H6	.42	12AX7	.69	75	.40
4BQ7	.92	6J4	1.50	12AZ7	.65	75	.40
4BZ7	.97	6J5	.38	12B4	.65	77	.40
5A05	.52	6J6	.50	12B6	.45	78	.40
5J6	.60	6KG6T	.36	12BA7	.59	80	.35
5U4G	.45	6L6	.65	12BE6	.45	84/6Z4	.41
5U8	.68	6S8GT	.74	12BH7	.59	117L7GT	1.39
5V4G	.56	6S47	.44	12BY7	.64	117N7GT	1.29
5X8	.78	6S7	.50	12CUG	1.09	117P7GT	1.29
5Y3	.29	6S7	.60	12K7	.49	117Q7	.35
5Y4G	.35	6S7	.43	12Q7	.44	117Z6GT	.60
5Z3	.29	6S7	.43	12S47	.87	807	1.49
6A7	.55	6SK7	.44	12S7	.59	1619	.59
6B4	.45	6SL7GT	.53	12S7G	.59	9002	1.19
6AB4	.45	6SN7GT	.53	12SH7	.59		

TO QUANTITY USERS!

Your initial order of \$150 or more entitles you to our special 10% discount or free Deluxe "60" Remington Razor. State your choice. This offer **not** good if you are taking advantage of free tube tester or generator offered elsewhere in this ad.

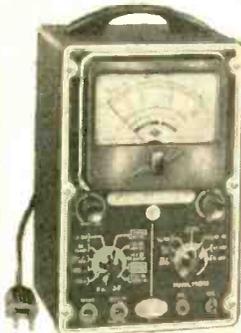
SOLAR ELECTRONICS

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Harrison, N. J.

ESsex
4-5300

New Model
670-A

New! SICO SUPER-METER



A Combination VOLT-OHM MILLIMETER PLUS
CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS

SPECIFICATIONS

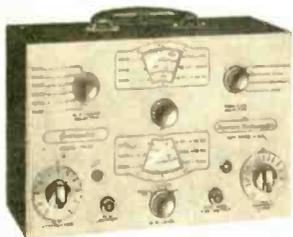
D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/
7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000
Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/
3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to
1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to
10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-
Bad scale for checking quality of electrolytic
condensers.)
REACTANCE: 50 to 2,500 Ohms 2,500 Ohms
to 2.5 Megohms
INDUCTANCE: 15 to 7 Henrys 7 to 7,000
Henrys
DECIBELS: -6 to +18 +14 to +38 +34 to
+58

ADDED FEATURE:

Built-in ISOLATION TRANSFORMER reduces pos-
sibility of burning out meter through misuse.

The Model 670-A comes housed. In a rugged
crackle-finished steel cabinet complete with
test leads and operating instructions.

\$28⁴⁰
NET



SICO New Model TV-50 GENOMETER

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

R. F. SIGNAL GENERATOR: Provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics. • VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal. • BAR GENERATOR: Projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars. • CROSS HATCH GENERATOR: Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect. • DOT PATTERN GENERATOR (FOR COLOR TV). The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for proper color convergence. • MARKER GENERATOR: The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency.)

MODEL TV-50 comes absolutely complete with shielded leads and operating instructions.

Only

\$47⁵⁰
NET

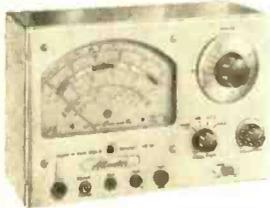
New Model TV-60



20,000 OHMS
PER VOLT

ALLMETER

Includes services never before provided by an instrument of this type. Read and compare features and specifications below!



FEATURES

- ★ Giant recessed 6½ inch 40 Microampere meter with mirrored scale.
- ★ Built-in Isolation Transformer.
- ★ Use of the latest type printed circuit and 1% multipliers assure unchanging accurate readings.

SPECIFICATIONS

8 D.C. VOLTAGE RANGES (At a sensitivity of 20,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500/30,000 Volts.
7 A.C. VOLTAGE RANGES: (At a sensitivity of 5,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500 Volts.
3 RESISTANCE RANGES: 0 to 2,000/200,000 Ohms, 0-20 Megohms.
2 CAPACITY RANGES: .00025 Mfd. to 30 Mfd.
5 D.C. CURRENT RANGES: 0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.
3 DECIBEL RANGES: -6 db to + 58 db.

R.F. SIGNAL TRACER SERVICE: Enables following the R.F. signal from the antenna to speaker of any radio or TV receiver and using that signal as a basis of measurement to first isolate the faulty stage and finally the component or circuit condition causing the trouble.
AUDIO SIGNAL TRACER SERVICE: Functions in the same manner as the R.F. Signal Tracing service specified above except that it is used for the location of cause of trouble in all audio and amplifier systems.

Model TV-60 comes complete with book of instructions; pair of standard test leads; high-voltage probe; detachable line cord; R.F. Signal Tracer Probe and Audio Signal Tracer Probe. Pilotfilm box for all above accessories is also included. Price complete. Nothing else to buy. ONLY

\$52⁵⁰
NET

EXAMINE BEFORE YOU BUY!
USE APPROVAL FORM ON NEXT PAGE

New!



Streamlined TUBE TESTERS

The New Model TV-40



C. R. T. TUBE TESTER

• Tests all magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!!

• A complete picture tube tester for little more than the price of a "make-shift" adapter!!

The Model TV-40 is absolutely complete! Self-contained, including built-in power supply, it tests picture tubes in the only practical way to efficiently test such tubes; that is by the use of a separate instrument which is designed exclusively to test the ever increasing number of picture tubes!

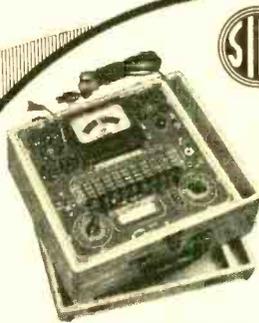
SPECIFICATIONS

Tests all magnetically deflected picture tubes from 7 inch to 30 inch types. • Tests for quality by the well established emission method. All readings on "Good-Bad" scale. • Tests for inter-element shorts and leakages up to 5 megohms. • Test for open elements.

Model TV-40 comes absolutely complete — nothing else to buy. Housed in round cornered, molded bakelite case. Only . . .

\$15⁸⁵
NET

**SHIPPED ON APPROVAL
NO MONEY WITH ORDER
NO C.O.D.**



New Model TV-11

TUBE TESTER

- ★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary.
- ★ The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
- ★ Free-moving built-in roll chart provides complete data for all tubes.
- ★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRA SERVICE — The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation time oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

The model TV-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

\$47⁵⁰
NET

TRY ANY
of the instruments on this or on the facing page, for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. **Mo Interest or Finance Charges Added!**
If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. D-211, 3849 Tenth Ave., New York 34, N.Y.

Please send me the units checked. I agree to pay down payment within 10 days and to pay the monthly balance as shown. It is understood there will be no finance, interest or any other charges, provided I send my monthly payments when due. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

- Model TV-40 . . . Total Price \$15.85 \$3.85 within 10 days. Balance \$4.00 monthly for 3 months.
- Model 670-A . . . Total Price \$28.40 \$7.40 within 10 days. Balance \$3.50 monthly for 6 months.
- Model TV-60 . . . Total Price \$52.50 \$12.50 within 10 days. Balance \$8.00 monthly for 5 months.
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- Model TV-50 . . . Total Price \$47.50 \$11.50 within 10 days. Balance \$6.00 monthly for 6 months.

Name _____
Address _____
City _____ Zone _____ State _____

(Continued from page 100)

The License Manual itself is the best study guide for the questions about FCC regulations. And it also does an excellent job of explaining what formulas to use and how to use them in answering the questions on determining how close to the edge of a band one can operate safely with crystals or frequency meters of various percentages of calibration error. But, if you have the slightest doubt about them, you should review your eighth-grade arithmetic or first-year high-school algebra book for information on decimal fractions and formulas.

News and Views

Tom Gallagher, KN4DRO/K4DRO, 5797 S.W. 60 St., South Miami, Fla., leads off this section of the *Transmitting Tower*. "The setup here is a Hart-75, which uses a 6AG7 into a 6CU6 at 75 watts, and an S-85 receiver. I operate on 15 meters only on a frequency of 21,129 kc. I have worked 24 states, but I never heard a WN7 on 15 yet. Where are they all? I'd like to sked KNØ, WN7, KN6, WN1 and Delaware. I am 13 years old and got my Technician license a month ago. 73."

Mark Michel, W9PJT, Lake Mills, Wis., reports: "I just got my General license and want to tell you about my good luck with low power as a Novice. I used a 6AG7 oscillator running 7-watts input to a 'long-wire' antenna. Working 80 meters only, my best DX was about 1100 miles in daylight and seven states. I was surprised to get so many 599X

reports with only 7 watts. I find that there is a lot of interference in the Novice bands, but that gives beginners the chance to become good operators, doesn't it?

"My new rig is a Globe Scout, because I plan to do some phone work now and also to work 40 and 10 meters.

"I will be more than happy to help would-be hams get their Novice licenses or Novices to obtain their Generals. I am fourteen years old. 73."

Jeffery Lehman, K2GQX, 25 Salem Road, Roslyn, L. I., N. Y. (Telephone: Roslyn 3-5937), writes: "I have lots of spare time, and I would like to fill it in some useful way. I would like to help anybody who wants to get into radio and obtain an amateur license. I have taught many Novices and have helped them get on the air after they have acquired their licenses. 73."

Graham Hunter, K2JJA (13), 200 Cabrini Blvd., New York 33, N. Y., writes: "I can sympathize fully with Mr. Longenecker's problem of living in an apartment and not being able to put up an efficient antenna (*Transmitting Tower*, December, 1955). I also live in an apartment where we are not supposed to put up any kind of antenna, so last March I put up an 'invisible' one. It is made of No. 30 magnet wire, with small white buttons for insulators, and it is about 100 feet long.

"I end-feed the antenna from my Viking Ranger transmitter. On 20-meter phone, I have worked Australia, Japan, and New Zea-

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land; on 40-meter phone, I have worked Hawaii; and on 15-meter phone, I have worked England. My receiver is an S-53A. 73." (It is more difficult to work DX on phone than on code with low power; therefore, it would seem that Graham's secret antenna must work very well. *Herb*)

J. T. McGerard, 172 Eighth St., Newington, Conn., has another solution to Frank Longenecker's antenna problem: "When I lived in an apartment building, I just hooked my receiver to the house TV antenna. Where I live now, I have two antennas, one 75 feet long and the other a 15-meter dipole. My receiver is an AR-2. I have heard a lot of DX in the last few months. 73."

Ted Heyck, KN5BXT, 1907 Bolsover Rd., Houston 5, Texas, writes: "I have been reading in *Transmitting Tower* about Novices who have worked the various states and about some of the Generals who have been fortunate enough to work outside of the USA. I have actually been on the air for three months. In that time, I have worked 25 countries inside and outside the iron curtain, and all continents.

"I use a Johnson Viking Ranger transmitter and an SX-96 receiver. At the moment, I am building a three-element beam antenna. (It must be for 15 meters. *Herb*)

"I want some of those 'puffed up' Generals to see that a Novice class amateur is not just a little guy who can barely get his signal across town. 73."

Temple "Buzz" Fay, WN1EUT, 78 Paradise Rd., Swampscott, Mass., reports: "I use a single 6L6 transmitter, feeding a 67½' antenna. My receiver is an NC-100. Running a power of 15 to 20 watts, I have worked 12 states, with 11 confirmed. I'd like to know the address of WN8ENV for that missing card.

"I'd be glad to hear about the luck others have had using a single 6L6 transmitter. Also, I'd like to have some ideas about adding an amplifier. 73."

Richard Cunningham, Dallas, Texas, (no street address given), apparently recommends the "sneak-up-on-them-gradually" method of solving the antenna problem. "At present, I am located in a private home and I have had no antenna problems yet. After discussing the situation with my landlord, I put up a long wire. Now I have a 68' folded dipole, 10- and 20-meter doublets, a 15-meter beam, and a 135' wire. With the exception of the two 25' poles, you would hardly know they were there. Also, there are several types of 'whip' antennas that can be mounted on window sills. They come equipped with different types of mounting brackets.

"I use an SX-96 receiver with antenna change-over relays, and I have QSL cards from many foreign stations. Some nights, they come in like locals. 73."

Again, we have come to the end of the column. Before we part . . . do not forget to keep your letters, questions, and suggestions coming to the *Transmitting Tower*. Former readers of the *Ama-Touring* column are especially welcomed. Let's hear from you. 73,

Herb, W9EGQ

March, 1956

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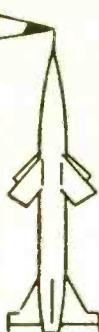
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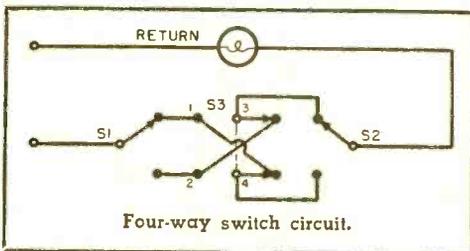
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After Class

(Continued from page 91)

any electrical supply store. If both *S1* and *S2* are up, the circuit is completed through carrier A; with both switches down, the current flows through carrier B. If one switch is up and the other down, the circuit is open; then, throwing either switch to its other position results in an "on" condition.

For the more ambitious wirer, here is the so-called "four-way" circuit with



Four-way switch circuit.

which the same light or outlet may be controlled independently from only one of three different positions. The four-way switch (*S3*) shown in the drawing is really a double-pole, double-throw type with crossover connections between outer poles.

CAPACITOR LEAKAGE

IN THE days of radio's adolescence, the mention of a "leaky" capacitor would generally bring to mind the vision of the slow drip of a liquid from a hole in a filter capacitor can. These were the times of wet electrolytic capacitors, corroded chassis, and holes in parlor carpets.

Today a leaky capacitor inspires no such visions; instead, it is interpreted as meaning a capacitor that, due to old age or other causes, has developed a defect which allows direct current to pass through it.

Capacitors used for blocking purposes or for coupling vacuum-tube stages to each other must have very little leakage. The diagram on page 108 helps to show why this is so. As in most capacitor circuits, an alternating current—audio, video, oscillatory, etc.—is to be permitted to flow through a chosen component while the flow of d.c. is completely blocked off by the selective action of the coupling capacitor *Cc*. In this case, the signal current is to cause a signal voltage to appear on the grid of the electron tube.

If the coupling capacitor begins to leak, a direct current flows up from ground, through *Rg* and *Cc* to the B+ of the power supply as indicated by the arrows. A voltage drop having the polarity shown thus develops across *Rg*, making the grid of the

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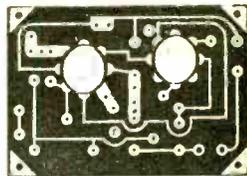
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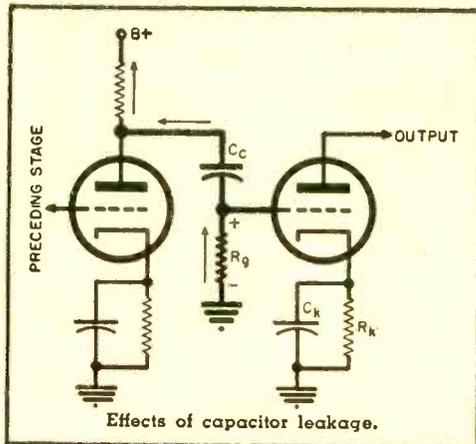
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Effects of capacitor leakage.

tube positive with respect to ground. During normal operation, negative grid bias for this tube is developed by the voltage drop across R_k . The leakage current is likely to produce a voltage that more than cancels the grid bias, producing distortion.

Capacitor leakage in other spots results in the kinds of troubles shown below:

Filter circuit—reduced output voltage, overheating rectifier, blown fuses.

Cathode bypass—serious distortion, excessive tube plate current.

Screen bypass—oscillation, loss of gain.

Tuned circuit—detuning, reduced response.

Decoupling circuit—loss of gain, oscillation.

Timing circuits (a.v.c., a.f.c., etc.)—incorrect time constant resulting in loss of function.

—30—

Signal Tracing

(Continued from page 59)

few minutes warm-up time. The green glow of the eye tube in the tracer will indicate that the tubes have heated. (6) Set the generator output to maximum. (7) Slowly advance gain control R_1 , noting that the generator modulation tone is heard from the speaker and also that the eye closes. The eye closes tighter and the speaker sound becomes louder as the control is advanced.

In the test procedure outlined, the signal tracer is operated from an amplitude-modulated r.f. signal. This is the type of operation encountered when tracing signals in radio sets and in some parts of TV receivers, and a detector-type pickup probe must be used. When using the instrument to trace an audio signal, i.e., in checking an amplifier, the detector is not needed and a conventional test probe of the kind used with multimeters can be substituted. —30—

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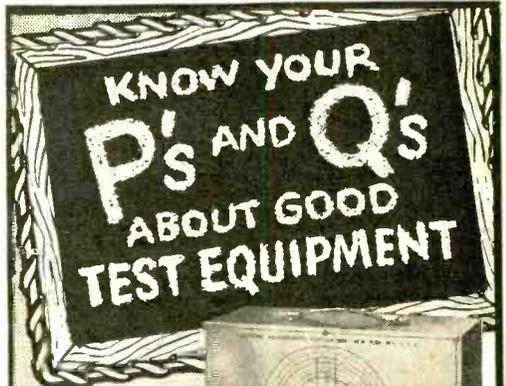
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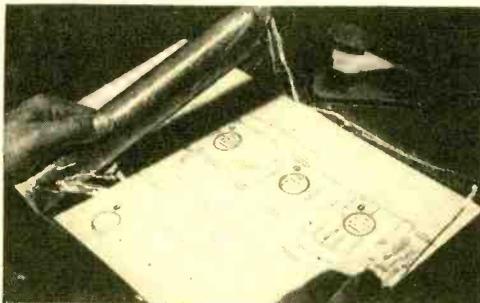


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KITCHEN WRAPPING PROTECTS PLANS

Transparent kitchen wrapping will provide a durable overlay to protect circuit plans during the wiring stage of construction. A china marking pencil can be used

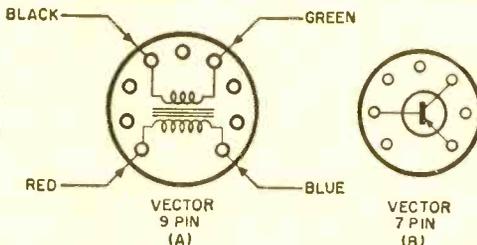


to trace completed portions of the circuit on the overlay, thus avoiding defacing of the original diagram. There is less chance of wiring error when using this method.

PROTECTING SMALL ELECTRONIC PARTS

In most experimentation, small electronic parts such as transistors and transistor transformers have a very short life expectancy. After losing a few precious transistors because of broken leads, the problem was solved by one experimenter in the following way.

Several Vector 7- and 9-pin bases of the plug-in type were purchased. These are



identified by The Vector Company as No. 7P and No. 9P respectively. The transistors and transformers were secured to the central plastic pillar of the plug with a drop of airplane cement. To separate the transistors and the transformers, a 7-pin plug was used for the transistors and a 9-pin plug for the transformers, making them in-

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024	.43	3BN6	.70	6AX4GT	.60	6K8	.65	7C6	.43	14B6	.38
1A4P	.33	3CB6	.52	6AX5GT	.57	6L6	.68	7C7	.45	14Q7	.50
1A7GT	.43	3Q4	.46	6B4G	.52	6L7	.42	7E5	.45	19BG6G	1.15
1B3GT	.65	3Q5GT	.57	6B8	.69	6N6GT	.60	7E8	.55	19T8	.65
1C5GT	.41	354	.47	6BA6	.47	6Q7	.40	7E7	.70	24A	.39
1D5GP	.43	3V4	.47	6BA7	.58	6S4	.40	7F7	.59	25AV5GT	.78
1E7GT	.41	5BQ7	.89	6BC5	.47	6S4T	.43	7F8	.70	25BQ6GT	.78
1G6GT	.41	4B27	.95	6BC7	.40	6SCT	.48	7G7	.75	25L6GT	.47
1H4G	.43	5AW4	.75	6BE6	.45	6S67	.41	7H7	.50	25W4GT	.43
1H5GT	.47	5J6	.63	6BF5	.40	6SH7	.43	7J7	.75	25Z5	.37
1J6GT	.47	5T4	.69	6BF6	.50	6SJ7	.43	7K7	.75	25Z6	.37
1L4	.45	5U4G	.43	6BG6G	1.15	6SK7	.45	7L7	.75	27	.25
1L6	.53	5U9	.74	6B7	.55	6L7GT	.55	7M7	.50	35A5	.46
1L4A	.57	5V4G	.59	6BJ6	.47	6SN7GT	.55	12AT6	.37	35B5	.50
1L6A	.47	5V3	.31	6BK5	.68	6SQ7	.39	12AT7	.66	35C5	.50
1L84	.57	5V4G	.36	6BK7	.76	6SR7	.42	12AZ7	.63	35L6GT	.47
1LCS	.49	5Z3	.41	6BL7GT	.75	6SS7	.41	12AU6	.41	35W4	.34
1L06	.47	6A7	.57	6BN6	.58	6T4	.95	12AU7	.53	35Y4	.34
1L05	.57	6A8	.45	6BOGT	.78	6T8	.68	12AV6	.35	35Z7	.39
1L13	.57	6B84	.43	6BQ7	.78	6U8	.75	12AV7	.67	35Z5GT	.34
1L65	.57	6AC7	.67	6BY5G	.58	6V3	.80	12AX4GT	.65	37	.29
1LW4	.64	6AF4	.79	6BZ7	.88	6V6GT	.42	12B6	.68	50A5	.48
1LN5	.47	6AG5	.50	6C4	.37	6W4GT	.39	12B4	.68	50B5	.50
1NSGT	.50	6AG7	.69	6C5	.35	6W6GT	.53	12BA6	.46	50C5	.50
1R5	.50	6AH6	.69	6CB6	.49	6X4	.34	12B06	.48	50L6GT	.43
1S5	.42	6AJ5	.70	6CD6G	1.15	6X5	.34	12BE6	.46	75	.42
1T4	.50	6AK5	.54	6D6	.48	6X8	.73	12BH7	.60	76	.44
1U4	.50	6A5	.49	6E5	.44	6Y6G	.55	12BY7	.65	77	.38
1U5	.42	6AQ5	.46	6F5	.37	7A4	.45	12BZ7	.61	78	.38
1V2	.65	6AR5	.46	6F6	.37	7A5	.53	12C6	.95	80	.34
1X2	.65	6AS5	.48	6G6	.40	7A6	.45	12S47	.45	84/6Z4	.44
2A3	.55	6AS6	1.70	6H6	.38	7A7	.43	12SJ7	.45	117L7GT	1.09
2A5	.57	6AS7G	2.19	6J4	1.79	7A8	.45	12SK7	.45	117N7GT	1.09
2A7	.65	6AT6	3.19	6J5	.39	7B5	.39	12SN7GT	.56	117P7G	1.09
3A4	.51	6AU4GT	.65	6J6	.47	7B6	.42	12SQ7	.37	117Z7	1.09
3A5	.50	6AU5GT	.59	6J7	.43	7B7	.41	12SR7	.45		
3A6	.45	6AU6	.42	6J8	.25	7B8	.45	12SV6T	.45		
3A8	.46	6AV5GT	.65	6K6GT	.37	7C4	.39	12X4	.37	117Z3	.35
3BC5	.54	6AV6	.39	6K7	.39	7C5	.42	12A47	.42	117Z6GT	.63

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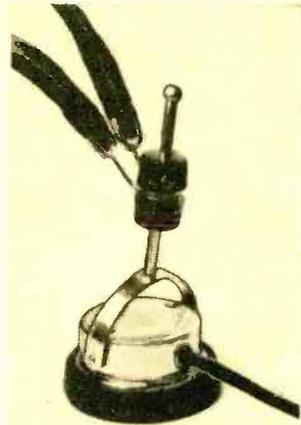
WESTERN RADIO Dept. APL-3 Kearney, Nebraska

stantly recognizable. Common transformers such as Stancor, etc., fit perfectly with room to spare.

The leads were soldered to the pins as shown in the drawing. To protect the components further, a 1" piece of Amphenol polystyrene tubing was glued to the Vector socket with Amphenol "Polyweld 912" cement. The 7-pin plug requires 5/8" inside diameter tubing, and the 9-pin plug requires a 3/4" inside diameter tubing. This polystyrene sleeve protects the transistor or transformer from the hardest abuse which either might receive.

IMPROVING ADJUSTING ROD ON EARPHONE

Many earphone headbands (which have no locking screws) gradually become so worn that it is impossible to keep them at the desired adjustment—the fork rods keep sliding up and down in the sockets when you put the phones on your head and take them off again. This problem may be solved by drilling holes through miniature plastic tuning knobs and fastening the knobs onto the rods, as shown in the photo.



Obtain four miniature plastic knobs with setscrews and having holes for 1/8" shafts; these are made for Ferri-loopsticks and miniature volume controls, etc. Twist the setscrews part way out and go through the knobs with a No. 23 drill, or whatever size drill is required in your case.

As shown in the photo, remove the ball-screws or flat-head screws at the top of

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each fork rod, and install the miniature knobs. Adjust the phones to your requirements, and then tighten the setscrews in the knobs. Now you will never have to worry about the phones sliding out of adjustment again. Knobs even smaller than the ones shown are available.

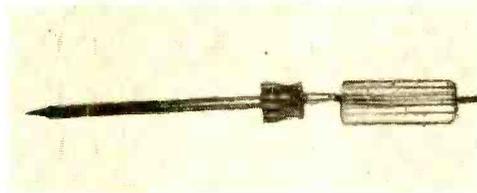
SCREWDRIVER MAKES SPECIAL TEST PROBE

A long, slender test probe that can fit into a crowded chassis, and which is insulated nearly to the tip to prevent shorts, can be made from a dime store screw-

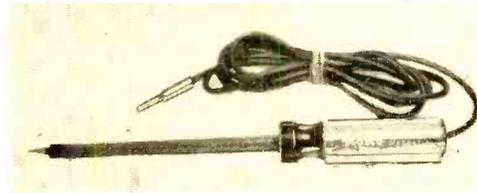


driver (15 cents). The screwdriver shown, as it came from the store, had a 4"-long shaft heavily covered with a break-resistant plastic tube of high dielectric strength. The outside diameter of the insulated shaft was $\frac{3}{16}$ " (see top photo).

To convert such a tool to a test probe, first make a cut around the amberyl plastic handle with a hack saw at a place that will leave about $\frac{1}{4}$ " of the shaft pro-



jecting from the cut. Next, bore a $\frac{1}{8}$ "-diameter hole lengthwise all the way through the severed part of the handle—for the wire lead to pass through. This hole should be enlarged to $\frac{1}{4}$ " at the cut end so that it will clear the wire lead soldered to the end of the screwdriver shaft (see center photo). Pass the wire lead through the handle and solder the end of the wire to the projecting shaft end. Cement the two



cut surfaces of the handle and press together firmly. Let the cement set for a day or two.

The completed test probe is shown in the bottom photo. Flexible rubber-covered

March, 1956

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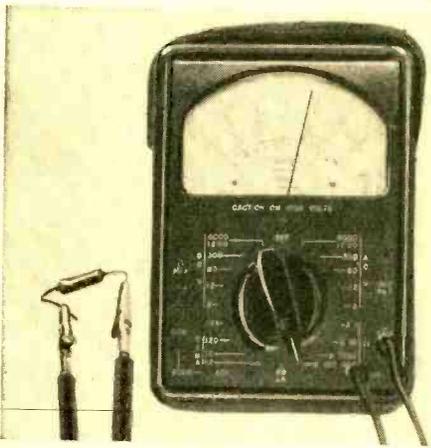
wire was used for the lead, and a phone tip was soldered onto the other end of the lead so that the probe could be plugged into the VOM. The blade on the end of the screwdriver shaft was ground to a sharp point. The end should be dipped in cold water now and then while grinding or heat will soften the plastic shaft covering.

CHECKING RECORDING TAPE

Run a new roll of recording tape through the recorder at least once prior to regular use. This precaution can prevent the tape from sticking, and consequently tearing, when you are doing some serious recording. The tape may be run on the fast forward if you wish. Any breakage can be located and spliced when nothing of importance is being recorded on the tape.

PRECISION RESISTOR TESTS OHMMETER

As precision resistors do not cost a great deal, several should be kept on hand in their plastic cases for a periodic check on



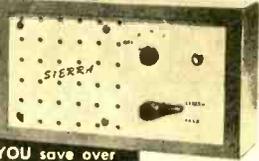
the accuracy of the ohmmeter calibration. Ideally, one should be on hand for each range, and should be so chosen as to fall between 10% and 90% of the scale reading, preferably towards the low side of the scale. The photo shows an ohmmeter being checked using a precision resistor.

IMPROVING SPEAKER RESPONSE

High-frequency response of low-cost 4" to 8" speakers can be improved somewhat by replacing the felt dust-cap with an aluminum dome and brushing a half-and-half mixture of castor oil and acetone on the edge compliance of the cone. The dome can be fashioned from the heavy aluminum foil used to package frozen foods. It is shaped by placing the foil on a thick rubber surface and striking it sharply with a ball-peen hammer. The resulting dome is then trimmed to size and cemented to the center of the speaker cone with an air-drying thermoplastic adhesive.

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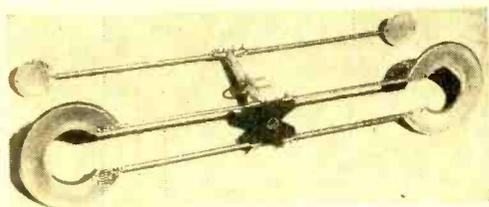
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TOOLS & GADGETS

"TORQUE-TENNA"

According to the *Snyder Mfg. Co.*, 22nd and Ontario Sts., Philadelphia, Pa., its new "Torque-Tenna" Model AX-100 is a complete departure in outdoor television antennas. It is half the size of a regular conical-type roof



antenna, weighs only 27 ounces, and is highly resistant to strong wind blasts.

Because of its small size and the fact that it occupies only one-fifth of the square footage of a traditional type of roof antenna, the "Torque-Tenna" eliminates a considerable amount of roof reflection and helps wipe out the problem of ghosts and "snow" on the TV screen. It can be used for black-and-white or color reception, and for u.h.f. or v.h.f. reception. Exclusive aluminum reflector discs are die-cut with holes to withstand high velocity winds. List price is \$7.50.

DECADE CAPACITOR

Model 100 decade capacitor, available from *High Fidelity Products*, Box 131, Owensboro, Ky., is a laboratory type unit

having a range of 0 to 10 μ fd. in 1- μ fd. steps. It is supplied in a standard tolerance of $\pm 10\%$ although closer tolerances may be had on special order.

The unit is designed for wave filters, loudspeaker crossover networks, equalizers, tuned circuits, etc. It is housed in a gray hammertone finished aluminum case 4" wide, 5" long, and 3" high. Net price of the Model 100 is \$9.95.



PRINTED CIRCUIT TV ACCESSORIES

Two TV accessories utilizing printed circuitry for capacitor and inductance functions are available from *Federal Electronics Sales*, Rockville Centre, N. Y. One is the "Bi-Fi" two-set antenna coupler for TV or FM which

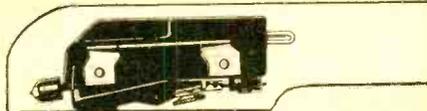
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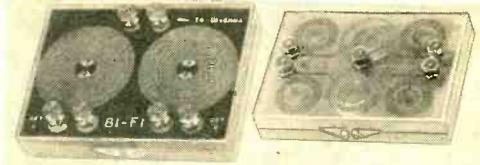
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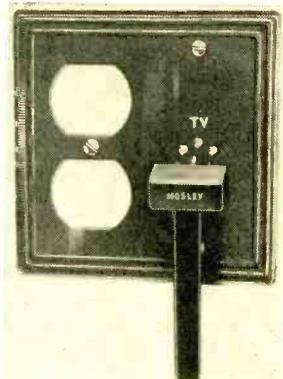


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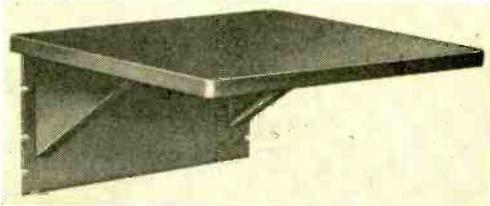
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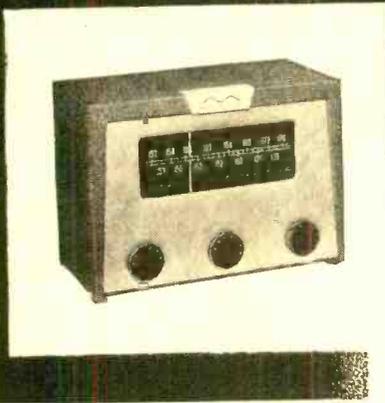
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Adding Tape to Hi-Fi System

(Continued from page 77)

way may be due to an a.c. potential difference between the two chassis (a nearly universal condition). Strong a.c. voltage on the shield is often capacity-coupled to the inner or "hot" lead of the cable. Since this feeds it directly to the amplifier input, hum goes through the system at a loud enough level to be troublesome.

To minimize—and often cure—such troubles, make chassis-to-chassis connections with two-wire shielded cable. Let the shield "float" at the output end as shown in Fig. 5. (This is a good dodge, by the way, to use in all hi-fi chassis-to-chassis connections.) To improve the connection further, bring the two chassis to the same a.c. level. As Fig. 5 shows, you can do this by wiring directly from the output chassis to the input connector of the following component.

However, if the output connector is grounded at its chassis (Fig. 6), the a.c. will travel over the signal cable anyway, so you might as well ground the shield at both ends. This is an important reason why a ground bus bar is better than a chassis ground. The bus would be connected to the chassis only at the input.

If you do have a chassis-grounded output connector, however, you might try an alternative method that sometimes reduces hum level—"float" the shield and use the separate wire from the output chassis to the input connector to complete the circuit, as shown in Fig. 7. But be warned: this may put enough a.c. potential in series with the signal to raise more hum than the other method. Experimentation is in order.

These shielding refinements aren't necessary in all cases. The signal from a tape recorder, for instance, is often high enough so that hum pickup in the cable never becomes an acute problem. A cable with shield connected to ground at each end, and a single inner wire, may be adequate.

As a final precaution with shielded cable, don't let bare shields come in contact with a chassis or with other shields. Such contact could upset all your hum-reducing tricks. A cable that has insulation over the shield is always safer.

All the principles outlined here will be shown in action on typical tape machines in the next article in this series.

-30-

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Carl & Jerry

(Continued from page 89)

like hours—the boy used his knowledge of the house to keep out of the way of the prowler, who quietly but systematically went about ransacking the whole downstairs. Whenever he found something to his fancy, he chucked it into a burlap sack he carried over his shoulder in true comic-book-burglar fashion. Since he moved very slowly and deliberately, it was not hard for Jerry to keep him in view without being seen himself. At one time the boy thought he heard the sound of a distant car motor, but he could not be sure. He was concentrating so hard on keeping out of the way of that probing flashlight beam that he had scant time to notice anything else.

Suddenly, as the man stood at the bottom of the stairs, a light was turned on in Jerry's room at the head of the stairs. It flickered on and off a couple of times and then went out; but at the first flicker the burglar had switched off his flashlight and moved swiftly toward the kitchen and the stairs leading down into the basement. Jerry, confident that the flickering light from his bedroom had been caused by the police coming through the outside door of the basement, followed warily. Just as he reached the head of the basement stairs, the furnace room below was flooded with light and two policemen with drawn revolvers faced the burglar standing in the middle of the floor.

"Don't move," the tall, lanky policeman commanded. His short, stout partner moved forward and placed a pair of handcuffs on the wrists of the burglar, whose mouth still gaped open with surprise.

"Boy, am I glad to see you guys!" Jerry exclaimed, thumping down the cellar steps. "Those brass buttons on your uniforms look prettier to me right now than any Christmas tree ornament I ever saw!"

"Now there's a heartfelt testimonial," the tall policeman chuckled; "but while the compliments are going around, you've got some coming for keeping cool and using your head. How did you happen to—"

PENTODE DEVELOPMENT QUIZ

(Questions on page 91)

1. Amplification plus feedback through the grid-plate capacitance of the tube. 2. Unless the screen has "holes" in it, electrons from the cathode cannot reach the plate of the tube. 3. The screen current is substantially less than that of the plate. Average figures for a modern pentode—the 6CB6—are: plate current = 9.5 ma., screen current = 2.8 ma. 4. Secondary emission of electrons from the plate of the tube due to primary electron impact. These secondary electrons flow to the screen, reversing the current flow in the tube and diminishing the primary plate current. 5. Since there is no second positive electrode in a triode, secondary electrons which leave the plate return to it at once.

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3V4	.55	6BQ7	.85	6X4	.35	35L6	.50
5Y4G	.60	6C4	.25	7A8	.60	48	.60
5Y3G	.65	2021	.75	7C5	.55	35Z5	.45
6AR4	.40	6CB6	.48	7F7	.55	50A5	.45
6AC7	.64	6C8	.48	7F8	.68	50B5	.55
6AG5	.45	6CD6	1.12	7N7	.55	50C3	.45
6AH4	.75	6C8	.45	7Q7	.75	50L6	.40
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He broke off sharply as strange sounds issued from the adjoining laboratory. There was a scratching at the outside door accompanied by a faint clicking that Jerry recognized as coming from the relay in the capacity-operated unit.

"Sh-h-h! Maybe it's an accomplice," the lanky policeman said, as he moved swiftly across the laboratory to the door and stood poised before it with his revolver tightly clenched in his fist. He jerked the door open and sprang to one side all in a single motion. There in the doorway—with one paw still raised to scratch the disappearing door—stood Bosco, a look of doglike astonishment in his brown eyes. Then he recognized Jerry, and his stubby tail began to vibrate at about fifty cycles per second.

"Come on in, you old rascal," Jerry ordered; then he dropped on his knees and hugged the shaggy dog with almost hysterical affection. "You got caught in the trap, all right, but when Dad hears that because of you we caught a burglar, maybe he won't worry too much about a few little scratches on the cellar door!"

-30-

Disc and Tape Review

(Continued from page 68)

You will know what I mean when you hear the very opening of the first movement, as Mahler's titanic forces are unleashed. The tremendous fanfares of brass, especially the massed French horns, are simply overwhelming! Throughout the recording you will more than get your fill of huge brass sonorities, vast percussion, and strings which soar one minute and the next minute are probing the sub-basement.

Frequency and dynamic range are quite wide but could have been still better; some groove distortion is in evidence but it is nothing serious. If you are not familiar with Mahler's music at all, I suggest that you listen to his *First Symphony* to get the feel of things. After that, you should be ready for the strong medicine of the *Third*. We will plan to do a survey of other Mahler recordings in some future issue.

Tape Review

I would like to bring to your attention this month a prerecorded tape made by the Berkshire Recording Corporation (BH-1003, 7½ ips, dual track, \$6.95). It comprises four concerti: *Concerto for Three Harpsichords in C . . . J. S. Bach*; *Concerto for Four Harpsichords in A . . . Vivaldi-Bach*; *Concerto for Trumpet in E Flat . . . Haydn*; and *Concerto for Horn in D . . . Haydn*.

Berkshire Recording Corporation is the prerecorded tape manufacturer for the newly combined Haydn Society-Urania record companies. This tape is part of their first release of tapes which contain such goodies as the COMPLETE *Don Giovanni* of Mozart, the Schubert *Seventh Symphony*, Tchaikovsky's *Sixth*, and quite a few others. Naturally, most of the tapes are derived from the master tapes of previously issued Haydn Society and

Urania recordings. As such, these tapes—and this one in particular—possess the same virtues and some faults found on the discs.

Particularly high in quality are the Haydn *Trumpet and Horn Concerti*, as many will remember from the notable disc. Here we have the same vitally "live" quality to the trumpet and horn as was heard on the disc, with the plus factor that there is less tendency to "blast" on hard-blown transients and the sound is generally cleaner. The strings are, as usual, much cleaned up so far as edginess is concerned as compared to the disc. Needless to say, the added dynamic range of the tape is always welcome.

The *Harpichord Concerti* are well recorded, and on tape the harpichord has lost some of the annoying "tinniness" characteristic of it on the disc. My only quibble here is a mite of tape flutter that cropped up occasionally . . . a minor fault that can be forgiven in a new venture, but it should be corrected as rapidly as possible.

All in all, the Berkshire tapes are darn good ones and give an indication that pre-recorded tape has finally "arrived." In fact, the really startling thing about these tapes is that, for the first time, they are directly competitive in price with disc recordings.

Consider the fact that before the general record price reductions went into effect the material on the tape containing the four concerti represented two 12" LP's which would have cost you \$11.90. Not only does this tape come cheaper than the new reduced disc price (which is prevalent throughout most of the country) but it is even cheaper than the *discount*-priced discs found in New York! Now we are getting somewhere! If the other tape companies will bring their prices into line, the millennium in tape will truly have arrived!

Jazz Corner

Worthy of mention this month is a record called *Julian Cannonball Adderly* (EmArcy MG36043, 12" LP, RIAA curve, \$3.98). The odd title is obviously someone's name, in this case a fantastically hard-drivin' alto sax man.

Cannonball is a huge fellow. One look at his massive chest, and you know whereof comes all that energy! This is Cannonball's first disc for the Emarcy people, and they have gone "all out" in providing him with a stellar roster of sidemen . . . no less than Max Roach and Kenny Clarke on the 'skins, J. Johnson himself on the trombone, brother Nat Adderly on trumpet, and other top-flight boys.

Cannonball has a lot of flexibility . . . he can blow hard but he can blow cool or sweet as well—especially at the slower tempos. He is somewhat reminiscent of Benny Carter, which is probably understandable as Cannonball idolized Benny. He is in no way derivative, however . . . his unique talent is his own.

Quincy Porter wrote the arrangements for this disc . . . a clever job, too, on such oldies as *Rose Room* and *You'd Be So Nice To Come Home To*. Cannonball himself contributed a composition entitled (logically) *Cannonball*; and there are other original numbers.

Soundwise, this is typical Emarcy . . . the close-to, super-realism school of recording,

March, 1956

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particularly effective with these small groups. A touch of reverb is added to liven up things a bit, and the Cannonball sax and the other instrumentalists come through with a hi-fi jazz sound which is among the best to be found on records. This record is not for everybody; but for those who like their jazz, it is an outstanding disc.

-50-



Boner Box

(Continued from page 48)

I would have gladly traded it for one small thought of cold, clear water. But she was proving something . . .

"Gimme the gismo."

She boiled to her feet and, slinging the counter over her shoulder, struck out across the barren waste, jabbing the probe fiercely in all directions. Suddenly, she skidded to a sand-splatter halt . . . the probe pointing straight down into the bleach grains of the creek bed.

"Here. Bring that shovel and dig *here*."

"I believe you, sweetheart!" I called winsomely.

But, like I say, she was proving something—fatigue-torn spouse or no fatigue-torn spouse. She loped back, snatched up the short spade and began making the dry-creek bottom fly in billowing, choking clouds of sand . . . some of which, from the sizzle effect on contact with already scorched human hide, seemed slightly hotter than the cinders of Hell.

"See!" When the sandstorm settled, she stood triumphantly waving an ancient looking tibia . . . or perhaps it was a femur. I wasn't certain then and I'm not certain now. Anyway, it was bone, alrighty.

On the long, sweltering hike back to the car, she darted here and there, digging up more bones to prove and reprove her theory. Because she obviously had me like Grant had Richmond, I graciously agreed that she must be right. With her and that "boner box" never missing a single sun-bleached steer skull or coyote skeleton all the way to the car, what else could I say.

Several harried weeks have passed since our uranium outing and I have sworn Missus Wife to a blackmail silence with sundry concessions like breakfast in bed and no dish-washing. For one thing, the gloating little blackmailer gave me a wonderful idea for my electronic folly. I was prepared to dismantle it—still in a fog as to how such a thing could be—and rebuild a more normal, functional counter when something she trilled sarcastically into my ear set the creative wheels of planning into motion.

"Maybe you can sell your bone detector to a dog lover's society or hire out to remove canine caches from neighborhood lawns!" And while she howled with hysterical delight, I put the old mind back to work.

If I can modify this crazy counter so it will signal impulses in the presence of old . . . *really old* bones, I've got it made. Or don't you agree that the Smithsonian Institute would pay handsomely for a gadget no archeologist should be without?

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Tuning the Short-Wave Bands

(Continued from page 87)

music until 1830 close-down. (JM, FB, JB, Editor)

Liberia—ELWA, Monrovia, was noted on 4900A kc. at 2200-2315 with English request program and time checks. Despite QSB and QRM, the signal is usually good. (GN)

Madagascar—Anyone needing this country should currently watch 9515 kc., FIQA, Tananariva, around 2330. At press time, they were coming through nearly every evening. (ER)

Malaya—B.F.E.B.S. is on new frequency of 11,725 kc. at 0630-0700 and taking a BBC relay at 0645; it is also noted on 7120 kc. at 0845-0900 in English. Another station is operating as the Green Network, Singapore, on 5010 kc., at 0830-0845. This is a Chinese network. (RR)

Monaco—Radio Monte Carlo can be found on 7349 kc. around 2205 with a religious program in English. Program is "The Hour of Revival" and is parallel to 6035 kc. (SW)

Mozambique—A new outlet is CR7BD, 15,080 kc., Radio Clube de Moçambique, Lourenco Marques. Schedule is Thursdays only at 1100-1255. CR7BF, 11,740 kc., s/on at 2245, is one of the best signals now. (RL, ER)

Norway—LLG, 9610 kc., Frederikstad, carries "Norway This Week" on Sundays at 2100-2120 in English. (MA)

Pakistan—Radio Karachi, 11,725 kc., has English news at 2100 followed by a musical session. (SH)

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Paraguay—A new station, ZPA7. *Radio Guarani*, in Asuncion is being heard at 1800-2000 on 15,200 kc. (RL)

Philippines—The Far East B/C Co. is maintaining three program services (Philippine, Overseas, and Manila's Fine Music Station) on six s.w. frequencies, broadcasting a total of 34 languages and dialects per week. The channels used are: DZB2, 3345 kc.; DZH6, 6030 kc.; DZH7, 9730 kc.; DZH8, 11,855 kc.; DZH9, 15,300 kc.; and DZO9, 17,800 kc. The mailing address is: Far East Broadcasting Co., P.O. Box 2041, Manila, P. I. (EB)

Sarawak—The Sarawak Broadcasting Service, Kuching, is heard on 5052 kc. at 0800-0810 with a BBC news relay; their own news may be heard to 0815; music to 0830. This is a fine catch for most anyone! (RR)

Solomon Islands—The Solomon Island B/C Service at Honiara, is now operating on 5960 kc., according to *Radio Australia*. The call for this channel is VQ02. S.w. schedule is not

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Bobby Wilkins (BW), Honey Grove, Texas

known as yet but may possibly be 0200-0300 on weekdays only. (*World Radio Handbook*)

Spain—*Radio Nacional de Espana*, Madrid, is now using a new frequency of 12,000 kc. on the 1800-1845 and 2215-2255 English xmsn to North America, in parallel with 9360 kc. (RL)

Switzerland—Still in use to North America are 9533 kc. (HER4), 6165 kc. (HER3), and 11,865 kc. (HER5). The first xmsn is 2030-2215, second xmsn 2315-0000; both daily, in English. (DS, SW)

Turkey—*Radio Ankara*, TAT, 9515 kc., can be heard at 1545-1600 and 1800-1845 in English; news and music. (GN, BW)

USSR—The "Moscow Mailbag" may be heard at 2100 on Sat., Sun., on its many channels. (BW)

Windward Islands—The Windward Islands Broadcasting Service, Granada, is heard on a new frequency of 11,830 kc. at 1700-2115, in parallel with 3395 kc. The 5980-kc. outlet has been dropped. (RL)

Venezuela—*Radiodifusora Venezuela*, YVKB, Caracas, 4290 kc., is being heard regularly at 1800-2325 s/off. Programs in Spanish. (LM)

New and Deleted Stations

From the *World Radio Handbook*, we have the following list of new and deleted stations:

Honduras—New stations include: HRVW3, *La Voz de Centro America*, San Pedro Sula, 5955 kc., 500 watts, 0800-2300; HRQX, *La Voz del Pueblo*, Tegucigalpa, 5965 kc., 500 watts, 0800-0000; HRYN2, *La Voz Del Merendon*, San Pedro Sula, 6060 kc., 1 kw., 0800-2300; HRMH, *La Voz del Junco*, Santa Barbara, 6075 kc., 500 watts, 0800-2300; HQFM, *Gen. Francisco Morazan*, Tegucigalpa, 6090 kc., 10 kw., 0800-2300; HRMF, *La Voz de Patio*, La Ceiba, 6135 kc., 500 watts, 0800-0000; HRTW, *Union Radio Hondurena*, Tegucigalpa, 6165 kc., 1500 watts, 0800-2000.

Deleted stations are: HRMS, *La Voz de la Patria* (does not exist); HRA, *La Voz de Lempira* (delete on broadcast band only); and HRLP, *Radio America* (delete on broadcast band only).

Nicaragua—New stations include: YNAV, *Radio Continental*, Managua, 5045 kc., 1 kw.; YNRL, *La "V" de la Victoria*, Granada, 5045 kc., 75 watts; YNRM, *Radio Musun*, Matagalpa, 7602 kc., 200 watts; YNBX, *Radio Oriental*, Granada, 7620 kc., 100 watts; YNWN, *Radio Granada*, Granada, 7312 kc., 150 watts; and YNRA, *Radio Atlantico*, Bluefields, 7753 kc., 150 watts.

YNV and YNAM have ceased operations.

Bolivia—New stations are: CP39, *Radio Cobija*, Correo Central, Cobija, 4855 kc., 250 watts; and CP40, *Emisora LAB*, Hotel Bolivar, Cochabamba, 6160 kc., 1 kw.

Deleted stations include: CP44, *Radio Popular*, Cochabamba; CP15, *Radio El Condor*, La Paz; and CP24, *Radio Abaroa*, La Paz.

Guatemala—S.w. stations in this country are now listed as follows (when no city is mentioned, location is Guatemala City): TGZB, *Radio Oriental*, Zacapa, 3335 kc., 90 watts; TGZA, *Radio Oriental*, Zacapa, 6160 kc., 250 watts; TGAR, *Radio Quetzal*, 5960 kc., 300 watts; TGJA, *Radio Nuevo Mundo*, 5990 kc., 3000 watts; TGTA, *Radio Sonora*, 6000 kc., 250 watts; TGDA, *La Voz de Occidente*, 6020 kc., 250 watts; TGTQ, *Radio Internacional*, 6030 kc., 2000 watts; TGCO, *La Voz del Tropico*, Coatepeque, 6040 kc., 500 watts; TGXX, *Radio Ciro's*, 6060 kc., 1500 watts; TGCB, *Radio Colonial*, Antigua, 6080 kc., 350 watts; TGCA, *La Voz de las Americas*, 6100 kc., 350 watts; TGQA, *Radio Nacional*, Quezaltenango, 6110 kc., 1 kw.; TGDX, *Radio Central*, 6140 kc., 400 watts; TGAZ, *Radio Continental*, 6150 kc., 500 watts; TG CX, *Radio Cristal*, 11,750 kc., 350 watts; TGWA, TGWB, *Radio Nacional*, *La Voz de Guatemala*; TGNA, *Radio Cultural*, 5952½ kc., 5 kw.; TGNB, *Radio Cultural*, 9668 kc., 5 kw.; and TGNC, *Radio Cultural*, 11,850 kc., 5 kw. TGWA, TGWB are state-owned; others are commercial.

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GLOSSARY OF ELECTRONIC TERMS

This glossary, which is being published in serial form, started in August, 1955. It consists of a selected group of definitions taken from the booklet "A Dictionary of Electronic Terms," published by Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. The complete dictionary, containing over 3500 terms, is available from Allied at 25 cents a copy.

switch—A mechanical device for completing, interrupting, or changing the connections in an electrical circuit.

synchronous vibrator—An electromagnetic vibrator that simultaneously converts a low direct voltage to a low alternating voltage and rectifies a high alternating voltage obtained from a power transformer to which the low alternating voltage is applied. In power packs, it eliminates the need for a rectifier tube.

tank circuit—An inductor and a capacitor in a parallel-connected resonant circuit. Since such a circuit has the ability to store energy for a short period of time, it acts as a reservoir or tank. Hence the name "tank circuit."

tap—A connection point or contact made in the body of a resistor or coil.

telemetry—The transmission of readings of meters or gauges to remote locations. May be by radio or other means.

telephony—Transmission and reproduction of audio sounds by electrical or electronic means, with or without connecting wires.

television—The transmission and reception of a rapid succession of images by means of radio waves traveling through space or over wires.

temperature-compensating capacitor—A capacitor whose capacitance slightly and predictably varies with temperature.

Tesla coil—An air-core transformer having a few turns of heavy wire as primary and many turns of fine wire as secondary. The oscillatory discharge across a spark gap applied to the primary results in extremely high value of high-frequency voltage across the secondary, which is capable of producing a brush discharge between widely separated electrodes in air. Also called **Tesla transformer**.

test lead—A flexible insulated lead, usually with a test prod at one end, for making tests, connecting instruments to a circuit temporarily, or making other temporary connections.

test prod—A metal point attached to an insulating handle and connected to a flexible test lead.

test record—Type of phonograph record for checking and adjusting audio reproduction systems. Test records are used to determine frequency response and distortion, and to check the synchronization of binaural equipment and the condition of phonograph styli. Also used to adjust pickup arm set-down position and the tripping action of automatic record changers.

thermistor—A tiny resistance thermometer in which the active element is a semi-conductor having a large temperature coefficient of resistance. Among its applications is the measurement of microwave or infrared power.

three-wire system—A direct-current or single-phase alternating-current system comprising three conductors, one of which (the neutral wire) is maintained at a potential midway between the potential of the other two.

thyatron—Hot-cathode grid-controlled gas-discharge tube.

time constant—A concept of use in the production of distorted waveforms such as square or saw-tooth voltages: In a capacitive circuit, the product of C (farads) times R (ohms) gives the time (seconds) to charge or discharge a capacitor to the extent of 63%. In an inductive circuit, the ratio L (henrys) divided by R (ohms) gives the time (seconds) for current to change 63% of the total value. The voltage or current rates of change are not uniform. In the time at which the process is 63% complete, change would have been complete if it had continued at the initial rate.

time-delay relay—A relay in which the energizing or de-energizing of the coil precedes movement of the armature by an appreciable and generally determinable interval.

time signals—One of the technical radio broadcast services of the National Bureau of Standards radio station WWV, at Washington, D. C. Time announcements are made at 5-minute intervals. Eight carrier frequencies are used; modulating frequencies for the time signals are 440 and 600 cycles, transmitted alternately. These signals are used by Armed Forces installations, ships at sea, industry, jewelers and other persons for setting timepieces. They are transmitted by International Morse Code and radiotelephone.

transformer—An electrical device, without moving parts, that transfers electrical energy by electromagnetic induction from one or more circuits to one or more other circuits. May be used to step up or step down voltage. Does not affect frequency. Transferred energy remains constant except for the inherent copper wire and coil losses. Consists essentially of one or more coils inductively coupled. For power or audio transformers, iron cores are used; in r.f., either air or powdered iron cores.

transient—A temporary component of current existing in a circuit during adjustment to a changed load, different source voltage, or line impulse.

transistor—A compact unit consisting of a pellet of semi-conducting material having a point contact with a wire. Transistors are replacing tubes in some applications involving rectification, detection, amplification or oscillation. They do not require filament or heater voltage. (Junction transistors are more commonly used at present than the point-contact type.)

transit time—The time required for an electron to travel from one electrode to another in a vacuum tube.

transmission line—A set of conductors used to transfer signal energy from one location to another, or to transmit current over long distances for power purposes.

transmitter—(1) A comprehensive term applying to all of the equipment used for generating and am-

plifying an r.f. carrier signal, modulating this carrier with intelligence, and radiating the modulated r.f. carrier into space after it is amplified additionally and fed to the transmitting antenna. (2) In telephony, the microphone that converts sound waves into electrical energy varying at audio frequency rate. (3) The generator unit of a synchro system, commonly known as a "master" which controls the "slave."

treble—The higher audio frequencies. The high audible tones.

trickle charger—A device designed to charge a storage battery at a low rate continuously to keep it fully charged.

trigger circuit—A multivibrator circuit in which either of the two tubes can operate stably, but the firing of either tube extinguishes the other. The "flip-flop" action is produced by a trigger pulse in the grid of both tubes. Modifications make possible the use of positive or negative triggering, a double flip-flop or one-shot operation. Used in radar and counting circuits.

triode—A three-electrode vacuum tube, usually having a cathode, control grid and anode.

tube—A device which produces amplification, oscillation, rectification, or other useful results by controlling the flow of electrons in a circuit external to the tube, and through a vacuum, gas or vapor inside the tube.

tube noise—Noise originating within a vacuum tube, such as microphonics and "shot-effects."

tuned circuit—An inductance-capacitance circuit that may be adjusted to resonance at a desired frequency.

tuning—(1) Adjusting the inductance or capacitance (or both) in a coil-capacitor circuit. (2) Adjusting all circuits in electronic equipment for optimum performance.

tuning indicator—Any device which indicates when a radio receiver is tuned accurately to a radio station.

turnover cartridge—A phonograph cartridge for playing both standard and microgroove records. Consists of a single cartridge with a standard and microgroove stylus and a mechanism which permits pivoting the cartridge so that the proper stylus contacts the record groove. Some turnover cartridges consist of two independent cartridges mounted back-to-back; one cartridge has a stylus for microgroove records and the other has a stylus for standard records.

turns ratio—The ratio of the number of turns in a secondary winding of a transformer to the number of turns in the primary winding.

tweeter—A specialized type of loudspeaker designed specifically for the reproduction of treble frequencies. Tweeters are employed in coaxial speakers and in multi-unit speaker systems.

twin line—A type of transmission line which has a solid insulating material, in which the two conductors are placed parallel to each other, and whose impedance is determined by the diameter and spacing of the conductors and the insulating material. Several different impedance values are in common use (75, 150 and 300 ohms). Also known as **twin lead**.

two-way switch—A switch used for controlling electrical or electronic equipment components or circuits from either of two positions.

ultra-high frequency—A Federal Communications Commission designation for the frequency band from 300 to 3000 mc. In television, channels 14 to 83, or 470 to 890 mc.

ultrafax—A communications system utilizing radio, facsimile and television methods for transmitting printed information.

ultrasonics—The field of physics dealing with the production, reception, detection, absorption, examination and application of acoustic waves of 20-kc. frequency and above. At present these extend into the megacycle region.

ultraviolet—A range of invisible radiation frequencies beyond the visible spectrum at the violet or high-frequency end, and extending into the region of low-frequency x-rays.

undamped oscillations—Oscillations of an electromagnetic wave whose energy source constantly restores losses incurred by the load or radiation; they may be constant or varying (modulated), and are characterized, generally, by sine waveform (positive and negative peaks of the same amplitude).

undamped wave—A continuous wave with undamped oscillations.

undercutting—Cutting too shallow a groove or cutting with insufficient lateral movement of the stylus during sound recording.

unidirectional antenna—An antenna designed to radiate with maximum strength or receive with maximum sensitivity in a particular direction and with minimum radiation or reception in the opposite direction.

unidirectional microphone—A microphone that picks up sounds entering it at the front, but is "dead" to sounds entering at the sides or back.

universal output transformer—An output transformer having a number of taps on its winding to permit its use between the audio-frequency output stage and the loudspeaker of practically any radio receiver or amplifier by proper choice of connections.

unmodulated—Without modulation; the r.f. carrier signal alone, as it exists during pauses between station programs.

unmodulated groove—A silent groove on a recording; a groove cut without sound.

vacuum—An enclosed space from which practically all air has been removed. (Note: A perfect vacuum is not attainable.)

vacuum tube—An evacuated enclosure including two or more electrodes between which conduction of electricity through the vacuum may take place. A general term used for all electronic tubes.

variable-mu tube—A super-control or remote cutoff tube. A vacuum tube with a grid designed so that the amplification factor and the mutual conductance are variable by the grid-bias voltage value.

varistor—A resistor whose value varies with the instantaneous value of current or voltage applied to its terminals. Useful for modulation of a carrier wave.

vernier dial—A tuning dial in which each complete rotation of the control knob causes only a fraction of a revolution of the main shaft, permitting accurate adjustment.

very high frequencies—A band of frequencies in the radio spectrum extending from 30 to 300 mc. In television, channels 2-13, or 54-216 mc.

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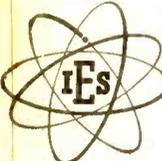
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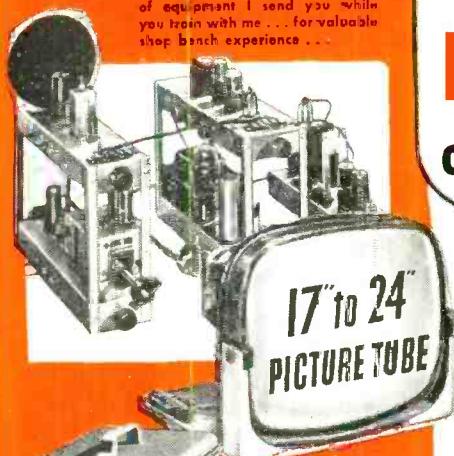
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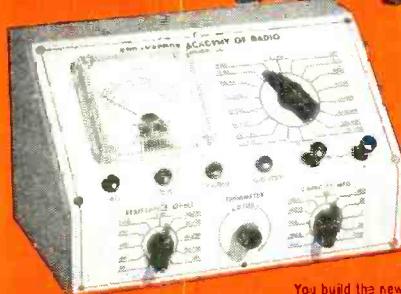
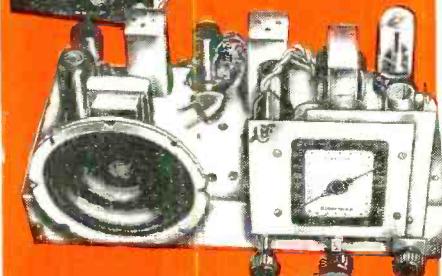
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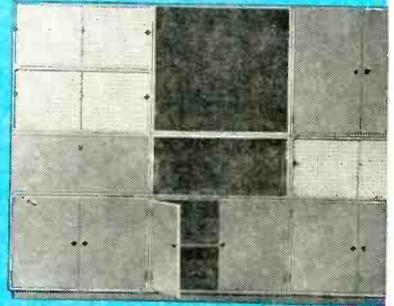
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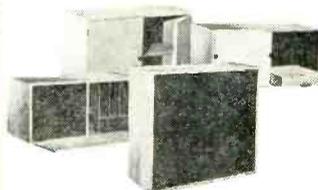


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